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The Evolution of Information-Driven Safeguards

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Abstract. From the adoption of the Model Additional Protocol and integrated safeguards in the 1990s, to current International Atomic Energy Agency (IAEA) efforts to deal with cases of noncompliance, the question of how the Agency can best utilize all the information available to it remains of great interest and increasing importance. How might the concept of “information-driven” safeguards (IDS) evolve in the future? The ability of the Agency to identify and resolve anomalies¹ has always been important and has emerged as a core Agency function in recent years as the IAEA has had to deal with noncompliance in Iran and the Democratic People’s Republic of Korea (DPRK). Future IAEA safeguards implementation should be designed with the goal of facilitating and enhancing this vital capability. In addition, the Agency should utilize all the information it possesses, including its in-house assessments and expertise, to direct its safeguards activities. At the State level, knowledge of proliferation possibilities is currently being used to guide the analytical activities of the Agency and to develop inspection plans. How far can this approach be extended? Does it apply across State boundaries? Should it dictate a larger fraction of safeguards activities? Future developments in IDS should utilize the knowledge resident within the Agency to ensure that safeguards resources flow to where they are most needed in order to address anomalies first and foremost, but also to provide greater confidence in conclusions regarding the absence of undeclared nuclear activities. The elements of such a system and related implementation issues are assessed in this paper.

1. Introduction

After more than 15 years of implementation of strengthened safeguards and integrated safeguards, and the development of a State level concept, a new safeguards system is emerging. With the Model Additional Protocol, the authorities of the Agency have been expanded, increasing both the scope of safeguards declarations and the degree of access.

Safeguards are no longer implemented in an entirely prescriptive manner, dictated by checklists and criteria. Information, wherever it may come from, is recognized as a key feature of the new system, allowing the Agency to understand the nuclear operations in a state and to identify any gaps in its understanding. Organizational units focused on open source information analysis, including satellite imagery, have been created. Traditional inspection goals have been modified to shift resources to support this analysis and related

¹The term ‘anomaly’ is used throughout this paper to refer to irregularities or inconsistencies produced from relevant assessments, not in reference to its formal definition in safeguards implementation.

reporting efforts, as well as other activities. In recent years, the Agency has also gained valuable experience in investigating cases of noncompliance in Iran and the DPRK, and exercising the flexibility and ingenuity that such activities demand.

Yet significant questions and challenges remain for the Agency. Noncompliance issues will likely continue to pose challenges, both in the implementation of safeguards and the perception of their effectiveness and value. The Agency will have to balance its efforts to maintain "situational awareness" globally while simultaneously drilling down to resolve irregularities when events demand it.

This has presented numerous management difficulties, from staffing and training to resource allocation. Acquiring the right collection of skills and employing them across the range of Agency functions is difficult. Connecting the dots is simply not as easy (or as straightforward) as filling in the blanks during a material inventory. Collaboration and integrated analysis is vital.

Safeguards resources can be expected to remain limited, even if efforts to increase the Agency's budget are successful. The allocation of scarce resources and the prioritization of agency efforts must be done strategically. Safeguards cannot afford to waste effort. The Agency must continue to review its practices over time to see if the effort expended on any particular task is commensurate with the safeguards benefit.

The flexibility in safeguards implementation that Member States have granted the Agency has made it able to function in a more dynamic fashion. Avoiding a "one size fits all" approach has produced certain efficiencies. Yet this economy could come at the cost of transparency. While much of the Agency's work must remain confidential, safeguards decisions must be made in a context of objectivity with a clear understanding of methods and objectives. The Agency will continue to enjoy the confidence of Member States if inspection efforts are being applied prudently in a fair manner, and anomalies are addressed in a timely manner.

The term "information-driven safeguards" (IDS) has been used to describe the current state of evolution of the safeguards system. When reconciling the new and varied activities of the Agency, the term is useful in providing an inclusive theme. However, it plays a limited role in defining Agency operations. Exactly how are safeguards being driven by information? To what end? Information is periodically evaluated in the context of required annual reports, leading some to describe the work as "calendar-driven safeguards." There is a need to establish a more comprehensive vision for the Agency that fully captures the utility of information analysis in safeguards implementation.

In thinking about possible futures for the international safeguards system, certain boundary conditions must be understood. The application of safeguards must remain unbiased and applied in an evenhanded manner. Timely detection of diversion must be maintained. More broadly, the product of the successful application of safeguards must be Member State confidence. If States are confident in how safeguards are applied, they can be confident in the Agency's conclusions, even if the specifics necessarily remain confidential. In judging performance, States will ask a variety of questions. Is the Agency cognizant of nuclear developments around the globe? Can the Agency be trusted to act on information in an effective and timely manner in support of deterrence objectives? It is critically important that these questions can be answered in the affirmative.

2. A Knowledge-Based Approach to Safeguards

Given the current trends in safeguards, one can anticipate the further extension of information analysis in Agency practices. Recognizing that the application of safeguards does not take place in a vacuum, approaches that take full advantage of the knowledge, access and expertise the Agency possesses are needed.

It is useful to discuss information-driven safeguards in terms of three basic functions: data gathering, data analysis and anomaly resolution. This analytical cycle unfolds along two related but unique information tracks: data provided by others and data compiled by the Agency itself. While both are essential, it is in the latter category where the Agency's ability to independently test and validate its understanding of nuclear activities in a state might be expanded upon in the future.

The Agency's data gathering capacity has expanded enormously in recent years. With the Additional Protocol, traditional state declarations have expanded in scope. Open source collection has been added, capturing enormous amounts of information in a wide array of formats. Performing triage on this data and verifying its credibility requires a significant amount of effort.

Data gathering also occurs as part of the development and implementation of a State Level Approach and Annual Implementation Plan. In this process, proliferation pathway analysis for the State is used to target areas of investigation and develop plans for complementary access. This provides important new data sets and independent sources of information. This data is reconciled with existing information. This check on the "internal consistency" of all available information is a key element of current information analysis efforts.

Where an anomaly or inconsistency exists, whether arising from a third party source or from Agency collection, it must be understood and resolved. This is a decidedly different task from the data gathering and analysis described above. It is inherently investigative, requiring a certain degree of creativity and imagination. It is a fact-driven process where leads must be followed up and alternate rationales examined. New information that would be useful must be identified and then acquired using a wide array of methods and authorities. As anomalies are driven by external events, they are also difficult to plan for, presenting unique management and human resource problems for safeguards.

The results from work in each of these areas—from data collection through anomaly resolution—find their way into one of several tangible Agency "products." The State Evaluation Report (SER) contains a description of the nuclear situational awareness in the State. It also contains an analysis of the internal consistency of the available information. The State Level Approach and Annual Implementation Plan describe the associated data gathering efforts of the Agency, and the State Implementation Report gives a review of the overall functioning of the system. Noncompliance reports to the Board serve to record the results of important anomaly resolution efforts.

When considering resource questions it is reasonable to ask, what is the relative priority across these efforts? How much energy and resources should be expended in data gathering, analysis and anomaly resolution? How much energy and resources should be expended in producing the various reports referenced above? The need to remain efficient will not recede

with time. The Agency must continue to make the best of limited resources. It would be particularly desirable if the nature of safeguards implementation by its design drove resources where they are most needed, that is, where confidence is most lacking—while ensuring confidence is not eroded in areas where it is now relatively high.

3. The Unique Role of the Agency

As information driven safeguards further develop, the IAEA should focus its attention on what it is uniquely suited to do—resolving anomalies while independently pursuing nonproliferation assessments designed to build confidence in broader Agency safeguards conclusions. These activities should be understood as fundamental Agency functions which deserve organizational focus and dedicated resources. In the process, supporting activities and reporting efforts should be streamlined to improve efficiencies and facilitate analytical efforts.

To manage anomalies, the Agency should adopt a deliberate approach to data gathering based on priorities set at an Agency-wide-level rather than on a state-by-state basis. Formal mechanisms should be in place to ensure that these priorities are reviewed in a timely manner. Under safeguards, all states are equal, but all anomalies are not. An environmental sample containing plutonium at a research facility not engaged in related work presents a more direct concern than information pertaining to the existence of previously unknown analytical equipment at a declared site which the Agency routinely visits. While this is done informally today, a rigorous process ensures that in less obvious cases, data drives the available investigatory resources as necessary, and not, for example, an annual schedule for a State Evaluation.

Such a process would also allow concerns regarding illicit transfers and procurement networks to be taken into account when tasking safeguards resources. For example, if open source information suggests a commercial entity known to have engaged in illicit trafficking in the past has transferred relevant material to a state, resolving this inconsistency could be given higher priority. It is the context of the transfer that makes the information more significant and deserving of greater attention.

At the state level, in order to strengthen Agency conclusions regarding the absence of undeclared activities, increased attention should be given to proliferation pathway assessments. Rather than reconciling new data with old to determine its consistency, such assessments would ask a fundamentally different set of questions: If proliferation were occurring, what might you expect to see? Is there any evidence to support such a premise? Analytically, this approach exercises a different set of skills and is inherently more investigative in nature. Utilizing information analysis and the Agency's current ability to make simple requests for clarifications, noting that nothing precludes States from providing information beyond current declarationsⁱⁱ, such analyses could constitute a more significant element of IDS in the future.

As has often been noted, "absence of evidence is not evidence of absence." The Agency must continue to be a source of original information and not just a recipient. This is particularly true as fewer inspector days in the field are envisioned with the growth of remote monitoring and even remote inspections. The type of dynamic information exchange

ⁱⁱ See for example, Article 8 of the "Model Protocol Additional to the Agreement(s) Between State(s) and the International Atomic Energy Agency for the Application of Safeguards."

that occurs during the Agency's initial assessment of the completeness of a State's initial declaration under INFCIRC 540 can be utilized, albeit at a dramatically reduced level, to support such pathway analysis and maintain confidence over time in Agency conclusions regarding the completeness of a State's declarations.ⁱⁱⁱ

4. Hypothesis Testing at the State Level

The Agency uses safeguards declarations, open source and other information to develop and continuously update the picture of the nuclear activities in a State. This ongoing activity is passive in the sense that the Agency receives information from others. While necessary and important, the effectiveness and credibility of the Agency can be strengthened through greater use of existing authorities to test various hypotheses regarding the possible existence of undeclared nuclear activities.

Hypothesis testing is a technique with a long history of application in the Agency. Traditional safeguards focused on nuclear materials accounting which has a formal statistical means for testing "diversion" hypothesis. Conceptually, this approach can be extended to the State level in a qualitative manner. Hypothesis testing applied at the State level would direct data gathering and analysis resources at a few targeted pathways to see if any evidence exists that is suggestive of an undeclared program. The body of information the Agency has compiled in various databases is a valuable resource in this context. Over time, from year to year, a comprehensive set of such assessments can be produced that would strengthen safeguards conclusions in the important area of "completeness" of a State's declarations.

The Physical Model describes all known technical pathways for arriving at weapon usable material. This set of options is theoretically the same for all states, but one set of scenarios could be deemed more credible or attractive for a given state based on an understanding of its known capabilities, resources, etc. For example, an analysis of journal or trade publications could indicate a specialized capability for the production of large magnets or high tensile strength materials of potential use in various enrichment applications. The associated set of technical pathways can be translated into a set of possible proliferation scenarios for the state. This would help to bound the problem and provide a framework for developing State-specific assessments.

This process already occurs during the annual development of a State Level Approach and presents an opportunity for the Agency to add independent assessments to the available body of knowledge regarding a State's nuclear activities. Expanding this work would provide useful training on how to conduct safeguards relevant investigations and, if necessary, exercise authorities such as complementary access that will prove useful in dealing with future noncompliance issues should they occur.

It is clear that individual proliferation pathways pose different levels of concern in different States. Rather than material form and quantity, pathway attractiveness can determine the focus and intensity of safeguards. Similar to the process of prioritizing anomalies on an Agency-wide basis, such an approach could be used to direct safeguards resources in a manner that differentiates between states on the basis of the body of knowledge available to

ⁱⁱⁱ As the State level concept applies to all States with full scope safeguards agreements, pathway analysis can also be employed in INFCIRC/153 States. Such safeguards assessments can be viewed as the periodic verification that initial declarations of "all" nuclear material subject to safeguards remain valid.

the agency and its state-specific context. Perhaps a given State does not have any high priority pathways in it or the transparency and access available in one State makes the investigation straightforward and quick. This would mean that limited information analysis resources would have to be expended in that State to arrive at a safeguards conclusion. Alternatively, if a State is not transparent or fails to cooperate, additional Agency resources would have to be applied. Resources would therefore naturally flow to the more difficult cases.

This approach also provides a means of characterizing safeguards efforts and evaluating overall safeguards performance. The number of proliferation pathway assessments performed can easily be described. The degree of effort expended in searching for indicators of pathway use offers a measure of the confidence States can have in the Agency's conclusions when no evidence of proliferation is found. The quantity and quality of pathway analyses could be used as a performance metric for the Agency rather than, for example, the completion of SERs.

5. Implementation Issues

If Agency knowledge and expertise is to be leveraged more heavily in IDS, what will be required in the way of implementation? If anomaly resolution and proliferation assessments are given top priority, how well is the Agency prepared to perform these functions?

In terms of proliferation assessments, assistance in performing State-specific proliferation pathway analysis would be valuable. The hypothetical number of proliferation scenarios in any given State is large. An automated means for developing, categorizing and assessing them at an appropriate level of detail would be useful. In any given year, it would be impossible to evaluate "all pathways," but over several years the systematic sampling of pathways could prove to provide significant coverage. Archiving analytical results of evaluations along pathways can also serve the Agency's knowledge management objectives.

In this context, a means for maximizing the utility of the information contained in the physical model is also needed. The proliferation indicators captured in the physical model have been developed over many years with the help of many Member States. Linking this information electronically to pathways chosen for assessment can help guide analysis efforts and interpret the results.

The process of prioritizing pathways from State to State requires broad Agency involvement in the development of State Level Approaches. There will remain a need for country specialists to identify the most plausible pathways for a given State, but as part of a collaborative team effort, regional and other proliferation experts in the Secretariat must also contribute to the process, for example, to alter priorities based on objective assessments of safeguards relevant issues. This places additional knowledge management and information sharing demands on the Agency's information technology systems.

To enable dynamic, timely and effective resolution of anomalies, a modern information architecture is essential. This will be vital both from an effectiveness and efficiency basis. Given scarce resources, there is simply no other way for IDS to succeed.

Robust collaborative analysis capabilities are a must. Analysts in the Agency, whether they reside in Operations, Information Management or elsewhere, will all have an important role

to play. To properly assess new information, and develop effective data gathering strategies to resolve safeguards issues, a diverse set of specialists will be needed. Confidentiality must be respected but appropriate access must be provided. A common information management system that possesses these features and serves the entire department of safeguards is needed.

In terms of staffing and human resource development for IDS, there are several alternatives to consider. It seems likely that in the future the distinction between inspector and analyst will be less meaningful. In terms of job requirements, a more useful distinction will be between data gathering and reconciliation activities on the one hand, and data analysis and State-wide anomaly resolution activities on the other.

Information collection requires a different skill set from investigative assessments. A fluid personnel system with staff trained in both activities would be desirable. Performing both missions at the same time may prove to be impractical however, given the demands of verification at declared facilities. There may simply not be enough time for an individual to perform both functions well. It may be necessary to acknowledge the differences and focus training and job responsibilities accordingly.

The demands of collaborative analysis require the employment of information tools for the tracking of open issues and communication of findings. When a priority anomaly has entered the queue for evaluation, an automated and systematic means for tasking analysts, sharing analytical results and bringing issues to a close would aid productivity and produce timely results. Such a system could also be used to document and archive Agency assessments, helping to preserve institutional knowledge and facilitate relevant safeguards reporting.

With regard to reporting, it would seem that safeguards reports covering the results of any significant anomaly resolution activities, and the results of the Agency's hypothesis testing activities in a State should be the primary focus of higher level management review. The current SER gives significant attention to a description of ongoing nuclear activities. While a continuously updated snapshot of nuclear activities in a State is critical for drawing safeguards conclusions, the results of these investigative activities are of greater importance.

This observation has implications for the drafting of State Evaluation Reports. If a picture of a State's nuclear activities is maintained electronically in a Virtual State File, and a means for tracking anomaly resolution is provided in a collaborative analysis tool, a status report could be produced at any point in time. This could reduce the burden of producing the annual SER. The physical production could even be dispensed with entirely if the information was available electronically in an up-to-date form. This would support an analytical process that can operate on a more continuous basis rather than SER-driven deadlines.

To support timely anomaly resolution, the Agency should exercise its existing authorities more frequently. An expansion of hypothesis testing as described above would allow this to occur in a non-contentious manner. This would not necessarily involve the utilization of complementary access rights. There is nothing preventing the Agency from asking for additional information as part of pathway analysis activities. This could help establish a norm of greater transparency in States as such visits would become a routine part of normal safeguards implementation.

When complementary access authorities are to be utilized, the suite of tools available should be expanded. The capability to perform a wide array of measurements in the field is necessary. If answers can be obtained in a timely manner without having to leave the country, additional follow-up activities can be pursued. This has obvious effectiveness and timeliness advantages.

What is clear is that the teaming of diverse sets of experts will be of paramount importance to the future of information-driven safeguards. Crosscutting analytical teams will be involved in the prioritization of pathways and anomalies. They will be utilized in the tasking of follow-up efforts, as well as in the analysis of results. Safeguards conclusions will necessarily be drawn by higher level authorities in the Agency, but assembling the right working-level teams to ensure that the right set of analysts are assigned the right tasks will be an ongoing challenge. The Agency has made significant progress in this area, for example, with the establishment of the State Evaluation Working Groups this summer. This is an important area for safeguards implementation that will benefit from iterative trials.

Calibrating the ultimate resource requirements for information-driven safeguards has proven to be difficult. Reporting the number and quality of analytical products, supporting both anomaly resolution and hypothesis testing, allows Member States to judge the adequacy of current budgets and staffing. If high-priority anomalies are not being resolved in a timely manner, more analysts may be needed. If States view the extent of open source collection is too limited, or the number of analytical products supporting pathway analysis are too few to support credible conclusions of "completeness," arguments for additional support can be made with a sound basis. This balance can be examined from year to year in an attempt to "right size" the IDS enterprise.

6. Conclusions

A safeguards system that fully utilizes the knowledge available to the Agency and possesses the infrastructure necessary to support independent, dynamic and collaborative analysis will be needed if the IAEA is to succeed in satisfying the dual objectives of safeguards effectiveness and efficiency in the future. Facilitating anomaly resolution activities and proliferation assessments should be a key focus in extending the use of information analysis at the Agency. Efforts are underway in both areas but significant implementation issues remain. The formation and use of teams of experts with the proper set of analytical skills will present an enduring management challenge to the Agency. The current focus of IDS on the drafting of State Evaluation Reports should be reevaluated to see if it is the best use of Agency resources. If implemented successfully, a knowledge-based safeguards system would help ensure that limited agency resources are directed at safeguards priorities.