INTEGRATED SAFEGUARDS – CURRENT STATUS OF DEVELOPMENT AND PLANS FOR IMPLEMENTATION

Jill N. Cooley
Department of Safeguards,
International Atomic Energy Agency,
Vienna,
Austria

Abstract

The development of the conceptual framework, safeguards approaches, and implementation guidelines and criteria for integrated safeguards continues to be one of the International Atomic Energy Agency's priorities. Integrated safeguards refers to the optimum combination of all safeguards measures available to the Agency under a comprehensive safeguards agreement and an additional protocol to achieve maximum effectiveness and efficiency, within available resources, in meeting the Agency's safeguards objectives. Over the past year, substantial progress has been made on the development of facility-type-specific integrated safeguards approaches, the State-level approach concept, and other aspects of implementation including the use of unannounced inspections, the role of State and regional systems of accounting and control, and procedures for randomization of inspections. The paper will provide a current status of the development of integrated safeguards with particular emphasis on its main elements, progress to date and plans for implementation.

1. BACKGROUND

Since the discovery of Iraq's clandestine nuclear weapons programme, extensive efforts have been expended by the International Atomic Energy Agency (IAEA) and its Member States to strengthen and make more efficient the IAEA safeguards system. The development and approval of strengthening measures was responsive to this discovery and, especially in the case of the Model Additional Protocol [INFCIRC/540 (Corrected)], to the IAEA Board of Governor's reiteration in 1995 that the safeguards system for implementing comprehensive safeguards agreements should be designed to provide for verification by the Agency of the correctness and completeness of States' declarations, so that there is credible assurance of the non-diversion of nuclear material from declared activities and of the absence of undeclared nuclear material and activities. The predominant focus of the Model Additional Protocol is to strengthen the Agency's capability to detect undeclared nuclear material and activities, in order to provide credible assurance of their absence. The Agency's ability to detect the diversion of declared nuclear material, and thus provide credible assurance of the absence of diversion, continues to be based primarily on the measures provided for in comprehensive safeguards agreements.

Ultimately, the aim of the Agency is to achieve the optimum combination of all safeguards measures available under comprehensive safeguards agreements and additional protocols, in order to achieve maximum effectiveness and efficiency within the available resources in exercising the Agency's right and fulfilling its obligation in paragraph 2 of INFCIRC/153 (Corrected). This optimum combination is known as "integrated safeguards".

2. CURRENT STATUS OF ADDITIONAL PROTOCOLS

As of October 2001, the Board has approved additional protocols for 52 non-nuclear-weapon States with comprehensive safeguards agreements; 21 have since entered into force and one is being applied provisionally pending entry into force. The implementation of additional protocols with nuclear-weapon States and other States not having comprehensive safeguards agreements will also add to the overall effectiveness of the strengthened safeguards system. The Board has approved additional protocols with the five nuclear-weapon States, as well as with one State which has an INFCIRC/66-type agreement. In addition, measures foreseen under the Model Additional Protocol are being implemented in Taiwan, China.

As reported in the Agency's Safeguards Implementation Report, in 2000, in respect of seven States, each of which has a comprehensive safeguards agreement *and* an additional protocol in force or being provisionally applied, the Secretariat concluded that all nuclear material in those States had been placed under safeguards and remained in peaceful nuclear activities or was otherwise adequately accounted for. This conclusion derives from the evaluation of all information acquired in implementing safeguards agreements and additional protocols and of all other information available to the Agency for each of the above States. In the course of that evaluation, the Secretariat found no indication of diversion of nuclear material placed under safeguards or of the presence of undeclared nuclear material or activities in these States. For the other 12 States that had a comprehensive safeguards agreement and an additional protocol in force in 2000, the Agency's evaluations had not yet reached the stage where such a conclusion could be drawn.

The development of integrated safeguards continues to be one of the Agency's priorities. Co-ordinated by the Department of Safeguards, the development programme is being conducted with the assistance of a Group of Experts designated by the Director General, the technical advice of the Standing Advisory Group on Safeguards Implementation (SAGSI) and the involvement of Member States. Substantial progress continues to be made on integrated safeguards as reported in two information papers prepared for the Board of Governors in March and November 2000. [1, 2].

3. INTEGRATED SAFEGUARDS – OBJECTIVE AND GENERAL PRINCIPLES

The objective of implementing the measures provided for in a State's comprehensive safeguards agreement together with an additional protocol is to enable the Agency to draw the necessary safeguards conclusions and thereby provide credible assurance of both the non-diversion of nuclear material from declared activities and of the absence of undeclared nuclear material and activities in the State as a whole. Under comprehensive safeguards agreements alone, the traditional level of verification effort on declared nuclear material and the values of certain safeguards implementation parameters, particularly timeliness goals, are based on the assumption that undeclared nuclear activities, e.g. undeclared reprocessing or enrichment plants, may exist undetected. Under a comprehensive safeguards agreement and an additional protocol, the Agency's ability to provide assurance of the absence of such undeclared activities reduces the possibility that they may exist undetected and therefore creates the potential for changes in implementation parameters and reductions in verification effort for declared nuclear material. A conclusion by the Agency of the absence of undeclared nuclear material and activities in a State as a whole, particularly activities related to enrichment and reprocessing, would permit a redefinition of current safeguards implementation parameters, particularly for less sensitive nuclear material (e.g. depleted, natural and low enriched uranium and irradiated fuel), with corresponding reductions in the current level of safeguards verification effort on such declared nuclear material. In addition, consideration of measures resulting in improved efficiency for the verification of sensitive nuclear material (e.g. separated plutonium and unirradiated high enriched uranium) is not precluded. Generic approaches for implementation under integrated safeguards are currently being developed for specific facility types, which will result in less inspection effort on declared material than there is with current approaches at such facilities.

The basic principles which govern the development of integrated safeguards are that:

(a) they should be non-discriminatory, i.e. the same technical objectives should be pursued in all States with comparable safeguards obligations although the measures actually used in individual States may differ;
(b) they should be based on State-wide considerations, i.e.
    (i) comprehensive evaluation of information for the State as a whole should play a key role in planning the activities implemented in that State, and
    (ii) 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; and
(c) nuclear material accountancy should remain a safeguards measure of fundamental importance.

The main focus of the work on integrated safeguards is the detailed development of safeguards approaches for various types of nuclear facility, the State-level approach concept, and implementation guidelines and criteria. This work includes:

(a) specifying in detail the process by which a conclusion of the absence of undeclared nuclear material and activities in a State can be drawn and maintained;
(b) considering what measures would subsequently be appropriate to apply to declared nuclear material in specific types of facility in order to continue to provide a conclusion of its non-diversion;
(c) developing State-level integrated safeguards approaches for specific States; and
(d) developing related implementation and evaluation guidelines, criteria, and procedures.

In addition, implementation-related aspects of integrated safeguards are being specified such as the conditions for conducting effective unannounced inspections and the procedures for the randomized selection of facilities for inspection.

4. CONDITIONS FOR THE IMPLEMENTATION OF INTEGRATED SAFEGUARDS

It is important to note that the entry into force of an additional protocol is not in itself a sufficient basis for the Agency to modify safeguards measures currently implemented in a particular State with a comprehensive safeguards agreement. To reduce certain traditional verification activities on declared nuclear material, conclusions of the non-diversion of such material and of the absence of undeclared nuclear material and activities in the State as a whole are required. The conditions for such conclusions, after entry into force of an additional protocol, include the following:

(a) the State has complied in a timely manner with the requirements of its safeguards agreement and additional protocol;
(b) the Agency has implemented the necessary measures for verifying declared nuclear material, has found no indication of diversion of such material and has drawn a conclusion of non-diversion of such material; and
(c) the Agency has:
    (i) conducted a comprehensive State evaluation based on all information available, including the declarations submitted by the State under Article 2 of the additional protocol, and satisfactorily resolved any inconsistencies and questions, and
    (ii) implemented complementary access, as necessary, in accordance with the additional protocol.

Once conclusions of the non-diversion of declared nuclear material and of the absence of undeclared nuclear material and activities can be drawn for a State as a whole, the implementation of integrated safeguards can proceed. However, the ability of the Agency to continue to draw such conclusions must be maintained under integrated safeguards by continuing to implement measures to verify the non-diversion of declared nuclear material, by continuously reviewing and evaluating information, by continuing to take all actions necessary to resolve questions and inconsistencies and by conducting complementary access as necessary. If, during the implementation of integrated safeguards in a given State, the Agency were not able to reaffirm the conclusion of non-diversion of declared nuclear material or of the absence of undeclared nuclear material and activities for the State as a whole, corrective actions would have to be taken which, depending on the circumstances, could include restoring safeguards activities in the State to the level defined by traditional safeguards, while continuing to implement the measures of the additional protocol.

Specification of the process for drawing and maintaining a conclusion of the absence of undeclared nuclear material and activities in a State has largely been completed. Guidelines have been developed which identify the conditions a State has to meet and the activities the Secretariat has to perform, in implementing a comprehensive safeguards agreement and an additional protocol together, to enable the Secretariat to draw a conclusion of the absence of undeclared nuclear material and activities in the State as a prerequisite to implementing integrated safeguards in that State and to maintain its ability to

draw such a conclusion thereafter. Guidance is provided for prioritizing locations for complementary access to assure the absence of undeclared nuclear material and activities at site, mines, concentration plants and other locations with nuclear material and sets out levels of complementary access considered adequate for drawing a conclusion of the absence of undeclared nuclear material and activities in the State as a whole for the first time and for re-affirming the conclusion in subsequent years. The guidelines are in provisional use and will be revised as appropriate in the light of experience gained.

5. DEVELOPMENT OF INTEGRATED SAFEGUARDS APPROACHES FOR SPECIFIC FACILITY TYPES

A conclusion of the absence of undeclared nuclear material and activities establishes the possibility to reconsider the verification measures and implementation parameters that would subsequently be appropriate to apply at specific types of facility to continue to provide a conclusion of non-diversion. The work involves assessing the current approaches, as defined in the current Safeguards Criteria, and defining new approaches taking into consideration a conclusion of the absence of undeclared nuclear material and activities in a State. As these new integrated safeguards approaches are developed, specific implementation and evaluation criteria for each type of nuclear facility will be defined.

The principles governing work on facility-specific integrated safeguards approaches include:

(a) providing coverage of all plausible diversion and misuse scenarios associated with the specific facility type by which a State might seek to acquire nuclear material for a nuclear explosive device;
(b) retaining nuclear material accountancy as a safeguards measure of fundamental importance;
(c) evaluating the material balance annually, using random selection of facilities where appropriate;
(d) ensuring that the Agency maintains an ability to re-establish nuclear material inventories within the traditional timeliness period to the level specified in the current Safeguards Criteria; and
(e) ensuring non-discrimination among States by setting the same safeguards objectives for all facilities of a given type in States where integrated safeguards are being applied (however, the specific measures used in pursuing those objectives may differ from State to State according to individual facility characteristics and State-specific considerations.)

5.1. Timeliness Verification Goals

There are a number of issues which are important in the development of integrated safeguards approaches and which are general or common to several facility types. First is the timeliness goal for irradiated fuel. The current value of 3 months is based on the assumption that all necessary undeclared reprocessing, conversion and manufacturing facilities needed for recovering plutonium from irradiated fuel exist in a State, that these processes have been tested, and that the non-nuclear components of a nuclear explosive device have been manufactured, assembled and tested. The Agency's ability to detect undeclared nuclear material or activities in a State permits a reassessment of this value. Accordingly, an increase in the timeliness verification goal for irradiated fuel to one year is being proposed. As well as reflecting the confidence that the Agency would be able to derive in the absence of undeclared nuclear material and activities, this change is consistent with the requirement for annual material balance closures, which remains a principle under integrated safeguards. The cost savings to the Agency arising from such a change are an important consideration. With the same considerations in mind, the timeliness goal for fresh mixed oxide (MOX) fuel assemblies has also been reassessed. A change from the current value of 1 month to a goal of three months is being proposed. As with irradiated fuel, the change recognizes that further processing would be needed to produce directly usable weapons material from fresh MOX fuel assemblies and that the Agency has an increased capability, under integrated safeguards, to detect any such processing.

5.2. Unannounced Inspections

The use of unannounced inspections, i.e. inspections for which no advance notification regarding inspection timing, activities or location is given to a State, in accordance with paragraph 84 of INFCIRC/153 (Corrected), is foreseen as an important component of integrated safeguards approaches for facilities. Unannounced inspections, because of their unpredictability to a State and a facility operator, not only enhance the Agency's ability to detect diversion or nuclear material and/or the misuse of a facility but also help to deter any such actions. The increased use of such inspections should also permit cost savings for the Agency. However, to be effective, unannounced inspections must meet certain conditions related to their preparation and conduct. These conditions include the possibility:

(a) for the inspection to be carried out at any time necessary to meet the objectives of the inspection,
(b) for the inspectors to begin safeguards activities in a timely manner, and
(c) for the Agency to make its inspection arrangements without the knowledge of State authorities.

The detailed specification of these conditions is now under development. When completed and evaluated, they will be included in advance arrangements between the Agency and State authorities on the implementation of unannounced inspections. Keeping in mind that it may not be possible to fulfil these conditions in some States or facilities, alternatives to unannounced inspections are being developed and incorporated into the proposed generic facility-type approaches.

5.3. Increased Cooperation with State and Regional Systems of Accounting for and Control of Nuclear Material

Increased cooperation with State and regional system of accountancy and control (SSACs/RSACs) is also an important issue with a potential for increased effectiveness and efficiency for the Agency and is being considered as a possible factor in implementing integrated safeguards, taking into account State-specific conditions and the effectiveness of the SSAC/RSAC. Conditions and procedures for such co-operation are now under development by the Secretariat with active assistance by the Group of Experts and Member States Support Programmes (MSSPs). When completed, a decision will be taken on the extent to which co-operation between the Agency and SSAC/RSAC will be incorporated into integrated safeguards approaches.

5.4. Use of Surveillance

Another issue in the consideration of new approaches is the Agency's experience with the use of surveillance as a safeguards measure. Surveillance has played an important role in many safeguards situations over many years and will continue to do so in future. The procurement and replacement of surveillance equipment has represented a significant part of the cost of safeguards implementation. However, in some cases, it has not been sufficiently reliable, with resulting additional costs and effort for the operator, the State and the Agency. The review of surveillance data can also be labour intensive and the results of reviews are not always conclusive, leading to the need for further verification activities. The consideration of possible alternatives to surveillance, where appropriate, has therefore been an element in the design of new approaches.

5.5. Facility-Type-Specific Integrated Safeguards Approaches

Facility-type specific integrated safeguards approaches have already been developed for:

(a) light water reactors, both with and without fresh mixed oxide fuel;
(b) research reactors and critical assemblies;
(c) on-load refuelled reactors; and
(d) spent fuel storage facilities.

Features incorporated into these approaches include an annual physical inventory verification (PIV), the use of unannounced inspections where conditions for their implementation can be met and they are shown to be cost-effective, and randomized selection of facilities for inspection. In addition, options are proposed where unannounced inspections cannot be conducted effectively.

As described in GOV/INF/2000/26 [2], the one-year timeliness goal for irradiated fuel results in the elimination of announced quarterly inspections and of the need for permanently installed surveillance recording continuously at a light water reactor (LWR) without MOX. For a LWR with fresh MOX, the three-month timeliness goal for fresh MOX assemblies results in the elimination of announced monthly inspections. For efficiency in meeting this timeliness goal, it is proposed that fresh MOX fuel assemblies be under containment and surveillance (C/S) from receipt at the reactor until loading into the core. The timeliness goal for fresh MOX fuel can then be achieved by announced quarterly interim inspections or by quarterly evaluation of remotely transmitted C/S data. To maintain continuity of knowledge of the core fuel at LWRs both with and without MOX fuel, installation of temporary surveillance during refuelling and of a core seal between refuellings is proposed. The proposed approach for research reactors incorporates various options to accommodate the variety of research reactors under safeguards including random selection of reactors with small amounts of nuclear material for a PIV and additional unannounced inspections at high power reactors (e.g. greater than 25 MWth). The proposed integrated safeguards approach for on-load refuelled reactors includes the continued use of unattended flow monitors for core fuel discharges and C/S measures over the spent fuel ponds, both for cost effectiveness. In addition, detailed facility declarations of spent fuel transfer to dry storage operations in combination with unannounced inspections by the Agency to verify these transfers are foreseen to reduce Agency inspection effort. These facility-type-specific approaches are at varying stages of review and evaluation by the Secretariat, with input from the Group of Experts and from SAGSI. The Secretariat plans to continue the evaluation of the proposed approaches, including the impacts on costs, in the framework of the State-level integrated safeguards approach which will take into account all safeguards-relevant State-specific factors and conditions.

6. THE STATE-LEVEL INTEGRATED SAFEGUARDS APPROACH

A State-level integrated safeguards approach will be formulated for a State by combining the integrated safeguards approaches for the specific facility types present in the State and the implementation of additional protocol measures (specifically complementary access), taking into account the State's nuclear fuel cycle, the relationship between facilities and other State-specific features (for example, the Agency's ability successfully to carry out unannounced inspections in the State and the technical effectiveness of the SSAC). This combination will be made in an optimal way to achieve maximum effectiveness and efficiency within available resources. Information evaluation will play a key role in establishing and planning the activities under the State-level approach. The first State-level integrated safeguards approach for a Member State with an additional protocol in force was prepared for Australia. Implementation of the approach on a provisional basis began in January 2001. State-level integrated safeguards approaches for other States are currently being developed.

In developing the State-level approach concept, the Secretariat is taking into consideration results obtained by several MSSPs participating in the development of integrated safeguards under a joint project initiated by the Secretariat in 1998. Currently, eleven MSSPs are participating in the project. The three main areas of study are:

(a) the development by some of the MSSP States of approaches for integrated safeguards for fuel cycles similar to their own;

(b) the development of concepts and procedures for the evaluation of the impact of these and other integrated safeguards approaches on the effectiveness, efficiency and cost of safeguards; and

(c) increased co-operation with SSACs/RSACs.

Four meetings have been held by the Department of Safeguards with representatives of MSSPs involved in the task in order to co-ordinate the work being done by the MSSPs and to communicate progress on that work and on the work being undertaken by the Secretariat. The next meeting with the MSSPs is scheduled for Spring 2002.

7. COSTS

Achieving overall cost neutrality when integrated safeguards is implemented on a sufficiently broad scale remains a goal. Cost neutrality in this context has as a reference point the actual level of expenditure on safeguards activities in 1997[1] (around $95 million, compared to a regular budget figure for safeguards of $82 million) i.e. before any additional protocol-related activities were implemented. There will, however, be an increase in costs related to the implementation of safeguards in any State during the period after an additional protocol enters into force and pending a conclusion that all nuclear material in the State has been placed under safeguards and remains in peaceful nuclear activities. During this period, both traditional safeguards verification activities and additional protocol measures will be implemented. Thereafter, the reduction in inspection effort for less sensitive nuclear material should, in the long run, at least partially offset increases related to information review and evaluation at Headquarters, to the follow-up of questions and inconsistencies and to the implementation of complementary access as required. The introduction of other efficiencies, e.g. those resulting from internal management restructuring, have helped to offset some such increases.

8. ONGOING AND FUTURE ACTIVITIES

The development of all aspects of integrated safeguards is continuing. The departmental Integrated Safeguards Working Group (ISWG) continues to meet weekly to develop integrated safeguards approaches for specific facility types. Current ISWG work is focused on Depleted, Natural and LEU fuel fabrication facilities. The next facility type to be considered is R&D facilities. Implementation-related aspects of integrated safeguards being further elaborated within the Department are the conditions for conducting effective unannounced inspections, anomaly resolution under integrated safeguards, and detailed cost analyses for integrated safeguards approaches. In addition, work on guidelines and criteria for the design, implementation and evaluation of State-level approaches, including facility specific criteria, is proceeding in parallel. The Group of Experts continues to meet quarterly to review the work of the Secretariat in all aspects of integrated safeguards development. The Group's current development efforts are focused on defining the role of SSACs in integrated safeguards.

In future, the conditions for, and formulation of, the Agency's findings and conclusions regarding undeclared nuclear material and activities will be further developed and refined as the implementation of additional protocols proceeds. The guidelines for drawing and maintaining conclusions of the absence of undeclared nuclear material and activities in a State, which are being implemented on a provisional basis, will, as experience in their use is gained, be revised or further developed. Development and evaluation will continue on proposals for integrated safeguards approaches at other specific facility types. In addition, State-level approaches will be designed for specific States as they become candidates for integrated safeguards. It is expected that the conceptual framework for integrated safeguards in all types of nuclear fuel cycle will be largely completed by the end of 2001. Work will proceed on actual implementation of integrated safeguards in specific States when the necessary conclusions have been drawn regarding the non-diversion of declared nuclear material and the absence of undeclared nuclear material and activities. As experience is gained through implementation of integrated safeguards, adjustments to the system can be made, as appropriate, in an evolutionary manner.

[1] This reference level does not include additional costs related to major new projects such as safeguards for the large reprocessing plant at Rokkashomura in Japan.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, The Development of Integrated Safeguards, GOV/INF/2000/4, 9 March 2000.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, The Development of Integrated Safeguards, GOV/INF/2000/26, 17 November 2000.