Nuclear Safeguards - A System in Transition

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SUMMARY "Classical" safeguards have a strong emphasis on nuclear materials accountancy, and are primarily concerned with verifying nuclear activities as declared by the State – what has been termed the correctness of States' declarations. Following the Gulf War, failure to adequately address the possibility of undeclared nuclear activities – the issue of the completeness of States' declarations – has been recognised as a major shortcoming in the classical safeguards system, and major changes are in progress to strengthen the IAEA's capabilities in this regard. Agreement has been reached on a Model Protocol substantially extending the IAEA's authority, and there has been good progress in developing the new approaches and technologies required to ensure this authority is used effectively. IAEA safeguards are undergoing a major transition, towards greater emphasis on information collection and analysis, diversity of verification methods, incorporation of more qualitative judgments, and improved efficiency. These changes present major challenges to the IAEA and to the international community, but the end result will be a more effective safeguards system.

1. INTRODUCTION

Nuclear safeguards are a key element in international action against the spread of nuclear weapons. Safeguards are directed at the verification of peaceful use commitments, given by States through international agreements to use nuclear materials and technology for exclusively peaceful purposes.

The overwhelming majority of States have renounced nuclear weapons - recognising that the possession of these weapons would threaten, rather than enhance, their national security – and have entered into various treaty commitments to use nuclear materials and technology for exclusively peaceful purposes. The most important of these treaties - because it is almost universal - is the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

For most States the political commitment against acquisition of nuclear weapons has been carefully reached and is strongly held. Their observance of treaty commitments does not depend on the deterrent effect of verification activities. Nonetheless, it is an important maxim of international arms control to "trust, but verify". The establishment of a credible verification mechanism to provide confidence that all parties are honouring their treaty commitments plays a vital part in reinforcing those commitments.

Broadly, safeguards may be described as a complex system of declarations by States, verified by technical measures such as inspections and evaluations, undertaken principally by the International Atomic Energy Agency (IAEA). It should be emphasised that the task of safeguards is not prevention, except in so far as risk of discovery may act as a deterrent to a would-be proliferator. The IAEA is not an international policeman. Rather, the political objective of safeguards is to exercise a positive influence on the behaviour of States: by providing assurance to reinforce non-proliferation commitments; and by deterring non-compliance through the risk of timely detection. Importantly, safeguards serve to assist States who recognise it is in their own interest to demonstrate their compliance to others. Thus safeguards are a vital confidence-building measure in their own right, as well as being a major complement to the broader range of international confidence-building measures.

Safeguards are complemented by other important measures such as: export controls on nuclear items; national intelligence activities; and political incentives and sanctions.

1.1. The Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

The NPT is the centrepiece of the international nuclear non-proliferation regime. The Treaty was concluded in 1968 and entered into force in 1970. It

is now almost universal, with only four States remaining outside the NPT or equivalent non-proliferation commitments. Of these, three (Israel, India and Pakistan) have unsafeguarded nuclear facilities (the fourth, Cuba, has safeguards on all its nuclear activities).

The NPT has been essential to establishing the conditions under which a general renunciation of nuclear weapons has been possible. It has done this by:

- providing a legal framework within which States can express their commitment to use nuclear energy for exclusively peaceful purposes; and
- providing a credible verification mechanism, IAEA safeguards.

The key provisions of the NPT can be outlined as follows:

- Nuclear-weapon States (NWS) agree not to assist any non-nuclear-weapon State (NNWS) to acquire nuclear weapons.
- NNWS agree not to acquire nuclear weapons or other nuclear explosive devices, and to accept IAEA safeguards on all their current and future holdings of nuclear material (what are termed "full-scope" safeguards).
- All Parties agree to cooperate in the peaceful uses of nuclear energy - but not to supply nuclear items to a NNWS unless under safeguards.
- All Parties agree to pursue nuclear disarmament, and complete and general disarmament.

1.2. IAEA Safeguards

The current, "classical", system of IAEA safeguards has its origins in the verification of peaceful use conditions applied by nuclear suppliers in the 1950s and 1960s. Verification activities were undertaken at supplied facilities, or facilities using supplied materials. Initially verification was undertaken on a bilateral basis, but following the establishment of the IAEA in 1957 this activity was gradually transferred to the Agency. These early safeguards measures were "facility-specific", and facility-specific safeguards agreements still apply to States outside full-scope safeguards, ie the NWS and the four non-NPT States.

Following conclusion of the NPT in 1968, a new safeguards system was developed, to give effect to the commitment by NNWS to accept full-scope safeguards, ie safeguards on all their current and future holdings of nuclear material. This is what has become known as the "classical" safeguards system.

Classical safeguards are based on the verification of nuclear materials accountancy. Nuclear facility operators are required to maintain, under the supervision of each country's national safeguards authority, detailed accounting records of all movements and other physical transactions involving nuclear material. IAEA inspectors regularly visit nuclear facilities to verify the completeness and accuracy of this documentation through activities such as checking inventories, sampling and other analytical procedures.

Nuclear material accountancy is complemented by other techniques such as *containment* (eg the placement of special seals on nuclear items), and *surveillance* (eg the operation of automatic cameras), to maintain *continuity of knowledge* between inspections. With the increasing complexity of modern nuclear facilities, especially large-scale bulk-handling facilities such as reprocessing plants, use of containment and surveillance is assuming greater importance. Containment and surveillance, in the form of remote monitoring systems, are also becoming increasingly important as a way of improving both the cost-efficiency and the effectiveness of safeguards.

Classical safeguards are directed primarily at the detection of diversion, ie the undeclared removal of nuclear material from safeguards coverage. The IAEA has not been expected to look for undeclared nuclear activities, except as these would be revealed through diversion.

Prior to the 1991 Gulf War, it was thought the establishment of a self-contained capability to produce nuclear weapons material entirely separate from a State's declared nuclear program would be too large and difficult an undertaking for most would-be proliferators. It was also thought that any attempt to establish clandestine military-capable facilities (plutonium production reactors and reprocessing plants, or enrichment plants) would be readily detected by national intelligence activities – in which event it was considered the duty of the States concerned to bring the matter to the attention of the international community. Thus diversion of nuclear material from facilities under safeguards was considered the more plausible scenario, and it was thought the existence of any clandestine nuclear activities would be revealed through detection of diversion.

The situation discovered in Iraq however indicates the more likely course for a proliferator: not only is diversion of safeguarded material unattractive because of the likelihood of detection, but in fact there are limited opportunities to divert *weapons grade* materials because these are unusual in civil programs. Accordingly, a State pursuing a weapons program would need to establish nuclear upgrading

capabilities - enrichment or reprocessing. If the State is able to do this clandestinely, it is unlikely to risk detection by diverting safeguarded material.

2. STRENGTHENING OF THE SAFEGUARDS SYSTEM – THE ISSUE OF UNDECLARED NUCLEAR ACTIVITIES

Events in Iraq have shown that for safeguards to continue their key confidence-building role, it is essential to adequately address the issue of detection of undeclared nuclear activities. This is the major focus of current safeguards development. At the same time, safeguards must become more efficient, so as to manage an expanding workload within budget constraints. It can be seen that new techniques, such as remote monitoring (CCTV and other systems which transmit encrypted data to the IAEA by phone or satellite) and environmental analysis, offer both improved efficiency (through reducing inspection time) and greater effectiveness.

Efforts to strengthen safeguards have proceeded at two levels, the technical and the institutional. Technical efforts, to develop the technology and the methodology to address the risk of undeclared nuclear activities, have made good progress, though there is much more to be done. At the institutional level, in 1997 the IAEA Board of Governors agreed the text of a Model Protocol which is to be used as the basis for each State to conclude an individual Protocol additional to its existing safeguards agreement, giving the IAEA substantially increased authority.

2.1. The Model Protocol

Key elements of the strengthened safeguards regime, of which the Model Protocol is a central element, are:

- The IAEA is to receive considerably more information on nuclear and nuclear-related activities, including through an "Expanded Declaration" by each State and widened reporting requirements. This includes, *inter alia*, information on nuclear-related R&D activities, production of uranium and thorium, production of heavy water and graphite, and nuclear-related imports and exports.
- IAEA inspectors have rights of complementary access: to anywhere on a nuclear site; to various locations included in the Expanded Declaration; and to locations elsewhere in the State to carry out environmental sampling and other verification measures.
- Access on nuclear sites can be short-notice, 2 hours or less, if carried out with a routine inspection.
- The IAEA can employ environmental sampling, to look for indications of undeclared nuclear activities anywhere in the State. Initially this is to be "location-specific", but the Protocol recognises the possibility of using "wide-area" environmental sampling, looking for nuclear indications over extensive areas, once the efficacy of this technique has been established.
- Information analysis and the conduct of complementary access are to be used to establish a State Evaluation, that is, the IAEA will apply its safeguards approaches and draw its conclusions on the basis of the State as a whole.

Although the IAEA can implement some aspects of strengthened safeguards without reliance on the Additional Protocol, the Protocol is central to efforts to establish more effective safeguards, and it is imperative that it be brought into general application without delay. The Protocol, in conjunction with the basic NPT safeguards agreement, is a consolidated statement of the contemporary "Agency safeguards system", and should be seen as the standard for full-scope safeguards pursuant to the NPT. Australia is urging other States to conclude their Protocols with the IAEA as soon as possible, and it is hoped there can be a substantial number in place by the time of the NPT Review Conference in April 2000.

3. INTEGRATED SAFEGUARDS

Although implementation of strengthened safeguards is still at an early stage, attention is already focusing on merging classical safeguards and safeguards strengthening measures to yield an optimally effective and cost-efficient outcome. This is known as safeguards integration, and is recognised as a high priority.

The development of safeguards aimed at undeclared activities has obvious implications for the application of classical safeguards aimed at diversion from declared inventories: in the case of natural and low enriched uranium, and plutonium in spent fuel, diversion is plausible only if the State has the capability of upgrading diverted material by enrichment or reprocessing. If it were possible to derive an acceptable level of assurance that the State has no undeclared enrichment or reprocessing capability, diversion of these materials would largely cease to be an issue.

Of course some of the benefits of integration will be achieved only in the long-term: eg at this stage the technical means and procedures necessary to demonstrate a high degree of assurance of the absence of undeclared enrichment and reprocessing have yet to be established - and indeed absolute assurance is unlikely to be ever achieved. Thus an

appropriate level of assurance of non-diversion will be required from classical safeguards for the foreseeable future. That level will be high for materials that require minimal downstream processing and so offer limited opportunity for detecting downstream activities (eg highly enriched uranium, separated plutonium). For less sensitive materials, the appropriate level can be determined in the light of progress with strengthened safeguards.

An important part of integrated safeguards will be the evaluation of the State as a whole, both in reaching conclusions about a State's performance of its treaty commitments, and in developing the safeguards approaches required to reach these conclusions. The classical safeguards system has been characterised by a uniform approach to safeguards implementation – although existing safeguards agreements provide for flexibility, taking account of factors such as the characteristics of the State's nuclear fuel cycle, its international interdependence, and the effectiveness of the national safeguards system, in practice opportunities for flexibility have not been used to advantage. Integrated safeguards are to be applied to the State as a whole, and no two States will have identical circumstances. For optimal effectiveness and cost-efficiency, differences between States will need to be taken into account. This will have to be done in a transparent way, using objective criteria, to avoid any suggestion of discrimination.

4. AUSTRALIA'S ROLE

Australia, through ASNO, has been closely involved from the outset in the development of strengthened, and now integrated, safeguards. Our involvement has taken a number of forms, including:

- development of new safeguards technology and methodologies under Australia's formal Support Program of assistance to the IAEA;
- participation in various experts groups and meetings advising the IAEA;
- field trials of new safeguards methods in Australia – one of the most recent examples being facilitation of a visit to the Ranger uranium mine as part of the development of verification techniques applicable to uranium production;
- we played a major role in the negotiation of the Model Protocol, and in September 1997 Australia became the first country to conclude a Protocol based on this model, reflecting the Australian Government's strong support for the strengthening of safeguards.

5. CHALLENGES AHEAD

The critical challenge for the safeguards community is to establish a credible capability to detect undeclared nuclear activities. Success in achieving this is much harder to measure than for verifying declared material, and the assurance derived will be less certain. While it is important to avoid over-expectation, however, we must take care not to under-estimate what can be achieved.

It is vital that the IAEA is able to present authoritative conclusions about the absence of undeclared activities in a State. If States have no clear conclusions from the IAEA they may act on unsupported suspicions about the perceived proliferation activities of others. If that were to cause some to reconsider their commitment to non-proliferation the consequences for the non-proliferation regime would be severe.

While the detection of undeclared nuclear activities will not be easy, the IAEA will be better equipped for this task than individual States. The IAEA will have at its disposal its own expertise together with substantial information resources, extensive inspector access, and increasingly sophisticated technology. It will be important however that States assist the IAEA where they can, eg by providing intelligence information.

For States to derive the necessary degree of confidence from the IAEA's new safeguards activities, they need to be satisfied that the IAEA has done all that is reasonable and prudent in each situation. Some important factors in this regard are expected to include:

- a clearly established methodology for how the IAEA collects and analyses information, the extent to which it pursues specific matters, and the way it exercises its inspection and complementary access rights;
- a quality assurance process to ensure a satisfactory standard of performance across all relevant areas;
- a rigorous process of evaluation, which would take into account not only safeguards performance as such, but would put this in a wider context, looking at all the information available to the IAEA relating to the State's non-proliferation credentials;
- all these matters should be documented in guidelines which would be available to Member States.

Some cultural change will be needed in safeguards practice. Classical safeguards have encouraged a rather mechanistic approach to safeguards. Now inspectors need encouragement to be more inquisitive, but still in a rigorous way so that the

international community can have confidence in their findings. The transparency and cooperation of States are further essential elements of the strengthened regime. The international community will have to view any lack of cooperation, particularly where IAEA access is obstructed, very seriously. Overall there is room for optimism that, as strengthened safeguards develop and experience grows, they will make a major contribution to international confidence-building.

6. CONCLUSIONS

The present non-proliferation regime - based on peaceful use commitments verified by IAEA safeguards - has served the international community well. The overwhelming majority of States have renounced nuclear weapons - the existence of a credible verification system being an essential factor in their decision. The regime has thus created conditions favourable to international peace and security, under which most States have been able to benefit from peaceful applications of nuclear technology.

The IAEA's safeguards system is an evolutionary, not a static, system. Safeguards practice has undergone substantial refinement since the conclusion of the NPT. Now the evolution of safeguards is entering a period of substantial change, from a mainly quantitative system, which provides a high degree of assurance about declared nuclear activities, to a more qualitative system, which is addressing a much less tangible area - the absence of undeclared nuclear activities.

With the extension of safeguards into the area of assurance against undeclared nuclear activities, it is natural to anticipate that the safeguards system will start to evolve in new directions. Some of the themes in this transition are expected to include:

- a shift in emphasis from declared inventories and flows of nuclear material at individual facilities, towards safeguards approaches based on evaluation of the State as a whole;
- a move from mechanistic uniformity in safeguards implementation to a more flexible approach, which takes account of the differences between States' nuclear fuel cycles and other factors;
- a balance between classical and new safeguards measures, achieved by integration of the two, with the exact balance likely to vary with the circumstances of each State;
- diversification of detection methods, introducing methods based upon quite different principles, resulting in a more robust system;
- greater emphasis on transparency of national nuclear programs.

Under classical safeguards the IAEA's methods were well understood - if the IAEA was satisfied about the performance of a particular State, most States were prepared to accept the IAEA's conclusions. With the new safeguards system, which incorporates a much greater degree of judgement, however, the degree of assurance which States can derive will depend very much on their understanding of, and confidence in, the IAEA's methodologies and the verification activities actually undertaken with respect to particular States.

The IAEA faces a considerable challenge not only in establishing methodologies which are as technically effective as possible, but in reporting on its performance in a way which has necessary credibility and provides sufficient assurance to meet the political objectives of the safeguards system. It is of critical importance to the international community to have the most effective safeguards system, and States must be prepared to support, and to contribute constructively to, the process of ongoing development which this will require.