

The safeguards revolution - where to from here?

J. Carlson, on behalf of SAGSI (Standing Advisory Group on Safeguards Implementation)

Chairman, SAGSI

Abstract. In the past decade safeguards have moved from a relatively routine system, operating in a seemingly benign environment, to a system undergoing radical change, having to reinvent itself to respond to major challenges. Traditional safeguards developed with an emphasis on nuclear materials accountancy, and on verifying the correctness of declared nuclear material inventories. The need to avoid discrimination came to be interpreted as requiring uniformity in safeguards implementation – exemplified in the Safeguards Criteria. Today it is recognised that the greatest single safeguards challenge is the detection of undeclared nuclear activities - safeguards need to provide assurance of the completeness as well as the correctness of States’ declarations. The development of new methods, approaches and technology – and a new safeguards culture – are needed to respond to this challenge. In contrast to the previous uniformity, the new safeguards are underpinned by a State-level approach, designing safeguards implementation to address the acquisition paths available to each State, and other State-specific factors. At the same time, new techniques and detection technologies are being developed. The broadening of available verification measures will require greater adaptability at the implementation level - more options will be available to inspectors, there will be less emphasis on routine inspection activities, and much more emphasis on observation skills. Verification activities directed at the possibility of undeclared activities will involve new ways of thinking. SAGSI has played a significant role working with the Secretariat in developing the new safeguards approaches. This paper outlines some key concepts that underlie the continuing safeguards revolution, and SAGSI’s views on the further development of the safeguards system.

1. Introduction

It is no exaggeration to describe the ongoing changes to the IAEA safeguards system as revolutionary. In the past decade safeguards have moved from a relatively routine system, operating in a seemingly benign environment, to a system undergoing radical change, having to reinvent itself to respond to major challenges. The process of revolution needs to be ongoing. The conceptual framework for the new safeguards system has been developed, but this framework has to be consolidated through new implementation practices. There is much more to be done if the safeguards system is to be successful in meeting current and future challenges.

When the traditional comprehensive safeguards system was introduced, in the early 1970s following the conclusion of the NPT, the rationale underlying the safeguards system was seen as being very different to today. At that time it was thought that proliferation would require diversion of safeguarded nuclear material and misuse of safeguarded nuclear facilities. It was considered beyond the capability of most States to establish a wholly clandestine nuclear fuel cycle, independent of safeguarded nuclear material and facilities. So, it was thought, an effective system was a matter of applying suitably rigorous safeguards procedures to declared material and facilities.

During the 1970s and 1980s the traditional safeguards system developed in conditions of apparent stability, where the main challenge was seen as resource allocation – how to manage a steadily growing workload with a relatively static budget. During this period the traditional safeguards system developed with an emphasis on nuclear materials accountancy, and on verifying the **correctness** of declared nuclear material inventories. The organizational culture developed around the use of quantitative and relatively mechanistic procedures. This culture

was reinforced through a particular policy perspective, specifically, that avoiding discrimination required **uniformity** in safeguards implementation.

Yet this apparent stability proved to be dangerously misleading. Beneath the surface, clandestine nuclear programs remained unrecognised and undetected. By the time of its discovery, following the First Gulf War, Iraq's clandestine nuclear program had been growing for over a decade undetected by safeguards. The discovery of this program prompted a review of the safeguards system to identify ways and means of strengthening it.

Today it is recognised that the greatest single safeguards challenge is the detection of undeclared nuclear materials and activities. In IAEA terms this is expressed as requiring that safeguards should provide assurance of the **completeness** as well as the correctness of States' declarations. The development of new methods, approaches and technology – and a new safeguards culture – are needed to respond to this challenge.

In contrast to the previous uniformity, the new safeguards are underpinned by a State-level approach (SLA), designing safeguards implementation to address the acquisition paths available to each State and other State-specific factors. At the same time, new techniques and detection technologies are being developed. Verification activities directed at the possibility of undeclared activities are being developed, reflecting new ways of thinking. The SLA, coupled with the broadening of available verification measures and techniques, will require greater adaptability at the implementation level – more options will be available to inspectors, there will be less emphasis on routine inspection activities, and much more emphasis on observation skills.

A significant revolutionary aspect of safeguards development is the enhanced use of expert judgment in drawing safeguards conclusions. Conclusions about the **absence** of something (e.g. undeclared nuclear materials and activities) can never be as definitive as conclusions based on quantitative methods applied to a finite problem – the verification of a declared inventory. For the new safeguards conclusions to be credible, a number of conditions need to be satisfied: that States understand the process for looking for indicators of undeclared activities and accept it as appropriate; that States are satisfied the process is applied at the requisite standard; and that States are satisfied judgments are exercised and conclusions drawn in a suitably disciplined, **non-discriminatory** way. All of this involves new approaches compared with the traditional quantitative system, including analysis of a broader range of information, and a quality assurance system to ensure appropriate standards of implementation and decision-making.

SAGSI (Standing Advisory Group on Safeguards Implementation) comprises a group of safeguards experts – currently 18 – appointed by the Director General to advise him on safeguards implementation issues. SAGSI was founded in the mid 1970s, following the establishment of the safeguards system set out in INFCIRC/153. In the early years, amongst other things, SAGSI was instrumental in developing safeguards design parameters such as the significant quantity, establishing timeliness goals, and developing the format for reporting on safeguards performance in the Safeguards Implementation Report (SIR). Following the 1991 Gulf War, SAGSI, in collaboration with safeguards technical experts both within and outside the Secretariat, helped to develop the strengthened safeguards measures in Programme 93+2. These ideas and concepts for the strengthened safeguards system eventually led to the implementation of the “Part I” measures, and then the “Part II” measures of the Additional Protocol. SAGSI has also played a significant role in working with the Secretariat to

conceptualize and develop integrated safeguards facility approaches as well as the State-level approach.

The sections that follow touch on SAGSI's recent contributions to the safeguards revolution, describe more fully some key concepts that underlie the continuing safeguards revolution, and outline SAGSI's views on the further development of the safeguards system.

2. SAGSI's review of the Safeguards Criteria

A major characteristic of traditional safeguards has been **uniformity** in implementation – essentially the same inspection activities were applied at similar facilities in different States, with limited differentiation between States. As a consequence, inspection effort was concentrated in those States with the largest fuel cycles. While some considered such a situation was the price to be paid for a technically-based, non-discriminatory system, many others considered that the allocation of safeguards effort that had evolved represented an inefficient use of scarce resources, particularly as none of the States accounting for the greater proportion of the safeguards effort was considered to pose a significant proliferation risk.

Though in recent years the concentration of inspection resources in the three States accounting for the largest proportion of these resources has eased, for many the perception remains that traditional safeguards are inherently inefficient, because they do not provide a mechanism for prioritising safeguards effort towards areas considered to present highest proliferation risk. The safeguards criteria – which specify the safeguards activities required at each facility – were seen as a major factor contributing to this situation.

The Secretariat has established safeguards criteria for each type of facility under safeguards. Originally the safeguards criteria had been developed to assist in **evaluation** of safeguards performance, but over time the criteria came to specify the scope, the normal frequency and the extent of the verification activities needed to achieve the inspection goals for each type of facility. Thus the criteria were used for planning and implementing verification activities as well as for evaluating the results therefrom. This resulted in a number of rigidities being built into the safeguards system.

In 2003 the Secretariat sought a substantial increase in the Agency's budget, particularly for the implementation of safeguards. In the context of the debate over this increase the Board of Governors' Programme and Budget Committee called for:

A review of the modernization and the flexibility and cost-effectiveness of safeguards working methods The aim of this exercise shall be to enhance the effectiveness and efficiency of the IAEA's safeguards system, while maintaining its credibility.

At the time of the Board of Governors' approval of the budget increase, and in response to the above call, the Director General stated that the Office of Internal Oversight Services would evaluate the effectiveness and efficiency of the safeguards programme, while SAGSI would be asked to undertake a specific technical review of the safeguards criteria. The Director General stressed that the primary driving force in the Agency's verification work must always be **effectiveness** and **objectivity**.

Accordingly, the Director General asked SAGSI to review the role, structure and content of the Agency's safeguards criteria, and to make recommendations for any specific changes that would improve the efficiency of safeguards while maintaining the ability of the safeguards

system to provide credible assurance of the non-diversion of nuclear material from declared activities and, as appropriate, the absence of undeclared nuclear activities.

The terms of reference for the review asked SAGSI to focus on light water reactors and on-load reactors – including transfers of spent fuel from such facilities – and research reactors/critical assemblies. In addition, SAGSI looked at storage facilities, with particular reference to spent fuel storage, and fuel fabrication facilities. Collectively, these various facilities accounted for some 78% of the Agency’s inspection effort (as measured in PDI – person/days of inspection).

Review of the role and structure of the safeguards criteria required SAGSI to go beyond the facility types referred to in the terms of reference, and to examine a number of generic issues, such as new processes and documentation for integrated safeguards. In addition, SAGSI examined a number of “cross-cutting” issues – i.e. issues affecting a number of facility types.

Although SAGSI focused particularly on efficiency issues, efficiency and effectiveness are not mutually exclusive – and SAGSI has recommended a number of efficiency improvements that would also result in strengthened effectiveness.

In carrying out its review, SAGSI identified **key concepts and principles** that should remain substantially unchanged under either traditional or integrated safeguards, areas where flexibility would be possible in appropriate circumstances, and factors to be considered in recommending any changes to safeguards criteria/approaches. These concepts and principles include:

- nuclear materials accountancy will remain a safeguards measure of fundamental importance;
- safeguards measures should cover all plausible acquisition paths;
- where an acquisition path involves declared nuclear material or facilities, detection of diversion is not to be solely dependent on verification activities relating to the undeclared segments of the acquisition path;
- the benefit of unpredictable (i.e. to the State/operator) inspections and verification activities;
- the importance of the Agency being able to reach independent safeguards conclusions.

Another key principle is the essential contribution of inspector presence to safeguards effectiveness – discussed further below.

During the criteria review, SAGSI discussed and debated at length topics ranging from the arcane details of safeguards approaches at specific facility types to new, and in some cases, radical concepts for safeguards planning, implementation, and evaluation. It is the new ideas and concepts, and where they might take the safeguards system in the future, that are the focus of the remainder of this paper.

3. The new ideas – furthering the revolution

SAGSI found that the safeguards criteria remained broadly appropriate for the circumstances of traditional safeguards, but recommended a number of efficiency improvements, including:

- greater use of unattended and remote monitoring technologies;
- different ways of achieving timeliness – including randomised inspections;

- the importance of **unpredictability** – through random/unannounced/short-notice inspections.

SAGSI concluded that a criteria-driven approach is not appropriate for integrated safeguards. Instead, the basis for safeguards implementation should be a State Level Approach (SLA) developed and documented for each State. New processes should take the place of the criteria – SAGSI recommended giving effect to the SLA through an annual safeguards implementation plan, supported by what SAGSI termed “inspector instructions”.

While the safeguards objectives remain similar for all States, State Level Approaches are intended to reflect the optimal combination of safeguards measures for each State, taking into account State-specific factors and adjusting safeguards intensity accordingly, e.g. through specifying selected safeguards measures and the facilities to be inspected.

SAGSI recommended against using “criteria” in integrated safeguards. In place of the safeguards criteria, SAGSI advised the Secretariat to develop a State Level Approach for each State, an annual safeguards implementation plan (AIP) for the State, and operational-level documents setting out the activities for meeting the verification objectives for facilities selected for inspection (and, where appropriate, providing choices of means of meeting the objectives). In subsequent discussions with the Secretariat, it was agreed that the AIP, giving effect to the SLA, would provide the basis for safeguards planning, implementation, and evaluation. The AIP and the operational-level documents would serve the function of the inspector instructions which SAGSI had proposed.

SAGSI emphasised that it was essential to avoid carrying over to integrated safeguards the rigidities found in traditional safeguards. Appropriate adjustment must be made for State-specific factors – otherwise safeguards effort under integrated safeguards will ultimately be determined, as with traditional safeguards, mainly by quantities of material and numbers of facilities.

Although SAGSI highlighted the need to move away from uniform application of safeguards, SAGSI also drew attention to the need to ensure Agency-wide standards of effectiveness. Consistency of process is very different to – and should not be confused with – uniformity of implementation. The traditional safeguards criteria, which specify only one way of applying safeguards implementation parameters, are not appropriate to integrated safeguards, since integrated safeguards involve the optimum combination of measures – requiring **selection** amongst possible measures.

This, in turn, will require the development of new methodologies for safeguards evaluation. This will include broadening the range of information that can be taken into account in evaluating nuclear programs – an area requiring considerable further development.

Since the Criteria Review, SAGSI has continued to work with the Secretariat on the development of the concept and application of the State Level Approach, which has become the foundation for integrated safeguards.

A State Level Approach is also important for traditional safeguards

For a State under traditional safeguards, the extent to which State-level factors can be reflected in the State Level Approach will be more limited than in the case of a State with an additional protocol in force and for which the Agency has drawn the broader safeguards

conclusion. However, SAGSI concluded that the State-level factors set out in INFCIRC/153 paragraph 81 should be considered for **all** States subject to comprehensive safeguards. Recent experience shows that in making adjustments for State-specific factors the safeguards system must be capable of increasing, as well as reducing, safeguards intensity. As States remaining under traditional safeguards will be the exception rather than the norm, an important aspect of the State Level Approach will be assessing the adequacy of the standard facility-level safeguards approaches for such States.

Evaluation for integrated safeguards should not be based on implementation criteria. Instead, evaluation should be based essentially on whether and how the verification objectives specified in the State Level Approach were met, as indicated by the results of the activities carried out under the annual implementation plan.

Under traditional safeguards the safeguards criteria had become associated with a rigid approach both to implementation and particularly to evaluation. The “checklist” approach used for evaluation had also led to a predominantly “checklist” approach to safeguards implementation. A primary objective of evaluation under integrated safeguards is to ensure that safeguards in the State are implemented in accordance with the SLA and the AIP. SAGSI continues to work with the Secretariat to develop and refine evaluation concepts for integrated safeguards.

Integrated safeguards involve continuing cultural change

The rigidities in traditional safeguards implementation are the result of uniformity – a particular vision of achieving non-discrimination under the conditions of traditional safeguards. Under integrated safeguards, in addition to adaptability in developing State Level Approaches, the broadening of available verification measures will require greater adaptability at the implementation level – more options will be available to inspectors, there will be less emphasis on routine inspection activities. Verification activities directed at the possibility of undeclared nuclear activities involve new ways of thinking.

Moving from uniform implementation strictly defined by criteria involves moving to a result-oriented culture, whilst upholding non-discrimination values. This will also require greater application of expert judgment and decision-making at all stages and levels of safeguards implementation. As discussed, major change is also required in safeguards evaluation.

Achieving substantial change, while maintaining the effectiveness, quality and overall non-discriminatory character of safeguards implementation and evaluation, is a complex matter that requires the right strategies and management commitment. Change *is* taking place – the Agency has already made good progress in these directions – but taking the process forward, broadening and accelerating it, will be a continuing challenge.

Reducing inspections should not be an aim in itself. Achieving efficiencies in routine inspection tasks enables prioritisation of inspector time, optimising use of the skilled inspector resource to activities of greatest verification value. SAGSI emphasised the essential contribution of inspector presence to safeguards effectiveness. There are many tasks that can be performed effectively only by an inspector – and the observational skills of the inspector are assuming increasing importance.

Achieving efficiencies in safeguards implementation is not only a matter for the Agency – greater cooperation between the Agency and States is required. Greater cooperation between

the Agency and SSACs can significantly improve efficiency through cooperative endeavours. In addition to ensuring that SSAC data are timely and accurate, areas for cooperation include: the use of unattended and remote monitoring; mailbox approaches for reporting data; the conduct of joint inspections; and enabling unannounced/short-notice inspection. Many States are already active in these areas, but there is more to be done. SAGSI noted these activities require a high level of commitment and competence on the part of SSACs.

SAGSI is currently working with the Secretariat on the development of new guidelines for SSACs, including a revision of the “Guidelines for States’ Systems of Accounting for and Control of Nuclear Materials” (IAEA/SG/INF/2) which will be published in the “International Nuclear Verification Series” as the top level SSAC Guidelines document and supported by a series of other guideline implementation documents, including the Nuclear Material Accountancy Handbook and ISSAS Mission Guidelines.

Further efficiencies could come from the concept of **infrequent intensive verification**, which SAGSI recommends for further study. This concept builds on the advantages of unpredictability in verification. The concept could be used as an alternative to the normally defined level of routine inspections – resulting in net savings. This would involve a trade-off between further reductions in routine inspections and unpredictable but occasional and intensive inspections. The concept could also be used to supplement routine inspections, providing flexibility to introduce more intensive inspections in response to emerging circumstances.

Associated with the concept of infrequent intensive inspection is the concept of a safeguards operational support team (“SOST”) – also recommended for further study. SOST would comprise a group of specialist inspectors who can be drawn upon to supplement routine inspection operations. The Secretariat already does this *ad hoc* – with SOST this would be established on an ongoing basis.

4. Further development of the safeguards system

The new ideas and the ongoing revolution in safeguards will continue to develop in a dynamic international nuclear context that may see significant expansion and growth in the use of peaceful nuclear technologies and continued challenges to the nonproliferation regime from a small number of States. The IAEA safeguards system, working on behalf of the international community, must continue to provide confidence in the peaceful uses of nuclear energy. SAGSI expects to continue to contribute to the ongoing safeguards revolution by considering key technical questions surrounding the implementation of IAEA safeguards. Some of these questions are identified in the following paragraphs.

Peaceful nuclear activities are expected to grow overall, and importantly for safeguards, to expand into new regions. The safeguards system will have to keep pace; but it is unlikely that safeguards growth can be linear with the increase in global nuclear activities. The concepts outlined in the State Level Approach, which permit the development and implementation of “intelligent” safeguards, will be essential to meet the demands to maintain a credible system that is both effective and efficient. Will the Secretariat be able to ensure that the State-Level Approach to safeguards implementation and evaluation continues to evolve to reflect experience gained as well as the development of new safeguards-relevant equipment and technology? Will the safeguards system remain credible?

Experience to date has shown that greater use of information and advanced technologies are essential elements of the safeguards system, and these can be expected to increase in importance in the future. What advances can be expected in the fields of information collection and analysis that can be employed by the Secretariat? What are the essential technologies needed to strengthen the safeguards system and how can they best be employed? Given the continuing importance of research and development in this area, how can we ensure there is an appropriately structured R&D programme reflecting the needs and priorities of the safeguards system?

Wider acceptance of the Additional Protocol and more States coming under integrated safeguards will contribute to effectiveness and efficiency gains for the safeguards system. Experience gained in the implementation of IS can be expected to improve safeguards implementation leading to additional gains in both aspects of safeguards. What additional adjustments to safeguards implementation are warranted?

New fuel cycle concepts, such as assured fuel supply, multilateral fuel cycle centres, and new partnerships can all have a major impact on the use of safeguards resources. Until there is further development of these ideas it is unclear how they might impact on safeguards, but it is clear they must be developed in concert with the safeguards community to ensure the optimal use of safeguards resources. How can we ensure that safeguards considerations have an appropriate influence in the fuel cycle choices facing the international community?

The lessons learned from the proliferation activities of a few States, and the revelation of an illicit nuclear trade network, have illustrated that the possibility of clandestine facilities and associated undeclared materials and activities are real threats that must be addressed by the safeguards system. How can the safeguards system enhance its ability to detect these undeclared nuclear materials and activities? What are the impacts on the safeguards system of the possibly wide-spread availability of, for example, centrifuge designs?

In short, what will the safeguards system look like in five or ten years? How can the current system build a sound foundation to support the international nuclear enterprise of 2036 (30 years from now)? If history is a useful guide, consider the safeguards implemented in 1976 with those implemented under the current system. The changes have been dramatic, even if the fundamentals are the same. There is every reason to believe that the safeguards system will continue to evolve, with periods like the recent one in which the pace of change can be truly characterized as revolutionary.

SAGSI Members 2004-2006

Mr. J. Carlson (Chairman), Mr. M.-G. Albert, Mr. J. Casterton, Mr. A. Chabane Sari, Mr. Y-M. Choi, Mr. J. Eibenschutz, Ms. S. Fernández Moreno, Mr. R. Howsley, Mr. Liu Y., Mr. K. Naito, Mr. B. Pellaud, Mr. V. Pushkarev, Mr. K. Raghuraman, Mr. G. Stein, Mr. J.W. Tape, Mr. D. Tillwick, Mr. A. Valseth, Mr. L.A. Vinhas.

Mr. E. Haas (2005-2006), Mr. N. Tuley (2004-2005), Scientific Secretary.