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Nuclear safeguards: developments and challenges

John Carlson

For most states the commitment not to acquire nuclear weapons has been carefully made and is strongly held. Observance of their legal obligations under the 1968 Nuclear Non-Proliferation Treaty (NPT) or other treaties which foreclose the nuclear weapon option 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—in this case safeguards applied by the International Atomic Energy Agency (IAEA)—to provide confidence that all parties are honouring their treaty obligations plays a vital part in reinforcing such commitments.

Traditionally, IAEA safeguards have been primarily concerned with verifying nuclear activities declared by the state—that is, determining the *correctness* of states' declarations. Failure to address adequately the possibility of *undeclared* nuclear activities being conducted—the issue of the *completeness* of states' declarations—has, since the 1990–91 Gulf War, been recognised as a serious shortcoming in the classical safeguards system. As a consequence, IAEA safeguards are undergoing a major transition towards greater emphasis on information collection and analysis, diversity of verification methods, incorporation of more qualitative judgements and improved efficiency. These changes present considerable challenges to the IAEA and the international community, but the result will be a more effective safeguards system.

A successful reform of 'classical' safeguards will bolster global confidence in compliance with NPT commitments, and is therefore a crucial element in support of efforts to prevent the spread of nuclear weapons.

The system of safeguards[1] developed to give effect to full-scope safeguards commitments under the NPT is commonly described as the 'classical' system. It is characterised by:

- an emphasis on the verification of nuclear materials accountancy, using containment and surveillance as complementary measures; and
- a focus, inherited from pre-NPT safeguards, on the concept of diversion. This means that the removal of nuclear material from *declared* facilities or locations needs to be detected.

Before the strengthened safeguards reforms were initiated, the IAEA had not been expected to look for *undeclared* nuclear activities, unless these were revealed through the agency's detection of diversion. While the IAEA has the right of *special inspection,* which can be applied to undeclared as well as declared locations, this right had never been exercised. It was generally considered that it should not be invoked unless there was substantial evidence of a safeguards breach.

The discovery of Iraq's clandestine uranium enrichment and nuclear weapons programme, however, indicated the more likely course for a proliferator: not only is diversion of safeguarded material unattractive because of the likelihood of detection, but there are limited opportunities to divert *weapons grade* materials because these are unusual in civil programmes. Accordingly, in most circumstances a state pursuing a weapons programme 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 nuclear material covered by safeguards.

Strengthening the safeguards system

One of the lessons learned from the Iraq experience is that, if safeguards are to continue their key confidence-building role, it is essential that the issue of detection of undeclared nuclear activities be addressed. At the same time, safeguards must become more efficient so that the IAEA is able to manage an expanding workload within budget constraints.

Shortcomings in classical safeguards

The principal weakness in standard safeguards agreements (INFCIRC/153 agreements[2]) is the limitation they place on the IAEA's access for routine safeguards inspections. Only declared nuclear facilities (and certain *locations outside facilities*) may be inspected, and even within facilities only defined *strategic points* are open to inspection. Iraq was able to take advantage of this restriction: it was discovered

Some facts and figures

In 2000 there were 71 states, plus Taiwan, with significant nuclear activities.[A] Seventy of these states have safeguards agreements with the IAEA:[B]

- 61 have comprehensive safeguards agreements[C] pursuant to the NPT, or its equivalent, applying safeguards to all existing and future nuclear activities and material
- four states (Cuba, India, Israel and Pakistan) have 'INFCIRC/66'-type safeguards agreements,[D] applying safeguards only to designated facilities and material (in the case of Cuba, safeguards apply to all existing nuclear facilities and material, and the country has concluded an Additional Protocol for the application of strengthened safeguards)
- the five nuclear weapon states (NWS)[E]—China, France, Russia, the UK and the US—have 'voluntary offer' agreements applying safeguards to designated facilities and material

A further 70 states have concluded safeguards agreements with the IAEA but have no significant nuclear activities. Fifty-four NPT parties have not yet concluded NPT safeguards agreements, as required by the treaty,[F] although three of these have other forms of comprehensive safeguards agreements, for example, under the 1967 Treaty of Tlatelolco. As at 31 December 2000 the following were under IAEA safeguards:

- 902 facilities and 'locations outside facilities'
- 726 tonnes of plutonium—72 tonnes were unirradiated, including 3.3 tonnes in fresh MOX[G] fuel; the amount of spent fuel discharged from safeguarded power reactors in 2000 was 37 tonnes
- 21.8 tonnes of highly enriched uranium (HEU), including 14.4 tonnes of unirradiated HEU
- 48,974 tonnes of low enriched uranium (LEU)
- 91,686 tonnes of source material (mostly natural uranium)

In 2000 the IAEA had 217 safeguards inspectors. The total staff of the IAEA's Department of Safeguards was 507. In addition there were 59 temporary staff and 20 experts provided free by member states. The IAEA performed 2,467 inspections at 584 facilities and locations outside facilities, representing 10,264 person-days of inspection effort in the field.

In 2000 the IAEA continued to operate with a zero real growth regular budget allocation. The safeguards expenditure from the regular budget was US$70.6 million (around 36 percent of the IAEA's total budget). In addition, member states contributed extra-budgetary funds of US$10.3m, bringing overall safeguards expenditure to US$80.9m.[H]

NOTES

A Significant nuclear activities are defined by the IAEA as comprising a research reactor and/or other nuclear fuel cycle activities.

B A further state, Georgia, has an NPT safeguards agreement which has been signed but not yet brought into force. Georgia's only nuclear facility, a research reactor, was shut down some years ago.

C 'Comprehensive safeguards' is synonymous with 'full-scope' safeguards.

D So called because the model text is set out in IAEA Information Circular 66 of 1965.

E The NWS are those recognised by the NPT as possessing nuclear weapons prior to 1 January 1967 (Article IX.3 of the NPT).

F Article III.4 of the NPT requires the conclusion of safeguards agreements within 18 months of accession.

G Mixed oxide—fuel comprising a mixture of plutonium and uranium oxides.

H In US dollar terms the 2000 safeguards budget was some 11 percent less than that of 1999 due to exchange rates, specifically the strong dollar relative to the Austrian schilling, the currency in which the IAEA operates (its headquarters are located in Vienna).

after the Gulf War that some clandestine activities had been undertaken at safeguarded sites away from the strategic points where agency inspectors were able to go. A related deficiency was the lack of any mechanism through which the body of information which was accumulating regarding Iraq's interest in nuclear weapons could trigger additional verification activity.

Addressing these shortcomings

Since the early 1990s the IAEA, with the assistance of member states, has been engaged in a major undertaking to strengthen and streamline the safeguards system. From the outset, it was recognised that under a strengthened safeguards system the IAEA would need:

- greater rights of access, both at declared nuclear sites and to other places in the state—but, unlike special inspections, on a non-accusatory, hence non-confrontational, basis;
- greater capabilities to acquire and analyse information; and
- deployment of new technologies, particularly environmental analysis.

The principal objectives of this work are to:

- shift the focus from declared inventories and flows of nuclear material at individual facilities towards safeguards approaches based on evaluation of the state as a whole;
- provide credible assurance of the absence of undeclared nuclear material and activities in the state; and
- diversify the methods of detection, resulting in a more robust safeguards system.

By 1995 the IAEA and member states had developed a detailed outline of strengthened safeguards measures. There was general acceptance that certain of the measures proposed (termed 'Part 1' measures) could be carried out under existing safeguards agreements. The IAEA Board of Governors endorsed the implementation of these in March 1995, in time for the NPT Review and Extension Conference in April.

For certain other measures (termed 'Part 2' measures), additional legal authority was necessary and a new legal instrument, complementary to existing safeguards agreements, was negotiated. This took the form of a model Additional

Protocol, to serve as the basis for each state to conclude an individual protocol additional to its safeguards agreement with the agency. The text of the model Additional Protocol (designated INFCIRC/540) was agreed by the Board of Governors in May 1997.

Advances in safeguards technologies

The development of new techniques and equipment for safeguards falls under three broad headings: the introduction of entirely new technologies; improvements in existing technologies; and the application of new technologies to established tasks. Major areas of development include:

Environmental sampling This technique is based on the fact that nuclear activities release small particles of material and/or gases. These releases can be detected at some distance from their point of origin. Samples for analysis can be obtained from swiping building surfaces, such as the walls of laboratories, or from the natural environment—air, water, soil and vegetation. Environmental analysis proved to be highly effective in unravelling Iraq's clandestine nuclear programme, and since then analytical capabilities have substantially improved.

While the IAEA is currently using environmental sampling on a location-specific basis, studies are being undertaken into the feasibility of 'wide-area' environmental sampling, looking for indications of nuclear activities over extensive areas, for example, through sampling the air and river water. Practical experience has been gained with this technique in Iraq. At present, there are technical aspects to be overcome, including cost, but this could be a valuable technique for the future, either generally or in particular regions.[3]

Satellite imagery The IAEA is studying the use of commercially available satellite imagery, *inter alia* as a means of confirming information provided by states (for instance, in the Expanded Declaration: see below), and indeed has begun the routine use of imagery. It is receiving expert assistance from several states and is establishing its own imagery unit. Satellite imagery has considerable potential for the detection of undeclared facilities. As satellite techniques become more widely used for commercial and scientific purposes the costs are decreasing substantially.

Remote monitoring This technique involves the transmission of surveillance images (for example, from video cameras) or other data (for example, from electronic seals and sensing instruments) in digital form directly to IAEA headquarters via the public telephone network, the Internet or satellite. Use of remote monitoring can result in substantial reductions in inspection effort, as well as making safeguards information available on a much more timely basis (in real time or near-real time).

The strengthened safeguards system

Key aspects of the strengthened safeguards regime, of which the Additional Protocol is a central element, are as follows: 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; IAEA inspectors have rights of complementary access to any part of a nuclear site, and to a wide range of other locations, as discussed below; and the IAEA can employ environmental sampling, initially on a 'location-specific' basis, but the Additional Protocol recognises the possibility of using 'wide-area' environmental sampling once its efficacy has been established.

State evaluation

Central to the strengthened safeguards concept is the state evaluation, a comprehensive analysis by the IAEA of all the information available to it regarding the nuclear programme of each state. A substantially increased amount of information is available to the IAEA as a result of implementing strengthened safeguards measures, including: information supplied by the state itself, under its safeguards agreement and its additional protocol, and voluntarily; information from the IAEA's verification activities, including inspections and complementary access, and information from other areas of the IAEA; open-source and related information; and information such as export data provided by third parties.

Through the state evaluation process the IAEA seeks to establish a thorough understanding of a state's nuclear and nuclear-related activities, including the consistency of declared activities with the nuclear programme as a whole, and whether there are questions and inconsistencies requiring further explanation. The analytical framework includes the use of a 'physical model' of the nuclear fuel cycle, which characterises all the processes for converting nuclear source material to

weapons-usable material and identifies indicators for each process, in terms of the equipment and the nuclear and non-nuclear material involved. An 'acquisition path analysis' is undertaken of the means available to the state for acquiring fissile material. All these matters are taken into account in reaching a conclusion about the absence of undeclared nuclear material and activities in the state.

Evaluations for each state are performed by the responsible state evaluation group, which is headed by a member of the relevant Operations Division and also has experts from support divisions. Completed state evaluation reports are reviewed by the interdepartmental Information Review Committee. Each state evaluation is the subject of ongoing review—the initial analysis is used to identify areas requiring further clarification, including through the conduct of safeguards activities such as complementary access and environmental sampling, and the results of these activities are fed back into the evaluation process.

Additional information

The Additional Protocol requires additional reporting, both initially in the Expanded Declaration and subsequently through regular updates. The goal is to have a more comprehensive picture of each state's fuel cycle, including the front end and back end of the fuel cycle. Principal matters covered include:

- detailed information on activities (past and present) at nuclear sites;
- capacity and annual production of uranium mines and uranium and thorium concentration plants;
- holdings, imports and exports of uranium or thorium which has not reached the composition and purity suitable for nuclear processing;
- holdings and uses of nuclear material exempted from safeguards;
- nuclear fuel cycle-related research and development (R&D) not involving nuclear material—examples might include development of laser isotopic separation technology using stable isotopes, or development of components for enrichment equipment;
- the manufacture of: components for enrichment equipment; zirconium tubes; nuclear-grade graphite; flasks for irradiated fuel; construction of hot cells; and manufacture or upgrading of heavy water; and
- the import and export of specified equipment and non-nuclear material.[4]

While these items go beyond the scope of standard (INFCIRC/153-type) safeguards agreements—which apply to nuclear material which has reached 'the starting point of safeguards'[5]—they are clearly highly relevant to nonproliferation commitments, and the information gleaned is important for establishing the absence or otherwise of undeclared nuclear material and activities. The inclusion of this information addresses significant omissions from the coverage of classical safeguards.

Complementary access

Complementary access—that is, access by IAEA inspectors to places not covered by safeguards inspections—is a measure introduced through the Additional Protocol to safeguards agreements, and is an essential part of the strengthened safeguards regime. The Additional Protocol provides for complementary access:

1 as of right, on a 'selective basis', to establish the absence of undeclared nuclear activities at nuclear sites, and certain nuclear-related locations such as uranium mines and concentration plants, and holdings of uranium and thorium and exempted nuclear material;
2 where necessary to resolve a question relating to the correctness and completeness of information, or to resolve an inconsistency relating to that information, at certain other nuclear-related locations (such as those involving R&D without nuclear material or the production of nuclear-related materials and components) and other places in the state.

In the event of a question or inconsistency (at locations encompassed by 2 above), the IAEA must give the state the opportunity to resolve the matter before requesting access, unless delay would be prejudicial. The protocol provides that if the state is unable to provide access it shall make every reasonable effort to satisfy IAEA requirements by other means.

Guidelines have been developed for the exercise of complementary access, covering the selection of locations covered by 1 above, and to determine whether access is warranted in the event of questions and inconsistencies (2 above). In either case, complementary access is regarded as a routine aspect of additional protocol implementation. As a formal matter, complementary access is initiated by a written request from the relevant Operations Division Director.

Integrated safeguards

The next major stage in the evolution of IAEA safeguards is 'integrated safeguards'. These do not represent a separate safeguards system, but rather a rationalisation of classical and strengthened safeguards measures—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. The efficiencies possible under integrated safeguards are essential to fulfilling the commitment of the IAEA Secretariat that the strengthening of safeguards will be budget-neutral over time.[6]

Under classical safeguards, the level of verification effort is determined on the assumption that clandestine nuclear activities may exist. Thus, the determination of timeliness for the detection of diversion of spent fuel incorporates the assumption that an undeclared reprocessing plant may exist for processing diverted material immediately after diversion. Thus, the inspection frequency for spent fuel at light water reactors (LWRs)—three months—corresponds to the time required to reprocess spent fuel and manufacture the separated plutonium into weapon components (the 'conversion time').

The basis of integrated safeguards is that classical and strengthened safeguards are mutually reinforcing and some classical safeguards measures may become redundant when strengthened safeguards are fully implemented. As strengthened safeguards establish credible assurance of the absence of undeclared nuclear activities, a corresponding reduction is possible in the intensity of classical safeguards effort. For example, 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 establish such a facility, and this can be reflected in a reduced inspection frequency for spent fuel, from once every three months to, say, once every year.

The state-level approach

A key feature of integrated safeguards is the application of a state-level approach. Both evaluation and (particularly) safeguards implementation are undertaken on the basis of the state as a whole. This is in contrast to classical safeguards which proceed on a facility-by-facility basis, in which inspection effort is a consequence

of the categorisation and amount of nuclear material at each facility. Integrated safeguards allow for greater cost efficiency by taking account of state-specific circumstances. Rather than treat all types of facility identically regardless of the state in which they are located, facilities can be considered in their broader contexts, such as the place of each facility in the state's fuel cycle and the possible fissile material 'acquisition paths' available to the state.

Conditions for the introduction of integrated safeguards

The IAEA 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 involves two stages, 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 a state—would be based on the following conditions:

- the state has concluded an additional protocol;
- the state has complied in a timely manner with the requirements of its safeguards agreement and additional protocol;
- the IAEA has conducted a comprehensive state evaluation;
- the IAEA has concluded that declared nuclear material has not been diverted;
- the IAEA 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.

Implementation of integrated safeguards

As of mid-October 2001, the IAEA has introduced integrated safeguards in only one state, Australia, which was the first to bring an additional protocol into effect,

in December 1997. Australia was also the first to pass through the requisite evaluation cycle to qualify for integrated safeguards. Integrated safeguards have been in effect in Australia since January 2001. The development of integrated safeguards is an iterative process, and experience gained in Australia can be expected to be useful in the implementation of integrated safeguards elsewhere. The first application of integrated safeguards to a large-scale nuclear programme is expected to be in Japan.

Challenges ahead

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.

The greatest single challenge—critical to the credibility of the safeguards system—is to address the issue of undeclared nuclear activities effectively. It is vital that the IAEA is able to present authoritative conclusions about the absence of such 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. Such a situation could be detrimental to the nonproliferation regime.

How realistic is it to expect the IAEA to be able to detect undeclared nuclear activities? 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. The difficulties encountered in Iraq in the 1990s, where there was a very intrusive verification regime following the Gulf War, show that this is not easy. On the other hand, compared with individual states, the IAEA 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. It is most important for the agency's work to be complemented through states making available information obtained through national means, including intelligence activities.[7]

Other essential elements in the success of this work will be the transparency of states and their willingness to co-operate with the IAEA. Since the great majority of states will wish to co-operate, the whole-of-state evaluation should thus be easier

and in the final analysis more credible. On the other hand, it can be expected that refusal to co-operate, especially obstructing the exercise of access rights, will be viewed seriously by the international community.

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. Important factors are likely to include: a clearly established methodology for collecting and analysing information, the extent to which the agency 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 the inspectorate; a rigorous evaluation process which would not only take into account safeguards performance but put this in a wider context, looking at all information available to the IAEA relating to the state's nonproliferation credentials; and the documentation of all these matters in guidelines available to member states.

It is essential that the IAEA's conclusions be reported to the international community in a sustainable way. In this regard the agency is exercising due caution. Its conclusions for 2000 included the judgement that:[8]

> In respect of seven States,[9] the Secretariat—having evaluated all the information obtained through activities pursuant to these States' comprehensive safeguards agreements and additional protocols as well as all other information available to the Agency—found no indication either of diversion of nuclear material placed under safeguards or of the presence of undeclared nuclear material or activities in those States. On this basis, 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.

Some cultural change will be needed in safeguards practice. Classical safeguards have led to a rather mechanistic approach to safeguards implementation. Now inspectors need encouragement to be more inquisitive, but in a structured, disciplined way so that the international community can have confidence in their findings. Appropriate training will be an essential part of this change.

Conclusion of Additional Protocols

Although the IAEA can implement some aspects of strengthened safeguards without reliance on the Additional Protocol, the document is central to efforts to establish more effective safeguards, and it is imperative that it be brought into general application without delay. Only in states with the basic NPT safeguards agreement *and* an additional protocol can the IAEA provide comprehensive and credible assurance

Status of Additional Protocols

States with Additional Protocols and date of entry into force

Australia 12 December 1997 **Azerbaijan** 29 November 2000 **Bangladesh** 30 March 2001 **Bulgaria** 10 October 2000 **Canada** 8 September 2000 **Croatia** 6 July 2000 **Ecuador** 24 October 2001 **Ghana** provisional **Holy See** 24 September 1998 **Hungary** 4 April 2000 **Indonesia** 29 September 1999 **Japan** 16 December 1999 **Jordan** 28 July 1998 **Lithuania** 5 July 2000 **Monaco** 30 September 1999 **New Zealand** 24 September 1998 **Norway** 16 May 2000 **Peru** 23 July 2001 **Poland** 5 May 2000 **Romania** 7 July 2000 **Slovenia** 22 August 2000 **Turkey** 17 July 2001 **Uzbekistan** 21 December 1998

NOTES IAEA also applies protocol measures in Taiwan. Information correct as of 31 October 2001.

States with Additional Protocols plus date of signature, or approval by the IAEA Board of Governors [not yet in force]

Andorra 9 January 2001 **Armenia** 29 September 1997 **Austria**[A] 22 September 1998 **Belgium**[A] 22 September 1998 **China** 31 December 1998 **Cuba** 15 October 1999 **Cyprus** 29 July 1999 **Czech Republic** 28 September 1999 **Denmark**[A] 22 September 1998 **Ecuador** 1 October 1999 **Estonia** 13 April 2000 **Finland**[A*] 22 September 1998 **France**[A] 22 September 1998 **Georgia** 29 September 1997 **Germany**[A*] 22 September 1998 **Greece**[A*] 22 September 1998 **Ireland**[A] 22 September 1998 **Italy**[A] 22 September 1998 **Latvia** 12 July 2001 **Luxembourg**[A] 22 September 1998 **Mongolia** 11 September 2001 **Namibia** 22 March 2000 **Netherlands**[A*] 22 September 1998 **Nigeria** 20 September 2001 **Philippines** 30 September 1997 **Portugal**[A*] 22 September 1998 **Russia** 22 March 2000 **Slovakia** 27 September 1999 **Spain**[A*] 22 September 1998 **South Korea** 21 June 1999 **Sweden**[A*] 22 September 1998 **Switzerland** 16 June 2000 **Ukraine** 15 August 2000 **UK**[A*] 22 September 1998 **US** 12 June 1998 **Uruguay** 29 September 1997

NOTES A EU states intend to bring the protocol into effect simultaneously. Countries marked with * have fulfilled their internal processes for entry into force. Information correct as of 31 October 2001.

States with significant nuclear activities[A] that have not signed Additional Protocols

Algeria Argentina[B] **Belarus Brazil**[B] **Chile Colombia Democratic Republic of the Congo Egypt India**[C] **Israel**[C] **Iran Jamaica Kazakhstan Libya Malaysia Mexico North Korea Pakistan**[C] **South Africa Syria Thailand Venezuela Vietnam Yugoslavia**

NOTES A Significant nuclear activities encompass research reactors or other nuclear fuel cycle facilities; B Argentina and Brazil intend to bring the protocol into effect in conjunction with the regional safeguards authority, the Argentine–Brazil Agency for Accounting and Control of Nuclear Material (ABACC); C Non-NPT parties. Information correct as of 31 October 2001.

about the fulfilment of nonproliferation commitments. Clearly, the more widespread the Additional Protocol becomes, the more out of step with NPT commitments will be those states that remain outside strengthened safeguards.

To date the conclusion of additional protocols has been disappointingly slow. As at the end of October 2001 there were only 23 protocols in force. (In addition the IAEA is implementing additional protocol measures in Taiwan). A further 35 protocols had been signed, or approved by the Board of Governors.[10] It is of particular concern that there are 21 non-nuclear weapon states parties to the NPT with significant nuclear activities that have not yet even signed an additional protocol, much less implemented it.

The slow progress has been due in part to the need of many states to introduce complex legislation and administrative arrangements. But some states have not even expressed an intention to adopt a protocol. A number of Middle Eastern states have said that they will conclude additional protocols only when Israel does. This overlooks the fact that strengthened safeguards are an important confidence-building measure that could make a major contribution to reducing tensions between states in the region. The whole process of developing strengthened safeguards was prompted by Iraq's attempt to acquire nuclear weapons and now, in the same region, there are concerns about Iran's future intentions. It is essential to instil in these states an understanding that their national interests are best served by an effective international nonproliferation regime, not by a nuclear arms race. This should make the Middle Eastern states strong supporters of the Additional Protocol.

Some state-specific issues

There have been two serious challenges from within the nonproliferation regime—from Iraq and North Korea—which remain unresolved.

There is no indication that the present Iraqi regime will refrain from attempting to restart its nuclear weapons programme if it has the opportunity. The IAEA is able to perform (annual) routine safeguards inspections, but cannot carry out broader verification activities, as would be permitted under an additional protocol.

North Korea has yet to come into compliance with its safeguards agreement. This is an essential step for the provision of light water reactors (LWRs) under the

1994 Agreed Framework.[11] Currently the IAEA is able to carry out verification activities to monitor the 'freeze' in North Korea's nuclear programme pursuant to the Agreed Framework. However, for the country to come into compliance with its safeguards agreement will require co-operation with the IAEA in establishing the 'initial inventory' of nuclear material to be declared under the agreement. The IAEA successfully conducted a similar exercise in 'nuclear archaeology' when South Africa joined the NPT. It is to be hoped that as North Korea establishes closer relations with the international community it will appreciate the benefits of working with the IAEA on this exercise.

Safeguards resource issues

Budget pressures on IAEA safeguards activities are a continuing problem. The quantities of nuclear material and the number of facilities under safeguards continue to grow, and more of the material and facilities are in the 'sensitive' category (plutonium, enrichment and reprocessing). The trend towards IAEA reliance on extra-budgetary funding (now almost 13 percent of total safeguards expenditure) is continuing. Extra-budgetary funds, to which the US is the largest contributor, have helped alleviate shortages of safeguards equipment and facilitated the replacement of some obsolete equipment. Much of this equipment is essential for improving safeguards effectiveness and clearly should be funded from the regular budget. However, the regular budget allocation for safeguards is insufficient to cover all essential expenditures. Further, although it is hoped that strengthened safeguards can be cost-neutral in the longer term, initially there will be a substantial expenditure 'hump' until the conditions are satisfied for reductions in classical safeguards effort under integrated safeguards approaches.

The safeguards budget allocation is a complex issue, affected by the policies of member states towards the financing of United Nations organisations (most governments have adopted a policy of supporting zero real growth, which at least allows for inflation, or zero nominal growth, which is effectively a diminishing budget), and by the insistence of developing countries that a balance be maintained between the IAEA's expenditure on safeguards and expenditure on technical co-operation. The situation of the safeguards budget is particularly frustrating, considering that the IAEA's safeguards activities benefit the national security of every state. Yet its

safeguards expenditure (US$80.9 million in 2000) is insignificant compared with the funds which governments around the world allocate to national defence.

A further key resource issue, to some extent (although not entirely) caught up with the budget, is the maintenance of a qualified and experienced safeguards inspectorate. Here the issues of methodological and cultural change—the introduction of new and less mechanistic work practices ('detectives, not accountants')—are complicated by age factors: over the next few years a substantial proportion of senior and experienced inspection staff is due to retire. This presents a major challenge, but also a great opportunity to introduce new thinking.

Conclusions

The development of strengthened safeguards measures and even more the development of integrated safeguards are very much work in progress. In fact this is an iterative process—inevitably the approaches developed will require refinement in the light of practical experience.

Major issues being addressed include how to ensure that the verification activities undertaken by the IAEA are sufficient to credibly verify the absence of undeclared nuclear activities. This involves both establishing the appropriate methodology and ensuring that it is applied at an appropriate quality standard. An important set of issues concerns how to implement integrated safeguards in a flexible manner, based on state-specific factors, incorporating the expert judgement of the agency, in a way that avoids discrimination and delivers the required credibility.

Safeguards serve a vital confidence-building role—by assisting states which recognise that it is in their own interests to demonstrate to their neighbours and the international community that they are honouring their treaty commitments, and by enabling them to gain assurance that others are doing likewise. Thus safeguards operate in a political environment, giving expression to political undertakings as well as legal commitments. Safeguards should not be considered in isolation from this environment.

As a mostly technically-based system, safeguards are often viewed narrowly by critics who question their ability to prevent proliferation. Clearly safeguards must be credible. While this requires that they be technically sound, credibility ultimately involves political as much as technical judgements. Maintaining and enhancing

credibility is a complex matter and will be the underlying theme of safeguards development for some time.

The task of safeguards is not prevention as such, 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, safeguards serve an essential political objective by exercising a positive influence on the behaviour of states. Safeguards do this by: providing assurance to reinforce nonproliferation commitments; and deterring non-compliance through the risk of timely detection.

Safeguards make a major contribution to prevention by: raising the level of difficulty for the would-be proliferator to proceed undetected—hopefully dissuading it from the attempt; and providing the international community with timely warning and the opportunity to intervene through detection of proliferation programmes.

Ultimately, however, the prevention of proliferation depends on the will of the international community. In 1992 the Security Council declared that: 'The proliferation of all weapons of mass destruction constitutes a threat to international peace and security'. It pledged, furthermore, that 'the members of the Council will take appropriate measures in the case of any violations notified to them by the IAEA'.[12] Without a strong political commitment by the international community there is a limit to what safeguards can achieve. It is vital that the Security Council, and especially its permanent members, be prepared to uphold their declaration and take the necessary action if and when cases of proliferation arise.

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Endnotes

[1] For a detailed account of the development of the safeguards system and the NPT see David Fischer, in Trevor Findlay (ed.), *Verification Yearbook 2000,* Verification Research, Training and Information Centre (VERTIC), London, December 2000, pp. 43–56.

[2] IAEA *Information Circular 153* (INFCIRC/153/corrected), June 1972.

[3] Under the Additional Protocol, use of wide area environmental sampling requires the approval of the Board of Governors (Article 9).

[4] The equipment and non-nuclear material specified in Annex II of the Additional Protocol correspond to the Nuclear Suppliers Group 'trigger list' items.

[5] The 'starting point of safeguards' relates to nuclear material which has reached the purity or composition suitable for fuel fabrication or enrichment. The term is misleading, since nuclear material before this stage is also relevant to safeguards—an aspect now rectified by the Additional Protocol.

[6] Perhaps the clearest statement of cost neutrality is to be found in the Secretariat's report of 17 November 2000 to the Board of Governors (a restricted document), which states that: 'Overall cost neutrality for the implementation of safeguards remains a goal in developing integrated safeguards. Once integrated safeguards are implemented, the savings from reductions in some of the Agency's traditional safeguards activities can be redistributed towards the cost of implementation of additional protocol measures. A substantial redistribution of resources should be possible once integrated safeguards are implemented on a large scale'.

[7] This is in line with the Principles and Objectives agreed by the 1995 NPT Review and Extension Conference, which said that: 'States parties that have concerns regarding non-compliance with the safeguards agreements of the Treaty . . . should direct such concerns, along with supporting evidence and information, to the IAEA to consider, investigate, draw conclusions and decide on necessary actions in accordance with its mandate'. See UN document NPT/conf.1995/32/DEC.2, 11 May 1995, para. 9.

[8] IAEA, *Safeguards Implementation Report* for 2000 (restricted distribution).

[9] The states concerned were Australia, Ghana, the Holy See, Jordan, Monaco, New Zealand and Uzbekistan.

[10] These include the 15 European Union (EU) members, of which eight have fulfilled all internal requirements for bringing a protocol into effect. It will not enter into force for any EU state until all have done so.

[11] Under the Agreed Framework concluded between North Korea and the US, North Korea agreed to an IAEA-monitored 'freeze' of its indigenous graphite-moderated reactor and reprocessing programme, to come into compliance with its IAEA safeguards agreement, and to the eventual dismantlement of the frozen facilities. In return, North Korea is to be provided with two 1,000 MWe LWRs and, in the interim, heavy fuel oil for power generation.

[12] Statement by President of the Security Council, UN document S/23500, 31 January 1992.