IAEA Safeguards: Preparing for the Future

Shirley **Johnson**, Nikolai **Khlebnikov**, Vladimir **Kuchinov**, and Thomas **Shea**

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Center for Energy and Security Studies
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The International Atomic Energy Agency (IAEA) safeguards system plays a crucial role today as the principal mechanism for verifying compliance of states with their safeguards agreements with the IAEA and thus enhancing the international nuclear non-proliferation regime. IAEA safeguards also support the peaceful use of nuclear energy, advancing practically all sustainable development goals by assuring that such peaceful use does not contribute to the proliferation of nuclear weapons. To continue to serve these two tasks, the IAEA safeguards system must remain independent, technically sound, and transparent amid growing internal and external challenges to the IAEA's ability to continue providing credible assurances that states are honoring their safeguards obligations—particularly challenges to detecting indications of undeclared nuclear material or activities. Addressing these challenges, the IAEA will continue to need support and cooperation from its member states, especially from such countries as the Russian Federation and the United States.

Present Status of IAEA Safeguards Implementation and Challenges

According to the IAEA, in 2019, IAEA safeguards were applied in 183 states with safeguards agreements in force with the agency, and 136 states had both a comprehensive safeguards agreement (CSA), as required by the NPT, and an additional protocol (AP) in force. Safeguards were implemented at 1,324 facilities and locations outside facilities (LOFs) holding 216,448 significant quantities of nuclear material. Available resources for the IAEA Secretariat for safeguards included 862 staff and consultants from 93 countries, and €142.9 million in regular budget and €20.2 million in extra-budgetary funding. As the result of safeguards implementation in 2019, the IAEA Secretariat concluded that for 69 states all nuclear material remained in peaceful activities; for 106 states all declared nuclear material remained in peaceful activities; for three states nuclear material, facilities, or other items to which safeguards had been applied remained in peaceful activities, and for five states nuclear material in selected facilities to which safeguards had been applied remained in peaceful activities.[1]

These figures illustrate the amount of activity the IAEA Secretariat expended in implementing IAEA safeguards in 2019. To some extent, they serve as a measure of the amount of work carried out by the agency, though not its complexity or effectiveness. Safeguards effectiveness has at least two components: (a) the ability to detect noncompliance by a state with its obligations under its safeguards agreement and (b) the deterrent effect against such violations created by this detection capability. Therefore, if the ability to detect any

[1] IAEA, "IAEA Safeguards in 2019," www.iaea.org/sites/default/files/20/06/sg-implementation-2019.pdf.

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noncompliance is high, then the deterrence effect is presumably also high.

The IAEA Secretariat is currently going through a transition from the traditional facility-level approach (FLA) to a state-level concept (SLC), which was introduced in 2004 in the context of integrated safeguards for states for which the broader conclusion had been drawn.[2] Pursuing the SLC, in recent years the agency has gained experience in developing and implementing state-level approaches (SLAs) in states with both a CSA and an AP in force, for which the broader conclusion had been drawn. On the basis of that experience, the agency has carried out further activities to enhance the methods and the internal standards used in the developing the SLAs. Finishing the development and finalizing the transition from FLA to the SLA is important, together with considering the effectiveness of the related secretariat activities.

The IAEA Safeguards Statement for 2019[3] identified some areas where the agency continued to experience difficulties with safeguards implementation:

- Shortcomings in the performance and the effectiveness of state and regional authorities (SRAs) responsible for safeguards implementation and their respective systems of accounting for and control of nuclear material (SSACs/RSACs) had a significant impact on the effectiveness and efficiency of agency safeguards implementation.
- Some SRAs were deficient in one or more of the following areas: providing safeguards information to the agency; providing access to the agency to conduct in-field verification activities; providing sufficient technical effectiveness of SSACs; and providing adequate cooperation and logistical support related to the agency's verification activities in the field or at headquarters. Addressing these deficiencies required additional costs, effort, and resources for the IAEA and also, in many cases, for the SRAs and for nuclear facility operators.
- At the end of 2019, 32 states had operative small quantities protocols (SQPs) that had yet to be amended.

[2] The IAEA believes that, given the full exercise of its inspection rights as provided in a CSA and an AP, when finding no unresolved questions, it is reasonable to conclude that all nuclear material belonging to the state or under its control remains committed to peaceful use. This is the essence of the "broad" conclusion.

[3] Safeguards Statement for 2019, www.iaea.org/sites/default/files/20/06/statement-sir-2019.pdf.

Looking into the Future and Potential Challenges

The future of the IAEA safeguards system will depend on (1) the sustainability of the international nuclear non-proliferation regime and the possible development of other international instruments that could require IAEA safeguards as stipulated in the Article III.A.5 of the IAEA Statute; and (2) major developments in the peaceful use of nuclear energy.

On (1), there are no indications that in the foreseeable future there will be any change that will have a major impact on the international nuclear non-proliferation regime or that any near-term requirement for an additional safeguards mission for the IAEA under Article III.A.5 of the statute will emerge. There are no negotiations underway to resolve the Democratic People's Republic of Korea (DPRK) file; negotiations on a treaty banning fissile material production for use in nuclear weapons are blocked at the Conference on Disarmament in Geneva; and although the Treaty on the Prohibition of Nuclear Weapons may enter into force, no state possessing nuclear weapons is a signatory of this treaty.

Regarding (2), new developments in the of peaceful use of nuclear energy could create some challenges arising from emerging nuclear technologies in civil nuclear power, such as small- to medium-capacity reactors—especially factory-built units and floating nuclear power plants. Also, major issues remain for safeguards implementation, including the decommissioning of permanently shut-down or closed-down reactors, and the legacy of spent fuel.

It will be important to continue to develop new safeguards technologies and methods for improving safeguards' effectiveness and efficiency. Some topics that should be considered are enhanced physical models of nuclear fuel cycles; robotic techniques for the acquisition and integration of signals from various instruments and sensors; artificial intelligence for safeguards information gathering and analysis and for reviewing compliance; new methods and procedures to detect undeclared nuclear material and undeclared activities; the use of virtual reality to improve inspector and SSAC training; the use of space-based or aerial drone data-collection platforms under IAEA control; the use of distributed ledger methods for accounting for nuclear material; and the use of analog/digital data-stream-monitoring concepts for liquid-core reactors (e.g., molten salt) and process and waste streams in reprocessing plants (aqueous and non-aqueous processes).

Safeguards by Design

The importance of safeguards by design (SBD) and its relevance to the more efficient development of IAEA safeguards in the past has been extensively documented by the IAEA. Designing and building more safeguardable facilities is not only an aid to the IAEA and to the facility operator in developing and accommodating inspection activities; it can also reduce the complexity and safeguards challenges of design verification and increase the transparency of facility operations. Therefore, it is important that states developing or planning new nuclear installations cooperate with the IAEA at an early stage to understand when and how SBD of these installations will be implemented and contribute to better safeguards. Issues such as verification of the design, construction, and operation of the facility; access to the inventory of nuclear materials and flows; and verification and confirmation that the facility is functioning in the declared mode and is not being misused should be considered priority issues for such discussions. As part of future cooperation, the Russian Federation and the United States could assist the IAEA in encouraging governmental organizations and associated design and engineering companies to incorporate SBD. Further cooperation could also include working with the IAEA in describing how SBD contributes to strengthening an SLA. With transparency in mind, it would be useful if the IAEA could then revise its guidance on the issue in order to clarify the place of SBD in the SLC.

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Communications, Human Resources, and Competencies

There is a need to enhance communications between the IAEA Department of Safeguards and SRAs, who create national reports that are used by the IAEA to plan timely inspection activities. The reports are later analyzed together with inspection results by the Department of Safeguards and reflected in the Safeguards Implementation Reports (SIRs). Without the timely submission of accurate national reports, inspection activities might be delayed or incomplete, or might result in more intrusive inspections than otherwise necessary. This could possibly result in inadequate or inaccurate information for preparing the SIR and thus compromise the Safeguards Conclusion.

There continue to be situations where IAEA inspectors, SRA representatives, and facility operators may disagree. However, selecting qualified agency staff and training them in the practice of clear and factual communications and educating SRA representatives and facility operators on their safeguards obligations should allow the interests of all parties to be addressed. This is not a new problem, but one that might benefit by joint study.

Regarding IAEA safeguards staff resource management, priority should be given to preserving the expertise of deserving inspectors and analysts and maintaining continuity in the work of the Department of Safeguards. Noting that certain aspects of safeguards staff resource management have improved over time (e.g., job interviews have become mandatory, the hiring process has become more transparent, and training is intensive and ongoing so that today's inspectors and analysts now have better skills), there remain disparities both in selecting new staff and in terminating marginally performing staff.

Safeguards Instrumentation

Throughout the years, the IAEA has accumulated an impressive inventory of safeguards equipment that currently includes about 30,000 items. Planning new acquisitions, hardware and software maintenance, and phasing out obsolete equipment are continuing challenges for the Department of Safeguards.

Development of multifunctional equipment that can be used in the field for different types of measurements could improve the efficiency of safeguards equipment management. Because equipment failures can wreak havoc, such multifunctional equipment should include capabilities for very high operational reliability, autodiagnostics, and in-field repair by inspectors.

Safeguards Implementation in Extreme External Situations

The COVID-19 pandemic has shown that the IAEA may have to cope with situations that could adversely impact safeguards implementation—for example, by imposing

restrictions on travel, by closing national borders or restricting safeguards access to locations, or by reductions in safeguards funding. Other crises will happen—caused not only by health impacts such as COVID-19, but perhaps by climate change, regional conflict, or economic crises. It would be useful to examine what the Russian Federation and the United States might support to alleviate the impacts of such future events.

Readiness for Potential Verification Activities in the DPRK

Should a new agreement with the DPRK be concluded, it is quite likely that the IAEA would be asked to verify certain of its provisions and eventually apply safeguards under the existing DPRK CSA and a new AP, possibly similar to IAEA verification in Iran under United Nations Security Council Resolution 2231. Although at the moment progress on solving the nuclear issues on the Korean Peninsula seems to have reached a stalemate—and it may take years before the need for verification activities in the DPRK comes—it remains important to preserve the knowledge and skills in this area, building on the experience gained when the IAEA was working in the DPRK. The agency needs to remain ready, but at the same time it should reasonably refrain from significant commitments (both financially and in terms of human resources) until there is an encouraging level of progress to proceed with verification activities.

A related possibility could be to train specialists from the DPRK on IAEA safeguards implementation. The interest in such an initiative has been expressed in Pyongyang. (Similar trainings have previously been conducted in partnership of the IAEA and Australian Safeguards and Non-proliferation Office.) The latest suggestion for a similar system—training on disarmament by the United Nations Office for Disarmament Affairs—was blocked by a European country after a series of DPRK missile tests. In the meantime, this is something that should be kept in mind as an avenue for potential cooperation with the DPRK.

Specific Areas for Cooperation

Ongoing cooperation between the Russian Federation and the United States could include the following:

- Assistance to the IAEA Secretariat in developing or upgrading existing methodologies used in the SLC—for example, acquisition path analysis—to bring them to the state of the art to achieve the stated goal of each SLA. Data analysis methods and tools need to be explored to strengthen the synthesis and evaluation of information, including quantitative and qualitative verification data.
- Assistance to the IAEA Secretariat in developing methodologies for the analysis and validation of open-source information and information from third parties.
- Assistance to the IAEA Secretariat in developing reference materials and tools needed for the state evaluation groups in their assessment of a states' capability to accomplish the individual steps of acquisition pathways analyses. Such assistance could provide a way to increase transparency between the IAEA Secretariat and the IAEA member states.
- Assistance to the IAEA Secretariat in improving and upgrading technical capabilities in and approaches to verification, especially in light of the need, as demonstrated by COVID-19, for flexibility in adapting to demanding circumstances. Possible assistance might, inter alia, include more intensive utilization of unattended containment/surveillance systems and of monitoring and measurement systems with secure data transmission; expanding the use of remote inspection activities utilizing state-of-the-art cyber security technology; and assistance to the IAEA in offsetting limitations in normal services—for example, in providing travel when commercial transportation is stopped.

Cooperation between the United States and the Russian Federation in the area of IAEA safeguards should be organized and implemented at both intergovernmental and non-governmental levels.

- Assistance to the IAEA Secretariat in human resource management and training.
- Joint studies of potential ways to strengthen safeguards implementation: the universality of the AP; the potential relevance of the results of the November 2018 IAEA Safeguards Symposium and other technical meetings on IAEA safeguards; the reaffirmation of broader conclusions; and the future content and format of the SIR.

Potential Mechanisms for Cooperation

Cooperation between the United States and the Russian Federation in the area of IAEA safeguards should be organized and implemented at both intergovernmental and non-governmental levels.

Unfortunately, today it is very difficult to talk about intergovernmental cooperation; relations between the countries are at a very low level. At the same time, it should be remembered that in the past when relations were very difficult, it was still possible to maintain intergovernmental cooperation on nuclear non-proliferation and IAEA safeguards. It might be possible, for example, to have consultations on topics related to safeguards implementation presented in GOV and GC documents[4] under consideration by the IAEA Board of Governors or the General Conference, or in SIRs. It could also be worthwhile to improve the interaction between the Russian and American experts participating in Standing Advisory Group on Safeguards Implementation work and in safeguards technical working groups.

Due to the existing difficulties of interaction at the governmental level, cooperation through non-governmental organizations and interaction of expert communities is becoming increasingly important. The current project between CENESS and NTI is a good example. Given the results obtained during the implementation of this project, a long-term program of joint research in the field of IAEA safeguards could be developed.

[4] Official documents provided by the Director General to the Board of Governors or to the General Conference to convey information or to request specific actions.

CONCLUSIONS

1. The IAEA safeguards system plays a crucial role as the mechanism for verifying compliance of states with their safeguards agreements with the IAEA, and thus enhancing the international nuclear non-proliferation regime. IAEA safeguards also support the peaceful use of nuclear energy, contributing to reaching practically all sustainable development goals by assuring that such peaceful use does not contribute to the proliferation of nuclear weapons.
2. To serve these two tasks, the IAEA safeguards system must remain independent, technically sound, and credible.
3. There are growing internal and external challenges to the ability of the IAEA to continue providing credible assurances that states are honoring their safeguards obligations, particularly challenges in detecting indications of undeclared nuclear material or activities.
4. To address these challenges, the IAEA will need support and cooperation from its member states, especially from such countries as the United States and the Russian Federation.
5. Even in light of the fact that relations between these countries are at a very low level, it should still be possible at least to maintain cooperation at the governmental level on nuclear non-proliferation and IAEA safeguards on issues discussed in the IAEA governing bodies.
6. Cooperation through non-governmental organizations and interaction of expert communities is becoming increasingly important, as the current project between CENESS and NTI demonstrates. It seems reasonable to continue consultation by experts and exchange information regarding new developments in the IAEA safeguards area. The results obtained during the implementation of this project suggest that a long-term program of joint research in the field of IAEA safeguards should be developed.

Center for Energy and Security Studies
www.ceness-russia.org

Nuclear Threat Initiative
1776 Eye Street NW, Suite 600
Washington, D.C. 20006
www.nti.org

@NTI_WMD nti_wmd Facebook.com/nti.org

Center for Energy and Security Studies
(Центр энергетики и безопасности)
Mosfilmovskaya Str., 42, Bldg. 1
Moscow, Russia 119285
www.ceness-russia.org