INFORMATION ANALYSIS FOR IAEA SAFEGUARDS

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Abstract

The evolution of the International Atomic Energy Agency (IAEA) safeguards system over the last decade has reflected the recognition that, in order to provide adequate assurance that nuclear programs are exclusively peaceful, the IAEA needs to examine a state's nuclear activities in more detail than previously. The safeguards strengthening measures and the additional protocol have given the IAEA the authority for wider investigation of nuclear and nuclear-related activities. Not only is the IAEA now expected to verify that all nuclear material is satisfactorily accounted for, but it is also expected to be proactive in providing assurances that clandestine nuclear activities are not being carried out. This expectation extends to all states with comprehensive ("full scope") safeguards agreements, though clearly the IAEA is best placed to do this for states that have concluded an additional protocol.

In order to detect and investigate clandestine nuclear activities, the IAEA has had to embrace new information sources and expand its information analysis capability. The emphasis is on "actionable information", information that can be directly used in interactions with the state or states involved. Actionable information could lead to lines of inquiry, inspections or complementary access requests.

To analyse the new types of information available, the IAEA has expanded its information analysis capability. The Agency requires tools to collect, collate and report the information available and to provide coherent analysis which can be further used by the Agency. This last element is dependent on the Agency having analysts with both a nuclear background and the ability to undertake information analysis.

This paper explores the evolving need of the Agency to provide timely and accurate analysis with which to support safeguards assessments and actions. It also outlines how member states can assist the Agency by providing information, tools and expertise; and Australia's ongoing contributions to support the Agency's information analysis efforts.

1. INTRODUCTION

Up to the early 1990s, the IAEA system of safeguards was required principally to verify states' declarations of nuclear material. Since then international expectations of IAEA safeguards have changed markedly. Safeguards are now not only required to perform their traditional nuclear material accountancy role, but to be proactive in verifying that states with comprehensive safeguards agreements—essentially, non-nuclear-weapon states (NNWS) party to the Nuclear Non-Proliferation Treaty (NPT)—do not have nuclear weapons programs. This shift in expectations began with the discovery of Iraq's clandestine nuclear weapons program in the early 1990s. It continues to be driven by issues such as the IAEA's inability to access and verify the nuclear program in North Korea; the discovery of significant undeclared nuclear activities in Iran; and the revelations of a nuclear weapons program in Libya.

The level of expectation in the international community has now risen to the point where the IAEA is expected to investigate and provide assurances about the peaceful nature of nuclear programs in all

states, even those that have not concluded an additional protocol. This presents a growing challenge for the IAEA, and the Agency's hope of fulfilling this expectation lies with its ability to increase its knowledge about all states.

The safeguards strengthening measures, the additional protocol, and resolutions of the IAEA Board of Governors (such as recent resolutions seeking greater IAEA investigation of Iran's nuclear program) have provided the Agency with the much needed legal authority and political backing to investigate states' nuclear programs in more detail. The additional protocol requires states to provide additional information about their programs. It also requires that states give the IAEA greater access to nuclear sites and nuclear-related locations. In this context, safeguards inspections and "complementary access" under the additional protocol can be considered an additional source of information as well as a means of verifying the information from states' declarations (or other sources).

The analysis and integration of the full range of information that is collected by the IAEA is a challenging process requiring particular skills and expertise—expertise in information handling, technical knowledge of areas of the nuclear fuel cycle or of weaponisation activities, as well as knowledge about individual states. The "Physical Model"—an analytical tool that identifies, describes and characterises fuel cycle technologies and processes—is a key resource for the IAEA in its efforts to analyse the nuclear activities of states. The Physical Model provides a yardstick that can be used to ensure the coherence and consistency of the various elements of states' programs and the proliferation pathways available to each state.

The international community must have confidence that the IAEA has conducted its information collection and analysis activities in a consistent, non-discriminatory and competent way. In order to ensure this confidence it is necessary for these processes to be subject to stringent and transparent quality control and review mechanisms.

2. NEW REQUIREMENTS FOR INFORMATION

The idea of the IAEA handling and assessing information is by no means new. The IAEA has been handling information for safeguards purposes since the safeguards system started. However, most of the traditional information is quantitative in nature and comparatively easy to verify using the tools available to Agency inspectors under traditional safeguards. Typical examples are: quantities of nuclear material; numbers of fuel rods; or the flow of material through a facility or fuel cycle. These can be verified through measurement, calculation and observation.

What is new since the early 1990s is the range of information and information sources that the Agency is required to collect and collate, and the types of analysis that it needs to perform on this information. New information types are likely to include: plans; perceptions; policies; the areas of research within the state; and the technical knowledge available within the state. Such qualitative information cannot be confirmed using traditional safeguards verification tools. For example, if a state has plans to build a clandestine reprocessing plant, it would be very hard to confirm that such plans exist. Each piece of information helps to form part of a picture of the state's nuclear program and may confirm or contradict other information. It is the collection, collation, evaluation and analysis of information from a variety of sources that is the key to confirming—or unlocking—the true nature of states' nuclear programs.

In addition to studying states' programs, there is a growing demand for the IAEA to investigate non-state actors, procurement networks, and bilateral/multi-state interactions. These investigations cannot

be centred on traditional safeguards information sources (declarations and inspections) but must rely almost entirely on non-traditional information sources.

3. INFORMATION SOURCES

A number of sources can provide useful information for IAEA safeguards. Each source, while providing an insight into the state's activities, also comes with limitations. It is therefore only by gaining information from several, independent sources that a complete picture of past, present and planned future activities can be revealed.

The most important source of information for safeguards continues to be the state itself. Declarations and reports made under a state's safeguards agreement provide the database against which all other information can be compared. States that have concluded an additional protocol have made a political commitment to ensure greater transparency in their nuclear programs. They are also required to provide more extensive and detailed information about their past, present and planned future nuclear and nuclear-related activities, and the export of nuclear material and equipment to other states.

Protocol declarations cover information quite different to that in traditional declarations and reports. This additional information can support the state's traditional safeguards declarations and provide collaborative evidence about the state's nuclear program. Information in and supporting the protocol declaration could include copies of reports, research papers, plans, maps, photographs, details of dealings with other states, and more general information such as the state's power distribution network and power usage. In most cases information from states is expected to be detailed, specific, accurate, and traceable back to an organisation and an individual. The range of information can span all time frames (past, present and future plans) and can be both quantitative and qualitative.

The second most important source of information is the IAEA's own activities. Through its inspection efforts (and complementary access), it is able to gain independent information. This can be both quantitative (measurement of quantities, non-destructive essay, destructive analysis, environmental samples, diagrams, etc.) and qualitative (including the level of cooperation by state authorities, and characteristics of the state's nuclear activities such as the number of personnel involved, the level of technical competence and sophistication, overall level of program funding, and so on. The IAEA has other internal sources of information, such as from its internal databases, and from the nuclear safety, security and technical cooperation programs. The reliability of information from IAEA sources would be expected to be high. Depending how it was derived, this information could also be detailed, accurate and traceable.

Open source information provides another valuable resource for safeguards. This includes such things as satellite imagery, scientific literature, media reporting, and the internet. Satellite imagery is very good at showing what is on the ground at a known location and in monitoring large-scale activity at facilities over time. Imagery can provide accurate, reliable and independent information, but is heavily dependent on having known precise locations and favourable weather conditions. It is not capable of providing information about plans and intentions. Often imagery is also not able to provide details about the function of a facility. Imagery may be able to identify a building but not its use, or a reactor but not if it is producing weapons-grade plutonium. The use of commercially available imagery is often limited by its high cost.

Open source scientific literature, such as scientific journals, research papers, and conference proceedings can be useful in identifying research areas, organisations and individuals. A few journals focus specifically on nuclear issues, but most nuclear or nuclear-related information is scattered more

generally in a very large volume of published material. Some assistance in searching this material can be gained by using literature databases. Scientific literature is usually accurate, but very specific. It can highlight research interests or activities, but does not always provide a comprehensive insight into the research of a particular organisation.

Media reporting and the internet are the most prolific sources of nuclear-related reporting. However, they contain large amounts of inaccurate, incomplete, biased, repetitive or even fabricated material. Even when reports in the media or the internet appear to provide useful information it is difficult to assess the information's validity and origin. However, these sources can highlight areas that deserve further investigation. They are also valuable sources in providing insight into the technical, political, economic, and strategic circumstances within a state. Media reporting and internet pages are available in a variety of languages, but can sometimes be hard to obtain due to limitations (e.g. limited numbers, limited to a particular geographic region, or limited in accessibility).

Historically the pursuit—or renunciation—of nuclear weapons by states has often been in parallel with programs for other weapons of mass destruction (WMD) and WMD delivery systems. Therefore, a state's commitment and adherence to other WMD treaties and agreements can provide insight into the commitment of the state to nuclear non-proliferation. Although not presently practiced, there is scope for exchange of information between the IAEA and other non-proliferation treaty verification regimes and export control groups.

Information provided by states (about other states or non-state actors) and special interest groups (e.g. non-government organisations (NGOs) and non-proliferation research institutes) can provide unique data and intelligence that can provide knowledge and analysis not otherwise available or not easily accessible. This information can be of great value to safeguards. It is often sorted to highlight the most valuable information, and can include analysis. However, such information reflects the viewpoint of the originator, and does not always include the origin of the information or tangibles such as individuals' names, facility locations, material and equipment quantities, etc. Intelligence provided through national technical means in particular, can also come with limitations on its distribution and use within the IAEA.

4. INFORMATION ANALYSIS

When thinking about information, consideration must first be given to what types of information will be most valuable for safeguards purposes. This is likely to be information that can be used as evidence to substantiate or contradict previously established data (e.g. states' declarations) or that is otherwise actionable. By "actionable" is meant, information that can be directly used in interactions with the state or states involved, or could lead to lines of enquiry, inspections or complementary access. Actionable information needs to be robust, i.e. it needs to be traceable to an origin (e.g. an individual, photograph, journal, newspaper, etc.), the source and information must be credible, and the information must be specific.

With the need for actionable information, and given the variety of information sources available, the collection, collation, evaluation and analysis of information needs to be performed in a structured and focused manner.

Firstly, collection of information needs to be prioritised on sources that give the greatest return for the time and money spent. For example, although satellite imagery is limited to large scale activity already underway, is expensive and susceptible to climatic conditions, it gives a small quantity of robust, actionable information from a traceable source and provides highly reliable, specific and accurate

information. On the other hand, the internet provides vast quantities of material containing a small proportion of usable information. It is mostly neither robust nor actionable. Any examination of any given piece of information must therefore include an evaluation of the source itself. As mentioned earlier, source bias, reliability and traceability can have a significant effect on the usefulness of the information.

A lot of time can be spent on information **collection**, time that ideally should be spent on **analysis** of the information. Where the amount of information to be analysed exceeds the time allowed for analysis, the system is said to have gone into "information overload". The result of any increase in the volume of data available has a consequential decrease in analysis output unless steps can be taken to ensure a commensurate increase in the availability of analytical resources. Therefore, it is vital that the collection element of the information analysis process be well planned and managed.

Once information is collected, it needs to be collated into a filing system or database. Here the emphasis needs to be on the ease in which data can be stored, the retrievability of the information, and the ability of the system to facilitate comparison and the discovery of relationships between individual pieces of information.

The actual analysis of the information is a challenging process requiring particular skills and expertise—expertise in information handling, technical knowledge of areas of the nuclear fuel cycle or of nuclear weapons, and knowledge of the particular state. As it is unlikely that a single person will possess all the required knowledge, a team approach is required. For the IAEA it could be expected that the analysis team for each state would include safeguards operations staff, safeguards information technology staff, technology specialists, and possibly also country officers from the technical cooperation program.

The Physical Model was developed as an important tool to be used in support of the information analysis efforts of the IAEA in the context of strengthened and integrated safeguards. The Physical Model identifies, describes and characterises all known fuel cycle technologies and processes, especially those required for the acquisition of weapons-useable fissile material, as a guide for IAEA analysts and inspectors. The Physical Model is a living document subject to periodic review and update to take into account new information, the development of new processes and the lessons learnt in applying safeguards to new and existing facilities.

The Physical Model allows the IAEA to develop a comprehensive understanding of the potential diversion strategies available to a state at each of the various stages of nuclear development and to evaluate the potential for each stage to contribute to the overall proliferation potential within a state.

The analyst team needs to have identified objectives and outcomes to focus the assessment process. Objectives may include:

- the confirmation or contradiction of previously known information on individual people, organisations, facilities, material, research and development and entire state programs;
- assessing the importance of new information;
- identifying inconsistencies in information or gaps in knowledge;
- utilising the results of information analysis (including knowledge gaps) in ongoing safeguards planning and inspections;
- documenting the analysis results—this is vital for future analysis;

- if required, providing suitable reporting to senior IAEA officials, the state, Board of Governors (BOG) etc.

The identification of inconsistencies and gaps by the analysis team provides the focus for further investigation. The significance of these inconsistencies and gaps will, in part, depend on the potential proliferation pathways that they could open for a state. The Physical Model has a key role in the IAEA's treatment of these issues. How the IAEA investigates these inconsistencies and gaps will depend on their nature, and possible routes for investigation. Some may be best investigated by direct action from the IAEA, such as inspections or complementary access, others by questions to the state, or by open source searches. Therefore, in the planning and management of the information collection process a key element is the resolution of outstanding issues.

5. QUALITY CONTROL / ASSURANCE

Combined with strategies to collect safeguards relevant information from a wide variety of sources and analyse the information that is collected, the IAEA will have to develop a comprehensive strategy to provide quality control/assurance on its collection and analysis practices. This paper has already discussed the related issues of ensuring that the information collected is traceable and actionable—but quality assurance (QA) can have a wider role in this process. QA can serve both as a key means of ensuring transparency and as a possible means of improving the effectiveness of information analysis as a confidence building measure for the international community.

States need to have confidence that the IAEA is using its information collection and analysis tools in ways that are broadly consistent with the objective of maintaining a non-discriminatory technically based safeguards system. One way that this confidence could be achieved would be to make the full results of all information collection and analysis available to all states. Such an approach, however, would severely hamper the ability of the IAEA to collect data from sensitive sources and it would also, potentially, provide an opportunity for states to bypass IAEA information collection efforts.

While the need for information security is obvious, there is also a need to respond to the legitimate interest of states to understand how information is being treated within the Agency. One approach would be to establish a quality control/assurance system that is open, transparent and available for state scrutiny and review (i.e. the **system,** not state-specific information, would be open to review). Reporting on the aims, processes and effectiveness of information analysis, including QA results, could appear in the Safeguards Implementation Report (SIR). An approach of this kind would ensure that methods and structures of collection and analysis maintain their usefulness while allowing states a form of process review and evaluation.

6. USING INFORMATION AND ANALYSIS RESULTS

Information and its analysis provide extra support for safeguards assessments. The current ongoing examination of Iran's nuclear program has shown the value of the Agency's coordinated information analysis program. It has been able to illuminate discrepancies and undeclared activities and to focus further safeguards investigations. However, the release of such information and analysis outside the IAEA has to be carefully considered.

Where states wish to hide programs from the IAEA, the release of information and analysis can drive nuclear programs further underground. When the Agency's lines of inquiry are exposed, such states can try to discredit or stop the flow of information from those sources. States may change their plans and activities such that the focus of Agency investigation is maintained to declared activities and away

from clandestine activities. Disclosures can also give such states early warning that their clandestine activities are in danger of discovery.

The security of information and analysis must be considered at all stages in the information analysis process—from how individual pieces of information are gathered to formal reports such as those presented to the BOG. For example, if a state knows when and where satellite imagery was being taken, it could act to hide activities at those locations and times. Similarly, it could restrict certain newspapers or websites. What detailed information is provided in reports to the BOG needs to be carefully considered in terms of how such information could be misused.

Information analysis by the IAEA is not the same as the intelligence gathered by "national technical means"—no spies are involved, nor is information directly gained through covert means. All information is either freely given by states or organisations, available from open sources, or collected by the IAEA through its legitimate activities. The reporting of the Agency's information processes in the SIR would contribute to a better understanding of the process, and would demonstrate how this legitimate process is free from spying, bias or prejudice.

7. STATES' ASSISTANCE TO THE IAEA INFORMATION ANALYSIS PROCESS

The IAEA's information analysis process can be greatly enhanced by the active participation of states. Indeed, by assisting the Agency, states can increase assurances about their own peaceful nuclear programs.

The most significant assistance that states can provide is to bring an additional protocol into force. As well as being an extra political commitment to non-proliferation, the supplementary information and access rights given to the IAEA provides it with a greater ability to adequately assess the purely peaceful nature of nuclear programs. Even for states that have no nuclear activities, the additional information and access provided under the additional protocol is able to help the Agency confirm the lack of nuclear activity. States are not limited to providing information pursuant to their safeguards agreements, but should also provide additional material about their own nuclear and related programs, and about their dealings with other states.

As the information gathering and analysis processes can be time and resource intensive, states can also assist the IAEA by providing information (and analysis) on nuclear-related developments that occur outside their borders. Care needs to be taken that the origin of the information and its full or original presentation is provided in order for the material to be seen as free of bias.

Directly, states can assist by providing expertise and personnel to develop and implement the necessary information collection, analysis, and management techniques within the Agency. States have been undertaking this type of analysis for very much longer than the IAEA, and have valuable experience, knowledge and methodologies that can be transferred. Several states, including Australia, are currently assisting the Agency in this area through their safeguards support programs.

8. ASSISTANCE BY AUSTRALIA

Australia provides assistance to the safeguards information analysis process in several ways. Firstly, Australia is committed to transparency about our nuclear program. Australia was the first state to sign and bring into force an additional protocol. Many of the safeguards strengthening measures that underpin the additional protocol were given their first field trials in Australia before being opened up to wider use in other countries. We provide not only the information and access required under the

protocol, but also additional information such as facility and organisational reports, aerial photographs, briefings on developments between Australia and other states, etc.

Additional open-source information about other states is provided through several methods including a regional newspaper search and consolidation process. The aim of this program is to provide the Agency with amalgamated reports containing nuclear-related press reports that might otherwise be unavailable to the Agency.

This general assistance has been supplemented by technical assistance that has been provided in several ways:

- Analysis methodology development—the information-driven safeguards approach to determining safeguards activity allocation.
- Analysis tools—over several years, the development of topic search trees.
- Information collation software evaluation—assisting the Agency in determining the suitability of software to its requirements.
- Information collection and analysis for specific issues—Australia provides experienced personnel to undertake analysis on identified information gaps.
- Environmental sample analysis—Australia operates one of the laboratories that is part of the IAEA's network of diagnostic laboratories.

9. CONCLUSION

With greater expectations placed on the IAEA to uncover clandestine nuclear activities, the Agency has been required to shift its approach to investigating nuclear programs. Central to this change is the management of information and its analysis in all areas relevant to safeguards. However, with the range and amount of information available to the IAEA, it is imperative that the Agency's information gathering and analysis program be well managed and focused. To do this the Agency needs the assistance of member states in several areas, but the conclusion and implementation of an additional protocol is the primary means by which states can assist the Agency in fulfilling its responsibilities.