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INTEGRATED SAFEGUARDS - A CASE OF THE GOOD BEING THE ENEMY OF THE BEST?

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Abstract

“Integrated safeguards” are intended to represent the optimum combination of all safeguards measures available to the IAEA under comprehensive safeguards agreements and additional protocols which achieves maximum effectiveness and efficiency within available resources.

The purpose of integrating classical and strengthened safeguards measures is to achieve cost-effectiveness. The Agency has only a finite budget, and Member States expect efficiencies before considering budget increases. Fundamental to integrated safeguards is the elimination of redundancies—by focusing on detection of undeclared nuclear activities, strengthened safeguards address a shortcoming in classical safeguards, enabling reductions in routine safeguards intensity. A goal therefore is to establish appropriate levels for routine safeguards activity—and to ensure that classical and strengthened safeguards effectively complement each other.

The first priority for safeguards is to provide assurance on the observance of non-proliferation commitments. Here, the principal technical challenge is the development of effective measures to detect undeclared nuclear activities. If efficiencies could not be achieved without compromising effectiveness, this must be brought to the attention of Member States. To date however this has not been demonstrated (this point should not be confused with the issue of the overall adequacy of the safeguards budget)—and judgments on the performance of the safeguards system should be made on the basis of the system as a whole, looking at the complementarity of its various components.

The concept of integrated safeguards has been before the Board of Governors a number of times, integrated safeguards have been under development for some 2½ years, and practical application has begun. However, there are lingering concerns that cost considerations will lead to unacceptable compromises—indicating some misgivings about integrated safeguards as a concept. The objectives of integrated safeguards—effectiveness combined with efficiency—clearly represent a desirable, or “good”, outcome. Do integrated safeguards, however, work against the “best” outcome, which some may perceive as the continuation of current measures on declared nuclear material as well as strengthened safeguards?

The paper outlines the directions taken in the development of integrated safeguards, some of the major changes in the application of classical safeguards, and whether these could result in adverse outcomes.

1. INTRODUCTION

The background to the development of strengthened safeguards is well-known and need not be elaborated here. Strengthened safeguards are intended to address the detection of undeclared nuclear material and activities, an area not adequately dealt with by the “classical” safeguards system. As the development of strengthened safeguards progressed, it became apparent that classical and strengthened safeguards would be mutually reinforcing, and some classical safeguards measures would become redundant.

This can be illustrated as follows. Under classical safeguards, it is assumed that undeclared nuclear activities *may* exist, and the level of verification effort is determined on this basis. For example, the timeliness goal for detection of diversion of spent fuel incorporates the assumption that an undeclared reprocessing/plutonium extraction plant may have been constructed and commissioned, ready for processing diverted material immediately after diversion. Thus, the inspection frequency for spent fuel at light water reactors (LWRs)—three months—broadly corresponds to the time required to reprocess spent fuel and manufacture the separated plutonium into the metallic components of a nuclear explosive device (*conversion time*).

As strengthened safeguards establish credible assurance of the absence of undeclared nuclear activities, however, a corresponding reduction is possible in the intensity of classical safeguards effort. If there is credible assurance that a State has no undeclared reprocessing plant, the time required for conversion of diverted spent fuel will be extended by the very considerable time required to build and commission such a facility, and this can be reflected in a reduced inspection frequency for spent fuel, from three months to, say, 12 months.

Integrated safeguards

Recognition of the need to avoid redundancies led to development of the concept of “integrated safeguards”—defined as the optimum combination of all safeguards measures available to the IAEA under comprehensive safeguards agreements and additional protocols which achieves the maximum effectiveness and efficiency within available resources in fulfilling the Agency’s right and obligation to ensure safeguards are applied to all relevant nuclear material. The elaboration of integrated safeguards has been a major focus for the Agency, with assistance from Member States, for some 2½ years, and is likely to absorb considerable efforts for some time to come, since the Agency recognises this should be an iterative process, with refinement (or even substantial change) as practical experience is gained.

A number of objectives underlie integrated safeguards. There is the need to maximise cost-effectiveness, both in the efficient as well as effective use of existing resources, and to meet the expectations of Member States regarding the level of funding they are prepared to support in future budgets. Also important is the achievement of efficiencies as an organisational, not just a budgetary, goal—no modern organisation, whatever its field of operation, should maintain unwarranted activities. Finally, the benefits for the Agency’s professional staff should not be overlooked—elimination of redundant routines benefits morale, and is an important aspect of the evolution of safeguards work, allowing a shift to more challenging and satisfying tasks for inspectors and fostering the cultural change necessary for successful implementation of strengthened safeguards (conveniently, if not entirely accurately, shorthanded as a change “from accountants to detectives”).

Although there are very good reasons for actively seeking to eliminate redundancies, however, there appear to be some concerns about the integrity of a process where cost-saving is a major objective. The

underlying thought appears to be that cost considerations will lead to undesirable compromises—and that the best form of safeguards may be the classical measures unchanged, with the strengthened measures added.

To consider the validity of these concerns, it is necessary to look at the conditions to be met for the introduction of integrated safeguards, as well as some of the specific changes proposed in safeguards implementation.

2. ADVANCES INTRODUCED WITH STRENGTHENED SAFEGUARDS

Strengthened safeguards have been discussed in detail in a number of places, and only a very brief outline is given here. Key elements of strengthened safeguards are:

- **greater capabilities to acquire and analyse information** The range of information on nuclear and nuclear-related activities to be provided to the Agency by States has been considerably expanded, and in addition the Agency undertakes searches of open source information. Information from the Agency's analytical activities, inspections, etc. is used to develop individual *State Evaluations*, as a basis for planning safeguards activities and drawing safeguards conclusions;
- **extensive access rights** Through *complementary access* the Agency's access rights are very substantially extended, from the *strategic points* allowed under routine inspections to any place on a nuclear site, a range of locations specified in the Additional Protocol, and to other places in the State where required to resolve questions and inconsistencies;
- **new technologies** Of particular importance is environmental sampling and analysis—this is carried out on a “location-specific” basis, but the Protocol recognises the possibility of using *wide-area* environmental sampling if its efficacy is established. At present there are technical aspects to be overcome, including cost, but wide-area environmental sampling could be a useful technique for the future, where suitable conditions exist. Another technology gaining increasing importance for safeguards applications is satellite imagery.

Effectiveness issues

While strengthened safeguards have been under development for several years, they are still a “work in progress”, and are likely to remain so, in the sense that an ongoing program of technical improvement is expected (just as with classical safeguards). Because of the novelty of many of the concepts and techniques involved—and perhaps particularly because many of these are *qualitative* rather than quantitative in nature—there are concerns on the part of some that the Agency's capability to detect undeclared nuclear activities is unproven. Hence there is some reluctance to see reductions in routine safeguards inspection activity.

How realistic is it to expect the Agency to be able to detect undeclared nuclear activities, or at least the most significant (such as reactors, reprocessing, enrichment)? Clearly this is a much less definitive goal than the verification of declared material, and the level of assurance which can be provided will be less certain. The difficulties encountered in Iraq in the 1990s, where there was a very intrusive verification regime following the Gulf War, show this is not an easy task. On the other hand, compared with individual States, the Agency has considerable advantages to build on in pursuing this task. In addition to its expertise, the Agency will have comprehensive information bases, extensive access rights (the ability to “get under the roof”), and increasingly sophisticated verification methods.

If the safeguards system is to work to best effect, it is most important for the Agency's work to be complemented through States making available information obtained through national means, including intelligence activities. This highlights a very important aspect—that proliferation does not take place in a vacuum. There will be all kinds of warning indicators. If safeguards remain a narrow technical system, paying no attention to the environment in which it operates, it will be difficult to address problem areas effectively. This has been a disadvantage of the classical system—one of the lessons from this should be that non-discrimination does *not* mean uniformity in safeguards implementation. A challenge in the development of strengthened and integrated safeguards is to broaden the range of factors which can be taken into account, to enable safeguards effort to be prioritised—conscious however of the need to proceed on a clearly understood, objective, basis so as to avoid charges of discrimination.

There are good grounds for optimism that the new safeguards approaches and technologies will be effective in practice. Environmental sampling, for example, has the capability of detecting indicators of reprocessing and enrichment some distance from where these activities are taking place—and this capability should be significantly improved with further development. Certainly at the moment it is difficult to *quantify* the likelihood of strengthened safeguards activities being able to detect an undeclared reprocessing or enrichment facility, if such existed—but even if, at this stage, one were to assess the likelihood as relatively low, that would still represent a considerable advance over what is possible under the classical safeguards system, and detection capabilities can be expected to strengthen with further development and practical experience.

3. CONDITIONS FOR THE INTRODUCTION OF INTEGRATED SAFEGUARDS

It is essential to appreciate that qualification for integrated safeguards is not *automatic*, there are important conditions to be met. The Agency has determined that the introduction of integrated safeguards can be considered if there are positive results from the implementation of both classical and strengthened safeguards activities. For each State, therefore, progress to integrated safeguards is a two stage process, the first of which is to meet the requirements of strengthened safeguards.

A positive result—an initial conclusion that undeclared nuclear material and activities are not present in the State—would be based on the following conditions:

- the State has concluded an Additional Protocol (based on INFCIRC/540);
- the State has complied in a timely manner with the requirements of its safeguards agreement and Additional Protocol;
- the Agency has conducted a comprehensive *State Evaluation*;
- the Agency has concluded that declared nuclear material has not been diverted;
- the Agency has implemented *complementary access* as necessary, to resolve questions and inconsistencies identified during the information review process, and to assure the absence of undeclared nuclear material at sites and other locations specified in the Protocol, and has found no indications of undeclared nuclear material or activities.

This conclusion would be maintained, and should be enhanced, by ongoing implementation of the Additional Protocol and continued satisfactory resolution of any questions and inconsistencies. Obviously the level of openness and cooperation by the State will have a major influence on the Agency's ability to carry out its tasks satisfactorily. If the conclusion on the absence of undeclared

nuclear material and activities cannot be satisfactorily maintained, the Agency reserves the right to reinstate more intensive safeguards implementation.

Progress in the application of strengthened and integrated safeguards

At the time of writing (February 2002), there are 25 States with Additional Protocols in force. Only one State, Australia, has progressed to the stage of having integrated safeguards applied—since January 2001. A further 36 States have signed Additional Protocols but not yet brought them into force. There are 21 NPT Parties with significant nuclear activities that have not signed Additional Protocols. Thus, while the number of Additional Protocols is growing, the rate is disappointingly slow, and it seems it will be some time before strengthened safeguards, let alone integrated safeguards, is the form of safeguards being applied in the majority of States.

To date none of the States currently considered to be of proliferation concern have concluded Additional Protocols, and there is no indication they will do so in the near future. Clearly this is of concern to the international community, since the Agency does not have the opportunity to apply the full range of strengthened safeguards measures to those States, and only partial assurance of those States' compliance with non-proliferation commitments is possible. As the combination of classical safeguards (INFCIRC/153) and strengthened safeguards (INFCIRC/540) become firmly established as the NPT safeguards standard, the issue will arise as to how to regard those Parties that fail to meet this standard. It is to be hoped that all States will come to appreciate their national interests are best served by full participation in, and cooperation with, the non-proliferation regime.

It is generally assumed that if and when these States do conclude Additional Protocols, there will be significant questions and inconsistencies which will take considerable time and effort to resolve. Thus, the application of integrated safeguards to such States is not in prospect for some time, and concerns that these States could exploit the less rigorous inspection regime applicable under integrated safeguards are somewhat premature.

4. CHANGES TO SAFEGUARDS INSPECTIONS UNDER INTEGRATED SAFEGUARDS

As discussed earlier, the rationale underlying integrated safeguards is that increased assurance of the absence of undeclared nuclear activities—gained through information analysis, increased access, new verification technologies, and so on—warrants adjustments to the intensity of routine safeguards inspections. This applies primarily where diverted nuclear material would have to be upgraded in undeclared facilities—e.g. if spent fuel is diverted, reprocessing would be an essential part of the diversion scenario; if LEU is diverted, enrichment would be required. At this stage no changes are foreseen from integrated safeguards in the measures applying to unirradiated direct-use material (UDU) (separated plutonium and HEU), though some rationalisation is proposed for the specific case of unirradiated MOX fuel assemblies.

So far integrated safeguards approaches have been developed for a number of facility types: LWRs, research reactors, on-load refuelled reactors, spent fuel storage facilities, and natural uranium and LEU conversion and fuel fabrication facilities. Space does not permit discussion of all of these—for this paper LWRs have been chosen for discussion. LWRs have been given a high priority for the application of integrated safeguards because of the substantial proportion of safeguards effort currently expended on them.

Safeguards implementation at LWRs

Inspections at LWRs account for some 23% of the Agency's total inspection effort (in addition, thousands of hours are spent at IAEA headquarters reviewing surveillance films and tapes)—yet these facilities are not regarded as a serious proliferation risk, and in most cases they are located in States that are not considered to present any proliferation concern. Hence there are sound reasons for seeking to rationalise the inspection effort devoted to these facilities.

Under classical safeguards a three-month timeliness goal applies. There is an annual Physical Inventory Verification (PIV) and three quarterly inspections between PIVs. In addition, camera surveillance is maintained on spent fuel in storage ponds. Films or tapes from the cameras are collected and reviewed in accordance with the inspection schedule, i.e. every three months. As already noted, the three-month timeliness goal is based on the time required to reprocess spent fuel and process separated plutonium into metallic components, assuming a reprocessing/plutonium extraction plant is available and operational. However, if there is assurance no such plant is available, the need for a three-monthly inspection schedule can be re-evaluated.

The principal changes being considered under integrated safeguards are as follows:

- a change in the timeliness goal for spent fuel from three months to 12 months, eliminating quarterly inspections. The annual PIV would be retained, and a proportion of LWRs would be selected for one, or possibly more, random unannounced or short notice inspections during the year;
- removal of the requirement for camera surveillance—though cameras would be retained where this was warranted (and the Agency has decided camera systems already installed would not be removed while experience is gained in the implementation of integrated safeguards).

Do these changes represent a downgrading of safeguards coverage for spent fuel at LWRs? For a start, it must be emphasised that these changes would be introduced only under integrated safeguards, and integrated safeguards would not be introduced in a particular State unless the Agency was satisfied that the conditions outlined in section 3 above were met. Satisfying the conditions should result in assurance of the absence of undeclared reprocessing/plutonium extraction facilities.

Routine inspections

In these circumstances, in principle a three-month inspection frequency is not required, because if the State diverted spent LWR fuel the lead-time for plutonium separation would be considerably longer than three months. Here, the question could be asked, what if there *was* a reprocessing plant, which the Agency failed to find? How much confidence can we have that if such a plant existed it would be found? If there was a failure in this regard, the diverter could have up to 12 months to carry out the diversion scenario—though unannounced inspections would present the possibility of detection earlier than 12 months, a risk the diverter would have to take into account.

Surveillance

The other area of possible concern is the removal of camera surveillance, leading to a loss of “continuity of knowledge” (COK). How serious is this? A number of points are relevant here. Under classical safeguards surveillance was seen as a less intrusive (and less expensive) alternative to reverifying the contents of spent fuel ponds every three months—this consideration is not relevant when quarterly interim inspections are discontinued. The use of surveillance has been neither trouble free nor entirely effective. Loss of COK, from a variety of causes, is common—and indeed for this

reason in the late 1980s/early 1990s there were calls from some of the Agency's Operations Divisions to replace surveillance with scheduled reverification of spent fuel ponds.

Recently, critical study of surveillance films/tapes within the Agency has shown that surveillance results are not as clear as commonly thought—in many cases images are not sufficiently definite for inspectors to be certain about the nature of all the activities in a pond (especially activities under water). As one aspect of this, it is recognised that current surveillance approaches do not adequately address the “pin exchange” diversion scenario. Surveillance therefore is not necessarily a case of “seeing is believing”—surveillance is important for particular applications but should not be considered as indispensable across the board.

Pin exchange is an interesting illustration of the changes possible under integrated safeguards. Classical safeguards do not address this scenario effectively—current surveillance approaches are not adequate, and reverification in the event of loss of surveillance is directed only at entire fuel assemblies. The development of more rigorous and more easily-applied NDA measures would be a more effective approach than maintaining surveillance. On the other hand, as a consequence of the assurance of the absence of undeclared reprocessing gained through strengthened safeguards measures, there is also assurance that undeclared pin exchange is not occurring.

Towards “risk-informed” safeguards

The above discussion, it can be argued, approaches the issues the wrong way round, by looking at aspects of verification *method*, rather than the *need* for verification (i.e. assessment of *risk*). The consequences of change are best appreciated in context—how significant is the diversion risk posed by LWR spent fuel? Apart from the aspects that have been discussed—the time and effort involved in separating plutonium from spent fuel, and the risk of detection—another factor which should not be overlooked is the quality of plutonium available from this source.

Without getting into a detailed discussion of the contentious subject of plutonium isotopics, there is no doubt that the closer plutonium is to *weapons grade* the more attractive it will be for explosive use. It is debatable whether a diverter, with no nuclear weapons experience, would take the risk of basing a weapons program on *reactor grade* plutonium—though prudence dictates a safeguards approach sufficiently rigorous to ensure such material does not gain attractiveness by virtue of ready availability. On the other hand, where holdings of relatively low burnup plutonium exist—such as initial core loads (which can be close to weapons grade)—there may be a case for more intensive safeguards on such material.

Of course, if there is high assurance of the absence of undeclared reprocessing, more intensive safeguards would not be necessary. On the other hand—applying “defence in depth” principles—it might be desirable to consider doing more in some situations. In place of the uniform, “one size fits all”, approach that characterises classical safeguards, integrated safeguards provide the opportunity for flexibility, to tailor safeguards implementation to more appropriately reflect the risk involved. The challenge is to design safeguards approaches that make the most of this opportunity, meeting effectiveness and efficiency objectives.

A final observation: the performance of the classical safeguards system has never been perfect—the Agency regularly falls short of the attainment goals it sets for performance evaluation purposes (failure of surveillance systems being one contributing factor). Nonetheless, the Agency has still been able to reach positive safeguards conclusions, based on the totality of information it has available. Two conclusions can be drawn from this: clearly the full performance of classical safeguards procedures as currently prescribed is not essential; and the qualitative assessments used to compensate for shortfalls

in safeguards performance will be substantially enhanced by the structured framework and improved capabilities introduced with strengthened/integrated safeguards.

5. CONCLUSIONS

The choices made in the development of integrated safeguards do not represent a move away from a perfect system to a less perfect one. Strengthened and integrated safeguards address inadequacies in classical safeguards and introduce substantial new capabilities. Importantly, integrated safeguards provide the opportunity for safeguards effort to more appropriately reflect proliferation risk, rather than being determined by the number of facilities and quantities of material. Rather than focus on changes in routine inspection effort, one should evaluate integrated safeguards as a whole, taking into account how the various components of the safeguards system complement and reinforce each other.

The widespread establishment of integrated safeguards is a long-term program—the approaches and methodologies are still at an early stage, and the Agency’s capabilities will strengthen from the ongoing effort into developing new approaches and technologies, and from practical experience. This is reflected in the policy position taken by the Agency, that integrated safeguards are iterative, with ongoing refinement to be expected.

Given the conditions to be met before a State qualifies for integrated safeguards, the slow rate of Additional Protocol conclusions, and the fact that none of the States of proliferation concern have indicated an intention to sign Protocols any time soon, it is likely to be some years before integrated safeguards will be put under serious test. Concern at this stage that integrated safeguards could fail is, to say the least, premature.

Needless to say, it is important that if such States *do* conclude Protocols, and if they are able to satisfy the various conditions for the introduction of integrated safeguards, integrated safeguards should be sufficiently robust to provide the assurance required by the international community regarding their observance of non-proliferation commitments. Even for States that currently are exemplary members of the non-proliferation regime, it must be recognised that over time political circumstances can change—reinforcing the conclusion that integrated safeguards must be effective in practice as well as theory. Accordingly, it is important to keep progress and performance in integrated safeguards under critical review, in order to identify and remedy any areas of weakness.

Supporters of the safeguards strengthening program can make constructive contributions in a number of areas—supporting the Agency’s program of development in strengthened and integrated safeguards, and encouraging and assisting other States in the conclusion of new Protocols. It is also essential to ensure a realistic basis for the Agency’s safeguards budget—here, the efficiencies that can be delivered by integrated safeguards are a key element in securing the necessary political support.

Undoubtedly achieving the necessary effectiveness from strengthened and integrated safeguards presents a number of challenges—but the potential benefits of integrated safeguards require the safeguards community to give this effort our full support.