Viewpoint

Integrated Safeguards: Status and Trends

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The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) provides states parties with an opportunity to demonstrate to the international community their compliance with treaty obligations, by cooperating with the International Atomic Energy Agency (IAEA) in the application of safeguards. These safeguards constitute an important part of the complex structure of international confidence-building measures designed to provide a high level of assurance that all states parties to the treaty do not use nuclear material and facilities for military or unknown purposes.[1]

The specific nature and form that safeguards should encompass was a topic of intense discussion in the period leading up to the entry into force of the NPT in 1970. The negotiations of the model safeguards agreement, INFCIRC/153, were protracted and difficult.[2] There were occasions when the dictates of political expediency and national interest did not quite align with the technical requirements of safeguards. In the end, INFCIRC/153 emerged as a practical expression of technical safeguards requirements tempered by competing concerns of national sovereignty and an international need for confidence-building measures.

The safeguards that have grown out of INFCIRC/153 are customarily referred to as the "classical" safeguards system. Since its inception, this system has been strengthened by the regular introduction of new methods and techniques, improving both its effectiveness and efficiency for detecting diversion of nuclear material placed under safeguards. However, the classical system remained focused mainly on the correctness of the nuclear material inventories that states declared to the IAEA. The issue of the completeness of states' declarations has been addressed mostly in relation to the initial declarations to the IAEA by states (Spain, Republic of South Africa, Argentina, Brazil, and the Newly Independent States) that joined the NPT in the late 1980s and 1990s.

The classical system of safeguards had tightly defined limits and goals. Verification measures were restricted to defined "strategic points" within clearly delineated facilities at declared sites, and inspectors were discouraged from looking beyond those strategic points or having any curi-

osity as to what was adjacent to the delineated facility.[3] This safeguards system was not designed to detect the diversion or misuse of very small amounts of material, or to detect nuclear activities that had not been declared to the IAEA, other than what could be inferred through the detection of diversion.

In effect, the classical safeguards system was the product of a somewhat bifurcated view of the world. On one hand, the verification system assumed that a state was fully cooperating with the aims of the IAEA, that all relevant activities and material were generally declared, and that the verification activities at defined strategic points would provide a high level of assurance that safeguarded material was not diverted nor safeguarded facilities misused. On the other hand, the formal technical justification for the *timeliness* and *quantity* goals used in safeguards implementation assumed that a state had a fully clandestine, parallel fuel cycle that could be used immediately to process diverted material into weapons-grade material and eventually into weapons components.[4] In other words, it was assumed that the only resource that this clandestine fuel cycle lacked was nuclear material to process. Furthermore, it was assumed that this material would be taken from known or declared sources. The latter assumption ignored the possibility that a state could develop an independent parallel nuclear fuel cycle outside safeguards, beginning with the clandestine production of natural uranium or thorium.

By the early 1990s, the situation in Iraq had demonstrated that the compromises between technical and political goals that led to the development of classical safeguards challenged the ability of the IAEA to fulfill its overall objective in the area of nonproliferation. It became apparent that Iraq had taken advantage of the limitations upon the inspection process to conduct activities that constituted a violation of its obligations under the NPT.

In a sense, the failure to detect undeclared nuclear activities in Iraq did not reflect a failure in the classical safeguards system—the system operated as it was designed. It was evident, however, that the compromises made between the technical requirements of an effective system and the political requirements of a manageable system had allowed activities in violation of the NPT to go undetected. The need for assurance of the absence of undeclared nuclear activities and facilities assumed increasing importance, and it became imperative to update the classical safeguards system by incorporating measures to ensure that the IAEA possessed the capability to detect clandestine nuclear activities.

During the last 10 years, the effort to improve international safeguards has evolved from the implementation of safeguards strengthening measures within the IAEA's legal authority under comprehensive (INFCIRC/153-type) safeguards agreements, to work related to the implementation of measures contained in the Model Additional Protocol (INFCIRC/540)[5] and the development of what are termed "integrated safeguards."

This essay first highlights the background of and philosophy behind IAEA safeguards strengthening measures: the origins of the "Program 93+2," issues related to implementation of strengthening measures, and the need for complementary authority to apply some of these measures. Important elements of verification activities will be presented as well as an overview of the development of integrated safeguards. We will then discuss different views concerning integrated safeguards, highlighting the need to move from mechanistic to flexible, "smart" safeguards.

STRENGTHENED SAFEGUARDS MEASURES

Among the weaknesses that were identified in the classical safeguards system in the early 1990s were some of the political compromises referred to above; specifically, the limitation of routine verification measures to pre-arranged strategic points within delineated facilities. It was recognized that formalizing access beyond strategic points and outside the boundaries of delineated facilities had the potential to improve IAEA understanding of the nuclear fuel cycle in a state as a whole and, through this improved understanding, to improve the efficiency and cost-effectiveness of safeguards.

Program 93+2

Beginning in 1992, a number of decisions by the IAEA Board of Governors reaffirmed the requirements that safeguards should provide a high level of assurance regarding both the correctness and the completeness of states' declarations of nuclear material and endorsed specific measures for increasing the IAEA's capabilities to verify the completeness of declarations. In December 1993, the IAEA Secretariat introduced Program 93+2, which set forth a plan to evaluate the technical, financial, and legal aspects of a comprehensive set of safeguards strengthening measures and to propose a strengthened and more efficient safeguards system to the Board of Governors in

1995. Program 93+2 was intended to explore the weaknesses in the coverage of classical safeguards revealed by the experience in Iraq and to improve both efficiency and effectiveness. Some of the measures explored in this program were simply designed to make better use of existing and new verification technologies to improve the coverage of the classical safeguards system, while others were intended to make better use of the observational skills and intelligence of inspectors in the field. The most revolutionary aspects, however, were developed to enhance the detection of indicators that could arise when a state engages in a proliferation-oriented fissile material acquisition path.

In the middle of 1995, two categories were created for classifying proposed measures to strengthen the safeguards system: Part 1 measures that could, in the IAEA's view, be implemented under existing legal authority; and Part 2 measures that were believed to require new complementary—i.e., additional—authority.[6]

Implementation of Part 1 Safeguards Strengthening Measures

In 1995, the IAEA commenced with the implementation of Part 1 strengthening measures, which included the following major elements:

- broader access to information, including wider reporting of nuclear imports and exports, as well as the earlier provision of information on the design of new facilities (an essential aspect was the development of methods to improve safeguards-related information analysis);
- use of new technologies, in particular, the powerful new verification technique of environmental sampling was introduced, starting with enrichment plants and hot-cell facilities;[7] and
- optimal use of the classical system, including a wide variety of advanced verification technologies, with a major focus on identifying how unannounced inspections, in combination with additional operational data and advanced technology, could lead to more effective and efficient safeguards for a number of facility types.[8]

These Part 1 developments have resulted in substantial improvements in the following four areas: 1) information acquisition and evaluation;[9] 2) increased cooperation with the State Systems of Accounting for and Control of nuclear material and regional authorities, preserving the IAEA's capability to draw independent safeguards conclusions;[10] 3) environmental sampling, which has become well-established and is in routine use as a principal strengthening measure; and 4) inspector training.

Complementary Authority to Introduce Part 2 Safeguards Strengthening Measures

While there was broad agreement that the routine implementation of strengthened safeguards measures would enhance the effectiveness of the IAEA, there was some disagreement about whether the IAEA had the proper authority to introduce such measures unilaterally. As mentioned above, after extensive discussion, the proposed strengthening measures were divided between those that could be introduced within the framework of INFCIRC/153 and those that required some form of complementary legal authority.

The process of negotiating complementary legal authority had the potential to be as arduous and heated as the original negotiation of INFCIRC/153. Some experts argued that only Part 1 measures could be conducted, and that anything else would be revisiting issues underlying the entire safeguards system—with as much potential for weakening as for strengthening the system as a whole. Others, however, were of the view that the distinction between Part 1 and 2 measures was arbitrary and unnecessary, and that under INFCIRC/153 the IAEA was given sufficient authority to conduct all necessary measures. The majority of member states accepted that the application of Part 2 measures was of such intrinsic importance that the case for their application needed to be placed on a strong and universally recognized legal footing. According to this view, the difficulties inherent in persuading countries to sign on to the new regime were worth the effort. With the memory that previous political compromises had allowed Iraq to violate its commitments, states found the will to avoid further compromise.

The complementary legal authority that was eventually agreed to came in the form of an "additional protocol" to the INFCIRC/153-based safeguards agreement. The Model Additional Protocol was published as INFCIRC/540, and states acceding to this additional protocol specifically granted the IAEA the authority to conduct all of the safeguards strengthening measures within their jurisdiction. With this acceptance of additional measures, states were able to increase international confidence in the nonproliferation regime.

Complementary Access

"Complementary access" is the essence of strengthened safeguards—the element that makes these qualitatively different from classical safeguards. Possible only owing to the complementary legal authority granted to the IAEA by member states under additional protocols, complementary access plays a key role in the process by which the IAEA draws conclusions about the absence (or potential presence) of undeclared nuclear material and activities. This mechanism must be carried out in a consistent and non-discriminatory manner in accordance with the provisions of the additional protocol. IAEA internal guidelines provide guidance and the bases for the selection of the locations to be visited, in order to ensure both fairness as well as the authenticity of state declarations.

According to INFCIRC/540, there are three purposes for which complementary access may be conducted under the additional protocol: 1) to assure the absence of undeclared nuclear material and activities at sites, uranium mines, uranium concentration plants, and other locations with nuclear material; 2) to resolve questions and inconsistencies; and 3) to confirm, for safeguards purposes, state declarations on the decommissioned status of a facility or other location where nuclear material was customarily used. Requests for complementary access are intended to be selective, depending on the nature of the facility, its infrastructure, and the activities involving nuclear material.

Revolutionary at the time, complementary access is now seen as a routine aspect of additional protocol implementation. It will continue to be an important contributor to assessing and affirming the absence of undeclared nuclear material and activities, the need and urgency of which will be dependent on particular circumstances. There are two distinct phases for the implementation of complementary access:

1. During the initial protocol implementation phase, complementary access is employed to confirm the completeness of a state's initial declaration and the absence of undeclared nuclear material and activities—a necessary assessment before the IAEA can begin to implement integrated safeguards.
2. If the conditions for the introduction of integrated safeguards are satisfied, complementary access is then called upon as the IAEA finds necessary during the routine application of integrated safeguards. This will bolster the IAEA's ability to confirm the absence of undeclared nuclear material and activities.[11]

Required Level of Assurance and Need for Continuous State Evaluations

Some of the specific factors affecting the credibility of assurance provided by strengthened safeguards measures include:

- a clear and realistic understanding of the limitations of particular measures—it is important that these not be exaggerated. Nonetheless, the effectiveness of the safeguards system as a whole should also be taken into account;
- acceptance that the measures applied by the IAEA are appropriate for the purpose at hand, taking into account all relevant circumstances;
- confidence that the IAEA applies these measures in a competent and consistent manner;
- confidence that all credible fissile material acquisition paths are appropriately covered; and
- confidence that IAEA assessments and conclusions are independent and sound.

Credible assurance should be maintained and enhanced through the ongoing implementation of the additional protocol and the continued satisfactory resolution of any questions and inconsistencies that might arise. The evaluation of all information available to the IAEA about a given state's nuclear program is an essential step in establishing the basis for the implementation of integrated safeguards. The IAEA performs a three-phase evaluation process:

1. initial evaluation of state nuclear programs according to INFCIRC/153 safeguards agreements using all the information available to the IAEA;
2. expanded state evaluation conducted once an INFCIRC/540 protocol is in force and the initial declaration has been provided. This is an essential step in the process of drawing an accurate conclusion regarding the absence of undeclared nuclear activities and in meeting the conditions for the implementation of integrated safeguards; and
3. ongoing state evaluations based on the information derived from on-site activities and from information analysis once integrated safeguards are implemented. This includes the reassessment of earlier evaluation results based on new, ongoing information made available.

THE PHILOSOPHY BEHIND STRENGTHENED SAFEGUARDS

The underlying philosophy behind the classical safeguards system can be described as *process-based*. It as-

sumes that if the IAEA maintains an adequate level of knowledge of all significant amounts of nuclear material in a state's fuel cycle, then it can be sure that nuclear material is not diverted or misused. Hence, material accountancy and control measures are central to classical safeguards, as they provide the basis of the information that the IAEA uses in planning and implementing verification measures.

A strengthened safeguards approach, on the other hand, is *results-based*. Under strengthened safeguards, the IAEA seeks to arrive at measures to ensure directly that there is no misuse or diversion of material within a state. At this stage, accountancy and control measures retain considerable importance. In the future, however, these measures may be replaced to a greater or lesser extent by other verification processes, especially for less sensitive material.

We believe that the most important feature of the approach to safeguards under the additional protocol is that, in order to ensure effectiveness, the IAEA must arrive at an all-encompassing understanding of a state's nuclear fuel cycle. To achieve this, the IAEA must have knowledge of all of the fuel cycle activities that have ever been conducted in the state as well as an understanding of all planned activities. A clear and unambiguous comprehension of how each part of the fuel cycle relates to the whole must be attained. States must be prepared to clarify any apparent inconsistencies or imbalances between any part of the fuel cycle and the whole, as it is understood by the IAEA.

As part of the development of assessing a state's fuel cycle, the IAEA undertakes a thorough and systematic analysis of the fissile material acquisition paths that are possible. In effect, the IAEA must ask a series of questions: How could the state acquire highly enriched uranium (HEU)? What observable indicators would arise if it tried? How could the state acquire separated plutonium? What observable indicators would arise if it tried? In what way could declared facilities be misused as part of a plan to acquire HEU or plutonium? What observable indicators would arise as a consequence of this misuse? How long would it take the state to acquire significant amounts of fissile material by this route? What would the IAEA have to do to detect this possible misuse within that time period?

Recognizing that it will never be possible to definitively prove a negative (i.e., the absence of undeclared activities), strengthened safeguards measures seek instead to provide the IAEA with a credible level of assurance that there are no undeclared activities. To a certain extent, this involves a move away from mainly quantitative measures towards qualitative measures, in which information analysis plays a key part. The mechanically derived certainty that one plus one equals two (within the statistical limits of the measuring system) is replaced with the qualitative assurance that the "two" is not being used to violate NPT commitments.

MOVING TOWARDS INTEGRATED SAFEGUARDS

Since classical safeguards measures exist to ensure that material is not diverted to undeclared activities, a credible assurance that a state has no undeclared activities should theoretically allow certain intrusive safeguards measures that currently exist to be reconsidered and perhaps replaced with less intrusive measures. In other words, to ensure that the safeguards system is both effective and cost-efficient, it is not necessary for the IAEA to perform both the full range of classical safeguards measures and the full range of strengthened safeguards measures. Some diversion paths include the use of both declared and undeclared elements of the fuel cycle. In effect, if classical safeguards measures cover the declared portions of the diversion path, and strengthened safeguards measures cover the undeclared portions, then there will be elements of redundancy in the approach. These elements may perhaps be reconsidered. To a certain extent, classical and strengthened safeguards measures are complementary and self-reinforcing.

The concept of arriving at a set of safeguards that optimally combines elements of both classical and strengthened safeguards in a cost-effective way is referred to as "integrated safeguards." In his statement to the September 1998 General Conference of the IAEA, Director General Mohammed ElBaradei formulated the following fundamental principle of strengthened and integrated safeguards:

> In implementing the strengthened safeguards system, the IAEA's objective is to achieve optimum effectiveness and efficiency by meshing the current nuclear material accountancy system with the new qualitatively and technologically oriented system, within the framework of the commitment to overall cost neutrality.

Such an approach matches the expectations of many member states: new measures should not simply be added

to the old, and the planning basis for the integration of safeguards should be cost neutral.[12]

Two Different Approaches to Integrated Safeguards

As the international community progresses from the classical safeguards system, it is clear there are different approaches to what constitutes an integrated system and how it is to be achieved. No clear consensus has yet emerged. Some experts regard strengthened safeguards measures primarily as a useful adjunct to the classical system. Such an approach seeks to use the new information provided by strengthened safeguards as a means of improving the existing system while maintaining continuity with classical safeguards activities. This approach maintains the existing facility-focused principle of the classical safeguards system, starting at the facility level and working upwards to the state as a whole. Others, however, view the development of integrated safeguards as an opportunity to re-examine the safeguards system in its entirety and to construct a new system, starting from the underlying aims and objectives of safeguards in general. This approach starts from consideration of the state as a whole and evaluates the safeguards measures appropriate for particular facilities within the context of the given situation. In practice, the end results of such considerations may not in all cases be substantially different from each other—but the process by which integrated safeguards approaches with respect to facilities are developed would differ in many respects.

The simplest means of demonstrating the differences and similarities between these approaches is through examples of safeguards approaches for specific facility types. For example, under classical safeguards, the IAEA performs inspections of power reactors using low enriched uranium fuel at least four times each year. The rationale for this inspection frequency is that it would take approximately three months for a state to process the plutonium contained in spent fuel into a form suitable for use in weapons, if it had a pre-existing, undeclared reprocessing plant. Inspecting once each quarter is intended to provide the IAEA with a timely confirmation that the material has not been diverted. The new system of strengthened safeguards measures is, on the other hand, intended to allow the IAEA to derive a credible assurance that there are, *inter alia*, no undeclared reprocessing plants within a state. There is an inherent redundancy in continuing to expend inspection effort on the assumption that there is an undeclared reprocessing capability, given independent assurance that there is no such capability within the state.

Under a conservative, facility-oriented approach to integrated safeguards, credible assurance, once established for a particular state, would allow the IAEA to inspect each facility at a lower frequency (perhaps once per year or even less). This reduced inspection frequency would result in substantial savings in inspection effort without any real loss of inspection effectiveness. However, under such an approach, there is little possibility for actual improvement in overall inspection effectiveness.

Under a progressive, holistic approach to integrated safeguards focused at the state level, credible assurance of the absence of undeclared facilities, once established for a particular state, would underpin IAEA efforts to base the frequency and intrusiveness of its inspection effort on an (ongoing) evaluation of the state as a whole. Such an approach would allow the IAEA to concentrate its efforts on the elements of the fuel cycle thought to represent the greatest proliferation risk. On this basis, inspections at power reactors could be substantially scaled back to allow for an increased inspection effort at more sensitive facilities. This reallocation of resources could make possible an overall decrease in expended resources. A progressive approach has the potential to result in both substantial savings and improvements in overall effectiveness.

Basic Development Principles

The basic principles that govern the development of integrated safeguards include the following:

- non-discrimination: although the measures actually used in individual states may differ, the same technical objectives must be pursued everywhere with comparable safeguards obligations; and
- a comprehensive state-wide approach, with the following kept in mind: (1) a comprehensive evaluation of information for the state as a whole should play a key role in planning the activities implemented in that state; and (2) integrated safeguards approaches should be designed to provide coverage of all plausible acquisition paths by which a state might seek to acquire nuclear material for a nuclear explosive device.[13]

In spite of the overall support of the concept of strengthened safeguards measures and the impetus for a move towards an integrated system, the basic principles listed above have given rise to competing concerns reflecting state-specific considerations.

Non-Discriminatory Approach Versus Perceived Proliferation Risk

One issue that raises concern among a number of member states is the requirement that integrated safeguards be non-discriminatory. The classical safeguards system apportions efforts largely on the basis of the size and composition of a state's nuclear program. Accordingly, states with the largest and most complex nuclear programs absorb the greatest part of the IAEA inspection effort. It has been argued that states with large and complex civil nuclear fuel cycles, which form a large part of the general economy, are of lesser proliferation concern than states with isolated facilities that have limited economic significance. There have long been calls for the IAEA to distribute inspections according to some measure of the perceived risk of proliferation, rather than mechanistically linking them solely to the size of a state's nuclear program.

States that perceive themselves as likely beneficiaries of a form of favorable differentiation (i.e., those that consider their nonproliferation credentials beyond reproach) tend to favor a more nuanced approach to integrated safeguards. They argue that the IAEA should rely upon the credible assurance derived from strengthened safeguards to substantially reduce overall efforts within that particular state. In essence, they argue that the IAEA should be free to concentrate its efforts in areas of obvious proliferation concern.

On the other hand, states that see themselves as unlikely to benefit from favorable differentiation are generally reluctant to voluntarily accept any form of safeguards that is in any sense more stringent than that accepted by other states. They argue against any form of discrimination that would create a multi-tiered safeguards system, labelling some states a greater proliferation risk than their peers.

It is clear that a safeguards system based on perceived proliferation risk, rather than simply the number of facilities within a state, contains the potential of lower overall costs. It is not likely, however, that a system appearing discriminatory in nature could ever be acceptable to all states. As safeguards were accepted voluntarily in the first place, states which consider themselves to be discriminated against are unlikely to cooperate fully. Hence, there is a need to develop objective criteria to differentiate between states in a non-discriminatory way.

From Mechanistic to Intelligent Safeguards

This discussion raises major issues of principle concerning the implementation of integrated safeguards. Classical safeguards rely on the rigorous application of strictly prescribed measures, because to a major extent the spectrum of measures available to the IAEA was limited. For example, conversion times based on worst case assumptions about the time needed to convert civilian nuclear material to military use have been applied, because the IAEA was not given the tools to go beyond those assumptions. Integrated safeguards, on the other hand, substantially widen the information available to assist the IAEA in planning its verification activities and in drawing conclusions. Hence, we believe, integrated safeguards provide the opportunity to move from a rigid, "one size fits all" approach, to the application of qualitative judgment.

For example, the determination of the timeliness goal has always been a matter of policy as well as technical judgment—in classical safeguards the policy component is somewhat limited (e.g., taking account of practicalities in inspection scheduling). Under integrated safeguards, there is an opportunity to take into account factors based on expert judgment. For example, the current close correspondence between conversion time and timeliness may be unnecessarily rigorous in the context of integrated safeguards. There should be scope to consider qualitative aspects, such as a more realistic timeframe for conversion given the specific circumstances of the state in question. Even if the possibility of detecting certain kinds of undeclared activities through strengthened safeguards measures is currently limited, the totality of IAEA strengthened safeguards activities capable of identifying at least some anomalies and warning signs should not be discounted. Further, the maintenance of full cooperation with the IAEA under an additional protocol should provide some degree of confidence.

Ultimately, a conclusion on the absence of undeclared activities involves qualitative as well as technical judgment. The challenge under integrated safeguards is to develop methodologies that provide the required level of confidence in IAEA conclusions. Classical safeguards demonstrated that a rigorous, mechanistic approach does not necessarily result in effective outcomes. Integrated safeguards can be seen as a progression from mechanistic to intelligent safeguards: a reassessment of technical parameters must be part of this process.

CONCLUSION

Substantial progress has been made towards additional protocol implementation by states and by the IAEA. A sizeable number of member states now have an additional protocol in force, and the steps leading to the introduction of integrated safeguards in these states are being steadily accomplished.

A broad range of consensus has been reached among international experts on defining the general principles and basic elements of integrated safeguards. Some of these include: state evaluation, complementary access, increased unpredictability of inspections, and reduction of safeguards activities related to less sensitive nuclear materials. The concept of integrated safeguards proceeds on the basis of increased assurance of the absence of undeclared nuclear material or activities. This assurance depends on expert judgment, taking into account a range of considerations, including information analysis and strengthened verification activities. The level of cooperation by the state with the safeguards regime, and the degree of openness apparent in its nuclear activities, are also relevant considerations.

Just as with integrated safeguards there are sound reasons against a rigid application of safeguards goals, it is also important that decisions to reduce routine safeguards efforts not be too rigid. An essential principle of integrated safeguards is that the IAEA should be free to reapply more rigorous safeguards measures if it finds it is unable to reaffirm the conclusion of the absence of undeclared nuclear material and activities.

With general principles in place and agreed upon, the next step is finalizing the development of the facility-specific integrated safeguards approaches that would provide the IAEA with enough flexibility to accommodate all possible state-specific situations. At the request of the IAEA, member state "Safeguards Support Programs" are developing proposals for state-level integrated safeguards approaches, based on their own specific nuclear fuel cycles. This work by member states is one part of the IAEA development program directed to the completion of the technical framework for integrated safeguards by the end of 2001.

[1] The *Statute of the IAEA* grants it the authority "…to establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose; and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy." *Statute of the International Atomic Energy Agency,* Article III, A.5, July 29, 1957.

[2] *The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, INFCIRC/153 (Corrected), International Atomic Energy Agency, 1972.

[3] INFCIRC/153 defines a strategic point as a location selected during examination of design information, where, under normal conditions and when combined with the information from all "strategic points" taken together, the information necessary and sufficient for the implementation of safeguards measures is obtained and verified; a "strategic point" may include any location where key measurements related to material balance accountancy are made and where containment and surveillance measures are executed.

[4] The IAEA Safeguards Glossary defines the following terms: "Timeliness goal — the adaptation of the detection time to specific conditions arising from facility practice, available equipment, manpower, etc. It is incorporated in various features of the inspection plan, e.g., frequency of physical inventory taking, intensity of flow verification and frequency of activities in connection with containment and surveillance measures (film evaluation, seal checking etc)." "Detection time — the maximum time that may elapse between diversion and its detection by IAEA safeguards. According to the classical guidelines it should correspond in order of magnitude to conversion time." "Conversion time — the time required to convert different forms of nuclear material to the metallic components of a nuclear explosive device." "Significant quantity — the approximate quantity of nuclear material in respect to which, taking into account any conversion process involved, the possibility of manufacturing a nuclear explosive device cannot be excluded." *Safeguards Glossary*, International Atomic Energy Agency. Goals for timeliness and quantities of nuclear material were arrived at after discussions among experts from member states more than 30 years ago. While these goals were considered to reflect the underlying physics and chemistry of nuclear proliferation, to a certain extent they were set to reflect the practical limitations of the equipment available for safeguards at the time they were first considered. As with much of safeguards, the goal quantities were a compromise between the technical aims of safeguards and what was considered practical.

[5] *Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards*, INFCIRC/540 (corrected), International Atomic Energy Agency, September 1997.

[6] See, for example, *Strengthening the Effectiveness and Improving the Efficiency of the Safeguards System*, Report by the Director General to the General Conference, GC(39)17, International Atomic Energy Agency, August 22, 1995.

[7] Advances in technology make possible the use of new tools in the search for undeclared nuclear activities. Among these, environmental sampling is seen to be of particular promise. It could allow the IAEA to arrive at a broadly-based and well-founded understanding of the activities previously conducted at a site, independent of any operator's declaration of activities.

[8] In the discussions on strengthening IAEA safeguards, it was repeatedly stated that IAEA safeguards would be more effective if they were less predictable. A reduction in inspection effort could be achieved by reducing the number of interim inspections, in effect meeting the current timeliness goal with a lower probability. This could be done by replacing scheduled interim inspections for timeliness purposes with a smaller number of inspections, which would be random or otherwise unpredictable to the operator.

[9] A much more efficient and broad-based process was established at the IAEA to evaluate the increasing amount of information about states' nuclear programs, which became available to the IAEA as a result of recent safeguards strengthening measures. This includes information submitted by states, information obtained through verification activities, open-source information, and commercial satellite imagery. The ubiquity of information systems in the modern industrialized world provides hope that guided analyses of open source information could provide the IAEA with an increased chance of noting changes in a state's fuel cycle that might indicate a deviation from the obligations accepted under the NPT. The IAEA is tapping into disciplines such as design and safety engineering and applying them to safeguards-oriented analyses of state fuel cycles, in order to achieve a better understanding of program structures. The aim is to determine the internal consistency and relevancy of nuclear activities within a state, in order to ensure that the observed fuel cycle

is consistent with the declared activities and objectives.

[10] Progress has been made in several areas involving joint and shared activities with EURATOM, ABACC, and the SSACs of Japan and the Republic of Korea.

[11] The entry into force of an additional protocol is not in itself a sufficient basis for the IAEA to modify safeguards measures currently implemented in a particular state. The IAEA listed its requirements in *Strengthening the Effectiveness and Improving the Efficiency of the Safeguards System and Application of the Model Protocol*, IAEA General Conference Document GC(44)/12, August 16, 2000. As noted in this document, credible assurance can only be achieved when: 1) the state has complied in a timely manner with the requirements of its safeguards agreement and additional protocol; 2) the IAEA has implemented the necessary measures for verifying declared nuclear material and has drawn a conclusion of non-diversion of such material; and 3) the IAEA has conducted a broad-based state evaluation based on all information available, including declarations submitted under Article 2 of the additional protocol, and satisfactorily resolved any inconsistencies and questions using complementary access, as necessary, in accordance with the additional protocol.

[12] Since the idea of strengthened safeguards is, in part, to correct perceived deficiencies in the classical safeguards system, and it involves the IAEA in new activities, it could be expected that added costs may be involved. However, member states have maintained that the introduction of new measures should only take place in the context of no net increase in the cost of safeguards. States will obviously not support the addition of a new layer of mechanically-applied safeguards obligations without obvious benefit. The IAEA Secretariat has made it clear that cost neutrality cannot be achieved at the outset—the introduction of new safeguards measures will incur additional cost, with the opportunities for significant savings occurring only later (giving rise to the concept of a "hump" in safeguards costs). Further, it is essential that cost neutrality be seen as a guiding principle, rather than the ultimate objective. While cost-efficiency is important, it is of far greater importance that strengthened safeguards provide the requisite effectiveness.

[13] GC(44)12. Under integrated safeguards, the verification of declared nuclear material remains of fundamental importance. In accordance with the principle of non-discrimination referred to above, the generic safeguards approach for facilities of a given type remains the same in any state where integrated safeguards are applied. However, measures used in a specific approach may differ according to individual facility characteristics and state-specific considerations.