Title: A retrospective paper looking back 25 years at the U.S.-RF-IAEA Trilateral Initiative

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Abstract: The Trilateral Initiative was launched by Russian Minister of Atomic Energy Viktor Mikhailov, Director General Hans Blix, and U.S. Secretary of Energy Hazel O'Leary at their 17 September 1996 meeting in Vienna, Austria. The aim of the initiative was to fulfill the commitments made by Presidents Clinton and Yeltsin concerning IAEA verification of weapon-origin fissile materials and to complement their commitments regarding the transparency and irreversibility of nuclear arms reductions. Experts from the U.S., Russia and IAEA worked to explore technical, legal, and financial options for verification of classified weapons origin fissile materials. This paper will reflect on the history of the Trilateral Initiative, progress towards technical verification since then, and prospects for technology development to support future arms control efforts.

As a technical rather than a policy expert, I will steer away from future arms control treaty prognostications and focus on looking ahead in the monitoring and verification technology realm. The U.S. government is funding several programs to help prepare technology experts support future arms control initiatives. The U.S. 2022 Nuclear Posture Review states that successfully enforcing future arms control agreements will *require new technical capabilities for verification and monitoring*. It references investing in needed technologies as well as developing the next *generation of technical experts* required to negotiate and implement future agreements. Some examples of these programs include NNSA's Arms Control Advancement Initiative, Human Capital Development, enhanced basic R&D work on arms control monitoring and verification tools and technology, and the State Department's effort with the Nuclear Threat Initiative on partnering internationally for the development, testing and demonstration of monitoring and verification technology tools.

## Introduction

In 1991, Presidents George H. W. Bush and Mikhail Gorbachev met in Moscow and signed the first START or Strategic Arms Reduction Treaty agreement, which required both countries to reduce their total number of nuclear warheads and bombs by one third. Like previous arms control treaties, START focused on counting intercontinental-range ballistic missile delivery systems. The goals of the treaty were met by physical destruction of weapons systems, however, to remove the nuclear threat, something else was needed. Certain geographical areas were

declared to be free of nuclear-armed Air Launched Cruise Missiles or ALCMs. Containers large enough to contain an ALCM could be inspected visually or instrumentally. High neutron flux indicated a possible warhead. A simple "slab" detector ($^3$He tubes in polyethylene) was sufficient for this verification, since a large number of neutrons could suggest plutonium in a weapon.

By the mid-1990s, experts knew the next arms control question would be more difficult: How to deal with monitoring and verification challenges in a world with even lower numbers of weapons, and large stocks of weapons-usable nuclear material?

**The Trilateral Initiative**

The Trilateral Initiative was conceived to examine the technical, legal, and financial issues associated with IAEA verification of weapon-origin and other fissile material released from military programs in the U.S. and Russia. The Trilateral Initiative was officially launched by Russian Minister of Atomic Energy Viktor Mikhailov, International Atomic Energy Agency Director General Hans Blix, and U.S. Secretary of Energy Hazel O'Leary at their 17 September 1996 meeting in Vienna, Austria. The aim of the initiative was to fulfill the commitments made by Presidents Clinton and Yeltsin concerning IAEA verification of weapon-origin fissile materials and to complement their commitments regarding the transparency and irreversibility of nuclear arms reductions. Experts from the U.S., Russia, and IAEA worked to explore technical, legal, and financial options for verification of classified weapons origin fissile materials.

Developing a way for the IAEA to verify classified forms of fissile material in Weapons States was a new technical challenge. The states must both restrict the information provided to the IAEA and must control inspector activities to ensure that IAEA inspectors could not acquire classified information relating to nuclear weapons. States might need to impose further security requirements given the sensitive nature of the facilities involved. Classification issues are extremely complex. The classification systems in place in Russia and the United States shared many common elements but were not identical.

Why is there a need for physics-based inspection techniques in nuclear arms control? Because a piece of plutonium or uranium is not like a tank or an airplane that can be readily monitored as it's decommissioned or destroyed. One key challenge is that most fissile materials remain in classified form, or with classified characteristics. Additionally, the high costs and long process times required for the disposition of those materials could drive long-term monitoring protocols. To explore technical, legal, and financial options for future verification regimes, the parties organized a series of Trilateral workshops summaries in the table that follows.

***Technical Requirements – authenticating data without releasing classified information***
To verify classified forms of fissile material, the states must restrict the information provided to the IAEA and must control inspector activities to ensure that IAEA inspectors do not acquire classified information relating to nuclear-weapon designs.

***Legal Framework***
Appropriate legal arrangements would be necessary to engage the IAEA in the implementation of any new verification role. For the IAEA, this would require the Board of Governors to

approve the legal document accepting the terms and conditions, including the foreseen financing arrangements. In the 1990s the parties recognized this would be even more complicated in a less-cooperative geopolitical climate.

***Financial Considerations***

What will it cost and who will pay for it? As a technology developer, it wasn't my job to worry about who pays, but technology developers did understand then need to work to keep costs down.

***Technical Objective and Strategy***

A key challenge under the Trilateral Initiative was preparing for the possibility that excess fissile material in classified form may be offered for IAEA verification. To accommodate this possibility, the technical experts pursued an attribute verification approach for IAEA verification.

This approach included making independent unclassified measurements of **"attributes"** related to fissile materials of weapons origin to provide confidence the materials should be accepted into an IAEA verification system. The attribute measurement approach verifies that material is weapons-usable, but not that it has been used in a weapon. A second approach briefly considered involved a "**trusted**" template that could be used to match a set of similar items without revealing specific information about those items. The template-matching approach involves trust in an unverifiable template. Both approaches require development of monitoring systems to promote international confidence that the materials remain removed from weapons programs.

***Trilateral Initiative Technical workshop early timeline:***

***December 1997*** *first Technical Workshop at LLNL, U.S. (measurement demonstrations at the Superblock facility)*

***March 1998*** *Technical Meeting Obninsk, Russia (measurement demonstration at IPPE)*

***June 1998*** *SRS, U.S. – K-Area (tags, seals, and facility camera site demonstration)*

***March 1999*** *Technical Meeting Arzamas-16, Russia (measurement demonstration at Arzamas-16)*

***June 1999*** *at Technical workshop at LANL, U.S. (measurement demonstration at TA-18)*

***September 1999*** *Mayak, Russia (technical visit to storage site)*

*Prototype development continued into the 2000s in the United States and Russia under other initiatives.

***Trilateral Initiative Cooperative Technical Workshops***

Technical experts from the U.S. nuclear weapons laboratories (Los Alamos, Livermore and Sandia National Laboratories) began working with our counterparts at the Russian Federation's nuclear weapons laboratories to develop verification approaches that both provide confidence to inspectors and protect sensitive and classified information. We started with plutonium first (easier to monitor), developed and demonstrated a prototype plutonium attribute verification system with information barriers, and began planning for HEU next. We proposed new systems for reliable facility monitoring that also protected classified information. Specifically for the Trilateral Initiative, technology developers in the U.S. and Russian focused on equipment that would support verifications by the IAEA. This equipment included authentication tools for measurement systems with information barriers and in situ probes that would facilitate inspections by reducing the need to move material out of storage locations for reverification. The

IAEA established a new office with the Department of Safeguards to support the effort and promote regular updates for the senior IAEA leadership.

Lawrence Livermore National Laboratory hosted the first attribute measurement equipment demonstration under the Trilateral Initiative in December 1997. This demonstration led to a series of joint Russian Federation/U.S./IAEA technical discussions that focused on attribute measurement technology that could be applied to items with nuclear material having classified characteristics.

A first prototype attribute verification system with an information barrier was demonstrated at a Trilateral Technical Workshop in June 1999 at Los Alamos. The primary purpose of the 1999 workshop was to conduct preliminary demonstrations, and to perform tests and evaluations of prototype plutonium attribute verification systems (including information barriers) using plutonium in an unclassified form. The key features of this system were modularity, multiple layers of information protection, and simplicity of design. It's output display was a display with a pair of green (pass) and red (fail) lights for each attribute, and red/green lights to also indicate the status of the system (open/secure).

Classification issues are extremely complex. Both states agreed, at least as a working assumption, to set a threshold of less than 0.10 for the ratio of Pu-240 to Pu-239 as satisfying the weapons-grade plutonium attribute. Our classification guidance permits United States to acknowledge the fact that all U.S. weapon pits that contain plutonium have at least 500 grams of plutonium. So, these were the threshold (pass/fail) values used to demonstrate the attribute verification system. It should be noted that due to potential measurement uncertainties, a working threshold lower than 500 grams would be needed to potentially avoid false-negative results.

We learned a number of valuable lessons during these Trilateral workshops. Hardware and software integration was more difficult than we expected. Our Information Barrier needed a watchdog component, so all parties knew it was working. Testing and demonstration activities are never easy in an operating nuclear facility (even without involving international partners). More unclassified attributes were needed to build confidence. Technology is easier to collaborate on than legal frameworks and financial arrangements! "The devil is in the details" -- measurements that work in the lab may need substantial modification for the real world, for security or operational reasons. Compactness and ruggedness in the instruments help. Higher-resolution detectors yield greater confidence in measurements. Information security is incredibly important!

A joint working group of U.S., Russian, and IAEA experts was meeting in Vienna to discuss shared progress under the Trilateral Initiative when the terrorist attacks occurred on September 11, 2001. It quickly became clear that a dramatically new security environment marked by not just the end of the Cold War, but terrorist attacks in every part of the world, highlighted the need for cooperation in the international community to address the heightened challenges to verification.

In the early 2000s scientists from the United States and Russia continued to work collaboratively on technical options for verification of fissile material in classified form. Under a contract between Los Alamos National Laboratory and the Russian Federal Nuclear Center at Sarov, a full-capability attribute verification system was constructed for test and evaluation in Russia. This system with information barriers included a neutron multiplicity counter integrated with a high-resolution gamma ray spectrometer, both of which had special features to protect classified information. A Russian-designed security "watch dog" system disabled the entire measurement system in the event that any access way is opened, and the computational block and transmission devices to the inspectors' readout provide the agreed attribute verification outcomes without breaching security restrictions. Both countries also explored cameras, tags, seals, and portal monitors for item and facility monitoring.

In the lead up to the 2005 NPT Review Conference, the Trilateral Initiative was specifically called out as a success under Article VI of the NPT. The initiative represented demonstrative process towards international verification in relation to future nuclear disarmament, although there was no commitment by either state that the initiative would lead to a new verification role for the IAEA.

**Summary and Next Steps**

In 1996 the Trilateral Initiative was embarked on to examine the technical, legal, and financial issues associated with IAEA verification of weapon-origin and other fissile material released from military programs in the United States and the Russian Federation. The Trilateral Initiative succeeded to a considerable extent. It served as an active forum for joint development of solutions to common problems and helped bring the IAEA into a new context. The prevailing spirit was one of mutual respect and cooperation, which encouraged and built on the scientific diplomacy that emerged with the end of the Cold War and exercised the give and take needed for common solutions to emerge.

It was an exciting time for the U.S. and Russian national laboratories, and an era of great partnership with the IAEA. Our laboratories in both countries worked together to define and develop concepts and technologies for use in potential future arms control and nonproliferation agreements in partnership with the IAEA. They also demonstrated the ability of U.S. and Russian scientists to work cooperatively in the interest of international peace and security.

Now the question going forward is this: How to overcome monitoring and verification challenges in a world with growing numbers of weapons and stocks of nuclear material? In treaty verification the job of scientists and engineers is to develop tools that provide confidence – to the stakeholders in our own countries and to the international community – that all parties are upholding treaty commitments. In advance of future treaties, there is a clear need for continued research into reliable, secure, and cost-effective verification and monitoring techniques. The U.S. government is funding a number of programs to ensure the technology experts will be ready to support future arms control initiatives. Some examples of these programs include NNSA's Arms Control Advancement Initiative (which includes human capital development for the next generation of arms control experts), enhanced basic R&D work on arms control monitoring and

verification tools and technology and the State Department's effort with the Nuclear Threat Initiative on partnering internationally for the development, testing and demonstration of monitoring and verification technology tools. In addition, the 2022 U.S. Nuclear Posture Review asserts that successfully enforcing future arms control agreements will require new technical capabilities for verification and monitoring. It calls for investing in necessary technologies as well as developing the next generation of technical experts required to negotiate and implement future agreements. The Trilateral Initiative provided foundational work that can be build up going forward to address modern challenges for verification like cyber security and data authentication.