

**Means to Reinforce Research on Nuclear
Disarmament Verification: Report on a
Series of Regional Conversations**

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About VERTIC

The Verification Research, Training and Information Centre is an independent, not-for-profit non-governmental organisation. Our mission is to support the development, implementation and effectiveness of international agreements and related regional and national initiatives. We focus on agreements and initiatives in the areas of arms control, disarmament and the environment, with particular attention to issues of monitoring, review and verification.

VERTIC conducts research and analysis and provides expert advice and information to governments and other stakeholders. We also provide support through capacity building, training, legislative assistance and cooperation.

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Glossary: Acronyms and Abbreviations

ABACC	Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials
AFCONE	African Commission on Nuclear Energy
AU	African Union
CD	Conference on Disarmament
CEA	Commissariat à l'énergie atomique et aux énergies alternatives
COPUOS	Committee on the Peaceful Uses of Outer Space
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTBTO	Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization
CWC	Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction
ESARDA	European Safeguards Research and Development Association
EU	European Union
EURATOM	European Atomic Energy Community
FMCT	Fissile Material Cut-off Treaty
TOKYO TECH	Tokyo Institute of Technology
GSE-CTBT	Ad Hoc Group of Scientific Experts to Consider International Co-Operative Measures to Detect and Identify Seismic Events
GSE-NDV	Group of Scientific Experts on Nuclear Disarmament Verification
IAEA	International Atomic Energy Agency
IFSH	Institute for Peace Research and Security Policy
IPNDV	International Partnership for Nuclear Disarmament Verification
JRC	Joint Research Centre

NAM	Non-Aligned Movement
NPSGLOBAL	Nonproliferation for Global Security Foundation
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NTI	Nuclear Threat Initiative
OAU	Organisation of African Unity
ODA	Official Development Assistance
OPANAL	Agency for the Prohibition of Nuclear Weapons in Latin America
OPCW	Organisation for the Prohibition of Chemical Weapons
QNVP	Quad Nuclear Verification Partnership
SAGSI	Standing Advisory Group on Safeguards Implementation
TPNW	Treaty on the Prohibition of Nuclear Weapons
TRILATERAL INITIATIVE	United States/Russian Federation/IAEA Initiative
TTCP	Technical Cooperation Program between the United States and the United Kingdom
UKNI	UK-Norway Initiative
UN	United Nations
UNDC	UN Disarmament Commission
UNGA	UN General Assembly
UNIDIR	United Nations Institute for Disarmament Research
UNODA	United Nations Office for Disarmament Affairs
UNSC	UN Security Council
VCDNP	Vienna Centre for Disarmament and Non-Proliferation
VERTIC	Verification Research, Training and Information Centre
VTF	Voluntary Trust Fund
ZNF	Carl Friedrich von Weizsäcker Centre for Science and Peace Research

Introduction

The achievement and maintenance of a world free of nuclear weapons remain stated policy objectives of many governments. However, the geopolitical environment is presently insecure, with many nuclear-armed states continuing to point to their nuclear weapon-holdings as the only safeguard against large-scale conventional conflict, and as a deterrent from other similarly-armed states. Moreover, despite years of bilateral and plurilateral research initiatives, numerous questions remain as to how to verify the disarmament process as a whole and how to ensure that the remaining fissile materials and production facilities would only be used for peaceful purposes. These initiatives have also not yet yielded a formal process whereby their research results can be internationally shared, reviewed and debated leading to an initial set of recommended verification arrangements that may prove politically acceptable when a decision is made to comprehensively disarm.

This report is based on a series of four consultative workshops hosted by VERTIC throughout 2017 with stakeholders—both governmental and non-governmental—in Africa, Asia, Europe and Latin America, with the aim of exploring if further measures can be taken to enhance international cooperation on nuclear disarmament verification. The consultations discussed a hypothetical proposal, namely, the establishment of a multilateral Group of Scientific Experts as a focal point for future efforts in this field. The meetings examined whether such a group could meaningfully secure and indeed build on the embryonic network of international expertise on nuclear disarmament verification that currently exists through a sustainable and inclusive programme of work.

These consultative meetings confirmed that, in order to achieve and maintain a world without nuclear weapons, it is necessary to establish a multilateral and inclusive approach towards the development of the tools needed to undertake legitimate and credible nuclear disarmament verification. In other words, that addressing the technical challenges and developing agreed tools, solutions and methods for nuclear disarmament verification and monitoring in a truly joint manner would instil confidence and trust in the process of disarmament.

However, developing such an inclusive approach would require sustained investment and increased capacity levels across all states. At the same time, a multilateral initiative should seek to harness and expand upon work already undertaken while avoiding duplication of work. To do so, it would have to take into account lessons learned from past work in this area, understand the programmes of current initiatives, and leverage

the technical expertise these groupings contain. These include, *inter alia*, the UK-Norway Initiative (UKNI) and its successor – the Quad Nuclear Verification Partnership (QNVN); the International Partnership for Nuclear Disarmament Verification (IPNDV); the United States–United Kingdom Technical Cooperation Programme (TTCP); and the United States/Russian Federation/IAEA Trilateral Initiative.

Regional organisations such as the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL), the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC), the European Atomic Energy Community (Euratom) and the African Commission on Nuclear Energy (AFCONE) as well as the International Atomic Energy Agency (IAEA) have potentially an important role as well in developing a comprehensive and coherent approach to advance the development of solutions for nuclear disarmament verification.

The establishment of a multilateral scientific and technical group devoted to the examination of nuclear disarmament verification could be viewed as an endeavour with many challenges and obstacles needing to be bridged. These include:

- the formulation of an agreed mandate for a programme of work;
- the current lack of existing capacity to undertake innovative research in many non-nuclear armed states, and especially countries of the Global South, which makes it difficult for them to engage with the issues on an equal footing;
- little agreed understanding of what nuclear disarmament activities would need to be verified, what processes transparent nuclear disarmament requires, and what steps are required to achieve credible and irreversible nuclear disarmament; and,
- securing sustainable financial resources.

Notwithstanding these challenges, a globally coordinated programme of work to develop a verification regime that would ensure transparent and irreversible nuclear disarmament has significant utility in enabling all states—both nuclear armed and non-nuclear armed—to collaborate on the spectrum of nuclear disarmament activities, from individual warhead destruction to preventing the re-emergence of nuclear weapons. Furthermore, it would complement and reinforce past and on-going initiatives and partnerships, providing added value for the purpose of building global capacity, consolidating efforts in the field to date and identifying and coordinating future research needs.

This would mirror preparatory work undertaken for the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC), and for the

Comprehensive Nuclear-Test-Ban Treaty (CTBT). The processes leading to the CWC and the CTBT represent important historical precedents, from which many lessons can be learned even if the contexts and technical challenges differ from those associated with nuclear disarmament verification.

This report argues that a multilateral Group of Scientific Experts on Nuclear Disarmament Verification would present several benefits:

- it would increase the international knowledge-base of verification options;
- it would enable all states to actively collaborate in developing practical methods that would contribute to the verification of irreversible dismantlement of nuclear weapons, related (including fissile) material and associated facilities;
- it would provide a platform for long-term sustainability, capacity-building and consolidation of expertise;
- it would support sustained dialogue between technical experts, diplomats and policy-makers within and between the nuclear- and non-nuclear armed states in the quest for agreed verification measures.

The report concludes by elaborating on different ways by which scientific research and technical collaboration could be organised on the international level.

It is important to note that such a group could develop, in a more systematic manner, capabilities that would ultimately facilitate agreement on difficult technical issues before political negotiations on multilateral nuclear disarmament are undertaken, or indeed without a commitment to commence such negotiations.

Such capacities would also be useful in the event of unilateral or bilateral disarmament initiatives. The group would be seen as apolitical and accountable; it would also foster a sense of ownership and legitimacy, as all UN members would be provided with the opportunity to participate in ways that take advantage of their existing and potential national expertise and which could also take into account regional contexts.

In addition, the process would be transparent with respect to general purpose, specific research goals, duration, financial and other resources, as well as the procedures and methodologies to be employed during the research work. This will not only reinforce the commitment of both nuclear armed and non-nuclear armed states alike to nuclear disarmament but also demonstrate their political will to work jointly on the development of practical approaches to achieve it.

Key Considerations

Utility

Substantial progress towards the total elimination of nuclear weapons seems unlikely in the short term. However, this is not, and should not be viewed as, an impediment to efforts to either build multilateral verification capabilities or to address the technical challenges associated with verifying the dismantlement of nuclear weapons, the disposition of related material and the decommissioning of associated facilities. On the contrary, the current conjuncture provides a unique opportunity to initiate a globally coordinated programme of work to develop a verification regime needed to facilitate transparent and irreversible nuclear disarmament.

A multilateral Group of Scientific Experts would enhance cooperation between states, reduce tensions between the nuclear armed ‘haves’ and ‘have-nots’ and take advantage of the relationships forged between technical experts when working jointly with a clear vision of what needs to be scientifically achieved.

As a complement to past and on-going initiatives and partnerships (such as the UK-Norway Initiative and its successor – the Quad Nuclear Verification Partnership (QNVP); the International Partnership for Nuclear Disarmament Verification (IPNDV); the United States–United Kingdom Technical Cooperation Programme; and the United States/Russian Federation/IAEA Trilateral Initiative), such a grouping would also increase and consolidate the international knowledge-base of verification options and provide a sustainable platform for long-term work.

By its nature, a multilateral entity would be more inclusive than current partnerships and would provide added value for the purpose of building global capacity. As mentioned above, it could also play an important role in consolidating efforts in the field to date and in identifying and coordinating future research needs.

Past experiences have illustrated that the absence of favourable political and security conditions, and the technical challenges associated with verification of most if not all international treaties and conventions are not factors that should inhibit exploring evidenced-based, and scientifically sound, verification options. For example, the Ad Hoc Group of Scientific Experts for the CTBT illustrates how scientists from across ideological divides, working together with a clear mandate, can significantly assist future diplomatic processes and ensure that later political agreements (whether these agreements are multilateral or bilateral or indeed are changes to national policies) are implementable.

In many ways, the focus of the effort could mirror preparatory work for the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC), and for the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The CWC, when adopted, was an unprecedented disarmament treaty with respect to its scope, negotiating history and, importantly, its verification system. When the CWC was opened for signature in 1993, the original signatory states, recognising that considerable preparations were still needed, adopted the Paris Resolution, formally establishing the Preparatory Commission for a future Organisation for the Prohibition of Chemical Weapons (OPCW). In preparing the groundwork for the OPCW, the Commission launched a Provisional Technical Secretariat to finalise technical procedures left over from the negotiations such as the development of operational requirements, procedures for declarations, and the conduct of inspections.

It was also tasked with building the institutional structures of the new organisation, with a strong and cost-effective verification capability. Among its major achievements were solutions to several substantive verification issues.¹ The Preparatory Commission performed its tasks from 1993 until shortly after the Convention entered into force in April 1997.²

Preparatory work for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) was undertaken by the Ad Hoc Group of Scientific Experts to Consider International Co-Operative Measures to Detect and Identify Seismic Events, from 1976 until 1996. The group developed many of the procedures and technologies that are currently being used by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and laid the foundation for continual improvements of the operational verification regime for when the CTBT enters into force.

This Ad Hoc Group of scientists is a key example of how groups of experts can be used to provide capabilities that facilitate agreement on difficult technical issues for the monitoring or verification of compliance with a treaty.³

The group is also often cited for its ability to face the challenge of continuous scientific progress and its impact on international affairs. As such, it was a 'policy enabler' and not a 'policy driver'.⁴ In other words, by providing sound technical knowledge, it enabled policy change, namely, the agreement on the CTBT. It also served as a mutual training and education forum.

While these precedents differ in several key ways to the case of nuclear disarmament verification, the analogy is a useful starting point as they provide lessons or inspiration in terms of their mandated technical outputs but also with respect to the role they played in building the political confidence necessary for a shared understanding of the verification options available.

One important objective for a multilateral Group of Scientific Experts would thus be to develop capabilities to facilitate agreement on difficult technical issues for the monitoring or verification of compliance with a

comprehensive disarmament treaty or convention before political negotiations are undertaken. Indeed, such work would in no way entail or constitute a commitment to commence such negotiations. As already stated, the developed capabilities would also be applicable in other nuclear disarmament situations, including in a bilateral context.

Current and past verification initiatives

Verification research initiatives each have had or continue to have particular mandates and a specific focus. The UK-Norway Initiative (UKNI), for example, focused on bringing together a nuclear and non-nuclear armed state to discuss what verification tools and methods would be required to verify nuclear disarmament, and also to explore how all states parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) can contribute and cooperate to this end. The initiative's programme of work focused on the verification of war-head dismantlement, and covered technical topics such as managed access, information barriers and chain of custody.⁵ In 2015, the UKNI announced that it would seek to work with additional countries. Today, the UKNI has transformed into what is now known as the 'Quad Nuclear Verification Partnership (QNVP)' with the US and Sweden also participating. The QNVP is now planning to test monitoring technologies by conducting 'highly realistic arms control simulations'.⁶

The International Partnership for Nuclear Disarmament Verification (IPNDV) has brought together between 20 and 25 nuclear armed and non-nuclear armed states—with some participating more actively than others—and aims to assess approaches to monitoring and verification across the nuclear weaponisation lifecycle. The IPNDV was launched in December 2014 by the US Department of State in partnership with the Nuclear Threat Initiative (NTI). At its inaugural plenary in March 2015 in Washington, the IPDNV agreed to form three working groups to study verification issues through all stages of a nuclear weapons lifecycle.⁷

These Working Groups aim to develop a set of 10 output documents covering a diverse range of topics by the end of 2017 when the Partnership's initial phase concludes. These papers are intended to cover: a detailed assessment of potential verification requirements for monitoring the dismantlement of nuclear warheads, including what information might be needed to satisfy those requirements, and an assessment of the kind of assurance that states would likely seek from verification; the key elements of on-site inspections (OSI) for verification of nuclear disarmament undertakings; potential new inspection activities and techniques that could effectively verify compliance with future agreements as well as options for managed access and their applicability at different types of facilities and sites; and, the development of a chain of custody involving unique identification and tamper-indicating devices in a specific environment, such as a mock warhead storage area.⁸

Similarly, the US and UK Cooperation to Address Technical Challenges in Verification of Nuclear Disarmament was initiated with the declared objective to ‘develop and evaluate methodologies and technologies to verify potential nuclear weapon treaties, in support of shared US-UK commitment to Article VI of the Nuclear Non-Proliferation Treaty’.⁹ The cooperation was facilitated by the two countries’ ability to exchange classified nuclear weapons information in accordance with the terms of the 1958 Mutual Defense Agreement that ‘provides the framework for investigating highly sensitive issues in depth’. The initiative is currently examining the ‘development of a radiation portal for arms control monitoring applications and the completion of a multi-year warhead measurement and modelling campaign to inform future warhead verification research’. It will also continue investigations into chain of custody and data authentication.¹⁰

The on-going trilateral German-Russian-US Deep Cuts Commission, as a Track II initiative, seeks to devise concepts on how to overcome current challenges to deep nuclear reductions. The Commission strives to translate already existing political commitments to further nuclear reductions into concrete and feasible action. The framework offers the three countries the opportunity to analyse a cross-section of interests that are key to arms control and disarmament, including verification lessons learnt from strategic arms reductions.¹¹

Now defunct initiatives were also different to each other. The 1989 Black Sea Experiment, for example, studied the utility of ‘different radiation detectors for detecting the presence or absence of nuclear warheads on ships’.¹² On the other hand, the Trilateral Initiative (1996 to 2002) between the US, Russia and the IAEA, sought to examine techniques for IAEA verification of ‘weapon-origin fissile material deemed excess to military needs’.¹³

Non-governmental organisations and academic institutions are also involved in verification research activities such as nuclear weapons authentication using gamma and neutron measurements. They include: the Verification Research, Training and Information Centre (VERTIC), the Forschungszentrum Jülich, the Fraunhofer Institute for Technological Trend Analysis in Euskirchen, the Carl Friedrich von Weizsäcker Centre for Science and Peace Research (ZNF) at the University Hamburg,¹⁴ as well as the Institute for Peace Research and Security Policy (IFSH) also at the University of Hamburg.¹⁵ The European Safeguards Research and Development Association (ESARDA) continues to discuss and research verification issues, including the role of transparency, verification regimes, inspection models, satellite imagery and environmental monitoring.¹⁶

The need for a more coordinated approach

At present there is no umbrella forum to substantially share the results of these disparate research activities nor to identify gaps in the current body of knowledge or to initially assess which verification solutions may be politically acceptable. There is no structured and guaranteed way for the valuable research and approaches explored by past and on-going initiatives to be captured, preserved and shared.

In addition, many of the government-to-government arrangements were, or are, bilateral or trilateral in nature while participation in the IPNDV is by invitation only. Questions thus arise as to their sustainability, coherence and lack of inclusivity. In order to overcome these objections, the process to develop methodologies that enhance transparency and trust itself needs to be perceived as legitimate and internationally ‘owned’.

Funding is also dependent on a few states and private foundations who, given the changing nature of issues of global concern and their own internal agendas, are often not able to commit resources indefinitely.

Article VI of the NPT calls on ‘all states’ to take measures towards nuclear disarmament. This implies that taking practical steps towards nuclear disarmament is a shared responsibility, and not one that only falls on the nuclear armed states. As Lord Browne, then UK secretary of defence (2006–2008) and currently a VERTIC Trustee, stated with reference to warhead dismantlement, it is ‘of paramount importance that verification techniques are developed which enable us all – nuclear-weapon states and non-nuclear-weapon states – to have confidence that when a state says it has fully and irrevocably dismantled a nuclear warhead, we all can be assured it is telling the truth’.¹⁷ This is not only true for warhead dismantlement, but for all aspects of nuclear disarmament, including the disposition of weapon-usable material, and the monitoring of other sensitive fuel cycle-related activities, such as uranium enrichment, the stockpiling of heavy water, and the manufacturing of gas-centrifuge parts, to name a few.

To overcome these challenges, what is needed then is a long-term strategic approach based on the end-goal of developing an agreed set of tools for nuclear disarmament verification. For this, one needs not only a coordinated approach but also one that is comprehensive, assured of long-term investment (funding and other resources) and inclusive of all stakeholders globally.

Mandate

A fundamental question when considering the establishment of an expert working group is: ‘what ought this collection of people be working on?’ However, defining the mandate of a proposed scientific and technical group can be challenging from a number of perspectives—technical, legal and political.

An internationally mandated scientific and technical group would aim to enable all states—both nuclear armed and non-nuclear armed—to collaborate on a near-equal footing in developing practical methods for the verification of the irreversible dismantlement of nuclear weapons, related material and associated facilities. Its remit could be broad and encompass both the challenge of individual warhead destruction, for example, and the longer term task of preventing the re-emergence of nuclear weapons.

For state parties to the 1968 NPT, the group’s mandate would need to be aligned with their obligations under Articles I, II and VI. A mandate which is not fully consistent with these paragraphs would not garner

support from a significant majority of states. On the other hand, twining the mandate too tightly with obligations under the NPT would make it impossible for other nuclear-armed states—such as India and Pakistan—to participate in the work. However, the ultimate goal of eliminating all nuclear weapons, as enshrined in Article VI of the NPT, appears to be accepted by a significant section of the international community. A possible consequence is that some of the objects and purposes of the NPT could be reflected in the group's mandate; but a direct reference to the treaty might be counterproductive.

A scientific and technical group should aim to reflect work already conducted on the prohibition of the production of fissionable material for weapons purposes. This approach has recently been suggested by Canada, when it asked whether 'it is opportune to share information with each other on respective work pertaining to nuclear disarmament verification more broadly, and within the context of the requirements of a FMCT [Fissile Material Cut-off Treaty]'.¹⁸

The mandate would not need to carry with it, nor imply, any assumption that a state's engagement in the group also means that the country is willing to engage in negotiations on nuclear arms elimination in the short term. If it does, several, if not all, possessor states may decline participation.

The mandate will have to be formulated in a way that respects a country's non-proliferation obligations—which is, for the majority of states, set out in Articles I and II of the NPT—as well as their associated national security requirements. The mandate should, in other words, not be used as a pretext to acquire proliferative information; instead, it should enable the search for ways in which nuclear weapons could be safely and verifiably destroyed under effective international control. For example, the weight, composition and configuration of the weapon's fissionable material content are subject to the highest level of national secrecy controls. Divulging such information would be counter to the NPT's articles to prevent the spread of nuclear weapons through the transfer of relevant technology. It would also likely need to be accepted that other sensitive information, such as the specifications of high explosives, the internal dimensions of a casing, or the weapon's targeting and firing systems ought to be highly protected.

The above considerations, however, must also be balanced against the need to avoid making the mandate too rigid or formal. If this were to happen, the group's creativity and ability to be innovative would suffer. Moreover, a strict mandate would not stand up well when faced with changing political or technological circumstances. How to reach a formulation that is flexible, yet does not parse legal and national security boundaries, is a matter for further reflection.

One possibility when formulating the mandate is to borrow language from broadly accepted resolutions. Of principal interest is UN General Assembly (UNGA) Resolution 71/67 entitled 'Nuclear disarmament verification'.¹⁹ The resolution highlights the need to 'identify and develop practical and effective disarmament

verification measures’, in particular ‘tools, solutions and methods and capacity-building’ to that end. This language alone, however, may not be precise enough, and further elaboration of the points included in the resolution may be needed to gain additional guidance.

Alternatively, an expert group could be given an extensive remit, such as ‘to consider the problems arising’ with regards to the elimination of nuclear weapons and to ‘study the subject of controls and safeguards’ required to achieve verifiable disarmament. The advantage of a remit this broad is that the expert group would have a relatively free rein to define the problem further, and to engage in a wide-ranging examination of the issue. The disadvantage, especially if the group is left unchecked, is that it could deviate into tangential or obscure topics of little practical relevance or which in the end may not be politically agreeable. However, a broad remit could be useful if it is used as a ‘framework mandate’ under which interested states could ‘request’ examination of particular sub-issues, similar to the process under the UN General Assembly’s Committee on the Peaceful Uses of Outer Space (COPUOS).²⁰

COPUOS was set up by the General Assembly in 1959 to govern the exploration and use of space and has two subsidiary bodies—the Scientific and Technical Subcommittee and the Legal Subcommittee. The subcommittees report to the Fourth Committee of the General Assembly, which in turn adopts an annual resolution on international cooperation in the peaceful uses of outer space.

Even more precise formulations could call on an expert group to ‘develop detailed instructions’ for future ‘experimental tests’ of cooperative measures designed to verify compliance with a nuclear disarmament arrangement. If more detail is required, the expert group could be called upon to ‘develop inspection procedures’ and to ‘test and evaluate those procedures’ for the ‘demonstration of the dismantlement of nuclear weapons, relevant facilities and their associated materials’. The purpose of such dismantlement would be to obtain and transfer fissionable material to peaceful uses, and—if complementarity with expert groups working on an FMCT is desired—to halt the production of fissionable material for use in weapons.

For further discussion on potential options for how this work could be conducted, see below.

Challenges

There are a number of challenges that need to be overcome before such an expert group is established. The technical mandate issue is one. But there are also political issues concerning such a group’s mandate. It would need to be broad enough to accommodate the policy positions of both ‘immediate abolitionists’ and ‘step-by-step advocates’ as well as NPT states parties and non-NPT states parties.

In order to participate, states would need to be given room to interpret the group’s mandate to suit their foreign policy goals—NPT states parties should be able to justify their involvement under Article VI while

non states parties to the NPT should be able to rationalise their participation by their United Nations (UN) and/or Conference on Disarmament (CD) membership. This would bring together nuclear armed states who tend to have a longer term vision of nuclear disarmament and those non-nuclear armed states who have a much shorter-term vision of a world without nuclear weapons.

Further challenges include: the relative lack of existing capacity to undertake research work on these issues—especially within non-nuclear armed states from the Global South; the lack of an explicit mandate allowing certain institutions that could provide scientific and technical expertise to participate in such an initiative (such as ABACC, AFCONE and Euratom); limited financial resources available within the UN system and indeed amongst the traditional donor community as other pressing issues of global concern currently take precedent; and, importantly the perceived lack of political understanding and commitment by nuclear armed states to level the playing field in this area of study.

The multilateral group would also need to break from the narrow focus of existing initiatives on, for example, nuclear warhead dismantlement and on developing access protocols designed to prevent the sharing of sensitive proliferation related information and technology.

Another crucial problem is the present lack of a commonly agreed understanding of what nuclear disarmament activities would need to be verified. Progress on credible proposals for verification solutions relies on reaching a consensus on fundamental questions such as: what steps are involved in credible nuclear disarmament; which nuclear disarmament processes require more transparency than others; and, at what stage in the disarmament process is multilateral verification necessary.

As mentioned elsewhere in this report, it is envisaged that to reach consensus on which body should establish such a group and whom it would ultimately be accountable to would require much debate and discussion. This may prove difficult, as recent trends and events at the international level have negatively impacted on the support for multilateral initiatives, especially in relation to security. One of the key reasons for this can be found in the deep divisions currently existing between major nuclear powers, especially between the United States (US) and the Russian Federation.

This situation is exacerbated by long-standing difficulties in several multilateral fora which address disarmament issues, as evidenced by the lack of progress in the context of the NPT review cycle; the UN Disarmament Commission's difficulty in reaching consensus recommendations, producing positive outcomes or reaching substantive agreement; the CD's 20-year stalemate; and the lack of progress towards the entry-into-force of the CTBT.

The situation has also been aggravated by the profound disagreements surrounding the 2017 Treaty on the Prohibition of Nuclear Weapons (TPNW). This treaty represents the first legally binding international agreement

to comprehensively prohibit nuclear weapons and is supported by many non-nuclear armed states. Other states, including the nuclear-armed states and many of their allies, have called into question its value and verifiability. For example, in explaining its 'No' vote, the Netherlands argued that: 'the draft is, in essence, not verifiable [. . .] Of course, nuclear disarmament verification is something that we have just started to develop. The draft, however, fails to incorporate that notion by leaving sufficient flexibility for future developments, or by encouraging its members to participate in verification-related initiatives. Moreover, the draft contains a safeguards standard that even in this day is not sufficient for the IAEA to draw a conclusion about the absence of undeclared nuclear activities. It will certainly not provide the kind of assurances needed towards a nuclear free world'.²¹

Finding sustainable resources, including funding sources, would also present a challenge in a global environment that is financially constrained as the UN and individual member states prioritise other pressing issues, including climate change, global terrorism, migration and socio-economic development. It may therefore need to be funded through a combination of the regular United Nations budget, national contributions and a Voluntary Trust Fund (VTF).

Capacity building

Nuclear weapons and the programmes that have been developed to produce and maintain them are complex and diverse. As such, nuclear disarmament and its verification will also involve a range of complex activities and tools. Because of this, developing and maintaining robust and reliable verification capabilities is a key requirement to build the confidence required for progress towards nuclear disarmament.

All states have an equal right to participate in the process of verifying agreements to which they are party.²² Because of this, medium- to long-term capacity-building processes and programmes on verification techniques and mechanisms ought to be a key aspect of international efforts on nuclear disarmament and arms control.

A multilaterally mandated Group of Scientific Experts would be a driver for capacity-building and information exchange, empowering states to exercise this right. Multilateral approaches to nuclear disarmament verification would also leverage existing expertise to build up the capacity of all interested states to contribute to a more effective and efficient verification system.

The need for capacity building in this respect is also recognised in the Final Document of the 2010 NPT Review Conference, which states: 'All States agree on the importance of supporting cooperation among Governments, the United Nations, other international and regional organizations and civil society aimed at increasing confidence, improving transparency and developing efficient verification capabilities related to nuclear

disarmament'.²³ The creation of, and support for, a scientific group of experts on nuclear disarmament verification would be a clear practical measure to implement Action 19.

Continuous capacity building is also recognised in resolution 71/67 adopted by the UNGA on 5 December 2016, 'Nuclear disarmament verification': '... given the challenges associated with verifying nuclear disarmament continuous capacity-building and technical development are critical to bridging any shortcomings and establishing effective multilateral nuclear disarmament verification'. The resolution goes further in calling on 'all States to work together to identify and develop practical and effective disarmament verification measures . . . through, inter alia, advancing, understanding and addressing technical challenges of nuclear disarmament verification and monitoring, including tools, solutions and methods and capacity-building'.

Both the UKNI and the IPNDV include capacity-building as an explicit objective of their respective mandates. States involved in these initiatives are well positioned to assist other states in building their capacity in nuclear disarmament verification science and technology. Such capacity-building would also be in line with the priorities of institutions such as the EU with respect to non-proliferation and with the goals of developmental aid programmes aimed at least-developed countries.

Leveraging expertise

At the national level

Anecdotal evidence suggests that the knowledge required to investigate disarmament verification options mostly resides in the nuclear armed states.²⁴ The US, in particular, has a significant array of available expertise, but research efforts are continuing in countries such as the Peoples' Republic of China and the Russian Federation. Less is publicly known about the scale of the research effort in these countries, but it is unlikely to be on a similar level to the US. The United Kingdom (UK) maintains a small but capable cadre of experts. Little is known about the capacities of the French *Commissariat à l'énergie atomique et aux énergies alternatives* (CEA) in this regard. However, it is likely to maintain some readiness to deal with the subject matter.

Beyond the specific tasks of dismantling warheads and weaponisation plants, nuclear disarmament involves a range of other activities and types of facilities. As such, applicable knowledge can also be found in other countries and institutions. These range from countries with advanced nuclear fuel cycles, to defence research establishments in chiefly European states, for example, Germany, Norway and Sweden, to countries in the Global South with experience of operating research reactors.

While there is no publically available membership list of the US-initiated International Partnership on Nuclear Disarmament Verification, secondary evidence suggests that mostly European and North-East Asian

countries contribute with significant expertise. Latin American states—principally Argentina, Brazil and Mexico—participate to some degree. No African states are part of the initiative: this is partly a reflection of political will, but also, perhaps more significantly, reflective of a perceived lack of institutional ability to effectively participate. Knowledge may however also reside in countries that terminated their weapon programmes, such as South Africa or which repatriated weapons from their soil, such as Ukraine. Many of these states retain significant nuclear expertise, including through the operation of fuel fabrication technology or nuclear power programmes.

There is a need to engage in a concerted and sustained capacity-building effort if the objective is to enable these countries to participate in a scientific and technical exchange on an equal footing with the nuclear armed states. The problem in Europe and North-East Asia is not so much related to a lack of expertise, but rather a lack of will to direct resources to the disarmament verification challenge. While EU members and others closely associated with the Union, have started to direct more funding to the issue, a combination of more investment and a minor realignment of existing scientific and technical expertise is required in the short to mid-term.²⁵

At the international level

A range of relevant expertise resides in regional and international institutions. Whether this experience can be applied to scientific and technical aspects of nuclear disarmament verification, however, is uncertain. The principal challenge when attempting to leverage multilateral expertise on disarmament verification relates to respective organisational mandates. This problem is especially pronounced when discussing the role of the IAEA.

The IAEA holds applicable experience that could directly benefit international research.²⁶ At annual General Conferences, the organisation's member states adopt a resolution that reviews the operation of the agency's safeguards system. This resolution, commonly referred to as the 'safeguards resolution,' contains several provisions that highlight a potential role for the organisation in disarmament verification.²⁷ The agency, in its biennial budget, underscores the need to perform 'other verification tasks,' if 'in connection with nuclear disarmament or arms control agreements' and if 'requested by States and approved by the Board of Governors'.²⁸

While there is agreement that the IAEA should 'maintain readiness' to engage in verification tasks under nuclear disarmament agreements, there is resistance in some circles to the idea that the organisation should have a driving role in developing verification arrangements. Much of this opposition comes from the Russian Federation. For example, the Russian Federation, in June 2016, noted that it is 'definitely opposed to embroiling the IAEA in the verification of nuclear disarmament'. It highlighted that 'disarmament is not mentioned neither among the objectives, nor among the functions of the Agency specified in Articles II and III of the IAEA Statute'.²⁹ Whether this is a correct interpretation of the Statute or not, the Russian Federation's views need to be addressed not least because other states may hold similar opinions.

There is, however, general agreement that, to quote the Russian Federation's statement to the IAEA General Conference in 2017, the agency is 'a professional, nonpoliticized, technical organization' and that it ought to remain that way.³⁰ Nonetheless, the involvement of the agency in disarmament verification research and activities is not incompatible with these three principles. In addition, the agency has been involved in several disarmament verification ventures. There is also broad recognition that the agency is a 'centre of excellence' on verification, and that the development of disarmament verification provisions would be hindered by its exclusion from the process. Locating a scientific and technical group in Vienna would undoubtedly underscore the technical importance of disarmament verification research and development.

The European Atomic Energy Community (Euratom) is another entity with highly relevant scientific and technical expertise. Established in 1957, its principal task is to create 'the conditions necessary for the speedy establishment and growth of nuclear industries'.³¹ In carrying out this task, the organisation should 'promote research and ensure the dissemination of technical information'³² and 'make certain, by appropriate supervision, that nuclear materials are not diverted to purposes other than those for which they are intended'.³³ Euratom's research agenda is not freely set. Research activities are carried out in fields specified in the treaty's annex.³⁴ At present, research and development relating to nuclear disarmament verification do not, *prima facie*, fall under any of the envisioned activities under the treaty. However, the list can be amended by the EU's Council by qualified majority, but only on a proposal from the European Commission (after it, in turn, has consulted the Euratom Scientific and Technical Committee).³⁵

Drawing on the European Union's Joint Research Centre (JRC) could be another option.³⁶ The JRC provides scientific and technical support to the Commission, and is guided by a 'Commission Implementing Decision'. The centre's activities are wide-ranging and include support in diverse areas such as migration, trade agreements, aviation, gender equality, and international security.³⁷ It would be easier, perhaps, to engage the JRC through the EU's Foreign and Security Policy Framework.³⁸ JRC involvement would also include associated organisations, such as the European Safeguards Research and Development Association (ESARDA).³⁹

The Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) represents a regional centre of excellence in South America. It was created by a bilateral agreement signed in December 1991 between Argentina and Brazil. In February 1999, ABACC signed a cooperation agreement with Euratom focusing on safeguards-related research and development, as well as training. In 2012, the EU Commission approved a project on 'Strengthening the Safeguards Capabilities of ABACC' which deepened the two organisations' technical collaboration. While technical links do exist, the two entities are not equal players, in so far as the combined resources of Euratom/JRC are larger than ABACC's available expertise. Nuclear disarmament verification could be an enabler for further collaboration and cooperation between the two entities, however.

In both Africa and South America, legal and negotiating expertise could be found through the African Commission on Nuclear Energy (AFCONE)⁴⁰ and the Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (OPANAL).⁴¹

The African Union (AU) has had a long-standing commitment to global disarmament and non-proliferation since the first Ordinary Session of the Assembly of the then Organisation of African Unity (OAU), in 1964, adopted the Cairo Declaration on the Denuclearization of Africa. This declaration formed the basis and origin of subsequent efforts that culminated in the adoption of the Treaty of Pelindaba, which established the African continent as a Nuclear-Weapon-Free Zone.

AFCONE was established by Article 12 of the Treaty of Pelindaba as the body responsible for, *inter alia*, ensuring states parties' compliance with their obligations under the Treaty and its Protocols. In 2012, AFCONE adopted its programme of work, which consists of four pillars focusing on: a) monitoring states parties' compliance with their treaty obligations; b) nuclear and radiation safety and security; c) nuclear sciences and applications; and d) partnerships and technical cooperation with relevant regional and international bodies. Twelve states parties are elected as commissioners based on equitable geographical distribution and are represented by professionals with vast experience in the area of nuclear science and technology, security and diplomacy. The Secretariat of AFCONE is located in Pretoria, South Africa.

OPANAL is an intergovernmental organisation consisting of states in Latin American and the Caribbean which have signed and ratified the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean, known as the Treaty of Tlatelolco.

In 1992, OPANAL's General Conference approved amendments relating to the verification and control system established by the Treaty of Tlatelolco. The purpose of these amendments was to strengthen the verification system while recognising the inspection role of the IAEA when requested by parties to the Treaty. The General Conference at the same time upheld the principle that the organs of OPANAL would continue to be responsible for monitoring the application of the treaty's control system.

Relevant expertise could also be found in functionally related areas. For instance, the Organisation for the Prohibition of Chemical Weapons (OPCW) implements the 1993 Chemical Weapons Convention (CWC), which prohibits the use, development, production, stockpiling and transfer of chemical weapons. From a verification perspective, the convention addresses the verified destruction of chemical weapons and, through an industry inspection regime, aims to prevent the re-emergence of these weapons. Some suggest that, while the subject matter is different, the verification challenge is broadly aligned. Therefore, lessons learned by the OPCW in terms of destruction and industry inspections could be valuable when formulating scientific and technical advice on nuclear disarmament verification.

Conclusions

Benefits

Several *prima facie* benefits flow from the establishment of a scientific and technical group at the multilateral level. First, and perhaps foremost, would be the increase in verification studies and the provision of a coherent and internationally-agreed knowledge-base of verification options. Second, it would be a major driver for capacity-building and information exchange. Third, a multilateral body is likely to be viewed as more sustainable, apolitical and accountable than unilateral, bilateral and plurilateral initiatives. Finally, the group would instil a greater sense of ownership and legitimacy amongst non-nuclear armed states.

While a group like this could examine ways and means to undertake further research within limited budgets and existing organisational activities, it would perform a better function if it serves to incentivise governments to increase funds, enhance capacities, and work to adapt organisational mandates to accommodate work of this nature.

The possession of nuclear weapons is not universally regarded to be illegal. However, there exists an obligation to negotiate nuclear disarmament in all its aspects, and bring those negotiations to a conclusion. There is also broad acceptance that nuclear disarmament regimes should be under 'strict and effective international control'. An international scientific and technical group would demonstrate the commitment of both nuclear armed and non-nuclear armed states alike to nuclear disarmament and to the development of practical approaches to achieve it.

The active engagement in scientific and technical collaboration on nuclear disarmament verification is also likely to contribute towards the goals provided for in Article VI of the NPT, which refers to 'effective measures relating to nuclear disarmament.' In a 2009 article, Scott Sagan argues that nuclear weapon states and non-nuclear weapon states 'should both contribute significantly to funding the necessary major research and development effort for improved monitoring and verification technologies that will be needed if nuclear disarmament is to progress to very low numbers of weapons.'⁴² Arguing that the 'challenges of verification and enforcement of disarmament should be a high priority for future disarmament efforts', he strongly advocates that future NPT review conferences ought to 'address how best to promote increased verification and transparency'.⁴³

Parties to the Treaty on the Prohibition of Nuclear Weapons (TPNW) could argue that their participation in a scientific and technical group is contributing to the eventual fulfilment of Article 4 ('Towards the total elimination of nuclear weapons'). Their obligations under Article VI of the NPT would, of course, remain unaltered. States outside the NPT could argue that their participation in a scientific and technical group fulfils a common aspiration formulated in the United Nations, or that it aims to support the CD, as appropriate.

The establishment of a multilateral group of scientific and technical experts on disarmament verification could also be seen as another means to promote multilateralism in arms control. This concept is dealt within a long-standing, some would say orphaned, General Assembly Resolution entitled 'promotion of multilateralism in the area of disarmament and non-proliferation'.⁴⁴ While supported by India, Pakistan, the Democratic People's Republic of Korea (DPRK), the Peoples' Republic of China and the Russian Federation, the text has traditionally been opposed by Israel, the US and the UK. Most member states of the European Union have historically abstained from voting. In explanations of votes (when they happen) states tend to emphasise their commitment to the principles of the resolution, while noting that the text is not expressed in a balanced way.

Since several states appear committed to traditional notions of multilateralism, as expressed in the UN Charter, it could be worthwhile examining how future technological and scientific endeavours could support and reinforce this norm. Such an examination is not without some risk: while it may well make it more likely to attract states such as Russia and China, it may also create pressure on certain Western states to distance themselves from any such initiative.⁴⁵

A scientific and technical group could be established in a setting distinct from the NPT. In many ways, setting it up outside this particular non-proliferation regime is logical given that no state opposed the adoption of UN General Assembly Resolution 71/67 ('Nuclear Disarmament Verification'). Indeed, amongst the set of resolutions adopted by the General Assembly every year, only resolution 71/86 ('Comprehensive Nuclear-Test-Ban Treaty') has managed to achieve more support from the nuclear-armed states.⁴⁶ The conclusion that developing verification capabilities is of benefit to countries both within and outside the NPT appears to be supported by the voting patterns in the UN General Assembly. This arrangement would also allow nuclear-armed states such as India, Pakistan and (presumably) Israel to participate in the endeavour.⁴⁷

These countries are not parties to the 1968 NPT and are—for obvious reasons—therefore not keen to join international efforts that are designed to support the implementation of that treaty directly.⁴⁸ However, an initiative derived from these countries' commitments to the UN or CD may open up a path for their active participation.⁴⁹ Any scientific and technical undertaking will need their support if the expectation is that they would join any verification regime on nuclear disarmament at a later date.

If established correctly, a scientific and technical group could also serve as an essential conduit between the east and the west, as well as the north and the south. Moreover, a capacity building effort could be subsumed under Official Development Assistance (ODA), unlocking substantial funding streams. Several nuclear capable countries are ranked as upper-middle income and so qualify for development aid.⁵⁰

The exchange of ideas and proposals on a scientific level would establish links between technical communities globally in a fashion similar to, but more focused than, the CTBTO's Science and Technology Conference series. These conferences have several objectives, principally to 'enlarge the scientific community engaged in test-ban monitoring'; to 'enhance the exchange of knowledge and ideas between the CTBTO and the broader scientific community'; and, to 'present to the scientific community the needs of nuclear test monitoring and verification'.⁵¹ In a limited sense, these conferences could be viewed as a natural extension of the work of the Group of Scientific Experts on the CTBT. Most of the work of the GSE is now conducted by the organisation's 'Working Group B,' which deals with verification issues.

Devising verification methods to offer early detection of attempts at nuclear re-constitution remains a priority for all states, mainly since the knowledge to produce nuclear weapons will endure, most likely for eternity. The ability of former nuclear-armed states to reconstitute their nuclear arsenals is not without potential advantages. David Cortright and Raimo Väyrynen have argued that the 'prospect that these weapons could be reconstituted after they have been abolished provides a form of deterrence, a 'weaponless' deterrence in which the knowledge of how to make the bomb rather than the bomb itself becomes the basis of security'.⁵²

A reconstitution ability—whatever the benefits or drawbacks for the individual state—will make it especially important for former nuclear-armed states and non-nuclear armed states alike to establish the highest standards of verification going forward. This would imply continuing the effort to strengthen nuclear safeguards in today's non-nuclear armed states, but also to examine their future application in disarmed states. A knowledge base of verification techniques that is not only strong and comprehensive, but also shared multilaterally is an excellent way to build confidence that the international community would have the required instruments to detect attempts at rearmament.

Some tend to view verification research and development as a zero-sum endeavour; that it is fundamentally a resource allocation problem. This attitude may well be grounded in the political and economic realities of our time, but is, despite that, severely myopic. A group of scientific and technical experts would instead act as a significant driver for information exchange, and conceivably also for future investment. The effort is about building a base of capacity both within and outside the nuclear-armed states, and to grow capabilities from that base.

The technical aspects of nuclear disarmament verification are challenging but not insurmountable. Some are of the view that they could be solved within the next decade or so, but many more hold that it will require a sustained endeavour lasting more than 20 years. It is within the power of those with significant funding—mostly governments—to apply will and resource to the problem, which will, in turn, reduce the time needed for the examination to conclude.

Suggestions

While there is appetite for further and more coordinated work on disarmament verification, there is less consensus on how, where and by whom such work should be conducted.

The ‘UK-Norway Initiative,’ (UKNI) set up in 2007, is often referred to as one valuable initiative.⁵³ The ‘International Partnership for Nuclear Disarmament Verification’ (IPNDV) is highlighted as another constructive effort.⁵⁴ Notwithstanding this, a drawback of such initiatives is that they can be seen by some as closed clubs with issues concerning sustainability. That view can however be mitigated by considering the flexible nature of these initiatives, and the pre-existing relationships of the states and stakeholders involved which enables a creative space for participating institutes and states. Indeed, it is likely that such a format, in terms of the pre-existing relationships and flexibility, is a key factor in allowing such sensitive initiatives to emerge. They could therefore be seen as the beginnings of a wider, more structured and inclusive process. In addition, these efforts have intrinsic value, and it would serve no purpose to see them discontinued. Instead, the issue is how to draw on these efforts in a way that enables broader participation, affords a greater degree of ownership and sustainability, and which builds capacity to deal with future disarmament verification questions effectively.

Scientific and technical collaboration can take many forms, and this report elaborates on a few ways in which research can be organised.

In our consultations, four principal suggestions on how to organise work on the international level came to the forefront.

1. Option A. To continue as before, with principal effort at the national level, supplemented by various pluralateral research initiatives on the international level.
2. Option B. To establish a multilateral group that reports to the UN Secretary-General.
3. Option C. To establish a multilateral group that reports to the UN General Assembly.
4. Option D. To establish a multilateral group that reports to the Conference on Disarmament.

Option A: Continue with business as usual

Western governments in particular are very supportive of ad-hoc ‘coalitions of the willing’, which includes initiatives such as the IPNDV. Their support centres upon the perception that groups of this kind are more flexible in their method of working. The ability to produce tangible results may not be the most important aspect of such an initiative as they serve an important confidence-building function.

The IPNDV is expected to enter phase two of its programme of work in 2018 and with the series of 10 reports due to be publically available by the end of 2017, this may give impetus for further research activities. In addition, its fifth plenary meeting is scheduled for November 2017 in Argentina and may make a decision to expand its outreach to states currently not invited to participate in its working groups. The IPNDV’s member states’ confidence in its ability to make progress in addressing the complex challenges involved in the verification of nuclear disarmament is reflected in Canada’s recent contribution of approximately US\$135,000 to NTI to build an IPNDV website and to provide communications, outreach and administrative support.⁵⁵

At the same time, current membership consists of states party to the NPT, with nuclear armed states such as the Democratic People’s Republic of Korea, India, Israel, and Pakistan not included. South Africa, the only country to have voluntarily disposed of its nuclear weapons, is also not a participant. Thus, while the IPNDV seeks to promote a common understanding of the technical issues of nuclear disarmament verification, its exclusiveness could inhibit the development of a culture of cooperation and trust in the long-term.

The UKNI has been extended and expanded by the inclusion of Sweden and the US into what is now the Quad Nuclear Verification Partnership (QNVP). Together they have entered into a multi-year project aimed at building capacity through hands-on practical simulation exercises; the development of a realistic testbed for evaluating monitoring technologies; and, the drafting of a model verification protocol/standard operating procedure that could contribute to future discussions on how treaty monitoring activities could be implemented in the real world.⁵⁶

The QNVP seems to also operate within the confines of the NPT and will, for example, report on its activities during the 2020 NPT Review cycle. As such its work is primarily located within the NPT’s 2010 Action Plan to the exclusion of non-NPT nuclear armed states.

Option B: Establish a multilateral group reporting to the UN Secretary-General

Another option is to establish a multilateral group of technical experts reporting to the UN Secretary-General, modelled after the Standing Advisory Group on Safeguards Implementation (SAGSI).⁵⁷ This group, established in 1975, advises the IAEA Director General on the technical aspects of safeguards. Its members, who all serve in their personal capacity, are selected by the Director General with the consent of the state of

which they are nationals. They deal with questions submitted to it from the Director General, but also from the organisation's Board of Governors. They can also choose to examine an issue proposed by any SAGSI member. The Director General reports to the Board of Governors on the group's work, and transmits any views it may have on questions submitted to it. Members are appointed for three years, and their mandate can be renewed. Their functions include:

- 'Advise on technical objectives and implementation parameters of Agency safeguards, to assure their continued validity in the light of changing technical, legal and political circumstances;
- Make recommendations on increasing the effectiveness and efficiency of specific safeguards practices in meeting these technical objectives, taking into account available resources; and
- Advise on technical aspects of new types of verification missions for the Agency, related to nuclear material'.⁵⁸

The group meets as required but no less than once a year. Participating costs are mostly borne by the member states, and the group has support from the IAEA Secretariat. To draw inspiration from SAGSI, a group focused on disarmament but reporting to the Secretary-General could:

- Advise on the technical objectives and implementation parameters of proposed and envisioned nuclear disarmament verification measures, to ensure their technical, legal and political validity; and
- Advise on technical aspects of proposed multilateral verification arrangements, related to the dismantlement of nuclear weapons, disposition of related material, and the peaceful uses of remaining nuclear assets.

It would also meet at least once a year, drawing support from the United Nations Office for Disarmament Affairs (UNODA). The group's mandate could be established by several bodies within the United Nations family, such as the General Assembly or the Security Council, or the Secretary-General.

Considering a *Secretary General's Advisory Group on Nuclear Disarmament Verification* could be appealing, as it may not require an extensive period of establishment, and it could be run at relatively low cost. The group could work in parallel with the *Advisory Board on Disarmament Matters*, or be subsumed under its existing work mandate.⁵⁹ In both cases, enhancing the capacity of the United Nations Institute for Disarmament Research (UNIDIR) and then drawing on its support could be a beneficial side-effect. Advisory Group membership could be drawn from existing initiatives, such as the IPNDV and the QNVP, as well as from non-governmental organisations and academic institutions, which would give it a complementary and reinforcing effect.

However, it should be noted that SAGSI has been effective to date as it is advising on an on-going verification mandate. The United Nations does not have a mandate to conduct nuclear disarmament verification in its member states. In addition, there is a potential that its work could conflict with SAGSI and existing Advisory Groups established within the UN system.

Option C: Establish a multilateral group reporting to the UN General Assembly

Establishing a multilateral scientific and technical group under General Assembly rules would be quite straightforward.⁶⁰ The proposal would be handled by the UNGA First Committee, which has amongst its responsibilities to debate disarmament within the context of international peace and security. The First Committee would in turn refer the matter of establishing such a group to the General Assembly.

The promotion of multilateralism was first included on the disarmament agenda in 2002. Following the issue being raised in various disarmament fora and acting on behalf of the Non-Aligned Movement (NAM), South Africa introduced a draft resolution entitled ‘Promotion of multilateralism in the area of disarmament and non-proliferation’ at the First Committee of the General Assembly on 18 October 2002. Resolution 57/63 reaffirmed that multilateralism was the core principle in negotiations in the area of disarmament and non-proliferation.

Since then, resolutions designed to strengthen and deepen multilateral efforts in this area have been introduced and adopted in each session of the General Assembly.

The issue of multilateral verification in its broader application has been under consideration at the United Nations for several decades. The first UNGA Special Session devoted to disarmament held in 1978 established three general principles for disarmament verification: (i) In order to facilitate the conclusion and effective implementation of disarmament agreements and to create confidence, States should accept appropriate provisions for verification in such agreements; (ii) In the context of international disarmament negotiations, the problem of verification should be further examined and adequate methods and procedures in this field should be considered; and (iii) Every effort should be made to develop appropriate methods and procedures which are non-discriminatory and which do not unduly interfere with the internal affairs of other states or jeopardise their economic and social development.

Ten years later, the United Nations Disarmament Commission (UNDC), in one of its few agreed outcomes, further developed these three principles in a consensus report attached to which were appended ‘16 Principles of Verification’. These 16 principles, issued in the closing years of the Cold War, showed that these basic principles were already well established and largely accepted by the international community.

However, the UNGA, by definition, works through majority-voting, in the event that consensus cannot be reached, which opens up the possibility of future work being ‘hijacked’ by the majority. This could lead to

inadequate staffing given that the support of the nuclear armed states remains critical for the success of a scientific and technical group.

If the intention is to get this type of activity funded through the United Nation's General Budget, achieving adequate funding through the General Assembly's fifth committee may also be a challenge.

Option D: Establish a multilateral group subsidiary to the Conference on Disarmament

The Conference on Disarmament (CD) was 'established in 1979 as the single multilateral disarmament negotiating forum of the international community'.⁶¹ An option could be to establish a technical and scientific working group reporting to this conference. This would follow the precedence set by the Ad Hoc Group of Scientific Experts elaborating verification options for the CTBT.⁶²

One suggestion is to have two distinct sub-groups: one focusing on technical and scientific aspects of nuclear disarmament verification and the other looking into legal and policy implications. Both groups would take instruction from the CD itself, but derive its conclusions based on 'scientific consensus'. They could then issue a report to the CD, as well as other relevant bodies such as the IAEA and the UNGA. It could, similar to a group of experts set up by the Secretary-General, be supported by UNIDIR.

It could be argued that a proposed technical and scientific group could help revitalise the CD's work. As its operation would not commit any state to negotiations, it could be relatively easy to agree to. It could also allow delegations to allow for certain issues to progress—at least from a technical and scientific perspective—while the conference as such continues to search for a winning formulation on a programme of work going forward. The conference's consensus rule has sometimes been raised as its biggest disadvantage, but on something as sensitive as nuclear disarmament verification it may, in fact, be its biggest advantage. Since all questions posed to either sub-groups have to be formulated by consensus, the CD placement ensures that only those issue areas deemed relevant would be subject to examination. Moreover, the CD process would enable nuclear armed states to steer the scientific and technical work, ensuring that it does not deviate into areas that are potentially proliferative or which are sensitive from a national security perspective.

The CD has, however, been deadlocked for many years, and attempts to get the conference to agree on a programme of work and to commence substantive deliberations have been stymied.⁶³ While there are sound arguments for placing work of this kind under the CD (especially if non-members could be invited to participate—even as observers) there is a real risk that the proposal would fall flat given states' disagreements on the overall work programme.

Appendixes

Annex A: Project methodology

Between April and September 2017, the Verification Research, Training and Information Centre (VERTIC) hosted four regional consultative workshops – the first in Vienna, Austria (for Europe), the second in Pretoria, South Africa (for Africa) the third in Tokyo, Japan (for Asia) and the fourth in Rio de Janeiro, Brazil (for Latin America and the Caribbean). Stakeholders invited to participate included representatives of selected states, research institutes and, where relevant, regional multilateral organisations. In total, 63 persons participated in the consultations (excluding VERTIC staff members and rapporteurs).

Each workshop was held under the Chatham House Rule, and while participants were invited in their personal capacities, they were also free to articulate what they thought their government's or organisation's view might be.

For the sake of consistency and to collect a wide range of opinions on the key issues examined, all workshops shared a similar structure. Participants discussed a number of issues: how United Nations (UN) member states can expand on the emerging knowledge base of verification techniques already in existence or currently being developed; how this can be sustained into the future; and, whether a multilateral Group of Scientific Experts on Nuclear Disarmament Verification (GSE-NDV) could meaningfully address the challenge of creating a global, sustainable and inclusive capacity for nuclear disarmament verification.

Preparatory working papers were drafted for each workshop and used as talking points by presenters. Designed to stimulate debate and produce practical suggestions, the papers covered:

1. 'Workshop Context and the Importance of Initiatives Relating to Nuclear Disarmament Verification'—this paper also provided a brief background on the historically important role of the scientific community in arms control, disarmament and non-proliferation activities, see Annex B to this report.
2. 'The Role of the Group of Scientific Experts in the Negotiation of the Comprehensive Nuclear-Test-Ban Treaty'—this paper asked, what, if any, lessons could be learned from the experience of the 'Ad Hoc Group of Scientific Experts to Consider International Co-Operative Measures to Detect and Identify Seismic Events', which was active for 20 years, from 1976 until 1996. This group was tasked to 'specify the characteristics

of an international monitoring system' using seismological monitoring and developed many of the technologies that are currently being used by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and laid the foundation for continual improvements of the operational verification regime for when the Comprehensive Nuclear-Test-Ban Treaty (CTBT) enters into force, see Annex C to this report;

3. 'An Overview of Past and Present Networks and Groupings Devoted to Nuclear Disarmament Verification'—this paper focused on current and past initiatives of direct relevance to nuclear disarmament verification including the United Kingdom-Norway Initiative (UKNI)—now including Sweden and the US and known as the Quad Nuclear Verification Partnership (QNVP); the International Partnership for Nuclear Disarmament Verification (IPNDV); the United States–United Kingdom Technical Cooperation Programme; and the United States/Russian Federation/IAEA Trilateral Initiative, see Annex D to this report;
4. 'Groups of Governmental Experts (GGE) and Groups of Scientific Experts (GSE) Established in the Arms Control, Disarmament and Non-proliferation Field and in Other Areas of International Concern'—this paper examined the approach within the United Nations system of establishing groups of qualified experts to undertake in-depth studies on a particular topic and to make recommendations to the body that created them while, importantly, not being mandated to negotiate, see Annex E to this report.
5. The 'Nuclear Disarmament Verification' resolution adopted on 14 December 2016 by the United Nations General Assembly (UNGA/RES/71/67) was also referred to throughout each workshop, see Annex G to this report.

In addition, a respected analyst from each region was commissioned to produce a food-for-thought paper outlining the potential role that countries (both policy-makers and scientists) in that region could play in nuclear disarmament verification. These papers served as a basis for discussion on the utility of a multilateral GSE-NDV for the region and to examine, the expertise, if any, residing in that region both nationally and in regional organisations such as the African Commission on Nuclear Energy (AFCONE) in Africa; the European Atomic Energy Community (Euratom) in Europe; the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and the Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (OPANAL) in Latin America.

Annex B: Working Paper 1: Workshop Context and the Importance of Initiatives Relating to Nuclear Disarmament Verification

Background

The Verification Research, Training and Information Centre (VERTIC) is organising four regional workshops in 2017—the first was in Vienna, Austria (for European stakeholders), the second in Pretoria, South Africa (for African stakeholders), the third in Tokyo, Japan (for Asian stakeholders) and a fourth workshop—covering Latin America.

These workshops seek to explore issues surrounding the potential for establishing a *multilateral* Group of Scientific Experts on Nuclear Disarmament Verification (GSE-NDV) from the perspective of participants within each of these regions.

Each meeting will examine how UN member states can expand on the emerging knowledge-base of verification techniques already in existence or currently being developed and how they can sustain and guide it into the future. The objective is to propose a way to build on the embryonic network of international expertise on nuclear disarmament verification based on co-operation, support and outreach and to debate whether the creation of a *multilateral* Group of Scientific Experts is potentially the best route to achieve this.

The participants do not necessarily represent their country or their organisation's views—and as such each workshop is being held under the Chatham Rule allowing for the free flow of ideas—whether the opinions are on the utility or challenges of establishing such a multilateral group; its potential composition, scope, activities and mandate, as well as the political conditions that may be necessary for its formation.

On whether a GSE-NDV is necessary

VERTIC has not drawn any conclusions regarding the feasibility or desirability of such a group from the perspective of member states. Our own view is that the creation of a multilateral GSE-NDV could, *in the long-term*, assist in the development of a truly shared and trusted understanding of the technical, procedural and policy challenges of nuclear disarmament verification (especially between nuclear and non-nuclear weapon armed states). It could also generate sustained dialogue between scientific and technical experts, diplomats and policy-makers within and between the nuclear- and non-nuclear weapon states. A GSE-NDV could also consolidate efforts in the field to date, identify and coordinate research needs and initiate ways and means to undertake such research within limited budgets and organisational capacity.

Outcome of the workshop series

Thus our project will result in an initial assessment of the potential of a GSE-NDV based on the views gathered during the four workshops and supplemented by further research including with regard to the international disarmament verification environment and the experiences of both past and present networks and groupings devoted to nuclear disarmament verification.

Finally, this project builds on, and is informed by, VERTIC's work over many years in this field including initiatives that have brought together verification experts from around the world and the analysis and resources we have generated including our work examining the objective of consolidating a future role for the IAEA in such activities, as well as our activities in reviewing the requirements of verification technology.

Relationship to UNGA 71/67 on nuclear disarmament verification

The project, in some senses, aims to support the implementation of UN General Assembly Resolution 71/67 adopted on 14 December 2016.¹ Resolution 67 mandates the UN Secretary-General to establish a group of governmental experts of up to 25 participants on the basis of equitable geographical distribution to consider the role of verification in advancing nuclear disarmament. The group will meet in Geneva in 2018 and 2019 for a total of three sessions of five days each.

In the resolution, the General Assembly expresses its conviction that 'identifying and developing practical and effective measures of nuclear disarmament verification and monitoring' will 'foster confidence and facilitate efforts to achieve and maintain a world without nuclear weapons.'

It recalls previous UN efforts to promote verification, including resolution 62/21 of 5 December 2007 on verification in all its aspects,² and the 1990³ and 1995⁴ reports of the Secretary-General. The resolution also highlights the role of the International Atomic Energy Agency (IAEA).

In a passage, the resolution notes 'initiatives and partnerships among Member States, such as the initiative of Norway and the United Kingdom of Great Britain and Northern Ireland' and the International Partnership for Nuclear Disarmament Verification.⁶ It highlights that the role of these efforts is 'to enable active collaboration between States, in conformity with their international obligations, in developing practical methods that could contribute to the verification of irreversible dismantlement of nuclear weapons.'

Finally, the resolution calls upon *all* states to 'work together to identify and develop practical and effective disarmament verification measures.' Amongst practical measures, the resolution highlights 'technical challenges of nuclear disarmament verification and monitoring, including tools, solutions and methods and capacity-building.'

Thus, our project aims to debate the feasibility of establishing a multilateral group of scientific experts on nuclear disarmament verification. We intend to report on the outcome of our consultations to the First Committee later in the year, with the hope that our recommendations are considered by the forthcoming Group of Governmental Experts. To be clear, this project does not intend to establish a new parallel initiative, but rather to examine how existing efforts could, if necessary, be consolidated and put on a sustainable footing. Our discussions, which will be reflected in our final report, will need to take into account current initiatives on verification, such as those mentioned above – the UK-Norway Initiative and its successor, as well as the so-called International Partnership for Nuclear Disarmament Verification (IPNDV). We will also need to examine any lessons that can be learnt from previous initiatives such as the Black Sea Experiments—a series of seven experiments conducted in the late 1980s by the Soviet Academy of the Sciences and the US-based Natural Resources Defence Council. The experiments studied the utility of ‘different radiation detectors for detecting the presence or absence of nuclear warheads on ships’; and, the Trilateral Initiative between the IAEA, Russia and the US, which sought to examine techniques for IAEA verification of ‘weapon-origin fissile material deemed excess to military needs’. [See: **VERTIC Working Paper 3: *An Overview of Past and Present Networks and Groupings Devoted to Nuclear Disarmament Verification***]

We hope to examine how a formalised multilateral group, if deemed desirable, could complement existing initiatives and learn the lessons from earlier collaborative ventures.

To aid in our deliberations, we will also look at how a Group of Scientific Experts that operated between 1976 and 1996 was key in assisting diplomats, policy-makers and international legal advisors that the negotiation of a *verifiable* comprehensive ban on nuclear testing was indeed feasible. [See: **VERTIC Working Paper 2: *The Role of the Group of Scientific Experts in the Negotiation of the Comprehensive Test Ban Treaty***]

Whether or not, a similar concept could be exported to the international (and institutional) realities of 2017 and beyond is for participants to debate.

Importance of verification

Without effective verification, nuclear disarmament cannot be credibly assured or provide the trust and confidence needed by all States in their quest to significantly reduce the number of nuclear weapons and to eventually eliminate them entirely. Recent events in Syria have highlighted the importance of getting assurance about the completeness of state’s declarations, not just the correctness. Syria clearly illustrates the importance of getting verification right from the outset. Verification arrangements cannot be treated as an afterthought. Most of us also recognise that international co-operation in addressing the underlying scientific and technical questions on nuclear disarmament verification is of great importance. This need becomes pressing in light of

the need to reconcile two conflicting objectives: for example, the desire to ensure that the objects earmarked for dismantlement are bona fide warheads, while at the same time protecting sensitive information about their design features.

Currently, there are few tested verification approaches in the nuclear disarmament field. However, past and on-going initiatives in this field have carried out valuable research and explored useful approaches. This work needs to be not only captured and preserved for future generations but sustained, better co-ordinated and continuously renewed as technology advances.

The role of epistemic and scientific communities in arms control and disarmament

There are a number of academic studies illustrating how scientific communities have contributed to the formulation of policies, international law and non-proliferation regimes. Of note is Dr Sara Kutchesfahani's doctoral thesis submitted to University College London in 2010.⁷ Her thesis analysed the creation and successful implementation of Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and the Nunn-Lugar Cooperative Threat Reduction (CTR) Program, which, respectively, verified the non-nuclear weapon status of Argentina and Brazil and facilitated the denuclearization of Belarus, Kazakhstan, and Ukraine. These co-operative nuclear non-proliferation agreements are shown to be the result of a process involving substantial input and direction from experts constituting epistemic communities. Dr Kutchesfahani's analysis indicates that the Argentine and Brazilian scientific communities drove the thinking behind the mutual inspections and safeguards verification system that later became ABACC.

Also, and as noted by Sidney Drell and James E. Goodby, a very effective way to increase transparency and mutual trust is to organise programmes involving scientific collaboration in inter-laboratory exchanges.⁸ In the past, this has provided a way to promote understanding between the nuclear communities of the United States, Russia and China to a greater degree than short inspection visits, for instance, could achieve'.

For example, in preliminary talks during the 1990s, the United States and Russia discussed transparency and irreversibility of warhead dismantlement. Although the talks did not produce mutually agreed solutions, they did lay the basis for constructive, and ongoing work should the issue be re-engaged.⁹ For a detailed description of how Russian and United States scientists together addressed nuclear weapon safety under the Weapons Safety and Security Exchange agreement (WSSX),¹⁰ see Siegfried S. Hecker and Paul C. White, 'The US-Russian teamwork that kept nuclear weapons safe', *Bulletin of the Atomic Scientists*, 13 July 2017.¹¹

We should also note that the establishment of groups of qualified experts in the form of a Group of Governmental Experts (GGE) or a Group of Scientific Experts (GSE) is a relatively common approach within the

United Nations system as well as in other intergovernmental organisations such as the European Union (EU). These groups are often mandated to undertake in-depth studies on a particular topic and to make recommendations to the body that created them. Importantly, they are not mandated to negotiate, for example, a treaty or convention.

There are many examples of such bodies in the arms control, non-proliferation and disarmament fields as well as in other areas of international concern. Examples include the GGE tasked with making recommendations on possible aspects that could contribute to a treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices. Another example is the proposed GGE on lethal autonomous weapons systems.

The Intergovernmental Panel on Climate Change (IPCC), established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) is perhaps the most well-known expert group with a long-term mandate in a non-arms control field. [See: **VERTIC Working Paper 4**: A select list and description of Groups of Governmental Experts (GGE) and Groups of Scientific Experts (GSE) from other arms control, disarmament and non-proliferation initiatives and other fields]

Conclusion

Scientists are not generally known as people of war. However, they brought nuclear weapons into being and will have as much a role in their abolition as they had in their creation.

They will make sure that weapons designated for dismantlement are destroyed safely. The combination of fissile, radioactive materials and high explosives in a confined space means that they cannot just be crushed or burned, like an assault rifle or a tank. They cannot just be incinerated, like chemical weapons. They cannot be blown up, like mines or conventional explosives. The dismantlement of nuclear weapons is not an easy problem to solve. But we cannot just wish them away.

Scientists and engineers will have to make sure that the fissile material is able to be removed safely, reprocessed or destroyed in an irreversible way. Scientists and engineers will have to oversee the decommissioning of factories and other installations devoted to the production and processing of these materials. Moreover, scientists and engineers will have to design the equipment we need to ensure that all of this is done verifiably and in way that is as transparent as possible and that ensures that the processes are irreversible.

It is scientists and engineers that will be able to guide us towards durable and robust solutions that work in the real world – solutions that can be proposed, examined and tested – solutions that result in the development of practical and effective nuclear disarmament verification measures to eventually achieve and maintain a world without nuclear weapons.

Annex C: Working Paper 2: The Role of Scientific Experts with respect to the Comprehensive Nuclear-Test-Ban Treaty

A comprehensive ban on nuclear testing had been a foreign policy objective for many governments ever since the mid-1950s. However, negotiations on the Comprehensive Nuclear-Test-Ban Treaty (CTBT) did not begin until 1994. There were several reasons for this. Foremost, US-Soviet relations were coloured by the nuclear arms race and the Cold War. There were, furthermore, scientific and political disagreements over the verifiability of a proposed treaty prohibiting nuclear testing.

To achieve at least partial progress on the issue, Sweden proposed the establishment of a group to study the technical aspects of verification.

This ‘Ad Hoc Group of Scientific Experts to Consider International Co-Operative Measures to Detect and Identify Seismic Events’ which was established under the auspices of the then Committee of the Conference on Disarmament (now called the Conference on Disarmament (CD)), became commonly known as the ‘Group of Scientific Experts’ (GSE).

The GSE was active for 20 years, from July 1976 to 1996—at the height of the cold war the GSE was the only ongoing multilateral dialogue on disarmament issues.

The GSE’s mandate was to ‘consider and report on international co-operative measures to detect and identify seismic events, so as to facilitate the monitoring of a comprehensive test ban’. In other words, to conduct joint research into monitoring technologies and data-analysis methods for the verification of a comprehensive test ban.

Comprised mostly of seismologists it was tasked to ‘specify the characteristics of an international monitoring system’.

The group, of roughly 50 participants, had two Swedish chairs, Dr Ulf Ericsson (1976-1982) and Dr Ola Dahlman (1982-1996). The group’s scientific secretary was Norwegian, Dr Frode Ringdal.

The GSE reported to the Conference on Disarmament (CD) and produced several substantive reports throughout its lifetime.

Four senior political officers from the United Nations (UN) supported the Group as secretaries over the years that it met—twice a year for two weeks at a time in Geneva.

However, most of the work was carried out at the national level, in participating states, where scientists worked to design and test systems proposed by the Group as a whole.

The group conducted three major exercises:

1. GSETT-1, held in 1984, tested the extraction of data from seismic stations, the transmission of such data over an international network, and the handling of the information at Experimental International Data Centres.
2. GSETT-2, held in 1991, repeated the test but incorporated new technologies.

3. GSETT-3, held in 1995, repeated the experiment but on a much larger scale. It featured a single data centre located in Washington DC. The prototype data centre was in operation while the Comprehensive Nuclear Test Ban Treaty's own International Data Centre was being established.

One could therefore argue that:

1. The GSE helped to keep the ideas around a comprehensive test ban alive despite being established at a time when there was little or no political appetite for such a treaty.
2. The GSE had a political mandate – it was political [only] in the sense that the GSE's work was regulated through CD consensus decisions, a specific timetable of tasks and because it had to submit its reports to the CD. Its work was also restricted to seismic verification.
3. The agenda was broad enough to continue through two decades.
4. It was based on an initial principal design consisting of three main elements: a network of seismological stations, a rapid international exchange of data, and processing of data at international data centres.
5. Group members were appointed by governments but did not necessarily need to be state employees.
6. Its research agenda (and the scientific progress that came out of it) was not necessarily connected to political negotiations or the prevailing international climate.
7. However, from time to time, it was perceived as a substitute for negotiations.
8. The GSE's work enabled a period of international co-ordination of national technical means of verification.
9. An infrastructure funded by states supported the work.
10. The work created a common understanding of verification possibilities and knowledge.

According to Dunlop, this Group of Scientific Experts is a key example of how expert groups can be used to provide capabilities that facilitate agreement on difficult technical issues for the monitoring or verification of compliance with a treaty.

He further argues that such experts have been used as a surrogate for progress in negotiations until the political process is ready to move forward.¹ In other words, technical discussions can be used to keep momentum while the political process is maturing.

'The GSE is a perfect example [of the fact] that the biggest challenge for arms control is the continuously changing scientific progress and its impact on International Affairs . . . the GSE confronted the challenge to modify the verification system, going on step by step without any cessation even if political negotiations stagnated . . . the GSE helped to keep going the political process by developing the seismic monitoring system.'²

Jaap Ramaker, the Netherlands Ambassador chairing the final CTBT negotiation session, states clearly that the ‘value of this work and its contribution to the success of the CTBT negotiations cannot be overestimated’.³

At the same time, Sandra Alwardt, a researcher at the University of Hamburg states that the contribution of scientists to the successful negotiation of the treaty was not visible to the public.⁴ Some would argue that this was precisely why it was successful.

Importantly, the GSE was never a ‘policy driver’, but rather a ‘policy enabler’. In addition, the GSE also served as a mutual training and education forum.

Perhaps this is also a key observation—that scientists from across the political divide, quietly working side-by-side and over many years, can significantly assist diplomatic processes and indeed ensure that the diplomatic agreements are (able to be) implemented. ‘Collegial relationships that developed among participating scientists during previous collaborations will ease implementation of any agreed-upon system.’⁵

In summary then, and to quote Ola Dahlman:

‘The GSE proved that it was possible, and indeed most useful, to conduct preparatory scientific and technical analysis prior to political negotiations.

The work of the GSE was not seen as a substitute for political negotiations, nor a commitment to commence such negotiations - it was a thorough scientific and technical effort to develop and test the concept of a verification system.

The formal framework of the GSE provided by the Conference on Disarmament was important in several ways—it not only facilitated the Group’s meetings, it provided a link to a political or policy-making body.

The formal framework engaged the states, making it easier for them to not only commit experts to participate in the meetings, but also to make considerable investments in tests, monitoring stations, and other facilities.

The GSE was granted a unique long-term mandate determined its own management and leadership.

GSE had only two chairmen in 20 years. This resulted in a sustained, consistent, and focused effort over a long period of time.

The GSE’s activities also provided mutual learning among the global participants and many of the experts have since contributed to the implementation of the verification regime.’⁶

One thus needs to ask:

1. What, if any, lessons can be learned from this experience?
2. How did this Group (and indeed its predecessor (the Geneva Group of Experts (1958–1960)) prepare the foundation for political progress until the CTBT negotiations started?

3. Has this GSE set a precedent for how international science co-operation on nuclear arms control can make progress despite a political climate that is not conducive to treaty negotiations?
4. Can a GSE-NDV conduct work within a mandate that does not in any way imply that political negotiations might follow or that may prejudge their possible outcome?
5. Are there other relevant examples where groups of scientists were active while the international political climate for negotiating was not conducive?
6. Are there other relevant examples where groups of scientists played a key role in outlining what was technically feasible rather than politically desirable?

Annex D: Working Paper 3: Nuclear Disarmament Verification Initiatives: The State of Play¹

An examination of past and current initiatives related to nuclear disarmament may prove instructive for the establishment of a multilateral Group of Scientific Experts. This examination would take into account the scope, subject matter, duration, stated goals in terms of outputs and outcomes, communications strategy, and transparency level policies of these initiatives. In addition, it should also consider the organisational structure, the selection and background of participants, as well as what risks and challenges they faced to conclude their work.

A. Black Sea Experiment

Conducted in 1989, the Black Sea Experiment refers to a series of seven experiments conducted between the Soviet Academy of the Sciences and the Natural Resources Defence Council (US). The experiments studied the utility of ‘different radiation detectors for detecting the presence or absence of nuclear warheads on ships’.² The results, which confirmed some observed weaknesses among passive radiation detectors for verifying the presence or absence of nuclear weapons were discussed during two joint meetings in July and December 1989. The Black Sea Experiment provided the stage for a demonstration of scientific collaboration and a starting point to discuss the technical means to verify sea-based nuclear weapons. Importantly, it was one of the first instances that showed the value of lab-to-lab collaborative projects demonstrating that adversaries can work together to improve the political relationships.³

B. Trilateral Initiative

The Trilateral Initiative was launched in 1996 by the US, Russia and the IAEA. It sought to examine techniques for IAEA verification of ‘weapon-origin fissile material deemed excess to military needs’. In so doing, the initiative needed to identify credible verification procedures that nevertheless did not involve Agency access to sensitive nuclear weapons related information. Over the course of 98 meetings, the initiative surveyed current measurement equipment (starting with approved IAEA equipment), and gradually developed an agreed measurement methodology, including a statement of equipment requirements. This was translated into functional specifications and designs, which informed the creation and demonstration of prototype equipment.⁴

In addition, the three parties established a Joint Working Group to consider the technical, financial, and legal aspects of these verification activities.

Despite the progress that had been made and the expressions of support by each party, no more work was carried out under the initiative after 2002. However, some analysts believe that the Model Verification Agreement produced could still serve as the basis for bilateral or multilateral agreements between the IAEA and

nuclear-weapon States wishing to demonstrate, in a verifiable manner, that weapon origin and other fissile material released from defense programmes remains irreversibly removed from nuclear weapons programmes.⁵ In addition, efforts have been made to ensure the work carried out can be used in the future. A 2015 paper by Tom Shea and Laura Rockwood ‘proposes a framework for IAEA verification of steps toward nuclear disarmament. The proposal is premised on IAEA verification of fissile material, in any form, whether classified or not, that is submitted by any state possessing nuclear weapons, whether party to the NPT or not. The paper identifies technical, legal, and financial solutions to the challenges posed by such verification, and describes a way forward to the full implementation of the proposed framework.

The paper also notes that ‘the technical verification method developed under the Trilateral Initiative would form the basis for verification under this proposal. However, additional research and development would be necessary for success, even at the earliest stage.’ Consequently, the paper proposes the establishment of an ‘IAEA Center for Nuclear Disarmament Verification Research and Development’ to facilitate fissile material verification in relation to nuclear disarmament. It is suggested that the centre would include ‘a network of complementary laboratories and universities in states interested in participation, including laboratories in non-nuclear-weapon states (NNWS) as well as in states possessing nuclear weapons’.⁶

C. US and UK Cooperation to Address Technical Challenges in Verification of Nuclear Disarmament

In 2000, the US and the UK started an on-going co-operative initiative to ‘develop and evaluate methodologies and technologies to verify potential nuclear weapon treaties, in support of shared U.S.-U.K. commitment to Article VI of the Nuclear Non-Proliferation Treaty’. The initiative states that it began with familiarisation with previous research and future plans, and moved to the integration of accumulated joint research and analysis into ‘increasingly realistic warhead dismantlement exercises’. It sought to ‘apply policy, technology and operations expertise to develop and evaluate targeted approaches for transparent reductions and monitoring of nuclear warheads, components, fissile materials and associated facilities’.⁷

The co-operation was facilitated by the two countries’ ability to exchange classified nuclear weapons information in accordance with the terms of the 1958 Mutual Defense Agreement that ‘provides the framework for investigating highly sensitive issues in depth.’

The initiative highlighted its relevance to the international community by noting that it has focused on ‘identifying and developing technologies and procedures that protect classified and sensitive unclassified information while allowing: managed access for inspectors at nuclear weapons facilities; confirmation of declared nuclear weapon attributes; chain of custody for nuclear warheads and components through the dismantlement process; monitored storage of nuclear weapons, components and materials; and authentication of inspection equipment.

The initiative produced a report on its activities from 2000 to 2015 and conducted briefings among the P5 in 2009 and to the international community more broadly in 2014 at the Preparatory Committee for the 2015 NPT Review Conference.

The initiative is currently looking at the ‘development of a radiation portal for arms control monitoring applications and the completion of a multi-year warhead measurement and modelling campaign to inform future warhead verification research’. It will continue investigations into chain of custody and data authentication. These ongoing collaborative activities ‘will further inform next steps’.⁸

D. UK-Norway Initiative on nuclear warhead dismantlement verification

The UK and Norway have been working together since 2007 in a unique technical collaboration to address a key proliferation-related challenge that verifying the dismantlement of nuclear warheads can pose. The Initiative (UKNI) has focussed on bringing together a Nuclear (NWS) and Non-Nuclear Weapon State (NNWS) for the first time to discuss what verification tools and methods could be required to verify nuclear disarmament, and also to explore how all states parties to the NPT can contribute and cooperate to this end.

According to the UKNI’s website, the initiative was ‘a first-of-its-type collaboration between a NWS and a NNWS which supports the aims of Article VI by investigating the technical and procedural challenges of verifying possible future nuclear disarmament and arms control agreements.’⁹

The UKNI have presented their findings through technical papers, and presentations at various NPT Preparatory Committees and Review Conferences as well as in other fora.

Technical topics covered included discussion of concepts such as managed access, information barriers and chain of custody.

Both States have concluded that their joint work has demonstrated that:

- a. Significant contributions to nuclear disarmament verification research can be made by both NNWS and NWS;
- b. All States Parties to the NPT are able to make an active contribution to their Article VI disarmament obligations through verification research, whilst fulfilling their obligations under Articles I and II;
- c. Non-Nuclear Weapon States’ cooperation in nuclear disarmament verification research is necessary in order to achieve effective and mutually trusted technical and procedural solutions to support verifiable multi-lateral nuclear disarmament; and
- d. Increased trust between Non-Nuclear Weapon States and Nuclear Weapon States is possible.

The UKNI has concluded that, ‘major technological development is still required to produce jointly trustable systems for deployment in the verification of nuclear warhead dismantlement . . . nuclear weapons disarmament

verification will require new technologies, including reliable measurement techniques, trusted and non-intrusive systems for data processing and protection and, efficient inspection protocols designed for this purpose.¹⁰ In addition, collaborative disarmament verification research will be necessary in order to achieve effective and mutually trusted approaches and solutions to support any possible future multilateral disarmament regime.¹¹ Importantly, both the UK and Norway, in their reports of the Initiative express the hope that their work would encourage new research initiatives and international collaborations.

In 2015, the UKNI announced that it will seek to work with additional countries. Today, the UKNI has transformed into what is now known as the ‘Quad’ with the US and Sweden joining. The Quad is planning to hold an arms control simulation in October 2017 that will seek to test monitoring technologies. Findings and results are scheduled to be presented at the 2018 NPT Preparatory Committee.¹²

E. The International Partnership for Nuclear Disarmament Verification (IPNDV)

In December 2014, the US Department of State announced a new initiative launched in partnership with the Nuclear Threat Initiative (NTI) focusing on nuclear disarmament verification—the International Partnership for Nuclear Disarmament Verification (IPNDV).

The following meetings have been held so far:

- March 2015—first plenary meeting in Washington, DC
- November 2015—second plenary meeting in Oslo, Norway
- June 2016—third plenary meeting in Tokyo, Japan
- November 2016—fourth plenary meeting in Abu Dhabi, United Arab Emirates.

A fifth plenary meeting is scheduled for late 2017 in Argentina.

IPNDV, as a ‘public-private partnership’, aims to assess approaches to monitoring and verification across the nuclear weaponisation lifecycle by channelling expertise from both nuclear and non-nuclear weapon states. Between 20 and 25 nuclear armed and non-nuclear armed states participate.

According to the US Department of State’s website, at its inaugural plenary in March 2015 in Washington, the IPNDV agreed to form three working groups to study verification issues through all stages of a nuclear weapons lifecycle.¹³

These Working Groups have met between the above Plenaries and aim to develop a set of 10 output documents by the end of the Partnership’s initial phase in late 2017.

Working Group One: ‘Monitoring and Verification Objectives’ is chaired by the Netherlands and the United Kingdom. This group expects to produce:

- a. A framework document with terms and definitions, principles, and good practices, and a broad flowchart showing possible monitoring and verification activities for key disarmament steps across the nuclear weapons lifecycle.
- b. A detailed assessment of potential monitoring and verification requirements for monitoring the dismantlement of nuclear warheads, including what information might be needed to satisfy those requirements, and an assessment of the kind of assurance that states would likely seek from verification;
- c. A capacity mapping document that outlines existing skills and areas of expertise applicable to key monitoring and verification activities, and identifies possible gaps; and a needs and planning document to fill gaps and identify priorities for future collaborative efforts.

Working Group Two: ‘On-Site Inspections’ is chaired by Australia and Poland. It will produce:

- a. A document outlining: the key elements of OSI for verification of nuclear disarmament undertakings, potential new inspection activities and techniques that could effectively verify compliance with future agreements as well as options for managed access and their applicability at different types of facilities and sites;
- b. A ‘best practices’ document highlighting skills, training requirements, and lessons learned from inspectors and facility operators who have OSI experience in diverse environments as well as objectives and broad outline for an inspector training course that would serve as a basis of future capacity building; and
- c. Proposed approaches and topics for future development of OSI for verification of nuclear disarmament.

Working Group Three: ‘Technical Challenges and Solutions’ is chaired by Sweden and the United States and is expected to produce:

- a. A series of presentations, workshops or seminars on key activities and lessons learned from the U.S.-UK Technical Cooperation for Arms Control program, the UK-Norway Initiative, and other relevant activities;
- b. An assessment of existing approaches for warhead authentication, including the systems that support attribute measurements and templates, and an outline of other techniques that could increase confidence that something is in fact a nuclear warhead;
- c. The development of a chain of custody paper, presentation or demonstration involving unique identification and tamper-indicating devices in a specific environment, such as a mock warhead storage area; and
- d. A mapping of existing and potential technical capabilities necessary to enable monitoring and verification at different stages of a nuclear weapon dismantlement process, and the level of confidence the technology brings to monitoring the dismantlement process, with a list that identifies capability gaps and weaknesses to inform future research.¹⁴

NTI has created an on-line archive of publications on the verification of nuclear weapons and materials—Monitoring and Verification Resource Collection.¹⁵

F. The Trilateral German-Russian-U.S. Deep Cuts Commission

The trilateral German-Russian-U.S. Deep Cuts Commission, as a Track II initiative, seeks to devise concepts on how to overcome current challenges to deep nuclear reductions. The Commission strives to translate the already existing political commitments to further nuclear reductions into concrete and feasible action. The framework offers the three countries the opportunity to analyse a cross section of interests that are key to arms control and disarmament, including verification lessons learnt from strategic arms reductions. The Commission consists of strategic thinkers, technical experts, and former military and government officials. Deep Cuts Commissioners aim to devise concepts that are pragmatic, realistic, and feasible to overcome obstacles to nuclear reductions. The Commission's purpose is to take into account the complex interdependency of current technical and political-military conditions. More recently, the Commission has argued that in order to prevent misperceptions, miscalculations, and the potential return of a costly arms race, both Washington and Moscow have to rediscover the instruments of diplomatic dialogue, military-to-military exchanges, and verifiable arms control.¹⁶

The Commission is coordinated by the Institute for Peace Research and Security Policy at the University of Hamburg (IFSH), the Arms Control Association (ACA), and the Institute of World Economy and International Relations of the Russian Academy of Sciences (IMEMO) with the active support of the German Federal Foreign Office and the Free and Hanseatic City of Hamburg.¹⁷

G. German Disarmament Verification Network

For several years, individual researchers in Germany have met to discuss issues relating to nuclear disarmament verification. As a grouping they constitute the 'Nuclear Disarmament Verification Network' and include such organisations as Forschungszentrum Jülich, the Fraunhofer Institute for Technological Trend Analysis in Euskirchen and the Carl Friedrich von Weizsäcker Centre at the University Hamburg.¹⁸

The Institute for Peace Research and Security at the University of Hamburg are also conducting a project on disarmament verification, focused on nuclear weapons authentication using gamma and neutron measurements.¹⁹

H. The European Safeguards Research and Development Association (ESARDA)

ESARDA brings together European organisations involved in safeguards research through annual meetings and symposia, as well as the establishment of working groups focused on particular issues. There are 31 member organisations and 7 associated partners from the US, Switzerland and Norway.²⁰

ESARDA's Novel Approaches / Novel Technologies and Verification Technologies and Methodologies Working Groups no longer meet but other working groups such as the Ad hoc Group on 'Verification Technologies

and Methodologies' continue to discuss and research verification issues, including the role of openness and transparency, verification regimes, inspection models; satellite imagery and environmental monitoring.

During the ESARDA Symposium 2013, a panel discussion on dismantlement verification was organised in co-operation with the German Network for Nuclear Disarmament Verification. Both technological and political issues were debated. A major discussion point made was the potential benefit of multinational, and in particular European, technical engagement. It was stressed that meaningful research can be conducted without access to classified information through working on the principal issues of measurement technology or managed access. Also examined was future work that could be undertaken in the context of ESARDA. An overriding problem identified during the discussion was the lack of funding.¹¹

The 39th ESARDA Symposium on Safeguards and Nuclear Non-Proliferation, held in Düsseldorf, Germany from 16–18 May 2017 also discussed verification technologies and methodologies and arms control and nuclear disarmament verification.

Annex E: Working Paper 4: Groups of Governmental Experts (GGE) and Scientific Experts (GSE)¹

The establishment of groups of qualified experts in the form of a Group of Governmental Experts (GGE) or a Group of Scientific Experts (GSE) is a relatively common approach within the United Nations system as well as in other intergovernmental organisations such as the European Union (EU).

These groups are often mandated to undertake in-depth studies on a particular topic and to make recommendations to the body that created them. Importantly, they are not mandated to negotiate, for example, a treaty or convention.

A. Chemical and Bacteriological (Biological) Weapons

Based on resolution 2454A of 20 December 1968, the General Assembly requested the establishment of a group of consultant experts on chemical and bacteriological (biological) weapons to prepare a report on chemical and biological weapons, their effects and use.²

The group was made up of medical experts and engineers from laboratories, research centres, and defence ministries. They met during the course of three sessions in 1969 and the report was made available in July 1969, to the then Conference of the Eighteen-Nation Committee, as well as to the General Assembly and the Security Council. The Conference of the Eighteen-Nation Committee (renamed in August 1969 as the ‘Conference of the Committee on Disarmament’ discussed the report at its 1969 session. Various proposals for action, including a draft convention for the prohibition of biological methods of warfare submitted by the United Kingdom were discussed.³

B. Biological Weapons Convention

a. VEREX (1992–1993)

VEREX, an Ad Hoc Group of Governmental Experts to Identify and Examine Potential Verification Measures from a Scientific and Technical Standpoint was established in 1991 by the Third Review Conference of the Biological and Toxin Weapons Convention (BTWC), whose purpose was to ‘identify and examine potential verification measures from a scientific and technical standpoint.’⁴ The GGE met in a series of sessions between 1992-1993 and delivered its report to a Special Conference of States Parties in 1994.

The report identified ‘21 potential verification measures’ and stipulated that ‘no measure on its own would be capable of verifying compliance but that some measures applied in combination did have the capability to do so’.⁵

b. Ad Hoc Group (1994–2001)

At the 1994 Special Conference which looked at the VEREX report, another Ad Hoc Group (AHG) of state parties to the BTWC was established to ‘consider appropriate measures including possible verification measures and to draft proposals to strengthen the BTWC, to be included, as appropriate, in a legally binding instrument’.⁶

In January 1999, the AHG initiated a third phase of negotiations, focusing on a framework for a Protocol. Its report contained many contrasting views and in July 2001 at the BTWC’s Fifth Review Conference, the United States indicated that it was unable to support the proposed Protocol leading to no progress on a full-fledged verification regime being made since then.

C. Fissile Material Cut-off Treaty (FMCT)

a. Group of Governmental Experts (2014–2015)

Based on UN Resolution 67/53 adopted on 3 December 2012, the General Assembly requested the establishment of a Group of Governmental Experts (GGE), made up of experts from 25 states ‘chosen on the basis of equitable geographical representation’. Most were civil servants from their respective Ministries of Foreign Affairs. The GGE was to produce a report in which it would make ‘recommendations on possible aspects that could contribute to but not negotiate a treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices’.⁷

The GGE met in Geneva for two sessions of two weeks each in 2014 and 2015 and their report was submitted to the Conference on Disarmament in June 2015. It provided conclusions and recommendations for future negotiators of a Fissile Material Cut-off Treaty (FMCT) based on their research into the technical, scientific and legal challenges of such a treaty – they agreed that their report, and the deliberations which underpin it, can serve as a valuable reference for States and should be a useful resource for negotiators of a future treaty.⁸

b. High Level FMCT Expert Preparatory Group (2017–2018)

Based on UN Resolution 71/259 adopted on 23 December 2016, the General Assembly requested the establishment of high-level FMCT expert preparatory group, made up of 25 states ‘chosen on the basis of equitable geographical representation’. Participation is without prejudice to national positions in future negotiations. Similar to the first GGE, the purpose of the establishment of this group is to make recommendations ‘on substantial elements of a future non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices’. The

first session took place in New York in March 2017 and continued in Geneva on 31 July 2017. The group will meet for two more sessions in 2018, with open-ended informal consultative meetings also taking place in between.⁹

D. Lethal Autonomous Weapons Systems

The final document of the 2016 Review Conference of the Convention on Conventional Weapons (CCW) agreed to establish a Group of Governmental Experts to examine the implications of emerging technologies in the field of Lethal Autonomous Weapons Systems (LAWS). The Group of Governmental Experts is set to convene from 13 to 17 November 2017 and to then report-back to the CCW's annual meeting on 22–24 November 2017.¹⁰ An earlier session planned in August 2017 has been cancelled.

The establishment of a GGE on LAWS follows three informal expert meetings that took place in 2014, 2015 and 2016, and brought together lawyers, scientists, human rights and security experts from a variety of entities ranging from national research laboratories to think-tanks and non-governmental organisations.

Importantly, participation is open to all High Contracting Parties and non-states parties, international organisations and non-governmental organisations.¹¹

E. Register of Conventional Arms

The UN Register of Conventional Arms (UNROCA) was created in 1991 by the UN Office for Disarmament Affairs (UNODA) and is the 'key international mechanism of official transparency on arms transfers' that serves to build confidence among states.¹²

Groups of Governmental Experts are convened every three years through a General Assembly resolution to work on expanding the Register's scope, with the last GGE meeting occurring in 2016. They report to the General Assembly, which 'may adopt a resolution incorporating the GGE recommendations'.¹³

The 2016 GGE report, reflective of the previous six reports, discussed states' participation in reporting to UNROCA as well as the inclusion of further categories of arms such as small arms and light weapons.¹⁴

F. Arms Trade Treaty

a. Group of Governmental Experts

In 2007, UN General Assembly Resolution 61/89 requested the Secretary-General to seek the views of Member States on the feasibility, scope and draft parameters for a comprehensive, legally binding instrument establishing common international standards for the import, export and transfer of conventional arms, and to submit a report to the General Assembly at its sixty-second session.

The resolution has requested that a group of governmental experts, be established on the basis of equitable geographical distribution, 'to examine, commencing in 2008, the feasibility, scope and draft parameters for a comprehensive, legally binding instrument establishing common international standards for the import, export and transfer of conventional arms, and to transmit its report of the group of experts to the Assembly for consideration at its sixty-third session.'¹⁵

The GGE, which consisted of diplomatic representatives from 28 countries, met for three sessions in 2008 and produced a report outlining the feasibility, scope and draft parameters of such a treaty. The GGE also recommended further consideration within the UN in an open and transparent way, leading to the establishment of the Open-Ended Working Group (OEWG).¹⁶

b. Open-Ended Working Group (OEWG)

In 2008, the OEWG was established under General Assembly Resolution 63/240. It was open to all states and met during six one-week sessions between 2009 and 2011 to consider where consensus can be found on a prospective treaty. In 2009, the General Assembly adopted resolution 64/48, which included a decision to convene a United Nations Conference on the Arms Trade Treaty, 'to sit for four consecutive weeks in 2012 to elaborate a legally-binding instrument on the highest possible common international standards for the transfer of conventional arms'. It established four preparatory committees in 2010 and 2011 to make recommendations to the negotiating conference on the elements necessary for an effective treaty.¹⁷

The Arms Trade Treaty (ATT), which regulates the international trade in conventional arms, was adopted by the General Assembly on 2 April 2013 and entered into force on December 24 2014.¹⁸

G. Small Arms and Light Weapons

a. Group of Governmental Experts on Tracing Small Arms and Light Weapons

Tracing illicit small arms and light weapons was a prominent issue discussed at the 2001 UN Conference of Small Arms and Light Weapons in All its Aspects. Based on the recommendation of the conference's programme of action, the General Assembly established the Group of Governmental Experts (GGE) on Tracing Small Arms and Light Weapons, made up of diplomatic representatives from 23 states.¹⁹

The GGE met during three one-week sessions between 2002 and 2003 and produced a set of recommendations presented to the General Assembly in July 2003.²⁰

This ultimately resulted in an 'International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons' being adopted by the United Nations General Assembly on 8 December 2005 as a politically-binding instrument.

b. Group of Governmental Experts to Consider Further Steps to Enhance International Cooperation in Preventing, Combating and Eradicating the Illicit Trade in Small Arms and Light Weapons in All its Aspects

Based on resolution 60/81, the General Assembly decided in December 2005 to establish a Group of Governmental Experts to consider further steps to enhance international cooperation in preventing, combating and eradicating illicit brokering in small arms and light weapons.

The GGE was made up of diplomatic representatives from 25 states and held three one-week sessions between 2006 and 2007. The consensus report produced by the GGE gave an overview of recent efforts undertaken to combat the issue as well as the ‘first internationally agreed description of what constitutes brokering in small arms and light weapons’. It was presented to the General Assembly in August 2007²¹ with recommendations aimed at enhancing international co-operation to prevent, combat and eradicate illicit brokering in small arms and light weapons and practical steps for implementation in the context of the UN Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects (UNPoA) and other UN measures (such as sanctions regimes).

H. Disarmament and Non-proliferation Education

Based on resolution 55/33 E, the General Assembly requested in November 2000 that a study on disarmament and non-proliferation be prepared with the assistance of a Group of Governmental Experts who should also invite ‘representatives of organisations of the United Nations system with special competence in disarmament or education or both to participate in its work and should also invite university educators, disarmament and peace-related institutes and non-governmental organisations that have special qualifications in education and training in the field of disarmament and non-proliferation to make written and oral presentations’.²²

The GGE was made up of experts from 10 states and received numerous contributions from UN disarmament agencies, other international disarmament-related organisations and civil society. The GGE met over the course of four sessions in 2001 and 2002 and produced a report, which was presented to and adopted by the General Assembly in November 2002. The report included a set of 34 recommendations for action.²³ Every second year the UN publishes a report reviewing the implementation of these recommendations by member states and civil society.²⁴

I. Missiles in All Their Aspects

Based on various General Assembly resolutions, there have been three different Panels of Governmental Experts (2001–2002; 2004; 2007–2008). All three Panels each met for three one-week sessions and, except

for the second panel, all produced a report by consensus, which was subsequently adopted by the General Assembly.²⁵

The Panels were made up of diplomatic representatives of states and discussed issues related to ‘the increasing number, range, technological sophistication and geographic spread of missiles and their capability of delivering weapons of mass destruction’.

J. Verification in all its Aspects, including the Role of the United Nations in the Field of Verification

The UN General Assembly requested the establishment of a Panel of Governmental Experts to study verification in all its aspects including the role of the UN in the field of verification in its resolution 59/60 of 2004. Two previous reports on the issue were commissioned and published by the UN in 1990 and 1995.²⁶

The panel met during three one week sessions in 2006 and a report was published in October 2006 containing 21 recommendations on solutions to generate greater confidence among states in the field of verification of international arms norms. The report was presented to the First Committee and adopted without a vote.²⁷ A VERTIC staff member served as an Adviser to the Chair of this GGE.

K. Developments in the Field of Information and Telecommunications in the Context of International Security

There have been five GGEs established in the field of information and telecommunications in the context of international security which have been convened at the request of the General Assembly: 2004–2005, 2009–2010, 2012–2013, 2014–2015 and 2016–2017. They have provided, and continue to provide, an important venue for discussion on issues relating to issues such as cybersecurity as well as the measures that are needed to address them.²⁸

The number of experts within the GGE has varied from one GGE to another, with 15 members in the first three GGEs, 20 in the fourth and 25 in the current group. According to a UNIDIR report on these GGEs, experts increasingly come from a diplomatic background rather than a technical background.²⁹ These GGEs meet for four one-week sessions during which they discuss various topics set out by the General Assembly resolution mandate and produce a report if they manage to reach a consensus. Consensus in this context is considered to be very important for setting the global agenda on cybersecurity.³⁰

The 2016–2017 GGE whose last meeting took place in June 2017 was unable to reach a consensus on its report resulting in only a procedural report being sent to the Secretary-General.³¹

L. Comprehensive Nuclear Test-Ban Treaty

Before and during the Comprehensive Nuclear Test-Ban Treaty (CTBT) negotiations, a Group of Scientific Experts (GSE), also known as the Ad Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and to Identify Seismic Events, was established in 1976 by the United Nations Conference on Disarmament and became continuous in 1982 until they disbanded in 1996 when the CTBT was signed.³²

The GSE, which met 45 times over a 20-year period, was made up of scientists from different member states represented at the Conference on Disarmament. They reported periodically to the Conference on Disarmament plenaries. They conducted three technical tests that provided the basis for the seismic network of primary and auxiliary stations, and they laid the groundwork for the International Monitoring System and the International Data Centre.³³

M. Peaceful Uses of Outer Space (COPUOS)

In 1959, the UN General Assembly established the Committee on the Peaceful Uses of Outer Space (COPUOS) in Resolution 1472 (XIV). This committee identified areas for international co-operation in the peaceful uses of outer space, devised programmes to be undertaken by the United Nations, encouraged research on matters relating to outer space, and studied legal problems arising from the exploration of outer space. During the 1960s and 1970s a number of agreements were adopted to prevent the weaponization of outer space.³⁴

In 2011, the General Assembly adopted resolution A/RES/65/68 which called upon the Secretary-General to establish a group of governmental experts (GGE) to conduct a study on outer space transparency and confidence-building measures (TCBMs).

The GGE held three sessions: the first and third sessions in New York from 23 to 27 July 2012 and from 8 to 12 July 2013 respectively and the second session in Geneva from 1 to 5 April 2013. Experts from 15 countries contributed to the final output of the Group. The experts agreed on a set of substantive TCBMs for outer space activities and recommended that States consider and implement them. Furthermore, the Group took stock of numerous proposals from governments and changes in the political and technological environment. The Group submitted its report (A/68/189*) to the General Assembly at its 68th session.³⁵

N. Wassenaar Arrangement

The Wassenaar Arrangement has been established in order to contribute to regional and international security and stability, by promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies. The Plenary establishes subsidiary bodies for the preparation of recommendations for decisions and calls ad hoc meetings for consultations on issues related to the functioning of the Wassenaar

Arrangement. At present, the main Wassenaar Arrangement subsidiary bodies are: The General Working Group (GWG) dealing with policy-related matters, and the Experts Group (EG) which addressing issues related to the lists of controlled items and proposes annual technical updates of the control lists.³⁶

O. Nuclear Suppliers Group (NSG)

The Nuclear Suppliers Group (NSG) is a group of nuclear supplier countries that seeks to contribute to the non-proliferation of nuclear weapons through the implementation of two sets of Guidelines for nuclear exports and nuclear-related exports. The Consultative Group (CG) meets at least twice a year and is tasked to hold consultations on issues associated with the Guidelines on nuclear supply and its technical annexes.³⁷

P. European Commission's Group of Scientific Experts on the fight against biological and chemical terrorism

Following the 9/11 and anthrax attacks of 2001, the European Council tasked the EU Council and the Commission to 'prepare a program to improve the cooperation between member states for the evaluation of risks, alerts and interventions', which should cover 'the detection and identification of infectious and toxic agents as well as the prevention and treatment of chemical and biological attacks'.³⁸

As part of this initiative, the Commission established a Group of Scientific Experts (GSE) on the fight against biological and chemical terrorism which brought together members from the ministries of research and defence of the EU's member states. The GSE was to 'draw up an inventory of research activities currently in progress, examine how these activities can best be mobilized and coordinated and identify what gaps there are and what additional research is needed'.³⁹

The GSE co-operated with the European Commission's Joint Research Centre (JRC)'s working group on bio-response and presented a progress report in March 2002 at the Research Council [Directorate-General Research and Innovation].⁴⁰

Q. European Commission's Group of Independent Scientific Experts to Study the Effects of Depleted Uranium

The European Commission's Environment Directorate-General enlisted a group of independent scientific experts to study the effects of depleted uranium and to 'to advise on the protection of the health of workers and the general public against the dangers arising from ionising radiation'. They were established according to Article 31 of the Euratom Treaty and met during two sessions in January and February 2001.⁴¹

The group was made up of 35 physicians, chemists and nuclear scientists from Member States. They produced a report which was published by the Commission on 6 March 2001 and concluded that ‘on the basis of available information, exposure to depleted uranium could not produce detectable health effects’.⁴²

Groups in fields other than security

R. EU Joint Action on Mental Health and Wellbeing—Group of governmental experts on mental health and well-being

The EU Joint Action on Mental Health and Wellbeing is a three-year initiative that aims at building a framework for action in mental health policy at the European level and builds on previous work developed under the European Pact for Mental Health and Wellbeing. A meeting of a Group of Governmental Experts on Mental Health and Well-being was held in Luxembourg on the 29-30th June 2015, the objectives of which was to share with representatives of the EU Member States a proposal for a framework of action on mental health developed in terms of the Joint Action on Mental Health and Wellbeing (JAMHWB).⁴³

S. The European Commission - Research, Innovation, and Science Policy Experts (RISE)

The European Commission established Research, Innovation, and Science Policy Experts (RISE) high level group (HLG) in June 2014, and renewed its mandate and membership in January 2016. RISE gives direct strategic support to the European Commissioner for research, innovation, and science and to the European Commission. It focuses on how to best use EU research, innovation, and science policy to address the European growth model and to create the conditions for growth that is smart, sustainable, and socially inclusive for the EU and associated countries within a globalised world.⁴⁴

T. Intergovernmental Group of Experts (IGE) on Competition Law and Policy

The Intergovernmental Group of Experts (IGE) on Competition Law and Policy is a standing body established under the United Nations Set of Multilaterally Agreed Equitable Principles and Rules for the Control of Restrictive Business Practices (UN Set) to monitor the application and implementation of the Set. Each year, the IGE meets to discuss ways of improving worldwide co-operation on competition policy implementation and enhancing convergence through dialogue. Rather than exercising any rule-making function, the IGE conducts its work through:

- Interactive debates
- Voluntary Peer Review of Competition Law and Policy

- Roundtables on specialised competition topics
- Reviews of technical assistance and capacity-building activities

When consensus on recommendations is reached, individual member countries decide whether and how to implement the recommendations (i.e. through unilateral, bilateral or multilateral arrangements, as appropriate).⁴⁵

U. Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC. The IPCC reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. As an intergovernmental body, membership of the IPCC is open to all member countries of the United Nations (UN) and WMO. Thousands of scientists from all over the world contribute to the work of the IPCC. Review is an essential part of the IPCC process, to ensure an objective and complete assessment of current information. IPCC aims to reflect a range of views and expertise. The Secretariat coordinates all the IPCC work and liaises with Governments.⁴⁶

Because of its scientific and intergovernmental nature, the IPCC embodies a unique opportunity to provide rigorous and balanced scientific information to decision makers. By endorsing the IPCC reports, governments acknowledge the authority of their scientific content. The work of the organization is therefore policy-relevant and yet policy-neutral, never policy-prescriptive.

The IPCC Trust Fund was established in 1989 by the Executive Director of UNEP and the Secretary-General of WMO. The IPCC Trust Fund finances the Panel and its activities. Adoption of the budget of the IPCC Trust Fund is the responsibility of the Panel.

V. Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)

The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is an advisory body, established in 1969, that advises the United Nations (UN) system on the scientific aspects of marine environmental protection.

At present GESAMP is jointly sponsored by nine UN organizations with responsibilities relating to the marine environment, and they utilize GESAMP as a mechanism for coordination and collaboration among them.

GESAMP functions are to conduct and support marine environmental assessments, to undertake in-depth studies, analyses, and reviews of specific topics, and to identify emerging issues regarding the state of the marine environment. GESAMP itself today consists of 16 experts, drawn from a wide range of relevant disciplines, who act in an independent and individual capacity. Studies and assessments are usually carried out by dedicated working groups, most of whose members are not sitting members of GESAMP but part of the broader GESAMP network.

To fulfil its mission, and as part of its Work Programme GESAMP will upon request:

- Integrate and synthesize the results of regional and thematic assessments and scientific studies to support global assessments of the marine environment;
- Provide scientific and technical guidance on the design and execution of marine environmental assessments; and
- Provide scientific reviews, analyses, and advice on specific topics relevant to the condition of the marine environment, its investigation, protection, and/or management.

In addition, GESAMP will regularly:

- Provide an overview of the marine environmental monitoring, assessment, and related activities of UN agencies and advise on how these activities might be improved and better integrated and coordinated; and
- Identify new and emerging issues regarding the degradation of the marine environment that are of relevance to Governments and Sponsoring Organizations.⁴⁷

Annex F: Selection of VERTIC material relating to nuclear disarmament verification

The IAEA and nuclear disarmament verification: a primer

Hugh Chalmers

Matters no. 11, September 2015

This primer seeks to facilitate an informed debate at domestic and international levels on the challenges and opportunities of multilateral verification of disarmament through the IAEA. It aims to strengthen capacity among IAEA Member States and other stakeholders in verified nuclear disarmament by providing the reader with an introduction to the main issues associated with an IAEA role in nuclear disarmament verification.

Member state views on an IAEA role in verifying nuclear disarmament

Hugh Chalmers

Matters no. 10, September 2015; Survey Results Table, September 2015

VERTIC has conducted a survey of International Atomic Energy Agency (IAEA) member states to provide a more detailed and standardised assessment of views on an agency role in disarmament verification. The survey examines views on the steps the agency should take to equip itself for this role, and the types of support member states are prepared to give towards this end.

Exploring multilateral verification of nuclear disarmament: scenarios, modelling and simulations

Hugh Chalmers, David Keir, Larry MacFaul, Russell Moul and Alberto Muti

Matters no. 12, November 2015

The report provides a guide for developing simulation exercises to consider the technical, legal and political challenges involved in verifying nuclear disarmament. It explains how creating nuclear disarmament ‘scenarios’ and technical models of nuclear programmes can provide detailed and holistic environments in which to run these simulations. It also discusses questions that need to be addressed while exploring disarmament verification options to ensure that any proposed solutions are reliable, coherent, trusted and accessible.

Nuclear disarmament verification: the case for multilateralism

David Cliff, Hassan Elbahtimy, David Keir and Andreas Persbo

Brief no. 19, April 2013

In this brief, the case for multilateral involvement in nuclear disarmament verification is discussed, with reference to VERTIC’s ongoing capacity-building effort with non-nuclear-weapon states and intergovernmental organisations. This project has been running since 2011, with the objective of consolidating a role for the IAEA in disarmament verification, as well as reviewing the requirements of verification technology.

Multilateral verification: Exploring new ideas

David Cliff and David Keir

Brief no. 17, January 2012

This paper, by David Cliff and David Keir, outlines new thinking in the realm of multilateral disarmament verification and considers the arguments for incorporating multilateralism into future verified disarmament processes.

Verifying multilateral regimes: uncertain futures

Yasemin Balci

Brief no. 15, August 2011

This brief summarizes the discussions and conclusions of participants attending VERTIC's recently-held 25-year anniversary conference. The meeting, 'Uncertain futures: where next for multilateral verification?', discussed the operation and future direction of multilateral verification regimes. It was hosted by Wilton Park in Steyning, West Sussex, from 1–3 June 2011.

The CTBT: Verification and Deterrence

John R. Walker

Brief no. 16, October 2011

This brief looks at the capabilities of the CTBT's verification regime and the role of that regime in deterring clandestine nuclear testing. Dr Walker argues that in the context of CTBT verification, 'negotiators designed an integrated system that will clearly complicate the plans of any state thinking that it could evade that system and derive a meaningful political, military or strategic advantage from doing so.' He writes that the treaty's verification 'presents a formidable set of obstacles for a would-be violator to surmount.' That in turn, Dr Walker argues, plays an important role in deterring parties from attempting to evade the treaty in the first place.

Verified warhead dismantlement: past, present, future

David Cliff, Hassan Elbahtimy, Andreas Persbo

Matters no. 9, September 2010

The UK-Norway Initiative was not the first effort to look into dismantlement verification; nor will it be the last. Comparing the Initiative's strengths and limits with initiatives of the past seemed a good way to highlight its unique features, to explore which verification solutions might work in real-world scenarios, and to identify gaps in the current body of research.

Annex G: Resolution A/RES/71/67—Nuclear Disarmament Verification

The General Assembly,

Recalling the Final Document of the Tenth Special Session of the General Assembly, the first special session devoted to disarmament,¹ in particular the paragraphs relevant to verification, and the roles and respective mandates of the disarmament machinery bodies established therein,

Recalling also the decisions taken and commitments made by States parties at the 1995 Review and Extension Conference² and the 2000³ and 2010⁴ Review Conferences of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons related to nuclear disarmament verification,

Reaffirming the shared commitment to further progress in nuclear disarmament and non-proliferation,

Reiterating its deep concern at the catastrophic humanitarian consequences of any use of nuclear weapons, and reaffirming the need for all States at all times to comply with applicable international law, including international humanitarian law,

Recalling the unequivocal undertaking of the nuclear-weapon States to accomplish the total elimination of their nuclear arsenals leading to nuclear disarmament, to which all States parties to the Treaty on the Non-Proliferation of Nuclear Weapons⁵ are committed under article VI thereof,

Recalling also that significant steps by all the nuclear-weapon States leading to nuclear disarmament should promote international stability, peace and security, and be based on the principle of increased and undiminished security for all,

Recalling further that all States parties to the Treaty commit to apply the principles of irreversibility, verifiability and transparency in relation to the implementation of their treaty obligations,

Convinced that, while verification is not an aim in itself, further development of the multilateral nuclear disarmament verification capabilities will be required to provide assurance of compliance with multilateral nuclear disarmament agreements for the achievement and maintenance of a world without nuclear weapons,

Convinced also that, irrespective of different positions on the means to achieve the total elimination of nuclear weapons, identifying and developing practical and effective measures of nuclear disarmament verification and monitoring will foster confidence and facilitate efforts to achieve and maintain a world without nuclear weapons,

Recalling its resolution 62/21 of 5 December 2007 on verification in all its aspects, including the role of the United Nations in the field of verification, in which it took note of the report of the Panel of Government

Experts on verification in all its aspects, including the role of the United Nations in the field of verification,⁶ as well as the reports of the Secretary-General of 1990 and 1995,⁷ and recalling also the report of the Disarmament Commission outlining general principles elaborated upon or added to those stated in the Final Document of the Tenth Special Session of the General Assembly,⁸

Recalling also that the International Atomic Energy Agency, in carrying out its functions, shall conduct its activities in accordance with the purposes and principles of the United Nations to promote peace and international cooperation, and in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and with any international agreements entered into pursuant to such policies,

Mindful of the role of verification in existing bilateral and multilateral disarmament, non-proliferation and arms control agreements, and the importance of making use of existing capabilities of relevant international organizations and experiences and lessons learned, as appropriate,

Mindful also that, given the challenges associated with verifying nuclear disarmament, continuous capacity-building and technical development are critical to bridging any shortcomings and establishing effective multilateral nuclear disarmament verification,

Noting initiatives and partnerships among Member States, such as the initiative of Norway and the United Kingdom of Great Britain and Northern Ireland and the International Partnership for Nuclear Disarmament Verification, to enable active collaboration between States, in conformity with their international obligations, in developing practical methods that could contribute to the verification of irreversible dismantlement of nuclear weapons,

Noting also the contribution of representatives of civil society from the non-governmental, academic and research communities,

1. *Calls for* further efforts to reduce and eliminate all types of nuclear weapons, and reaffirms the unequivocal undertaking of the nuclear -weapon States to accomplish the total elimination of their nuclear arsenals;
2. *Reaffirms* that disarmament and arms limitation agreements should provide for adequate measures of verification satisfactory to all parties concerned in order to create the necessary confidence and ensure that they are being observed by all parties, and notes the development of broader partnerships and cooperative verification arrangements;
3. *Calls upon* all States to work together to identify and develop practical and effective disarmament verification measures facilitating the objective of achieving and maintaining a world without nuclear weapons

through, inter alia, advancing, understanding and addressing technical challenges of nuclear disarmament verification and monitoring, including tools, solutions and methods and capacity-building;

4. *Calls for* the development and strengthening of practical and effective nuclear disarmament verification measures, which will build confidence and facilitate the advancement of nuclear disarmament efforts, and affirms in this context the importance of credible verification in providing assurance of compliance with nuclear disarmament and non-proliferation obligations and commitments;
5. *Encourages* the Conference on Disarmament and the Disarmament Commission to substantively address nuclear disarmament verification;
6. *Requests* the Secretary-General to seek the views of Member States on the development and strengthening of practical and effective nuclear disarmament verification measures and on the importance of such measures in achieving and maintaining a world without nuclear weapons, and to report back to the General Assembly at its seventy-second session;
7. *Also requests* the Secretary-General to establish a group of governmental experts of up to 25 participants on the basis of equitable geographical distribution to consider the role of verification in advancing nuclear disarmament, taking into account the aforementioned report, which will meet in Geneva in 2018 and 2019 for a total of three sessions of five days each;
8. *Decides* to include in the provisional agenda of its seventy-second session, under the item entitled 'General and complete disarmament', a sub-item entitled 'Nuclear disarmament verification'.

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Endnotes

Main text

- 1 Organisation for the Prohibition of Chemical Weapons, Genesis and Historical Development <https://www.opcw.org/chemical-weapons-convention/genesis-and-historical-development/> (Accessed 11 October 2017).
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- 3 W. H. Dunlop, 'The role of Group of Scientific Experts in facilitating better international relations, particularly in arms control', Lawrence Livermore National Laboratory, 2012.
- 4 Sandra Alwardt, 'The GSE and the negotiations for the CTBT in the historical context of the international scientific and political process of nuclear arms control', ZNF University of Hamburg, Occasional Paper, March 2009, <http://d-nb.info/1012102130/34> (Accessed 11 October 2017).
- 5 'About us'. UKNI. <http://ukni.info/about-us/> (Accessed 9 October 2017).
- 6 Statement delivered on behalf of the Quad promoting exercise to the 2017 Preparatory Committee for the 2020 Review Conference on the Treaty on the Non-Proliferation of Nuclear Weapons, (Vienna 2-12 May 2017), <https://papersmart.unmeetings.org/media2/14684342/uk-on-behalf-of-the-quad.pdf> (Accessed 13 May 2017).
- 7 U.S. Department of State, International Partnership for Nuclear Disarmament Verification (IPNDV), <https://www.state.gov/t/avc/ipndv/> (Accessed 1 October 2017).
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- 10 NNSA et al, 'Joint U.S.-U.K. Report on Technical Cooperation for Arms Control'.
- 11 Challenges to Deep Cuts'. Purpose. <http://deepcuts.org/purpose> (Accessed 17 April 2017).
- 12 Thomas B. Cochran, 'The Black Sea Experiment', a paper presented at 'From Reykjavik to New START: Science Diplomacy for Nuclear Security in the 21st Century', sponsored by the National Academy of Sciences Committee on International Security and Arms Control and the U.S. Institute of Peace Center of Innovation for Science, Diplomacy, and Peacebuilding Keck Center of the National Academies, Washington DC, USA, 19 January 2011, https://www.nrdc.org/sites/default/files/nuc_11020401a.pdf (Accessed 7 October 2017).
- 13 Thomas E. Shea and Laura Rockwood, 'IAEA Verification of Fissile Material in Support of Nuclear Disarmament', Cambridge, Mass.: The Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard University, May 2015, <http://www.belfercenter.org/sites/default/files/legacy/files/iaeverification.pdf?> (Accessed 22 April 2017).
- 14 Malte Göttsche and Götz Neuneck, 'Panel Discussion: Disarmament Verification – a Dialogue on Technical and Transparency Issues', *ESARDA Bulletin*, No. 50, December 2013, <http://www.princeton.edu/~malteg/SB1.pdf> (Accessed 2 August 2017).
- 15 Malte Göttsche, Moritz Kütt, Götz Neuneck and Irmgard Niemeyer, 'Advancing Disarmament Verification Tools: a Task for Europe?', *Non-Proliferation Papers*, No. 47, October 2015, <http://www.princeton.edu/~malteg/PP1.pdf> (Accessed 5 October 2017).

- 16 'Structure', https://esarda.jrc.ec.europa.eu/index.php?option=com_content&view=article&id=32&Itemid=199
(site currently under maintenance as of 9 October 2017).
- 17 Quoted in: David Cliff, Hassan Elbahtimy and Andreas Persbo, 'Verifying Warhead Dismantlement: Past, present, future', *Verification Matters*, Number 9, VERTIC: September 2010.
- 18 'Canada's views on nuclear disarmament verification.' Nuclear Disarmament Verification. <https://goo.gl/fs8vV1> (Accessed 29 September 2017). See 'views of member states,' submission no. 6 on page 5.
- 19 'Nuclear disarmament verification.' A/RES/71/67. 14 December 2016. <https://goo.gl/NxEjKD> (Accessed 29 September 2017).
- 20 'United Nations Office for Outer Space Affairs.' COPUOS. <https://goo.gl/zDTqzd> (Accessed 29 September 2017).
- 21 Explanation of vote of the Netherlands on text of Nuclear Ban Treaty, 07 July 2017. <https://www.permanentrepresentations.nl/latest/news/2017/07/07/explanation-of-vote-of-ambassador-lise-gregoire-on-the-draft-text-of-the-nuclear-ban-treaty> (Accessed 9 July 2017).
- 22 See the UN General Assembly's 1996 resolution A/51/182 G, for a list of sixteen verification principles, including the notion that all states have equal rights to participate in the process of international verification.
- 23 NPT/CONF.2010/50 (note 2), p. 24.
- 24 The last comprehensive survey of global spending on disarmament verification research and development was conducted in 2002, see Tom Milne, 'Global Spending on Nuclear Disarmament Verification Work'. *Verification Matters* No. 2, VERTIC: 2002. At that time, spending in the United States dominated.
- 25 For several years, individual researchers in Germany have met to discuss issues relating to nuclear disarmament verification. As a grouping they constitute the 'Nuclear Disarmament Verification Network' and include such organisations as Forschungszentrum Jülich, the Fraunhofer Institute for Technological Trend Analysis in Euskirchen as well as the Carl Friedrich von Weizsäcker Centre and the Institute for Peace Research and Security both at the University of Hamburg.
- 26 See: 'The IAEA and nuclear disarmament verification: a primer', *Verification Matters* No. 11, VERTIC: 2015.
- 27 'Strengthening the Effectiveness and Improving the Efficiency of Agency Safeguards.' September 2017. <<https://goo.gl/S6kUpo>>. GC(61)/RES/12. (Accessed 29 September 2017). See in particular, preambular paragraphs (p) and (q) as well as operative paragraph 20, which notes 'that the Agency must remain ready to assist, in accordance with its Statute, with verification tasks under nuclear disarmament or arms control agreements that it may be requested to carry out by the States parties to such agreements.'
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- 29 'Statement by the Governor of the Russian Federation, Vladimir I. Voronkov at the IAEA Board of Governors session on agenda item 'Any other business' in response to the invitation to the Agency to participate in negotiations on the development of a convention to prohibit nuclear weapons, Vienna, 12–15 June 2016.' *Foreign Policy News*. 19 June 2017. <https://goo.gl/nmJWxA>. (Accessed 3 October 2017).
- 30 'Delegates' Statements - Russia.' Statements and Key Addresses to IAEA General Conference. <https://goo.gl/dFRDnW> (Accessed 3 October 2017).
- 31 Consolidated Version of the Treaty Establishing the European Atomic Energy Community (English), 2010/C 84/01, issued 30 March 2010, <<https://goo.gl/AKTrcR>>. [Euratom Treaty], article 1.
- 32 Euratom Treaty, article 2 (a).
- 33 Euratom Treaty, article 2 (e).
- 34 Euratom Treaty, article 4.2.
- 35 While it is not unfeasible to imagine the Commission putting forward a proposal to this effect, achieving a qualified majority in the Council could be challenging. The United Kingdom exiting the European Union in March 2019 will change the makeup of the Council, however, making it easier—perhaps—to garner a qualified majority. However, serious challenges would remain.
- 36 'European Commission', EU Science Hub. 10 April 2017. <https://ec.europa.eu/jrc/en>. (Accessed 4 October 2017).
- 37 'JRC in brief - EU Science Hub - European Commission', EU Science Hub. July 18, 2016. <https://ec.europa.eu/jrc/en/about/jrc-in-brief>. (Accessed 4 October 2017).

- 38 See European Union. Shared Vision, Common Action: A Stronger Europe. June 2016. <https://goo.gl/WkZWLB>. A potential basis could be that the EU will, according to its shared vision, 'strongly support the expanding membership, universalisation, full implementation and enforcement of multilateral disarmament, nonproliferation and arms control treaties and regimes', p. 41.
- 39 ESARDA brings together European organisations involved in safeguards research through annual meetings and symposia, as well as the establishment of working groups focused on particular issues. There are 31 member organisations and 7 associated partners from the US, Switzerland and Norway. ESARDA's Ad hoc Group on 'Verification Technologies and Methodologies' continues to discuss and research verification issues, including the role of openness and transparency, verification regimes, inspection models; satellite imagery and environmental monitoring. During the 2013 ESARDA Symposium, a panel discussion on dismantlement verification discussed the potential benefit of multinational, and in particular European, technical engagement.
- 40 The African Commission on Nuclear Energy. <http://afcone.peaceau.org/en/> (Accessed 5 October 2017).
- 41 'Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (OPANAL).' Español. <http://www.opanal.org/en/home-2/> (Accessed 5 October 2017).
- 42 Scott D. Sagan, 'Shared responsibilities for nuclear disarmament.' *Daedalus* 138, No. 4, 2009 pp. 157-68. doi:10.1162/daed.2009.138.4.157. (see page 162).
- 43 Scott D. Sagan, 'Shared responsibilities for nuclear disarmament.' *Daedalus* 138, No. 4, 2009 pp. 157-68. doi:10.1162/daed.2009.138.4.157. (see page 165). In light of these arguments, it is paradoxical that only one nuclear armed state *outside* the NPT abstained from voting on resolution 67/71 (DPRK), whereas two armed states *within* the NPT abstained (China and the Russian Federation).
- 44 See resolutions 57/63 of 22 November 2002, 58/44 of 8 December 2003, 59/69 of 3 December 2004, 60/59 of 8 December 2005, 61/62 of 6 December 2006, 62/27 of 5 December 2007, 63/50 of 2 December 2008, 64/34 of 2 December 2009, 65/54 of 8 December 2010, 66/32 of 2 December 2011, 67/38 of 3 December 2012, 68/38 of 5 December 2013, 69/54 of 2 December 2014 and 70/31 of 7 December 2015.
- 45 Moreover, it is quite difficult to ascertain how wedded these governments are to the concept of multilateralism, especially in light of governmental attitudes to the role of the International Atomic Energy Agency in disarmament verification.
- 46 The DPRK voted against resolution 86, while India abstained.
- 47 For instance, only the Peoples' Republic of China, Democratic People's Republic of Korea, Pakistan and the Russian Federation abstained from voting on UNGA Resolution 71/67 on disarmament verification. Israel and India voted for it, and so did the France, the United Kingdom and the United States. See United Nations. <https://gafv-vote.un.org/UNODA/vote.nsf> (Accessed 16 October 2017).
- 48 First, as these countries are not states parties to the NPT, they cannot be bound to any decisions or recommendations made by any NPT Review Conference. They were, after all, not involved in crafting these decisions. Second, anecdotal evidence suggests that these countries would be hesitant to join an initiative explicitly referring to the NPT, out of concern that this may signal an intention to be bound by decisions made by the NPT membership.
- 49 However, it may have the opposite effect as well. An initiative that *does not* refer to commitments undertaken under the NPT could force NPT-members keen to protect the integrity of that agreement (for whatever reason) to oppose it.
- 50 Countries such as Argentina, Brazil, People's Republic of China, Iran, Mexico and South Africa, all with stated interests in nuclear disarmament verification, are listed as 'upper middle income' on the OECD DAC List of ODA Recipients. Countries such as Egypt, India and Pakistan are listed as 'lower middle income.' The Democratic People's Republic of Korea is listed as 'other low income' country, but direct assistance is likely to be complicated by the United Nations sanctions regime.
- 51 See 'Science and Technology 2017.' CTBT: Science and Technology 2017: CTBTO Preparatory Commission. <https://www.ctbto.org/specials/snt2017/> (Accessed 17 October 2017).
- 52 David Cortright and Raimo Väyrynen. *Towards nuclear zero*. Abingdon: Routledge, 2010 p. 155.
- 53 'United Kingdom - Norway Initiative.' UKNi. <http://ukni.info/> (Accessed 3 October 2017).
- 54 'International Partnership for Nuclear Disarmament Verification.' Nuclear Threat Initiative – Ten Years of Building a Safer World. <https://goo.gl/HMwdcF> (Accessed 3 October 2017).
- 55 See: Martin Rioux-Lefebvre, Andrew Newman and Andrew Bieniawski, 'Progress Under the International Partnership for Nuclear Disarmament Verification', 4 July 2017, http://www.nti.org/media/documents/NTI_INMM_IPNDV_Paper_Jul2017.pdf (Accessed 10 July 2017).
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- 58 Robert Floyd, *The Standing Advisory Group on Safeguards Implementation (SAGSI)*. PPT. Australian Safeguards and Non-Proliferation Office, 23 October 2014. <https://goo.gl/w7W6SH>
- 59 'Advisory Board on Disarmament Matters – UNODA.' United Nations. <https://www.un.org/disarmament/institutions/advisoryboard/> (Accessed 9 October 2017).
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Annex B

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- 2 General Assembly resolution 62/21, *Verification in all its aspects, including the role of the United Nations in the field of verification*, A/RES/62/21 (5 December 2007), available from www.undocs.org/A/RES/62/21
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- 5 United Kingdom – Norway Initiative, <http://ukni.info/>
- 6 International Partnership for Nuclear Disarmament Verification, <http://www.nti.org/about/projects/international-partnership-nuclear-disarmament-verification/>
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Annex C

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- 3 Ramaker, 'The Final Test', 4-5.
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Annex D

- 1 This list and description has been compiled from various internet sources and is not intended to be comprehensive nor has the information been analysed in detail or verified as completely current.
- 2 Thomas B. Cochran, The Black Sea Experiment, a paper presented at 'From Reykjavik to New START: Science Diplomacy for Nuclear Security in the 21st Century, sponsored by the National Academy of Sciences Committee on International Security and Arms Control and the U.S. Institute of Peace Center of Innovation for Science, Diplomacy, and Peacebuilding Keck Center of the National Academies, Washington DC, USA, 19 January 2011 https://www.nrdc.org/sites/default/files/nuc_11020401a.pdf
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- 7 US National Nuclear Security Administration (NNSA), US Office of Nonproliferation and Arms Control (NPAC), UK Ministry of Defence and AWE, 'Joint U.S.-U.K. Report on Technical Cooperation for Arms Control', (May 2015), https://nnsa.energy.gov/sites/default/files/Joint_USUK_Report_FINAL.PDF
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- 11 The UK - Norway Initiative: Report on the UKNI Non-Nuclear Weapon States Workshop (7-9 December 2011) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/28423/120426_2011_ukni_workshop_final_rpt.pdf; See also: David Keir and Russell Moul, 'Investigating multilateral verification of nuclear disarmament: fuel cycle modelling for simulations', <http://www.vertic.org/media/assets/VI%202015/VI%20Chapter%205.pdf>
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- 13 U.S. Department of State, International Partnership for Nuclear Disarmament Verification (IPNDV), <https://www.state.gov/t/avc/ipndv/>
- 14 U.S. Department of State, International Partnership for Nuclear Disarmament Verification (IPNDV), <https://www.state.gov/t/avc/ipndv/>
- 15 Nuclear Threat Initiative, 'Monitoring and Verification Resource Collection', <http://www.nti.org/analysis/reports/verification-resource-collection/>
- 16 Challenges to Deep Cuts, 'Purpose', <http://deepcuts.org/purpose>
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- 18 Malte Göttsche and Götz Neuneck, 'Panel Discussion: Disarmament Verification – a Dialogue on Technical and Transparency Issues', *ESARDA Bulletin*, no.50 (December 2013), <http://www.princeton.edu/~malteg/SB1.pdf>
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- 21 Göttsche and Neuneck, 'Panel Discussion: Disarmament Verification'.

Annex E

- 1 This list and description in not intended to be comprehensive and has been compiled from various websites and other online sources. No detailed
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