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Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Overview

About the Verification Pilot Project

The Verification Pilot Project of the Nuclear Threat Initiative (NTI) convened technical and policy experts from around the world to develop recommendations for new approaches to verification that could enable future progress on arms reductions. As the two-year project moved forward, it became clear that innovating verification could also prompt near-term progress on non-proliferation and nuclear security.

NTI partnered with senior leaders from the U.S. Departments of Defense, Energy, and State as well as the governments of Norway, Sweden, and the United Kingdom. That dialogue identified the key challenges that became the subjects of the project's three expert working groups, which included more than 40 technical and policy experts from a dozen countries. *Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks* includes an overview and reports from the three working groups:

- The *Innovating Verification Overview* includes a foreword by Sam Nunn, NTI's chief executive officer and co-chairman, and key project findings and recommendations across report topics.

- *Verifying Baseline Declarations of Nuclear Warheads and Materials* analyzes how baseline declarations can contribute to near- and long-term arms control and non-proliferation goals and how to verify them without compromising sensitive information.

- *Redefining Societal Verification* explores how advances in information technologies, big data, social media analytics, and commercial satellite imagery can supplement existing verification efforts by governments and increase contributions from outside experts.

- *Building Global Capacity* considers the value of expanded international participation in the verification of nuclear arms reductions and how this participation can increase confidence in nuclear threat reduction efforts among all states.

The project builds on *Cultivating Confidence: Verification, Monitoring, and Enforcement for a World Free of Nuclear Weapons* (Nuclear Threat Initiative, 2010), which outlined key issues that states need to address to ensure that nuclear weapons reductions can proceed in a safe and transparent manner.

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ABOUT THIS PUBLICATION

This is a summary of a four-report series, *Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks*. To download the other three reports, visit nti.org/innovatingverification or send an e-mail to contact@nti.org for print copies.

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Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Verifying Baseline Declarations of Nuclear Warheads and Materials

PART OF THE *Cultivating Confidence Verification Series*

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Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Redefining Societal Verification

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Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Building Global Capacity

PART OF THE *Cultivating Confidence Verification Series*

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Foreword

By Sam Nunn

I t has been more than a quarter century since Ronald Reagan invoked the Russian proverb "trust but verify." Implicit in the saying is that if we strengthen verification, trust will be reinforced.

But are we prepared for verification today? How effective will verification approaches be in the future if we are not innovating new technologies and accounting for developments in the political and security environment?

Political will, innovation, and resources are prerequisites for robust verification—the kind that can both ensure stability and enable sweeping progress for global security. What's more, innovative approaches to verification can build confidence, transform thinking about what is possible to reduce nuclear risk, and spark political momentum.

Today, the conditions are not in place to achieve the necessary leaps forward, and more countries need to engage in developing them. States should be committed to building a set of technologies and activities that can support monitoring and verification of agreements—whether they aim to detect an illicit nuclear program or to ensure that promised dismantling of weapons is accomplished.

At this time, only a few countries—particularly the United States and Russia—have deep experience with nuclear disarmament verification. The rest of the world's capacity to meaningfully engage in verifying an arms reduction treaty is limited. For example, even if countries reached agreement tomorrow on a Middle East weapons of mass destruction-free zone, none of the regional actors would have the capacity or experience to verify it. What's more, solving regional nuclear challenges, like those in Iran and North Korea, will be more likely if their neighbors can play a role and be confident in verification.

Engaging more countries would build confidence in nuclear threat reduction and global security. The ongoing cooperation between Norway and the United Kingdom on nuclear warhead dismantlement verification is evidence that this type of collaboration can be done successfully.

Ultimately, robust verification is in every country's national security interest. Without it, the international community will never gain confidence that a state is complying with its commitments. When nuclear weapons or materials are involved, that lack of confidence undermines global security and can derail or stall the momentum of arms reductions or other nuclear threat reduction efforts. In short, verification can serve as the brake or the engine for arms control, and much greater capacity and participation are needed now and in the future for long-term success.

Verification can serve as the brake or the engine for arms control, and much greater capacity and participation are needed now and in the future for long-term success.

Innovating Verification: New Tools and New Actors to Reduce Nuclear Risks is the product of NTI's Verification Pilot Project, which involved three working groups comprising more than 40 experts from a dozen countries. We at NTI are grateful to members of these working groups for their valuable inputs and for the time and energy they committed to this series of reports.

While emphasizing the great progress made, the reports identify and predict gaps in the world's ability to verify future arms reductions—from global capacity and technical tools to national infrastructures. This fundamental finding leads to NTI's recommendation for an international initiative to develop verification approaches for the future. A sense of urgency and common purpose around this crucial task could build confidence and reignite resolve on nuclear threat reduction, regardless of the near-term prospects for traditional arms control.

These near-term prospects are daunting. Given the serious challenges in today's global security environment and the lack of trust in the Euro-Atlantic region in particular, some may argue that this is not the right time to undertake cooperative development of verification approaches. My experience with Senator Richard Lugar underscores that cooperation in a time of low trust is more difficult but more essential. Twenty-three years ago, we proposed the Nunn-Lugar Cooperative Threat Reduction program, a joint U.S.-Russian effort to help Moscow and the former Soviet states secure weapons, materials, and know-how when the Cold War ended and the weapons and materials were scattered across many countries and time zones.

It took a lot of effort and time to convince essential participants that securing and eliminating these materials was not a zero-sum game but a win–win for our nations and for the world. Despite a massive trust deficit after the Berlin Wall came down and at various periods since, Russian and U.S. defense workers, scientists, and members of the military over time learned to work together; for more than two decades, they verifiably destroyed thousands of nuclear weapons and delivery vehicles, secured and eliminated thousands of bombs' worth of nuclear material, and developed new areas for scientific and technical cooperation.

This work continues today.

As the numbers of nuclear weapons in the world decline, the consequences of uncertainty grow more profound, and verification becomes even more important. The crises in Syria and Ukraine show that verification has continuing and growing relevance for building political and public trust. Building this capacity improves accountability and spreads responsibility among more states to determine whether their allies and adversaries are matching their deeds to their words and pledges.

If we postpone the development of new approaches to verification, new arms reduction efforts will stall, and creating the conditions for a world without nuclear weapons will become even more difficult. Active steps on verification can strengthen non-proliferation and nuclear security in the near term and catalyze new arms reduction commitments in the longer term and are essential.

If we are to build the trust required for a safer world, verification efforts and improvements must be a top priority and must move to the front burner.

Sam Nunn
Co-Chairman and Chief Executive Officer
Nuclear Threat Initiative

Innovating Verification: Findings from the Verification Pilot Project

Every six months, the United States and Russia exchange detailed information about the numbers and locations of their strategic nuclear weapons. Eighteen times a year, highly trained U.S. and Russian inspectors visit each side's intercontinental ballistic missile, submarine, and air bases to verify the accuracy of the exchanged information and track any movements. Inspectors analyze site diagrams and reference points for geographic coordinates as they inspect sites, taking measurements and photographs and at times observing the elimination or conversion of certain weapon systems. Every detail, down to the equipment used and place of entry for the inspection team, is carefully coordinated and backed up by a robust system of rules and protocols. Staffers at the Nuclear Risk Reduction Center—a 24-hour watch center in Washington, D.C., with a counterpart in Russia—transmit data exchanges, inspection information, and notifications. Procedures are in place if either side needs to convene the Bilateral Consultative Commission to resolve questions or unforeseen issues. Stipulations ensure that each country can use its own national capabilities, including satellites and intelligence sources, to gather information free from interference.

Those actions, undertaken by negotiators, inspectors, and specialists, are part of the verification process outlined in the New Strategic Arms Reduction Treaty (New START) treaty. This process enables both sides to enter into the agreement confidently and reduce their nuclear weapons arsenals cooperatively. The verification and monitoring process in New START builds on experience and lessons learned from previous treaties, as well as from collaborative, professional working relationships that have fostered

predictability and stability, even during times of tension and disagreement between the two countries, which hold more than 90 percent of the world's nuclear weapons.

Verification measures are implemented around the world every day for commitments related to nuclear and chemical weapons, nuclear material, and other military activities. Inspectors use an extensive toolkit of instruments, techniques, and methods—including data exchanges, on-site inspections, tags and seals, containment and surveillance equipment, and environmental sampling—to verify compliance with a range of bilateral and multilateral agreements. The International Atomic Energy Agency, tasked with detecting the misuse of nuclear material or technology, dispatches international teams of safeguards inspectors to collect data at more than 1,200 facilities worldwide. Experts from the Organization for the Prohibition of Chemical Weapons oversee the destruction of chemical stockpiles and routinely inspect sites.

Such verification systems and methods are crucial to managing risks and mitigating threats, but gaps remain. The United States and Russia may further reduce their arsenals, which could include some types of weapons and delivery vehicles for the first time, requiring new verification approaches. More countries may decide to reduce their stockpiles, involving new players in a verification system. Countries may begin to accept limits on smaller items or materials that are more difficult to count—again requiring new, innovative tools. And the international community is anticipating the expansion of civilian nuclear power programs, possibly including sensitive enrichment and reprocessing capabilities. All of these changes will occur against a backdrop of quickly developing technologies and faster information flows that may demand more nimble government action.

Innovating verification is, therefore, a crucial mission for the international community. The mission is not just about solving technical problems—although more research and development is needed. Global verification efforts undertaken by countries now will boost global confidence, build political will, and address current nuclear non-proliferation and security challenges, in addition to building the toolkit for future arms reductions.

VERIFICATION AS A TOOLKIT

At its core, verification is a set of national and cooperative activities, tools, procedures, analytical processes, and fundamentally, judgments about what is happening with regard to specific activities defined in an agreement. No single approach by itself—on-site inspections, satellite imagery, data collection, or remote monitoring—will ever be enough. The sum of many complementary tools and techniques compose an effective verification system.

Experts from around the world gathered multiple times over two years as part of NTI's Verification Pilot Project.

As the numbers of nuclear weapons in the world decline, the consequences of uncertainty grow more profound. Verification approaches must evolve to account for new sources of information and technical tools, additional stakeholders, and issues such as cost and intrusiveness. Doubts and mistrust about verification can derail the momentum of key policy agendas. Without a commitment to assess and meet future verification needs, progress in nuclear reductions may sputter and stall. Inadequate verification can be the brake for arms control; appropriate verification can be an engine.

Verification can be used to meet policymakers' demands and to give them the confidence to engage in bilateral or multilateral negotiations, because they know they have the needed tools to ensure that all parties comply with agreements. Verification can also be used to create demand. Showing what is verifiable can strengthen the resolve of policymakers to seek new commitments or inspire new thinking on what is possible. Developing and implementing verification and monitoring activities may also increase transparency and build confidence in unilateral or non–legally binding commitments aimed at reducing nuclear threats.

VERIFIABLY REDUCING NUCLEAR DANGERS

In their groundbreaking series of op-eds in *The Wall Street Journal,* George Shultz, William Perry, Henry Kissinger, and Sam Nunn laid out their vision for working toward a world without nuclear weapons and outlined practical steps for states to reduce nuclear dangers and ultimately end them as a threat to the world. Their declaration reinvigorated a global debate on the role of nuclear weapons and ways to reduce nuclear dangers. As part of this effort, the Nuclear Threat Initiative (NTI), a non-profit, non-partisan organization, launched the Nuclear Security Project to support these statesmen and their mission.

One of NTI's key areas of focus has been to renew international thinking and innovation on stringent verification mechanisms, not only for a world without nuclear weapons, but for near-term policy priorities that are stalled and need a forward path. In 2010, NTI published a study, *Cultivating Confidence: Verification, Monitoring, and Enforcement for a World Free of Nuclear Weapons*, which explored the technical, political, and diplomatic challenges in this endeavour. The book outlined long-term issues that states need to address to ensure that nuclear weapons reductions can proceed safely and transparently.

In 2012, NTI created the Verification Pilot Project to deepen the analysis of issues that *Cultivating Confidence* explored. In partnership with senior leaders from the U.S. Departments of Defense, Energy, and State, as well as from the United Kingdom, Norway, and Sweden, the project sought to build knowledge and strengthen capacity for international verification efforts and future arms reductions goals, to build confidence between states with and without nuclear weapons, and to develop roadmaps for both technical and policy challenges that could be barriers to future progress.

Verification can be used to give policymakers confidence to engage in bilateral or multilateral negotiations, because they know they have the needed tools to ensure that all parties comply with agreements.

The project tackled a set of issues, scoped with input from senior policy leaders and technical experts, that would develop the foundations necessary to support future deep reductions of nuclear weapons globally, nuclear non-proliferation, and nuclear security. For example:

- There is no mechanism in place for tracking individual warheads or eventually accounting for all weapons-usable nuclear material.
- Advancements in big data and information analysis technologies could shed light on key activities and developments, but these tools are untested and not yet tailored to verification tasks.
- Key players are excluded from some verification arrangements or, in some cases, do not yet have the necessary expertise to participate.

These challenges set the foundation for the Verification Pilot Project's three expert working groups, which included more than 40 technical and policy experts from a dozen countries. The working groups met several times, both individually and collectively, and produced the following reports:

1. ***Verifying Baseline Declarations of Nuclear Warheads and Materials*** analyzes the potential for baseline declarations to help address near-term and long-term arms control and non-proliferation challenges, including the need to build confidence that there are no hidden nuclear warheads or materials. The working group focused on how baseline declarations could be verified without compromising sensitive information and on how such a process could build international technical capacity and trust over time.

2. ***Redefining Societal Verification*** explores how advancements in information technologies, big data, social media analytics, and commercial satellite imagery could supplement existing verification efforts by governments and increase contributions from outside experts.

3. ***Building Global Capacity*** considers the value of expanded participation in the verification of nuclear arms reductions and how this participation can increase confidence in nuclear threat reduction efforts among all states. The group also explored ways to build greater international capacity for verification and transparency so that interested countries would be prepared to actively participate in these efforts.

The two-year effort concludes with four reports: a separate report for each working group and this overview, which includes the executive summary for each report. Individual members of the working groups were not asked to endorse each and every finding and recommendation. Rather, NTI presents the reports in an attempt to fairly represent the discussions, debates, and conclusions of the highly qualified and committed individuals who participated. A list of the members of the working groups is included in each executive summary.

COMMON THEMES

Despite the diverse nature of the working groups' subject matter and participants' backgrounds, some common themes emerged independently from each group. These findings can serve as a foundation for future verification approaches and offer an outline for how the international community can begin to prepare for the verification challenges posed by future nuclear reductions. Specific recommendations for policymakers, technical developers, states with and without nuclear weapons, and the broader international community are included in the executive summaries of each working group report, but these common themes highlight issues that connect all of the project's working group deliberations and that apply to the broader international verification agenda.

Source: Kaveh Sardari

Working groups discuss findings and share ideas halfway through the two-year project.

1. The international community must work to build and sustain a global cadre of verification experts.

Despite decades of nuclear verification activities, primarily between the United States and Russia, the global expert base is limited. Years of inattention and underfunding has set back disciplines relevant to verification and monitoring. This deficiency is a crucial issue in the United States and Russia, and capacity is even less developed in other states.

All three working groups recommended that more states—both with and without nuclear weapons—should join international verification efforts to make them more effective and build confidence. To do this, all states must identify core competencies, build a cadre of experts, and seek to develop and participate in international verification efforts. Such an effort should include new bilateral technical exchanges and multilateral initiatives. The United Kingdom–Norway cooperative effort demonstrated how a state without nuclear weapons could participate in verifying the dismantlement of a nuclear weapon. Along these lines, one working group recommended that experts from different countries work jointly to develop new technical tools, allowing deeper understanding of verification processes and trust in outcomes.

2. Collaborative international work on verification should start now.

There is a lack of urgency in advancing verification policy and technical research. However, political change can happen quickly—even unexpectedly—and bold steps could be hindered if verification capacity lags behind policy appetites. New and proven verification tools and approaches can empower decisionmakers to press for action if they are confident that nuclear reductions can be successfully implemented, but these instruments take time to develop. Steps are needed at several levels and include preserving historical records, organizing internal agencies and departments to successfully manage verification processes, and jointly developing equipment for key monitoring tasks. These actions can create new tools and generate opportunities for nuclear threat reduction.

3. Future research and development should cross disciplines, communities, and nations.

All states have something to gain by expanding the circle of experts who can quantifiably verify the inventory and irreversibility of nuclear arms reductions.

Effective verification approaches require a diverse set of expertise and perspectives. Instrument developers need guidance from policymakers on what information equipment should deliver and what data must be protected in a measurement process. Data analysts need to work with data collection and legal experts to know what information is available and what rules govern its use. States with nuclear weapons need to understand concerns from states without nuclear weapons and determine what level of visibility into a verification process is needed for those states to have confidence that treaty commitments are being met.

Currently, excessive national, disciplinary, or institutional stovepiping hinder verification efforts and undermine even well-intended efforts to build capacity. For too long, the nuclear weapons verification community has seen its task as so unique and sensitive that it has isolated itself, thereby generating distrust and reducing the possibility for innovation. With appropriate regard for the protection of sensitive information, deliberate efforts to cross-fertilize—even outside the nuclear weapons arena—can lead to new solutions to difficult verification problems.

4. A new framework is needed for sensitive information.

Information about nuclear weapons can be extremely sensitive. Historically, however, the urge to protect sensitive information or keep technical development efforts secret has led to verification approaches being pursued in isolation, even among facilities within the same country. Each country has an opportunity to reevaluate what information is sensitive and should be protected and what information could be shared openly or on a limited basis.

For many states, engagement on these topics will be new. For others, new thinking may challenge the orthodoxy or counter long-held assumptions about what is possible to do, share, or explore. Challenging assumptions is necessary, taking into account that verification is intended to serve vital national security objectives. Therefore, it may prove valuable to reassess why a particular piece of information is considered classified or why access to a particular site is prohibited. In some cases, past decisions may be reinforced; in other cases, conclusions might change. Ten years ago, it would have been inconceivable that the United States and Russia would exchange global positioning system coordinates of nuclear delivery vehicles, but both sides determined that the interests of their countries were better served by sharing that information than by keeping it secret. A framework that considers the broader benefits of sharing certain information, in addition to any risks, will be crucial to making progress on even harder challenges.

5. No single verification approach is enough.

Only by layering verification tools and approaches and by rationally combining them can states build confidence in the overall system. No single verification tool is ever completely effective, and it is unrealistic to set this as a goal. Instead, the goal should be to build the strongest web of measures in which cheating is likely to be either detected or deterred.

Each working group identified areas in which the contribution of one of the other working groups was relevant. For example, the working group on baseline declarations recognized that the set of tools designed to identify undeclared warheads or materials had limitations, which might be addressed by the new approaches being reviewed in the societal verification working group. Verification instruments and techniques should be thought of together as a system that can give states the most confidence in the overall results.

6. Verification is an area where all can contribute.

Not all states have equal roles, equal access to information, or equal interest in participating in verification efforts. However, all states have something to gain by expanding the circle of experts who can quantifiably verify the inventory and irreversibility of nuclear arms reductions. All states within the Nuclear Non-Proliferation Treaty need to demonstrate their commitment to undertaking "effective measures" leading to general and complete disarmament. It is in the interest of all states with nuclear weapons to show the processes by which reductions can verifiably take place, including the pace of dismantlement and ultimate disposition of the components.

For states without nuclear weapons, a better understanding of and participation in the verification process can build confidence that states with nuclear weapons are meeting their commitments because their actions can be demonstrated rather than just asserted. For states in regions of tension, verification may help reduce uncertainties that under-
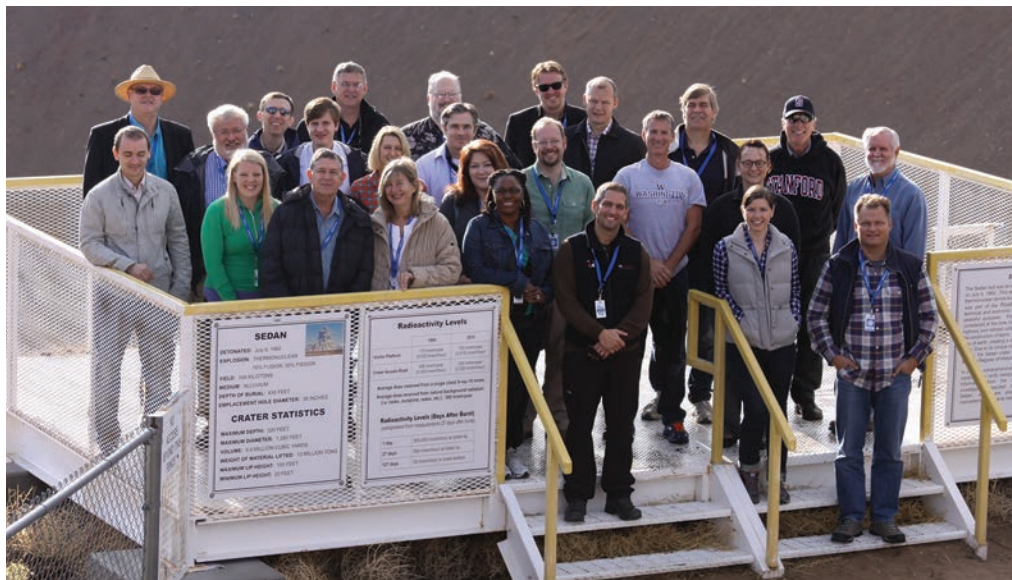
Source: Nevada National Security Site

Members of the Verification Pilot Project visited Sedan Crater at the Nevada National Security Site.

mine trust and lead to potentially dangerous decisions about nuclear weapons, technologies, and other activities pursued in the name of national security. Engagement in verification will be crucial for all states participating in regional nuclear weapon-free zones involving disarmament processes or implementing regional arms control efforts.

A WAY FORWARD

It is time for the international community to fundamentally rethink the way it designs, develops, and implements arms control verification approaches. An international initiative pursued with creativity, broad participation from states with and without nuclear weapons, and a sense of urgency and common purpose could make a significant contribution, regardless of the near-term prospects for traditional arms control efforts.

There is historical precedent for such work. Beginning in 1976, an international group of scientists and technical experts came together in the Group of Scientific Experts to support the negotiations of the Comprehensive Test Ban Treaty. The group was supported by governments and worked for more than 20 years to develop monitoring and verification technologies and data analysis methods for a comprehensive nuclear test ban. The process of international collaboration and the technical findings played a key role in building confidence among negotiators that they could conclude a treaty that

banned all nuclear test explosions and implement the verification necessary to support such treaty obligations.

An arms control or disarmament verification "experts group" should be broader than just technical experts, because non-technical monitoring procedures and issues such as protection of sensitive information will be key to developing politically acceptable verification approaches. States should come together now to begin an international process to assess verification gaps, to develop collaborative technical work streams, and to contribute to overall global nuclear threat reduction.

WORKING GROUP FINDINGS AND RECOMMENDATIONS

The following executive summaries offer a concentrated review of the scope and findings of the working groups. The issues and opportunities they outline are crucial, but they do not represent an exhaustive list of verification issues that require study, research, and development. A sustained international dialogue on a wide range of verification issues will be required to make meaningful progress.

Verification challenges can stall progress toward deep nuclear reductions. With the commitment of governments and the engagement of a growing cadre of professionals, however, verification can be the catalyst that inspires and empowers countries to make nuclear reductions and move toward a more secure world.

Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Verifying Baseline Declarations of Nuclear Warheads and Materials

VERIFYING BASELINE DECLARATIONS OF NUCLEAR WARHEADS AND MATERIALS

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Members of the Nuclear Threat Initiative's Verification Pilot Project endorse the general tenor of this report but were not asked to support each individual finding and recommendation. The views expressed in this report do not reflect those of the institutions with which the working group members are associated; their affiliations are listed for the purpose of identification only.

VERIFYING BASELINE DECLARATIONS OF NUCLEAR WARHEADS AND MATERIALS

Executive Summary

As states move to lower numbers of nuclear weapons and need the ability to detect and monitor smaller items and quantities of nuclear material, verification will become a more complex challenge. The full lifecycle—from material inventories, warhead assembly, and deployment to storage, dismantlement, and disposition—will eventually have to be monitored and verified, a task that will be extremely difficult if inspectors do not have detailed records of a state's total warhead and weapons-usable material inventory. Such records will take time to develop, and there are currently no agreed on mechanisms for recording, sharing, or verifying this information. Verifiable baseline declarations will be essential to filling this gap.

In 2012, the Nuclear Threat Initiative (NTI) charged a group of nearly 20 technical and policy experts with examining the issues and methods associated with verifying baseline declarations of nuclear warheads and weapons-usable materials. As part of NTI's Verification Pilot Project, the working group on verifying baseline declarations was divided into two subgroups. One analyzed warheads. The other studied nuclear materials.

The working group spent considerable time discussing what information a state might be required to declare up front and what exactly would constitute a baseline declaration. For this report, a baseline declaration is defined as an initial statement of the number or quantity of accountable items or materials—perhaps specified by parameters such as type or category—against which other information may be compared and future progress may be measured. Because the content, timing, and verification of an agreement that requires a baseline declaration would depend on which states were involved and how those states perceived the security environment, the working group did not try to prejudge the specific structure of future agreements and focused instead on arrangements that might be verified effectively.

Two Pantex production technicians work on a W76 warhead while a co-worker reads the procedure step-by-step.

VERIFIABLE BASELINE DECLARATIONS

A viable baseline declaration process could require states to declare the total sizes of their warhead and weapons-usable material inventories. Initially, this could be done in aggregate and be as simple as each state declaring three top-level numbers: the total inventories of warheads, highly enriched uranium (HEU), and separated plutonium. But because over time other states will need more confidence that these declarations are correct and complete, more detailed information would likely be required and subsequently corroborated by verification arrangements.

An agreement that at the outset requires a full inventory declaration, detailed accounts of items and material by type or use, and stringent verification protocols would be most effective. But if states prove reluctant to declare and verify this information in the near term, alternative arrangements could offer a path forward. More narrow verifiable baseline declarations could be a useful stepping stone for states that have not previously participated in arms control agreements and have limited experience with verification activities. For example, an agreement might only require the declaration and verification of a specific category of weapons, such as deployed or non-deployed warheads, or a subsection of a state's weapons-usable material holdings, such as plutonium recovered

through dismantlement of retired warheads. For states relatively new to the process, this could provide a foundation on which to build future verification efforts. Even if verifiable baseline declarations were not paired with an agreement to reduce warhead or material inventories, the process could strengthen confidence in advance of a negotiation and facilitate reciprocal reductions.

Informal declarations—those that occur outside the scope of formal agreements and are not verified—have some value in promoting transparency and confidence. This concept is not new. Some states have already informally declared detailed information about their weapon stockpiles and material holdings. The United States, France, and the United Kingdom have unilaterally declared the sizes of their nuclear arsenals. These measures can help establish data consistency over time. But formal baseline declarations—established cooperatively and including detailed verification provisions—would promote a much greater sense of security and stability and provide far better assurances for non–nuclear weapon states (NNWS).

An agreement that requires a full inventory declaration, detailed accounts of items and material, and stringent verification protocols would be most effective. But if states prove reluctant, alternative arrangements could offer a path forward.

VERIFYING WARHEAD DECLARATIONS

Accurate verification of warhead inventories is pivotal to any significant arms reduction process. Warhead verification will be challenging. There are three overarching requirements:

1. Authenticating that an item declared to be a warhead or warhead component is actually that.

2. Uniquely identifying each inventory item so that it is never counted twice or substituted with a fake and can be tracked within a high-security environment.

3. Maintaining continuity of knowledge throughout the process so that items can be monitored until they are removed from a state's inventory through final and irreversible dismantlement.

Where nuclear warheads are present, there will always be a fundamental tension between intrusive verification activities and stringent physical security, information security, and safety requirements. Given these constraints, this report outlines several issues and opportunities for verifying future warhead declarations. Several recommendations also are included for how parties might cooperate during future inspections and establish multilateral technical engagements that can lay the groundwork for future action.

Source: Kaveh Sardari

Members of the warhead subgroup discuss an early draft of the report.

VERIFYING WEAPONS-USABLE NUCLEAR MATERIAL DECLARATIONS

Over the long term, if states are to have confidence that future arms reductions are not negated by the production of additional warheads, it will be essential that all weapons-usable nuclear material be accounted for, tracked, and continuously verified. At the outset, the most effective declarations of weapons-usable nuclear material will include an aggregate total of a state's HEU and separated plutonium inventories, with as much detail as possible about the aggregate quantity of material in specific categories and uses. Given the political and technical challenges of accomplishing this, this report includes a sample form to guide states in preparing for future declarations and focuses on national preparatory work that can facilitate more robust declarations. A particularly significant undertaking is nuclear archeology—that is, validating plutonium and HEU production and preserving the materials, facilities, and records needed to clarify historical production, uses, and losses of nuclear materials.

Source: Petr Pavlicek/IAEA

Metallic seals are used to prevent unauthorized access to safeguarded materials. The inside of each seal has its own unique markings (like a fingerprint). Before a seal is used, the markings are recorded. If the seal is tampered with, these markings will change. When returned to the IAEA, the seal is carefully analyzed to ensure its integrity.

MULTILATERAL TECHNICAL ENGAGEMENT

A number of the basic methods needed for more complex verification tasks exist today, though further technical development is also required. For example, no inspecting party has been able to authenticate a measurement system with a built-in information barrier—a system of procedures, devices, or software used to protect sensitive information—after it has been used to examine a classified item. In addition, states have not yet developed detailed verification provisions for material in sensitive forms, such as in warheads or naval propulsion programs.

Perhaps a greater challenge is that there is an uneven playing field. The United States and Russia have extensive verification experience, and important work has been done with the International Atomic Energy Agency (IAEA) and between the United Kingdom and Norway. There is, however, a more general need to build international capacity and revitalize multilateral exchanges on the tools and methods required for future verification scenarios. While states have to ensure that sensitive information is not compromised, expanded participation in future verification activities could have concrete benefits. Because both nuclear weapon states (NWS) and NNWS have an interest in all parties living up to the commitments made under the Non-Proliferation Treaty (NPT), the declaration and verification of warhead or material baselines could provide

a useful platform for evaluating these commitments. Involving NNWS could strengthen trust and cooperation and help create a common understanding of challenges and constraints that nuclear warhead environments impose.

International scientific cooperation has helped address technical obstacles, promote common understanding of verification challenges, and inform policymakers of new and developing technical capabilities that could support the verification of new agreements. The former U.S.-Russia Warhead Safety and Security Exchange and other scientific cooperation arrangements, such as the U.S.-Russia-IAEA Trilateral Initiative and U.K.-Norway Initiative, engaged experts from different states to work on difficult hypothetical verification problems. Such activities can lead to common verification tools, acceptance of new verification mechanisms, and ultimately, progress on stalled policy priorities.

ESTABLISHING THE ABSENCE OF UNDECLARED WARHEADS AND MATERIALS

International scientific cooperation can lead to common verification tools, acceptance of new verification mechanisms, and ultimately, progress on stalled policy priorities.

While the details of declarations and verification protocols are subject to negotiation, any agreement—particularly agreements that accompany deep reductions—will require states to confirm that other states are not withholding a cache of warheads or materials from a declaration or conducting illicit activities at secret locations. To address this issue, states have largely relied on intelligence information, sometimes combined with rights to some form of challenge inspection. Nuclear warheads and small quantities of weapons-usable nuclear material—which likely would be the subject of future agreements—are much more difficult to find than long-range ballistic missiles, bombers, or submarines.

In the future, the technical measures discussed in this report can provide detailed information to support compliance determinations, but these tools and methods alone will not be enough. Given the substantial challenges and potential consequences of undeclared items, facilities, and materials, it will be important to integrate information from a variety of sources, including state declarations, other treaties or agreements, intelligence information, the activities of inspectors, and open-source information from journal articles, memoirs, satellite imagery, and traditional and social media. Over time, this integrated information can strengthen confidence that states are living up to their commitments, but it will be a long and difficult process. All stakeholders should prioritize the development and strengthening of verification resources and methods and use baseline declarations as a platform for capacity and confidence building.

WORKING GROUP RECOMMENDATIONS

The full working group put forward the following recommendations as priorities for governments to address the challenges of verifying nuclear warhead and weapons-usable nuclear material declarations. Perhaps most important, the group concluded that all parties—states with nuclear weapons, states without nuclear weapons, and international organizations—can and should play a role in future verification and monitoring activities.

The working group recommends that stakeholders:

- **Expand multilateral technical engagements.** Multilateral engagement on cooperative inspection methods, equipment, and activities should be expanded and prioritized. It can take years to qualify tools for inspections. States that have collaborated in developing and testing specific methods for high-security authentication, unique identification, and continuity of knowledge become intimately familiar with their design and application. Such familiarity can foster cooperation and may make states more likely to include these systems in future agreements. Outside experts and rising specialists from states without extensive verification experience should also be encouraged to participate. Including NNWS experts can strengthen international confidence in the integrity of verification systems and arrangements. Priority should be given to approaches that enable such participation without compromising sensitive information. Future collaboration should also take into account relevant safety and security qualification standards so that new methods and equipment comply with multiple national standards.

- **Prioritize verification research and dialogue.** Collaboration on verification methods and techniques should be complemented by a sustained dialogue among international experts on practical and technical approaches to baseline declarations and verification arrangements. Such a process would be most effective if it were conducted at the government level, with participation from other experts. Topics for engagement could include:

  – Declaration content and format

  – What information states are prepared to make public, exchange with other states confidentially, or share with particular states

  – What information should be preserved through nuclear archeology programs to facilitate future verification, such as historical information on material flows and facility information

  – What is needed for effective verification, what existing measures can achieve, what complementary regimes and activities can contribute, what obstacles may arise, and what areas require further development

  – Who would verify baseline declarations, what areas might be priorities for verification, and how verification could be phased in to address these top priorities

– How an integrated system for verification and evaluation could be developed, and how states can mitigate the risks posed by the retention or clandestine production of warheads or materials.

- **Review national classification standards and information.** For future verification systems to be as effective as possible, parties will need to deal with differences in national classification standards. This should begin with each state reviewing internally what it currently considers classified information, and whether certain information can be declassified or shared in some form with other governments in the context of deep reduction and verification requirements. The process should involve information security experts and verification specialists to better understand the benefits and risks involved and assess how to manage them. The careful sharing of classified information can simplify verification procedures, make technical methods easier to implement, and give states more confidence in the results.

SUBGROUP RECOMMENDATIONS

In addition to the recommendations of the full working group, each subgroup also outlined specific recommendations for states, international organizations, and outside experts to address unique challenges in verifying warhead and nuclear material declarations.

Warhead Subgroup Recommendations

- **Prioritize joint research on authenticating information barriers.** The United States, Russia, the United Kingdom, and others have had limited but important success in developing and demonstrating measurement systems with integrated information barriers that protect sensitive information. Verification measurements on classified warhead items or materials have been made in the presence of foreign specialists without releasing classified information. However, to date, it has not proved possible for these foreign specialists to authenticate the inspection system. For the host state to protect classified measurement results and at the same time allow an inspecting party to confirm that the equipment works as advertised, significant additional research and testing is needed. Creative solutions and suggestions for improvement should be solicited from information technology experts and could be crowdsourced as well.

- **Initiate an international technical assessment on warhead containers.** The ability to accurately measure a containerized warhead or component, without revealing sensitive information, is essential. The design and configuration of storage containers may vary dramatically depending on the container's purpose and intended contents, adding additional complexities to potential verification

efforts. A container study would give states a better understanding of container effects and help determine if standardized containers or standardized container design principles could simplify the confirmation process. Because some containers' internal configurations might be sensitive, modeling may be needed in certain cases.

- **Designate standalone verification facilities.** Verification activities at existing nuclear weapons facilities impose major security and safety burdens on those facilities and may prevent normal operations for a substantial amount of time. The facilities were never designed to host foreign inspectors. Extensive efforts must be made to protect nuclear weapons design information and other sensitive information, and some health and safety concerns may make it impossible for inspectors to carry out some tasks they deem necessary. Standalone facilities designed and built for verification activities would eliminate the disruption of normal operations at active nuclear weapons facilities. Special facilities could also be used during a dismantlement process, where verification would likely constitute an even higher burden on operational facilities. Prospective treaty partners or other international parties should be encouraged to participate in the design process and observe and verify the construction of any standalone facility to counter possible accusations of built-in opportunities for cheating.

- **Strengthen independent peer review and vulnerability assessments on ongoing research and development efforts.** As promising technologies advance through the development process, programs need to involve additional independent, scientific certification and vulnerability assessment teams. A more extensive peer-review process would bolster research and development (R&D) outcomes and acceptance, as would the detailed publication of research results.

- **Launch a joint study on the applicability of IAEA technologies for warhead environments.** IAEA measurement techniques and containment and surveillance instruments should be studied and tested for use in a warhead environment. Currently, the IAEA employs a wide variety of safeguards tools and techniques, including tags, seals, unattended monitoring, and environmental sampling. An international team of experts should explore whether or not these technologies would be useful for verification and could be used in a warhead environment.

- **Discuss warhead environments and safety and security requirements as a part of the P-5 dialogue on verification.** The P-5 states (China, France, Russia, the United Kingdom, and the United States) need to discuss and share information about the general nature of the safety and security concerns and procedures that characterize their respective weapons environments and which would bound the activities allowable in a baseline verification process. This information could be sensitive and might therefore be shared only among P-5 states—at least in the early stages of such a dialogue. The information sharing would constitute a type of

Nuclear materials subgroup members discuss what should be included in baseline declarations.

confidence-building measure that would help strengthen the basis for multilateral arms control in the future.

Materials Subgroup Recommendations

- **Preserve national records and collect oral histories from retired personnel.** To facilitate future baseline declarations and enable verification of those declarations, a top priority should be to preserve current and historical information on the production and disposition of weapons-usable nuclear materials, including physical and digital records. Where records are incomplete or inconclusive, questions should be clarified with personnel familiar with the operations concerned. Because some nuclear programs have been running for decades, these individuals are aging and may be nearing retirement or even deceased. This process should begin immediately, while personnel who can clarify details of historical operations are still available to recount oral histories.

- **Pursue joint R&D on nuclear archeology methods.** Funding and expertise for collaborative R&D of nuclear archeology methods for different reactor types and uranium enrichment technologies should be prioritized. Methods for graphite-moderated plutonium production reactors are well established, but further work is needed to develop approaches for heavy water reactors as well as gaseous diffusion and centrifuge enrichment plants.

- **Preserve physical facilities, where possible, to permit future verification activities.** U.S. plutonium production reactors at Hanford are temporarily preserved in an environmentally sound manner within newly built enclosures, making future studies on their graphite cores possible. Physical facilities should be preserved in a similar manner elsewhere. In most cases, such preservation will be compatible with verifiable facility deactivation and may also be the most cost-effective course of action.

- **Take and preserve measurements and samples before dismantling or disposing of facilities or waste.** Where dismantling facilities or disposing of relevant waste products is planned, measurements and samples should also be taken and preserved to make sure future verification efforts are possible and credible. Experts from other states or multilateral entities could also be asked to take measurements at facilities or validate quantities and characteristics of materials. Where anomalies exist, other experts could be brought in as a confidence-building or transparency measure to reconstruct missing information.

- **Lead nuclear archeology demonstrations.** The United States and Russia should collaborate to demonstrate to other interested states the current capabilities and limits of the graphite isotopic-ratio method (GIRM), a nuclear archeology technique for calculating plutonium production that relies on measuring the isotopic ratio for impurities in graphite from graphite-moderated reactors. Demonstrations at one U.S. reactor and one Russian reactor could be a precursor to international technical collaboration to improve existing nuclear archeology methods and develop new approaches for other types of reactors.

- **Develop verification approaches for naval fuel.** Due to national security and proprietary concerns, HEU in the naval sector is a particularly vexing verification challenge. States that use HEU in naval fuel should establish a cooperative dialogue to develop verification approaches to confirm, without compromising sensitive information, that none of the material designated for naval use is being used to produce warheads, in violation of agreements.

- **Share best practices.** Some states have valuable experience that, if shared, could enable other states to make unilateral declarations, reduce barriers to formal baseline declaration arrangements, and move the development of verification methods forward. U.S. and U.K. experts should engage with their counterparts in other states with nuclear weapons to share their experience in assembling information on their historic plutonium and HEU production and use. This

would enable states to implement best practices and establish their own inventory histories for unilateral declarations and future baseline declarations and verification. It would also be helpful if South Africa were prepared to develop a report on its experience of having the equivalent of a baseline declaration verified and if the IAEA, in consultation with South Africa, reported on its perspective on the lessons from the South African experience.

- **Make informal declarations on holdings of weapons-usable materials.** Voluntary and informal declarations of weapons-usable material holdings, unilaterally or in collaboration with other states, can be done without having to wait for formal agreements. These measures are of significant value in helping to establish data consistency over time. Some states have made informal declarations already. The more detailed the declarations are, the greater their potential value to transparency and confidence building.

- **Transfer weapons-usable materials that are excess to military requirements to civil programs under IAEA safeguards.** Where weapons-usable materials have been sanitized and are excess to military requirements, as with materials released through warhead dismantlement or stocks that are no longer needed, the material should be either verifiably disposed of and rendered practicably irrecoverable or transferred to civil programs and placed under IAEA safeguards. A longer-term objective should be for the IAEA to apply active safeguards to all weapons-usable materials in civil programs in all states. A study is needed on the funding and resources that would be required for the IAEA to do this.

Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Redefining Societal Verification

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REDEFINING SOCIETAL VERIFICATION

Executive Summary

Applying Transformative Technologies to Arms Control and Non-Proliferation Verification

A new facility appears in a country that has made specific treaty-based commitments regarding its nuclear weapons program. A blogger popular with nuclear experts posts a commercial satellite image and asks the community: What is this? Satellite imagery analysts, regional specialists, technical experts, native language speakers, and specialists from other disciplines, some not related to nuclear weapons or their associated technologies, weigh in. They assemble a compelling circumstantial case that the activity at the facility is suspicious.

In parallel, officials from the treaty partners assess what is happening and decide whether the facility is unrelated to treaty obligations or houses secret, proscribed activities. In addition to the information the outside experts have generated, government officials tap classified resources, including spy satellites, and purchase commercial satellite imagery of areas where national satellites did not focus or have a clear view. Open-source intelligence analysts, meanwhile, scour local native-language media for clues and check chatter. They also comb social media for references that could indicate the purpose of the building, and they search photo and video-sharing sites for images that show activity at the facility. Companies specializing in crucial, difficult-to-acquire materials are consulted to see if there have been attempted (or successful) procurements. Analysts combine all of the information, including from formal verification tools, to determine whether the country is using the facility to violate its treaty commitments.

The fictional scenario above raises important questions. Are governments prepared to use all the information-gathering and analysis tools at their disposal to respond to possible treaty violations? Do states understand the privacy and personal data protection issues related to these new areas of data collection? Are states prepared to respond if their private conclusion is different from the one reached by outside experts, whose analysis is public? The answer today to all those questions is no.

Information and communication technologies (ICT) have reshaped how countries, corporations, and private citizens share, collect, and analyze information. As global communication technologies have increased, so too has the amount of publicly generated data. The big data phenomenon has led to groundbreaking innovations in emergency response, humanitarian relief, disease control, and commercial marketing and sparked interest in the nuclear arms control and non-proliferation domains.

External analysis will continue to improve, whether or not governments leverage new media themselves or embrace the potential contribution of outside experts to treaty verification efforts.

This report redefines societal verification as a process by which states or international organizations can use information generated and communicated by individuals or expert communities for arms control or non-proliferation treaty verification. It should be based on sound, tested, and validated procedures that take advantage of the data now available to states. It would not rely on luck in finding a specific piece of information, mysterious analytical processes, or the tasking of citizens to become whistleblowers or amateur spies. The system of data collection and analysis developed for arms control or non-proliferation treaty verification can also contribute to broader nuclear confidence building and threat reduction.

The concept of societal verification, in some form or another, is not new, but ideas about how societal verification might contribute to state efforts have evolved in recent years. Even though state systems have not yet caught up to the promise of societal verification, in a world of abundant data and perpetual connectivity, the technical has joined the conceptual, making some level of societal verification a real possibility in a way that was not previously achievable.

With the vast amount of information available today, external analysis will continue to improve, whether or not governments leverage new media themselves or embrace the potential contribution of outside experts to treaty verification efforts. Accessible technical capacity, like smartphones with wireless communications connectivity, built-in sensors and geolocation capabilities, and data storage and processing capability continues to improve and expand. These capabilities offer knowledgeable citizens powerful tools to collect and share information.

Arms control verification has relied almost exclusively on tools such as on-site inspections and satellite imagery. Through societal verification, states can leverage new technologies and publicly available data to supplement national technical means (NTM) and other traditional verification methods.

A Model for Integrating Societal Verification (SV) in U.S. Treaty Verification
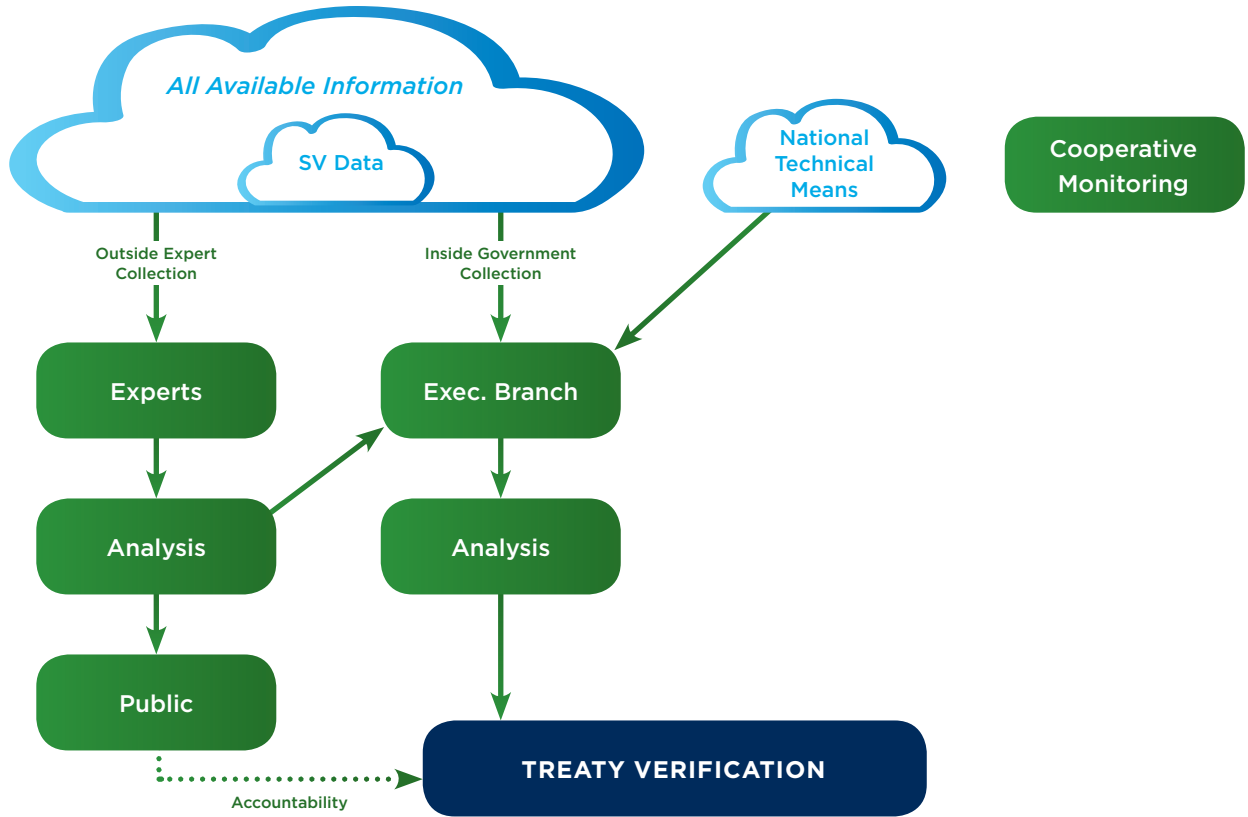
In this model, two paths connect to help the United States assess treaty compliance. On one path, the executive branch analyzes available data combined with national technical means and data from cooperative treaty monitoring (including on-site inspections). In parallel, outside experts, individually or collaboratively, analyze information and make public assessments about states' activities. This expert information would be an additional input to the official verification process and may raise additional questions or cue further examination by U.S. officials. This valuable contribution by outside analysts serves as government accountability.

Some emerging transformative technologies provide new information (geospatial data), and some are new means to transmit or widen the exposure of existing information (social media). To use these tools, states must decide which steps are most suitable for near-term application and which require further bureaucratic, institutional, diplomatic, and technical development.

A system's ability to adapt to and incorporate emerging technologies is often slower than the emergence of the technologies themselves. As the introduction of the telegraph and radio proved, it is difficult to predict the value of technology and new data as it is emerging, and the private sector and general public often prove more innovative and creative than governments in using the new tools.

The biggest challenges to data utilization are systemic and organizational rather than technical. Verification of treaties and compliance with agreements are fundamentally policy judgments made by states. This reality needs to drive any discussion of who collects what and how, to make a conclusion about whether states are meeting treaty obligations.

There are two primary points of input for societal verification data: analysis within government verification systems and analysis by outside expert communities. Regarding the process of data collection and analysis inside governments, there may be value to treating societal verification data like other open-source information for the purpose of cooperative monitoring and integration into state-level conclusions about treaty compliance. If states explicitly add these sources to their pool of knowledge, they can also include information generated by outside analytical communities. This second track is an independent path to identify and assess new sources of data and can contribute to official deliberations. Both tracks can utilize a diverse set of tools and function on a continuum from observing, or simply gathering information already being generated for other purposes, to mobilizing—that is, engaging with individuals or groups to generate new data.

The joining of data, communication methods, and technology transforms how the world looks at information, analysis, and dissemination. For arms control verification, a well-developed and integrated program to access societal verification data would prove at least additive to current treaty verification efforts and may dwarf the contribution of current open-source data. Societal verification could transform treaty verification, particularly in addressing the specific challenges posed by identifying undeclared and prohibited facilities or activities. Opportunities for strengthening a 21st-century verification regime could abound if public and private resources are focused on benefiting from societal verification tools, but significant issues must be understood before it becomes possible to calculate the value of such tools.

There is a pressing need to build and identify expert communities to participate in societal verification efforts. Communities of practice are reservoirs of knowledge. Some of these groups are part of traditional arms control stakeholder communities and some are not, and it is not always obvious who belongs or should belong. Having a reliable cadre of experts who are interested and prepared to assist in verification would be valuable to states and international organizations. Ad hoc and temporary analytic groups with diverse expertise can be formed akin to flash mobs. They are task oriented, and effective in meeting short-term, analytic challenges. With the consistent voices of permanent or temporary groups evaluating publicly available data, states will more easily and openly be held accountable for their public conclusions about treaty implementation and compliance.

Current technology and analytical tools have not yet shown that they can predict behavior, but verification is not forward looking; it is backward looking, focused upon an activity or event that has already occurred. Even with this somewhat simpler task, gain-

Source: Kaveh Sardari

Members of the *Redefining Societal Verification* working group discuss what constitutes societal verification.

ing a situational understanding requires a multidisciplinary approach, from computer science to sociology. Investing in societal verification with sustained engagement from the technical and policy communities can foster this approach.

Issues of privacy, data confidentiality, and legal oversight must be managed. Societal norms influence whether and how societal verification can be used in different countries. These issues are constantly evolving and pertinent standards and policies may not be created or accepted in the near future. It is essential to protect sensitive information, but the overall value of this data to a verification system suggests that some risk of exposure may be worth accepting.

States should take advantage of the potential contributions of societal verification. If they do not, they risk losing the opportunity to significantly strengthen arms control and non-proliferation treaty verification.

Working Group participants identified areas of critical need to advance the concept of societal verification for nuclear threat reduction. These recommendations include actions for government officials and policy makers, technical specialists inside and outside government, and other diverse expert communities, which will move societal verification from promise to practice.

RECOMMENDATIONS

Governments need to build a foundation for societal verification within the current arms control policy leadership. They should develop policies, diplomatic guidance, and bureaucratic structures to evaluate and integrate societal verification data in treaty verification. To take advantage of new tools and techniques, governments should:

- Map out an effective process for societal verification data integration and program management to support future verification systems and begin to address questions such as:
  - Which agency has the lead?
  - How will the effort intersect with the private sector, the intelligence community, and other potential contributors?
  - How can conclusions be validated using inputs from traditional verification tools?
- Begin international consultations on how future arms reduction agreements may acknowledge and develop rules for the use of societal verification data.
- Explore the possibility of experimenting with cooperative societal verification measures with allies to provide empirical data and lessons for how societal verification may be implemented in the future.
- Start developing rules related to the legal, ethical, and privacy concerns surrounding use of citizen-generated information.

The international technology and policy community should collaborate to develop a technology needs assessment/research and development roadmap to build capacity within government systems. Areas of exploration might include the following:

- Natural language processing of foreign languages as well as informal and unstructured language, such as slang and terms of art.
- Challenges posed by real-time processing of data versus queries of stored information.
- Identifying key or leading indicators of treaty-proscribed activities around which appropriate queries can be developed.
- Identifying attempts to censor or spoof data, especially where there is knowledge that information is being analyzed.
- Aggregating and integrating signals from multiple sources across platforms and data types to increase confidence.

Governments, in cooperation with outside expert communities, should establish channels to elicit the input of outside analysts to help build approaches for societal verification as follows:

- Assess capacity and fill gaps to enable contributions by outside experts to societal verification efforts of governments.

- Develop methods and mechanisms to educate expert communities outside the government on existing national verification efforts.

- Develop ways to identify, connect, organize, guide, assist, and reward experts, recognizing that validation and anonymity are not always compatible.

- Create paths to solicit input in a timely manner on potential verification challenges.

- Encourage discussions and cross-checking among external experts, facilitating a two-way information flow to build valuable capacity outside government.

NTI
BUILDING A SAFER WORLD

Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Building Global Capacity

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BUILDING GLOBAL CAPACITY

Executive Summary

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) includes a set of fundamental commitments: all parties will take steps toward disarmament, countries without nuclear weapons will not acquire them, and all countries can benefit from peaceful nuclear energy. All states have responsibilities and a vested interest in ensuring that the goals of the treaty are met.

States with nuclear weapons will be less likely to pursue deep reductions if more states acquire nuclear weapons or latent nuclear weapons capability because of the spread of uranium enrichment and plutonium reprocessing technologies. Non–nuclear weapon states (NNWS) thus have both an individual interest and a collective responsibility to ensure that the goals of the treaty are met, including through constraints on sensitive fuel cycle facilities to preclude the development of nuclear weapons programs. NNWS will be less likely to accept such constraints if they perceive that nuclear weapon states (NWS) are not taking their disarmament commitments seriously or, worse, are misleading the international community about their nuclear weapons reductions. All states have compelling reasons to hold the others accountable for their actions. For NWS, demonstrating compliance builds trust; for NNWS, being able to participate in some measure of verification is the most effective form of reassurance and allows them to appreciate the challenges NWS face in reducing their nuclear stockpiles. Further, states not party to the NPT have a stake in helping to develop and engage in verification of nuclear commitments, especially those that might relate to regional arrangements.

Verifying nuclear arms reductions is a highly complex and sensitive undertaking. Historically, states with nuclear weapons have tended to resist engagement with states without nuclear weapons due to concerns that sensitive information may be revealed in the process. Practical examples and joint projects help demonstrate that there is a great deal states without nuclear weapons can be involved with while successfully managing proliferation risks.

While reducing nuclear risks and ensuring that arms reduction commitments are being fulfilled are goals shared by all, individual countries' level of interest in arms control verification and technical capacity to participate in verification activities vary greatly and will change over time.

There are significant gaps at the national level in most countries when it comes to mobilizing and organizing the relevant technical and administrative skills, yet it might surprise some to realize that many of these skills already exist in most countries. For example, technologies used for nuclear medicine and remote sensing and geospatial data software can be applied to verification missions. A systematic process to define gaps and fill them—to build capacity—would allow new states to join verification and monitoring efforts when they are ready. There is evidence from past experimental projects that some states without nuclear weapons would show immediate interest in a focused dialogue on verification, if given the opportunity. For many other states, the consensus judgment of other, trusted countries would provide sufficient reassurance. Capacity building is not, however, a synonym for technical training; existing skills need to be brought together in a framework dedicated to arms control. This process will take years, so interested parties should start now.

> **There are significant gaps when it comes to mobilizing and organizing relevant technical and administrative skills, yet many of these skills already exist in most countries.**

RECOMMENDATIONS

Recommendations are grouped in three categories for states with nuclear weapons, states without nuclear weapons, and both groups collectively that will help to create a sense of common enterprise and solidarity.

States with nuclear weapons should

- **Determine national inspection sensitivities.** If states with nuclear weapons intend to work with states without nuclear weapons, they need to begin by ascertaining what knowledge, methodologies, and technologies can be shared without revealing sensitive information that could contribute to proliferation.

- **Establish, reestablish, or expand government programs dedicated to verification.** Dedicated government programs are required to devote the necessary resources to the task and ensure efforts are sustainable over the long haul.

- **Share information on risk management associated with inspections.** States with nuclear weapons can learn a great deal from each other about how inspections at sensitive facilities are managed. Sharing lessons learned will be useful and, eventually, will facilitate engagement with states without nuclear weapons.

Source: The Norwegian Defence Research Establishment (FFI)

The U.K.-Norway Initiative included a mock gravity bomb inspection.

- **Preserve program records, supporting data, knowledge, and institutional memory.** As the experience of South Africa, described in this report, shows, better documentation can increase the level of confidence in verification findings and reduce workloads. Maintaining clear and consistent records makes demonstrating compliance much easier.

- **Engage all nuclear-armed states in the dialogue on the glossary of concepts and definitions applied in nuclear arms control.** The NWS are developing a common understanding of concepts and definitions that will be helpful in streamlining collaborative nuclear activities. Engaging other nuclear-armed states on this topic could be a productive next step and build broader capacity for verification.

- **Evaluate how to make unilateral modifications to force size, structure, and posture more transparent.** Such actions have near-term benefits to confidence and long-term value by creating working relationships, demonstrating proof of concept for greater openness, and building a catalogue of tools and procedures that could be brought into future verification activities.

Building Global Capacity working group members discuss the implications of including states without nuclear weapons in arms control verification.

States without nuclear weapons should

- **Determine what they want to achieve from engagement in a verification process.** States without nuclear weapons need to develop a basic understanding of the benefits and limitations of verification to determine the value of engaging and the return that can be expected on that investment.

- **Promote academic programs that build verification skill sets.** Promoting specific programs with verification applications will help interested countries build capacity in functional areas.

- **Establish a government program dedicated to verification and identify a lead authority.** Just as in states with nuclear weapons, dedicated government programs in states without nuclear weapons are required to devote the necessary resources to the task and ensure efforts are sustainable over the long haul.

States with and without nuclear weapons collectively should

- **Share basic information related to definitions, methodologies, instruments, and relevant technologies.** Sharing basic information helps to facilitate cooperation by identifying similarities and differences and minimizing miscommunications.

- **Jointly develop academic curricula that build awareness about verification concepts.** Academic programs should provide basic knowledge, build capacity in functional areas, and promote sustainability.

- **Conduct site visits at nuclear facilities.** Preliminary site visits will help to acclimate hosts and visitors to safety and security requirements. This is sometimes referred to as managed access.

- **Share experiences and lessons learned from existing verification activities.** Experiences should not be limited to the nuclear realm and could include regimes such as the Chemical Weapons Convention.

- **Explore regional approaches to capacity building.** Different countries possess different skills that can be found in the government, military, academic, and private sectors. These should be brought together. Useful first steps include identifying regional champions for the verification mission and establishing a group of interested parties that will conduct joint outreach on verification issues through activities such as dedicated workshops.

- **Design and conduct a mock inspector training course.** This course could be modeled on the New Strategic Arms Reduction Treaty (New START) inspection regime, open to participation from states with and without nuclear weapons, and designed to share lessons learned from decades of U.S. and Russian experience.

- **Conduct joint development, testing, and certification of verification tools and nuclear forensics.** Joint development is an extremely effective way to build both knowledge and trust among partners.

- **Develop common understandings of information security processes and procedures.** Even if the information security processes of interested countries are not similar, understanding the similarities and differences will make cooperation much easier.

ABOUT THE NUCLEAR THREAT INITIATIVE

The Nuclear Threat Initiative (NTI) is a non-profit, non-partisan organization with a mission to strengthen global security by reducing the risk of use and preventing the spread of nuclear, biological, and chemical weapons and to work to build the trust, transparency, and security that are preconditions to the ultimate fulfillment of the Non-Proliferation Treaty's goals and ambitions.

Founded in 2001 by former U.S. Senator Sam Nunn and CNN founder Ted Turner, NTI is guided by a prestigious, international board of directors. Joan Rohlfing serves as president.

Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks

Overview

> "Progress must be made through a joint enterprise among nations, recognizing the need for greater cooperation, transparency, and verification to create the global political environment for stability and enhanced mutual security."
>
> ~ George P. Shultz, William J. Perry, Henry A. Kissinger, and Sam Nunn,
> "Deterrence in the Age of Nuclear Proliferation,"
> *The Wall Street Journal,* March 7, 2011

The Verification Pilot Project of the Nuclear Threat Initiative convened more than 40 technical and policy experts from around the world to develop recommendations for new approaches to verification that could enable future progress on arms reductions and prompt near-term progress on non-proliferation and nuclear security.

Innovating Verification: New Tools & New Actors to Reduce Nuclear Risks is a report series with the results of the project. It calls for the international community to fundamentally rethink the design, development, and implementation of arms control verification. An international initiative pursued with creativity, broad participation from states with and without nuclear weapons, and a sense of urgency and common purpose could make a significant contribution to global security.

This series of reports builds on *Cultivating Confidence: Verification, Monitoring, and Enforcement for a World Free of Nuclear Weapons* (Nuclear Threat Initiative, 2010), which outlined key issues that states need to address to ensure that nuclear weapons reductions can proceed in a safe and transparent manner.

Other publications in the Cultivating Confidence Series include *Verifying Baseline Declarations of Nuclear Warheads and Materials*, *Redefining Societal Verification*, and *Building Global Capacity*.

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BUILDING A SAFER WORLD