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Integrated nuclear safeguards: genesis and evolution

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The International Atomic Energy Agency (IAEA) implements 'safeguards' or nuclear verification measures to verify states' compliance with their nuclear non-proliferation commitments. The range of measures the Agency can use in any given state stems from the type of safeguards agreement that the Agency has concluded with it. For states which have both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) in force, the IAEA has the full range of safeguards measures at its disposal, including important strengthening measures endorsed by its Board of Governors. However, just as not all the tools in a tool-kit are used concurrently, safeguards measures are selected to respond to specific verification objectives. 'Integrated safeguards' are the means by which the IAEA seeks to achieve the most effective and cost-efficient[1] combination of safeguards measures to enable it to discharge its safeguards obligations and meet its verification objectives for states with CSAs and APs in force.

The objective of strengthened safeguards for such states is to provide credible assurance of the non-diversion of nuclear material from declared nuclear activities and of the absence of undeclared nuclear material and activities. What all this signifies in a practical sense can be understood only by reference to the provenance of the Agency's 'right and obligation', how that has been and is now being exercised through safeguards implementation, and what is meant by 'the optimum combination of safeguards measures'. This chapter seeks to explain these aspects and to place them in the context of the radically changed way in which the IAEA now draws its safeguards conclusions—the foundation of the assurances that it can provide about the exclusively peaceful nature of a state's nuclear activities.

Background

The Statute of the IAEA empowers the Agency to implement nuclear verification measures, or safeguards, to verify states' compliance with their nuclear nonproliferation commitments.[2] The scope of safeguards implementation stems from the nature of the safeguards agreement that a state concludes with the Agency. Most states have a CSA based on the model text in IAEA document INFCIRC/153 (Corrected) of 1972.[3] For such states—mainly but not exclusively in the context of the 1968 Nuclear Non-Proliferation Treaty (NPT)—the Agency has the right and obligation to ensure that safeguards are applied on all of their nuclear material (which by definition can be used only in non-proscribed nuclear activities) under their jurisdiction or control anywhere. The drafters of INFCIRC/153 (Corrected) considered, and the IAEA Board of Governors has since reaffirmed, that the scope of CSAs is not limited to the nuclear material actually declared by a state to the Agency under its safeguards agreement; it includes that which should be declared. The Agency has the right and obligation to ensure that nuclear material declarations submitted by states are not only correct but also complete. Despite this, the safeguards system as it had developed pre-1991 had limited capability to deal with 'completeness'.

That has since changed. The discovery of Iraq's clandestine nuclear weapons programme and other important factors[4] highlighted the shortcomings of safeguards implementation that focused, as it did then, on declared nuclear material and on safeguards conclusions drawn at the level of nuclear facilities. This set the stage and provided the catalyst for far-reaching efforts by the IAEA, with the support of its member states, to strengthen the safeguards system, in particular its ability to detect undeclared nuclear material and activities, and for much more broadly based safeguards conclusions to be drawn for a state as a whole.

Efforts to strengthen safeguards must also be seen against the backdrop of zero real growth, which characterised the Agency's budget for 15 years until the IAEA General Conference endorsed a budget increase in September 2003. This in part[5] explains the mandate the Director General gave to the Standing Advisory Group on Safeguards Implementation (SAGSI) in 1992 to re-examine safeguards implementation in order, concurrently, to reduce costs, meet new requirements and maintain effectiveness. SAGSI's work led to a fully-fledged safeguards development programme undertaken by the IAEA Secretariat from 1993.[6] Its main elements stemmed from

(a) a perceived need for the IAEA to acquire a much broader range of information than it was previously able to obtain about a state's nuclear material, activities and plans; (b) the need for more access for IAEA inspectors to nuclear sites and to other locations where nuclear material is or could be present; and (c) the use of advanced techniques and technology. The combination of these elements gives a state's nuclear programme greater transparency and equips the Agency to give enhanced assurance about the exclusively peaceful nature of such a programme.

A watershed in this respect was the approval of the Model Protocol Additional to Safeguards Agreements (Model Additional Protocol) by the IAEA Board of Governors in May 1997.[7] Although some of the measures of the safeguards development programme could be implemented on the basis of the legal authority conferred on the IAEA by CSAS, others could not (see table 1). APS based on the Model Additional Protocol give the Agency the complementary legal authority and the necessary technical measures to strengthen its ability to detect undeclared nuclear material and activities and thus to provide credible assurance of their absence.

The additional information,[8] increased access for IAEA inspectors[9] and the other technical measures which an AP provides for are vital to an assessment of the completeness of a state's declarations about its nuclear material subject to safeguards. That assessment is essential to safeguards conclusions, drawn at the level of a state as a whole,[10] that all of the state's nuclear material has been placed under safeguards and remains in peaceful nuclear activities or has otherwise been accounted for. Such a conclusion is a combination of two separate but interrelated elements: a conclusion that there is no indication that a state's declared nuclear material has been diverted from peaceful to proscribed use (the focus of the safeguards measures in a CSA); and a conclusion that there is no indication of undeclared nuclear material and activities in the state as a whole (the focus of the measures in an AP). This combination is possible only for a state that has both a CSA and an AP in force: it is only for such states that the IAEA has the full range of available safeguards measures at its disposal to reach the requisite safeguards conclusions.

Towards integrated safeguards

It was never the intention to 'layer' the IAEA's safeguards-strengthening measures onto one another.[11] The goal was and remains to integrate, in an optimal way,

Table 1 **Safeguards-strengthening measures**

A. Measures under comprehensive safeguards agreements

- State provision of design information on new facilities or on changes in existing facilities handling safeguarded nuclear material as soon as the state authorities decide to construct, authorise construction of or modify a facility; and the IAEA's continuing right to verify the design information over the facility's life cycle, including decommissioning.
- Agency enhanced evaluation of information from a state's declarations, Agency verification activities and a wide range of open and other sources (e.g., the scientific literature, news articles, satellite imagery, and third parties).
- State voluntary reporting on inventories, imports and exports of nuclear material and exports of specified equipment and non-nuclear material (components of this scheme are incorporated in the Model Additional Protocol).
- Agency use, to a greater extent than previously, of unannounced inspections within the routine inspection regime.
- Agency collection of environmental samples in facilities and at locations where, under safeguards agreements, IAEA inspectors have access during inspections and design information visits; and sample analysis at the IAEA Clean Laboratory and/or at qualified laboratories in member states.
- Provision of enhanced training for IAEA inspectors and safeguards staff and for member state personnel responsible for safeguards implementation.
- Agency use of unattended and remote monitoring of movements of declared nuclear material in facilities and the transmission of authenticated and encrypted safeguards-relevant data to the Agency.
- Closer co-operation between the Agency and the state (and regional) systems for accounting for and control of nuclear material (SSACs) in member states.

B. Measures under additional protocols

- State provision of information about, and IAEA inspector access to, all parts of a state's nuclear fuel cycle, from uranium mines to nuclear waste and any other location where nuclear material intended for non-nuclear uses is present.
- Agency collection of environmental samples at locations beyond those provided under safeguards agreements.
- State provision of information on, and agency short-notice access to, all buildings on a nuclear site.
- State acceptance of IAEA designations of inspectors and issuance of multiple entry visas (valid for at least one year) for inspectors.
- State provision of information about, and Agency verification mechanisms for, a state's research and development activities related to its nuclear fuel cycle.
- Agency right to make use of internationally established communications systems, including satellite systems and other forms of telecommunication.
- State provision of information on the manufacture and export of sensitive nuclear-related technologies, and IAEA verification mechanisms for manufacturing and import locations in the state.
- Wide area environmental sampling, after Board approval of procedural arrangements for such sampling and after consultations with the state concerned.

a set of measures to enhance the Agency's ability to verify correctness— essentially through nuclear material accountancy measures, complemented by containment and surveillance (C/S)—with measures to verify completeness—essentially through the much broader information and access measures in an AP.[12] Integration aims to take account of the synergy deriving from combinations of the two sets of measures and thus to achieve greater effectiveness and efficiency. For example, if the Agency is able to conclude for a state as a whole that there is no indication of undeclared nuclear material and activities,[13] especially activities related to enrichment and reprocessing, this should allow some safeguards measures to be applied at a reduced level.

Important in this context is the notion of timely detection, or the maximum time stipulated in traditional IAEA safeguards implementation criteria that may elapse between the diversion of a significant quantity[14] of nuclear material to a proscribed purpose and the detection of that diversion by safeguards activities. In cases where the Agency is not equipped with all the measures it needs to draw a conclusion in regard to the absence of undeclared nuclear material and activities for a state as a whole, it has to assume that the facilities and activities needed to convert diverted nuclear material from peaceful use to nuclear weapons-usable form may exist undetected in the state. In such circumstances, 'detection time' must correspond approximately to 'conversion time', or the time required to convert different forms of nuclear material into critical components of a nuclear explosive device. Conversely, if the Agency is able to conclude that there is no indication of undeclared nuclear material and activities for a state as a whole, it can adjust certain parameters of safeguards implementation, such as timeliness goals, for less sensitive types of nuclear material (depleted, natural and low-enriched uranium, DNLEU) and reduce the level of verification effort that would otherwise be required for such material. For example, the diversion of irradiated nuclear fuel and the existence of a clandestine reprocessing plant are each part of the same potential 'acquisition path' by which a state which was determined to do so could seek to acquire weapons-usable nuclear material. If the IAEA can draw a conclusion regarding the absence of any undeclared reprocessing plant in a state with both a CSA and an AP in force, it follows, prima facie, that it needs to spend less effort to verify that there has been no diversion of irradiated nuclear fuel in that state. This contributes to 'the optimum combination of measures' for effectiveness and efficiency.

The elements and features of integrated safeguards

Integrated safeguards consists of a number of 'piece-parts'—concepts, approaches, guidelines and criteria that govern their design, implementation and evaluation. Collectively, these elements form the 'conceptual framework' for integrated safeguards. This was developed between 1998 and 2001 by the IAEA Secretariat, assisted by a small group of external experts appointed by the IAEA Director General for their safeguards knowledge and expertise; by IAEA member states, especially through the mechanism of Member State Support Programmes (MSSPS) for safeguards; and with technical advice from SAGSI. The basic elements, which are described below, enable the IAEA to implement safeguards in the relevant states not only in an optimal way but also in the consistent and non-discriminatory manner expected of it. They take into account the fact that nuclear fuel cycles and nuclear facilities in individual states can and do differ. They provide the Agency with flexibility to allow state-specific features to be factored in. They also permit refinement in the light of practical implementation experience, further evaluation and developments in technology.

Element 1: The overall objective and basic principles of integrated safeguards

(a) The overall objective

The development of this element was guided by a combination of the Board of Governors' confirmation of the IAEA's right and obligation in respect of a CSA state; the verification measures necessary to fulfil that right and obligation; and the effectiveness and efficiency objectives of safeguards-strengthening measures. The overall objective of integrated safeguards is to achieve 'the optimum combination of all safeguards measures available to the Agency under comprehensive agreements and additional protocols which achieves the maximum effectiveness and efficiency within available resources in fulfilling the Agency's right and obligation in paragraph 2 of INFCIRC/153 (Corrected)'.[15]

Given that the IAEA is empowered to ensure that nuclear material declarations submitted by CSA states are both correct and complete, and that such assessments can be made only for states with both a CSA and an AP in force, it follows that integrated safeguards cannot be implemented in a state until initial conclusions have been drawn about the non-diversion of declared nuclear material (the focus of a CSA) and of the absence of undeclared nuclear material and activities (the focus of an AP). Once this has been achieved, the Agency must seek to reaffirm these

safeguards conclusions annually in the light of any additional information obtained about the state or of any follow-up action deemed necessary as a result of the evaluation process.[16] It does so both as an objective in itself and as a condition for the continued implementation of integrated safeguards.

(b) The basic principles

The basic principles underlying integrated safeguards will continue to guide their further development. First, integrated safeguards must be non-discriminatory. This means that, although the verification measures used in individual states might differ because of state-specific features, the same technical objectives must be pursued in all states with comparable safeguards undertakings. Additionally, through the application of the supporting guidelines and criteria developed for integrated safeguards (see the relevant paragraphs below), similar procedures are to be used in all states.

Second, integrated safeguards must also be based on state-wide considerations. More specifically, this involves two fundamental aspects. The first is that comprehensive information evaluation for a state as a whole is essential to integrated safeguards and plays a key role in planning and conducting the safeguards activities that are implemented for any specific state. For example, the state evaluation process can help to identify the state-specific features that need to be considered in selecting and using specific safeguards measures. The second aspect is that the integrated safeguards approach for a state (described below) must cover all possible acquisition paths by which a state might seek to acquire weapons-usable nuclear material. The state-level integrated safeguards approach must therefore cover paths by which nuclear material could be diverted from different stages of the nuclear fuel cycle as well as clandestine routes to the acquisition of such material. For any path involving both diversion of nuclear material from declared activities and the existence of undeclared nuclear activities, coverage needs to include verification measures on nuclear material as well as measures to detect undeclared activities.

A third principle is that nuclear material accountancy remains a safeguards measure of fundamental importance and will continue, under integrated safeguards, to be the basis for deriving a conclusion about the non-diversion of declared nuclear material in a state. Nuclear material accountancy begins with the nuclear material accounting activities undertaken by the operator of a nuclear facility and reported

to the IAEA by the relevant state in accordance with its safeguards agreement. Under integrated safeguards, the IAEA will continue to evaluate the nuclear material accounting information reported by states for conformity with established formats and standards and for correctness and consistency. However, the verification of less proliferation-sensitive types of nuclear material can be expected to be less intensive than previously and consideration can be expected to be given to greater use of statistical techniques and advanced technology.

Element 2: The design of an integrated safeguards approach for a state

An integrated safeguards approach is designed individually for each state with a CSA and an AP in force, and can be implemented when the requisite safeguards conclusions have been drawn. Approaches are developed in the framework of the same multidisciplinary state evaluation groups which prepare the safeguards state evaluations. They have two main elements: the safeguards measures to be applied at each facility and location outside facilities (LOF)[17] in the state; and a complementary access plan which sets out the general level and focus of the complementary access activities to be carried out in the state as a whole.[18] Some components of a state-level integrated safeguards approach might require discussion with the state concerned, for example, arrangements for conducting unannounced inspections at specific facilities. On the other hand, components such as the specifics of complementary access activities to assure the absence of undeclared nuclear material or activities at declared nuclear sites would probably not be discussed; to do so could well jeopardise the purpose of the access. Guidelines have been developed and are used to design state-level approaches to ensure maximum effectiveness and efficiency. The design includes considering state-specific features and characteristics; adapting model integrated safeguards approaches for application at specific facilities; and developing a plan for implementing complementary access at nuclear sites and other locations. Approaches for individual states are reviewed on a continuing basis and modifications made as required.

The initial and most important consideration in designing a state-level integrated safeguards approach is the nature and scope of a state's nuclear fuel cycle and related activities, including: (a) the structure of the nuclear fuel cycle, from uranium mines to nuclear waste; (b) the number and types of nuclear facilities, LOFs and associated activities carried out at nuclear sites; (c) the safeguards-relevant charac-

teristics of facilities and LOFs; (d) the inventory and flow of nuclear material within and between facilities; (e) fuel cycle-related research and development; (f) the manufacture and export of sensitive nuclear-related equipment and materials; and (g) the correlation of all this information. Other considerations include the feasibility of using effectively such advanced safeguards technology as the remote transmission of safeguards data from unattended C/S devices or measurement devices foreseen in the provisions of APS; the extent to which unannounced inspections to deter diversion or detect any undeclared activities in the state are both feasible and desirable; and the scope identified for enhanced co-operation between the IAEA and the state or regional system of accounting for and control of nuclear material (SSAC).[19]

An important step in designing a state-level integrated safeguards approach is to adapt the model integrated safeguards approaches for facility types (described below) to the specific features and characteristics of the state and to the design and operational mode of each of its nuclear facilities. Each model approach includes alternative ways, of comparable effectiveness, to meet the safeguards requirements.[20] The selection of any particular approach involves a comparative cost analysis of the alternatives. Adaptation also takes account of the Agency's experience in implementing safeguards at the specific facility and its co-operation with the SSAC and facility operator.

Complementary access plays a key role in the process of drawing an initial safeguards conclusion regarding the absence of undeclared nuclear material and activities in a state and in maintaining that conclusion. Thus, within the constraint imposed on the IAEA by an AP that it must be neither mechanistic nor systematic in verifying information submitted under its provisions, a state-level integrated safeguards approach describes the proposed level and focus of the complementary access activities considered necessary.

Element 3: Model integrated safeguards approaches for specific types of nuclear facility

One important starting point in developing integrated safeguards and the conceptual framework for them was the technical objective of safeguards at facilities defined in paragraph 28 of INFCIRC/153 (Corrected)[21] and the measures necessary to achieve that objective. Another was the premise that some types of nuclear facility

warranted more immediate attention than others because they were operating in states which were early candidates for integrated safeguards implementation and offered the most potential for reducing verification effort on declared nuclear material.

To date, model or generic integrated safeguards approaches have been developed for five major types of nuclear facility: (a) light water reactors (LWRS), with and without the use of mixed oxide (MOX) fuel; (b) research reactors; (c) on-load refuelled reactors (OLRS); (d) spent fuel storage facilities; and (e) DNLEU conversion and fuel fabrication facilities. Other approaches are under development. As indicated above, these approaches result in less inspection effort being expended on declared nuclear material than is the case with current safeguards approaches. Savings in inspection effort have now been calculated, *inter alia*, for states with large nuclear fuel cycles where the IAEA anticipates implementing integrated safeguards by 2005–2006. Thus savings in inspection effort for the basic model approaches at LWRS, OLRS and fuel fabrication plants have been calculated for the European Union countries, Canada and Japan. They range from approximately 27 percent for the power reactors to 38 percent for DNLEU fuel fabrication plants.

Model integrated safeguards approaches reflect the types of nuclear material associated with specific types of nuclear facility. Nevertheless, there are common denominators, such as:

- retaining the basic principle that nuclear material accountancy remains a safeguards measure of fundamental importance. The IAEA's current practice of evaluating the material balance annually for all types of nuclear material is therefore also retained (using random selection of facilities as appropriate);
- extending the timeliness goals for types of nuclear material where appropriate, given the IAEA's enhanced ability to detect undeclared nuclear material and activities. The timeliness goal for irradiated fuel has been extended from three months to one year. For fresh MOX fuel assemblies, it has been extended from one month to three months;
- random interim inspections, including unannounced inspections where feasible, to detect and deter undeclared activities at facilities and to provide a capability for early detection of diversion;
- less intensive verification requirements where the types of nuclear material at a facility are less proliferation-sensitive;

- modifying verification procedures for specific types of nuclear material in a way that enables the IAEA to re-establish the inventories of those materials within the applicable traditional timeliness period where there is any indication of possible diversion or of undeclared nuclear material or activities; and
- increased co-operation with an SSAC under specific conditions.

Much progress has been made in designing integrated safeguards approaches and preparing for implementation in states with APs in force. Australia was the first state in which integrated safeguards were implemented, in 2001. In Norway, implementation trials of unannounced inspections as envisaged in the integrated safeguards approach have been carried out and the implementation of integrated safeguards began there in 2002. In Indonesia, surveillance systems have been upgraded and procedures for short-notice inspections carried out in preparation for integrated safeguards implementation, which began in 2003. Trials and tests are under way in other states and state-specific integrated safeguards approaches are being developed for several states with little or only moderate nuclear activity. The model integrated safeguards approaches developed for LWRs, OLRs and research reactors are being adapted for states with large nuclear fuel cycles.

Element 4: Supporting guidelines

An important part of integrated safeguards is providing adequate guidance to those responsible for implementation to ensure effectiveness, consistency and non-discrimination at each step of the process. Guidelines have been developed for drawing the safeguards conclusions which govern integrated safeguards implementation; the conditions which must pertain before any such conclusions can be drawn; information review and evaluation; conducting complementary access at each of the categories of location identified in Article 5 of an AP; the handling of anomalies, questions and inconsistencies; and the conduct of unannounced and short-notice inspections.[22] Work is proceeding on guidelines for enhanced co-operation between the Agency and an SSAC.

Element 5: Integrated safeguards criteria, evaluation and reporting

(a) Criteria

Although the design of an integrated safeguards approach for a state is based on a flexible approach using common principles and objectives, suitably adapted model

facility-type approaches and supporting guidelines, more specific criteria are required, at both the facility and the state levels. Because nuclear material accountancy remains a fundamental measure of integrated safeguards, there is a need for facility-focused criteria, for instance, dealing with the examination of records and reports, the verification of a physical inventory of nuclear material and the evaluation of material balances. At the state level, criteria are required for integrated safeguards implementation and evaluation to ensure consistency. They include criteria related to nuclear material verification activities that are not specific to individual facilities, for example, the matching of data on transfers of nuclear material. There are also broader requirements such as those related to updating and reviewing state evaluation reports (SERS).

(b) Evaluation

Evaluation and reporting under integrated safeguards involves continuous evaluation of all relevant information and activities, and an annual assessment of safeguards performance. Evaluation takes into account the results of all safeguards activities conducted under an integrated safeguards approach, the results of follow-up actions to resolve any anomalies, questions and inconsistencies, and continuing review and evaluation of all other information available to the IAEA. The results of evaluations are documented annually in SERS[23] and provide the basis for safeguards conclusions.

(c) Reporting

Reporting to individual states on activities under CSAS and APS continues under integrated safeguards. Under a CSA, the IAEA provides the state with statements on inspection results and on the conclusions it has drawn. Under an AP, it also provides statements on the activities performed during complementary access, the results of activities relating to questions or inconsistencies, and conclusions drawn from AP activities. The collective results of safeguards evaluation processes are reported annually in the IAEA's *Safeguards Implementation Report* (SIR).

Cost and resource implications

At this juncture, it is not possible to estimate precisely how much integrated safeguards will contribute to cost savings. What is clear, however, is that, for the near to medium term, more resources are needed to carry out the activities which must

precede and are involved in the implementation of integrated safeguards. The work associated with the initial conclusions necessary for implementing integrated safeguards in a state involves considerable work at IAEA headquarters and in the field. It includes the processing and analysis of state declarations, state evaluation and complementary access. In 2002 alone, activities related to AP implementation involved over 29 person-years of effort, including 5.5 person-years expended on state evaluation activities. Considerable time, effort and care are required to produce and update SERS. Between 1997, when five SERS were produced and reviewed, and the end of 2002, a total of 165 SERS were produced and reviewed covering 83 states, 61 of which had significant nuclear activities. In similar vein, complementary access has to be carefully planned and prepared before implementation in the field, and reviewed and evaluated when the relevant safeguards staff have returned to Vienna. Complementary access was conducted 86 times in 17 states in 2002. This was mainly to ensure the absence of undeclared nuclear material and activities at nuclear sites and at the other locations where a state had declared nuclear material to be present.[24] As more states bring APS into force, the workload can be expected to increase further—all this in addition to the concurrent requirement to implement traditional nuclear material accountancy safeguards and to prepare to introduce sound, cost-efficient safeguards measures in major new facilities. For reasons such as these, it is clear that in the next few years, the significant increase in work related to the strengthened safeguards system is likely to be only partially offset by any savings from a reduction of in-field inspection activity.

Next steps

The component parts of integrated safeguards will continue to be developed or refined in the light of experience, further evaluation and technological developments. The goal now is to widen the scope of implementation as more APS enter into force and the necessary safeguards conclusions can be drawn. The rate at which APS are entering into force in states is falling short of expectations and is constraining the IAEA's ability to implement safeguards with maximum effectiveness and efficiency. As of the end of October 2003—more than six years after the Board of Governors approved the Model Additional Protocol—only 78 states had signed APS and only 37—less than half—had brought them into force. Extensive efforts

have been and are being made to encourage wider adherence to safeguards agreements and APs. The full potential of the strengthened safeguards system can be realised only through universal adherence to all the strengthening measures, including those of the Model Additional Protocol.

Conclusion

The implementation of safeguards makes a major contribution to international peace and security. Safeguards help a state to demonstrate compliance with its nonproliferation undertakings and through them other states receive assurance of that compliance. Because of its key contribution to international security, the safeguards system must remain effective. The IAEA has developed integrated safeguards to optimise effectiveness and cost-efficiency. Because integrated safeguards can be implemented only in a state which has both a CSA and an AP in force and for which the IAEA Secretariat has been able to draw the necessary safeguards conclusions, states need to work towards concluding those CSAs that have yet to be brought into force and towards universal subscription to APs based on the model text.

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Endnotes

[1] 'Effectiveness' is a measure of the extent to which the IAEA meets its safeguards objectives. 'Efficiency' is a measure of how well the human and financial resources needed for this are used.

[2] See Pierre Goldschmidt, 'Strengthened safeguards: meeting present and future challenges', *IAEA Bulletin*, vol. 43, no. 4, 2001, pp. 6–11; and Pierre Goldschmidt, *The IAEA Safeguards System Moves into the 21st Century*, Supplement to the *IAEA Bulletin*, vol. 41, no. 4, 1999.

[3] International Atomic Energy Agency, '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), IAEA, Vienna, 1972.

[4] Other issues directly influencing safeguards-strengthening measures were the difficulties the IAEA experienced (and continues to experience) in verifying the correctness and completeness of the initial report of nuclear material made by the Democratic People's Republic of Korea (North Korea) and its very different, positive experience in verifying the initial report of South Africa.

[5] Safeguards agreements in any case foresee the continuous development of safeguards verification, which must at all times take into account the interest of a state in (a) obtaining credible assurances, (b) not being impeded in its efforts to exploit the peaceful uses of nuclear energy, and (c) not being burdened with excessive costs. There is also a need to preserve the confidentiality of commercial and industrial secrets and of other knowledge obtained by the IAEA as a result of safeguards implementation.

[6] The programme began in 1993 and is described, *inter alia*, in a report to the 44th regular session of the IAEA General Conference, 'Strengthening the effectiveness and improving the efficiency of the safeguards system and application of the Model Additional Protocol', GC(44)/12, 16 August 2000. Refinements to the resulting measures continue to be made.

[7] Issued as 'Model Protocol additional to the agreement(s) between state(s) and the International Atomic Energy Agency for the application of safeguards', INFCIRC/540 (Corrected), IAEA, Vienna, 1998.

[8] This information is obtained from a state itself, from IAEA verification activities or from open and other sources of information available to the Agency. A state's declarations under articles 2 and 3 of an AP supplement the largely numerical nuclear material accounting data and design information submitted under safeguards agreements with site descriptions and with information about activities not involving nuclear material; waste processing; non-nuclear use of material; source material transfers and holdings; nuclear material activities; future plans; and equipment transfers.

[9] Access provided by a state to IAEA inspectors in accordance with the provisions of an AP is called 'complementary access'. Although Article 4 of an AP prescribes that the IAEA shall not mechanistically or systematically seek to verify the information provided by a state under Article 2 of its AP, the IAEA has the right to conduct complementary access for three purposes: (a) to assure the absence of undeclared nuclear material and activities at sites, mines, concentration plants and other locations where nuclear material has been declared to be present; (b) to resolve a question related to the correctness and completeness of the information provided by a state pursuant to Article 2 of its AP, or to resolve an inconsistency related to that information; and (c) to confirm, for safeguards purposes, the decommissioned status of a facility or a location outside facilities (LOF) where nuclear material was customarily used.

[10] The framework within which safeguards conclusions are now drawn is the safeguards state evaluation process. This seeks to integrate and assess the totality of information available to the IAEA about a state's nuclear activities and plans, whether provided by states themselves under safeguards agreements, under APs and voluntarily; deriving from the implementation of in-field verification activities; or obtained from open and other sources of safeguards-relevant information. The 'state-level' approach finds tangible expression in the state evaluation groups established to carry out evaluations and in the state evaluation reports (SERs) that result from them. These reports are regularly reviewed and updated: state evaluation is a dynamic process in which new information must continually be taken into account, assessed and factored into the

state evaluations. There are well established mechanisms for all of this within the IAEA, including senior management review of SERs. This is to ensure consistency of approach in evaluating all safeguards-relevant information available to the IAEA about a specific state; appropriate recommendations for any follow-up action required as a result of evaluation; and soundly based safeguards conclusions for each individual state which are reflected, inter alia, in the Agency's annual *Safeguards Implementation Report* (SIR).

[11] See Jill N. Cooley, 'Integrated safeguards: current status of development and plans for implementation', Proceedings of the 42nd Annual Meeting of the Institute for Nuclear Materials Management (INMM), July 2001; and Jill N. Cooley, 'The conceptual framework for integrated safeguards', Proceedings of the 43rd Annual Meeting of the INMM, June 2002.

[12] Nuclear material accountancy yields results and conclusions that are quantitative in nature. In contrast, the broader measures implemented under an AP yield results and conclusions which are more qualitatively based. See also note 8.

[13] Such a conclusion can only be inferred from the absence of any evidence to the contrary. Absence of evidence can never prove with total certainty that there has been no diversion or that there are no undeclared nuclear material and activities; it means only that, from a thorough evaluation of all relevant information available to the IAEA, no indication of diversion or of undeclared nuclear material and activities has been observed.

[14] A 'significant quantity' of nuclear material is the approximate amount for which the possibility of manufacturing a nuclear explosive device cannot be excluded. What this amount is depends on the nature of the nuclear material, for example, 8 kilogram (kg) of plutonium and 25 kg of uranium-235 contained in high enriched uranium (HEU).

[15] 'Report to the 44th regular session, IAEA General Conference on 'Strengthening the effectiveness and improving the efficiency of the safeguards system and application of the Model Additional Protocol', GC(44)/12, 16 August 2000.

[16] See note 10.

[17] A location outside facilities is any installation or location where nuclear material is customarily used in amounts of 1 effective kilogram or less. See International Atomic Energy Agency, *IAEA Safeguards Glossary*, IAEA, Vienna, 2001, p. 34.

[18] For the definition of complementary access, see note 9.

[19] Under a CSA, a state is required to establish and maintain a system of accounting for and control of nuclear material subject to safeguards under the agreement. The measures stipulated as necessary in this regard include those needed to determine the quantities of nuclear material on inventory and changes to these; a system of records and reports, including reports to the IAEA; and provisions to ensure that accounting procedures and arrangements are being operated correctly. These and other requirements constitute an important basis for the application of IAEA safeguards. An SSAC might also have a national objective—to account for and control nuclear material in the state for its own purposes.

[20] For example, one approach might involve using unannounced inspections to detect diversion of nuclear material or any undeclared nuclear activities at declared nuclear facilities. Another approach might involve announced inspections at dates selected randomly, supported by containment and surveillance measures.

[21] The technical objective is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown and the deterrence of such diversion by the risk of early detection. On the meaning of 'significant quantities' see note 14.

[22] The use of unannounced inspections is provided for in INFCIRC/153 (Corrected), but because of difficulties in practical arrangements they have in the past been used only to a limited extent.

[23] See also note 10.

[24] As provided for in Article 4.a.(i) of the Model Additional Protocol.