THE IAEA SAFEGUARDS SYSTEM *MOVES INTO THE 21ST CENTURY*

BY PIERRE GOLDSCHMIDT

For more than three decades the IAEA safeguards system has applied technical measures to assure the international community that the non-nuclear-weapon States party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) or similar agreements are honoring their commitments not to proliferate nuclear weapons.

The very essence of these commitments -- and their independent verification by the Agency -- is that they demonstrate transparency with respect to those States' exclusively peaceful nuclear activities. They thus promote trust among States, regions and the world as a whole.

Today -- as it has for some 30 years -- the Agency is able to provide assurance that declared nuclear material and other items placed under safeguards have remained in peaceful nuclear activities or were otherwise adequately accounted for in States that have safeguards agreements in force.

The Agency has also been able to identify -- and to alert the international community -- to the two known cases where States have not met their safeguards obligations. In 1991, soon after the end of what was known as the Gulf War, IAEA inspectors discovered Iraq's extensive clandestine programme for producing nuclear weapons. One year later, IAEA inspectors encountered difficulties -- that still persist -- in verifying the initial report submitted by the Democratic People's Republic of Korea (DPRK) on its nuclear material subject to safeguards.

During the early 1990s, the Agency also gained invaluable experience in verifying the initial report on nuclear material subject to safeguards submitted by South Africa and, at the Government's request, in assessing the termination of its nuclear weapons programme. South Africa is the first -- and so far the only -- State that has changed from a *de facto* nuclear-weapon State to a non-nuclear-weapon State party to the NPT.

These events prompted the Agency and its Member States to examine how the safeguards system in operation at that time could become more effective, particularly for detecting any undeclared nuclear material and activities that should have been declared by a State under its safeguards agreement.

This examination, begun in 1991, also covered improvements for more cost-efficient safeguards, given the resource constraints of successive near zero-real growth budgets for the IAEA and the Department of Safeguards dating back to the late 1980s. These constraints were occurring at a time of considerable growth in the number of comprehensive safeguards agreements and in the amount of nuclear material and the number of facilities to be safeguarded. These increases were due largely to the conclusion of comprehensive safeguards agreements with Argentina and Brazil and with a large number of the newly independent States of the former Soviet Union, many of which have substantial nuclear programmes. Then too, technology advances rapidly taking place offered possibilities for more effective verification while keeping the costs of safeguards at bay.

Under 223 safeguards agreements in force with 139 States, the IAEA verifies that safeguarded nuclear material and facilities are being used exclusively for peaceful purposes. More than 900 facilities are under safeguards and the Agency carried out just over 2200 inspections in 1999.

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The results of this examination have found expression in the steps that the Agency and its Member States have taken to forge a more rigorous safeguards system.

Since the early 1990s, the IAEA Board of Governors has adopted or encouraged strengthening measures in order to provide the Agency with more information than hitherto available about the nuclear programmes of States, greater access by IAEA inspectors to locations relevant for verification, and more powerful verification tools.

The process of strengthening IAEA safeguards achieved a milestone in 1997. In May that year, the Board approved the Model Additional Protocol to Safeguards Agreements which provides the legal basis for the significantly strengthened IAEA safeguards system.

By late 1999, most of the strengthening measures pursuant to safeguards agreements have been incorporated into routine safeguards implementation. All told, as of mid-December 1999, the Board has approved 46 Additional Protocols. They cover 41 non-nuclear-weapon States which have comprehensive safeguards agreements in force or awaiting ratification, one State with an INFCIRC/66-type safeguards agreement, and four nuclear-weapon States, each of which has a voluntary offer IAEA safeguards agreement in force.

Of these approved Protocols, eight have entered into force, and one is being implemented provisionally pending its formal entry into force. In two States, the implementation of the Additional Protocols has included complementary access to contribute to confirming the exclusively peaceful use of all nuclear material in these States.

The full implementation of a strengthened safeguards system will present technical, financial and political challenges. But the achievements thus far and the momentum building for the widespread adoption of the Model Additional Protocol bode well for the work ahead. The accomplishments have also instilled increasing recognition that the IAEA's extensive verification experience and expertise can support initiatives in the field of nuclear arms control.

To better understand how the Agency's safeguards system has come to play -- and why it will continue to play -- a fundamental role in the international non-proliferation regime, this report examines the major elements of the IAEA safeguards system. It also looks briefly at opportunities for the Agency to support initiatives in the field of nuclear arms control. Finally, it provides an historical perspective on the evolution of safeguards.

ELEMENTS OF THE IAEA SAFEGUARDS SYSTEM

The elements of IAEA safeguards are described from the perspective of how the system has operated through 1999 and how it is changing and likely to change over the near term as all safeguards measures are integrated to gain maximum effectiveness and efficiency within available resources.

What are Safeguards? By definition, the safeguards system comprises an extensive set of technical measures by which the IAEA Secretariat independently verifies the correctness and the completeness of the declarations made by States about their nuclear material and activities.

Traditional Measures. One set of measures relates to the nuclear material verification activities performed at facilities or other locations where States have declared the presence of nuclear material subject to safeguards. These measures are also referred to as "traditional safeguards". *(See box, page S-4.)*

Strengthening Measures. Another set relates to the measures endorsed or encouraged by the IAEA Board since 1992 for strengthening the safeguards system. *(See box, page S-5.)*

These measures fall into two categories. The first category comprises those measures to be implemented under the legal authority conferred by existing safeguards agreements. The second category comprises measures to be implemented under the complementary legal authority conferred by Additional Protocols concluded on the basis of the Model Additional Protocol.

When fully implemented in a State, the strengthening measures provided by a comprehensive safeguards agreement together with an Additional Protocol will allow the Agency to draw safeguards conclusions both about the non-diversion of declared nuclear material and the absence of undeclared nuclear material and activities in that State.

TRADITIONAL SAFEGUARDS:
DETECTING DIVERSION OF DECLARED NUCLEAR MATERIAL

Traditional safeguards are based on the concept of nuclear material accountancy verification, complemented by containment (e.g., seals) and surveillance (e.g., cameras and monitors). These activities are applied to nuclear material once it has been processed to a stage suitable for enrichment or for introduction into a reactor.

Nuclear material accountancy focuses primarily on the "correctness" of a State's declarations about its nuclear material present at facilities -- the aim being to independently verify that the inventories and flows of nuclear material are as declared or, in other words, that there has been no material mis-statement.

Traditional safeguards have tacitly assumed that the State has provided complete information covering all of its nuclear material subject to safeguards. There are practical reasons for this restriction, since under comprehensive safeguards agreements IAEA inspector access during routine inspections is limited to specified points ("strategic points") in the facility for material accountancy verification purposes. With this limited access, the Agency's ability to detect an undeclared nuclear activity that makes no use of safeguarded material is circumscribed. This was essentially the situation that came to light in Iraq and that has been subsequently addressed in the provisions of the Model Additional Protocol.

At this point, it is important to underscore that nuclear material verification activities have been -- and will continue to be -- the cornerstone of the safeguards system, particularly for confirming the absence of unreported production or separation of direct-use material (for example, plutonium and highly enriched uranium) in safeguarded facilities.

The incorporation of certain strengthening measures, such as environmental sampling, is enhancing traditional safeguards implementation, as described in the following section.

IAEA safeguards seals are examined at the Agency's headquarters to ensure that there has been no unauthorized access to or interference with nuclear material or safeguards equipment.

STRENGTHENED SAFEGUARDS:
DETECTING UNDECLARED NUCLEAR MATERIAL & ACTIVITIES

The second set of safeguards measures relates to the strengthening measures to be applied pursuant to safeguards agreements and Additional Protocols. These activities focus primarily on the "completeness" of a State's declarations -- the aim being to verify the presence of nuclear material as declared and to confirm that there is no indication of any undeclared nuclear material and activities in that State which should have been declared.

Conceptual Approach: The State's Nuclear Programme. Traditional nuclear material verification activities are designed to provide a set of "indicators" of diversion or of circumstances where the possibility of diversion cannot be excluded. These indicators (such as a statistically significant amount of "material-unaccounted-for") are used for assessing the correctness of a State's declarations regarding its nuclear material inventories, material flows and facility operations.

Safeguards strengthening measures, when supported by the provisions of the Model Additional Protocol, provide for a different set of "indicators" that can be used for assessing both the correctness and completeness of a State's declarations and whether there is a possibility of undeclared nuclear activities in that State.

The conceptual basis for such an assessment derives from the fact that a State's nuclear programme (past, present and future) involves an interrelated set of nuclear and nuclear-related activities that require, and/or are indicated by, the presence of certain equipment, a specific infrastructure, observable tell-tale traces in the environment, and a predictable use of nuclear material. The picture presented by these features provides the basis for an assessment of, first,

NUCLEAR MATERIAL ACCOUNTANCY: CORNERSTONE OF TRADITIONAL SAFEGUARDS

Traditional safeguards are based on nuclear material accountancy, complemented by containment (e.g., seals) and surveillance (e.g., cameras). These activities are analogous to those of financial accounting. Nuclear material accountancy records are maintained by facility operators for each facility under safeguards. The information on the nuclear material inventory – comparable to financial statements – is reported to the Agency through State authorities. These State declarations on nuclear material are the primary information source for the Agency's independent verification of the "correctness" of these declarations regarding nuclear material inventories, material flows and facility operations.

Technical Objectives, Safeguards Approaches & Safeguards Criteria. The technical objectives of these verification activities are to detect, within specified time-frames, the diversion of significant quantities of nuclear material from peaceful uses to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown; and to deter such diversion by the risk of early detection. These objectives are based on the principle that a certain quantity of nuclear material, a significant quantity, is needed to manufacture a nuclear explosive device and that a certain length of time is needed to convert that material into weapon usable form.

The approach for verifying a State 's declaration of its nuclear material takes into account all technically possible diversion paths at a certain type of facility, including the diversion of material for the unreported production or separation of direct-use material (e.g., plutonium and highly enriched uranium) at that facility. Among the factors considered in developing the safeguards approach are the design features of the facility, the form and accessibility of the nuclear material, and the measurement and analytical methods available to the Agency. Technical safeguards criteria are established for each type of facility under safeguards and specify the scope, the normal frequency and the extent of the verification activities needed to achieve the technical objectives of detection and deterrence.

On-Site Inspections & Design Information Verification. On-site inspections are the chief mechanisms for verifying that the inventory and flow of nuclear material present in the facility (or at a strategic point in the facility) are as declared and that there is no unreported production or separation of direct-use material at the facility.

Three types of inspections may be carried out: ad hoc inspections, routine inspections and special inspections. Ad hoc inspections are made to verify a State's initial report on its nuclear material or the report on changes thereto, and to verify the nuclear material involved in international transfers. Ad hoc inspections may also be carried out until a State's Facility Attachment (a part of its Subsidiary Arrangement) is legally in force. Routine inspections are most frequently used; they may be carried out according to a defined schedule or they may be of an unannounced, short-notice character. Special inspections are carried out unusually, and may be prompted by the State itself or by the Agency if it believes that the State concerned was not providing all the required information about its nuclear material or that it needed more information to fulfil its responsibilities under the safeguards agreement.

Visits may be made to declared facilities at appropriate times during the lifecycle for verifying the safeguards relevant design information. For example, such visits may be carried out during construction to determine the completeness of the declared design information; during routine facility operations and following maintenance, to confirm that no modification was made that would allow unreported activities to take place; and during a facility decommissioning, to confirm that sensitive equipment was rendered unusable.

Verification activities IAEA inspectors perform during and in connection with on-site inspections or visits at facilities may include auditing the facility's accounting and operating records and comparing these records with the State's accounting reports to the agency; verifying the nuclear material inventory and inventory changes; and applying containment and surveillance measures (e.g., seal application, installation of surveillance equipment).

Evaluating & Reporting on Safeguards Implementation. Technical parameters are used to evaluate whether the inspection activities at facilities have met the technical objectives of detection and deterrence. These largely quantitative findings are brought together with more qualitative information in order to derive safeguards conclusions about the non-diversion of declared nuclear material. The results of implementing these verification activities are reported annually to the Board of Governors in the Safeguards Implementation Report.

SAFEGUARDS STRENGTHENING MEASURES

Measures under Comprehensive Safeguards Agreements

- State provision of design information on new facilities or changes in existing facilities handling safeguarded nuclear material, as soon as the State authorities decide to construct, authorize construction or modify a facility; and the Agency's right to verify the design information over the facility lifecycle, including decommissioning.
- State voluntary reports on imports and exports of nuclear material and exports of specified equipment and non-nuclear material. (Components of this scheme are incorporated in the Model Additional Protocol.)
- Agency collection of environmental samples in facilities and at locations where, under existing safeguards agreements, inspectors have access during inspections and design information visits; and analysis at the IAEA Clean Laboratory and/or at certified laboratories in Member States.
- Agency use of unattended and remote monitoring of movements of declared nuclear material in facilities and the transmission of authenticated and encrypted safeguards-relevant data to the Agency.
- Agency use, to a greater extent than previously, of unannounced inspections within the routine inspection regime.
- Provision of enhanced training of IAEA inspectors and safeguards staff and of Member State personnel responsible for safeguards implementation.
- Closer cooperation between the Agency and the State (and regional) systems for accounting and control of nuclear material in Member States.
- Agency enhanced analysis of information derived from State declarations under safeguards agreements, Agency verification activities and from a wide range of open sources.

Measures under Model Additional Protocol

- State provision of information about, and IAEA inspector access to, all aspects of a State's nuclear fuel cycle, from uranium mines to nuclear waste and any other location where nuclear material intended for non-nuclear uses is present.
- State provision of information on, and IAEA short-notice inspection access to, all buildings on a nuclear site.
- State provision of information about, and IAEA inspection mechanisms for, a State's nuclear fuel cycle related research and development.
- State provision of information on the manufacture and export of sensitive nuclear-related technologies, and IAEA inspection mechanisms for manufacturing and import locations in the State.
- Agency collection of environmental samples to locations beyond those provided under safeguards agreements, when deemed necessary by the Agency.
- State acceptance of IAEA inspector designations and issuance of multiple entry visas for IAEA inspectors covering at least one year.
- Agency right to make use of internationally established communications systems, including satellite systems and other forms of telecommunication.

the internal consistency of the State's declarations to the Agency and, secondly, a point-by-point comparison of what the State says it is doing or plans to do within the scope of its nuclear programme and of the corresponding information available to the Agency from its own verification activities and from other sources.

Clearly, information is crucial for a safeguards State assessment: the more the Agency is aware of the nature and location of a State's nuclear and nuclear-related activities, the more comprehensive the safeguards assessment, and the better able it is to provide credible assurance of non-diversion of declared nuclear material and of the absence of undeclared nuclear material and activities in that State.

KEY COMPONENTS OF STRENGTHENED SAFEGUARDS

The strengthened safeguards system comprises the following key components:

- Agency access to, and evaluation of, substantially more information than previously available about a State's nuclear and nuclear-related activities and its use of nuclear material;
- Increased IAEA inspector access to relevant locations in the State and the associated mechanism of complementary access to contribute to confirming the exclusively peaceful intent of a State's nuclear programme;
- Use of advanced verification technology; and
- Enhanced effectiveness and efficiency of resource use, for example, through enhanced

training of safeguards staff and Member State personnel, and closer cooperation with State and regional systems for accounting and control of nuclear material.

These strengthening measures are discussed below, showing what has been done under the legal authority of IAEA safeguards agreements and, where appropriate, what is being done or is planned under the legal authority conferred by the Model Additional Protocol.

■ **Enhanced Information Access & Evaluation.** As a result of the strengthening measures being applied, the Agency now has at its disposal more information than previously available to support the safeguards evaluation and review of State's nuclear programmes -- information submitted by States pursuant to their reporting obligations and voluntary reports; information generated by its own verification activities at facilities and its activities under Additional Protocols; and information available from a wide range of open sources.

For example, States are now submitting, in a more timely manner, design information about new facilities and safeguards-relevant modifications or changes to facilities handling safeguarded material. The availability of this information, and the Agency's exercise of its right to verify this information throughout the facility lifecycle, are contributing to the assurance that safeguarded facilities are not being used for any unreported activities, especially for the production or separation of direct-use materials.

As of late 1999, a total of 52 Member States, including the major nuclear suppliers, have participated in the voluntary scheme for reporting their imports and exports of nuclear material, specialized equipment and non-nuclear material. To

SAFEGUARDS TECHNOLOGY & EQUIPMENT

■ **Non-Destructive & Destructive Assay Techniques.** Nuclear material verification activities at safeguarded facilities include independent measurements to verify quantitatively the amount of nuclear material declared by a State.

IAEA inspectors count items (e.g., fuel assemblies) and measure the content, element or isotopic concentration or other attributes of these items using non-destructive assay (NDA) techniques which do not physically or chemically change the item. These measurement findings are compared with the facility operator's records and the State declared figures in order to detect missing items or whether a large amount of declared material is missing ("gross defect testing"). Also, IAEA inspectors may weight the items and measure them using NDA techniques, such as neutron counting or gamma ray spectrometry, in order to detect whether a fraction of a declared amount of material is missing ("partial defect testing").

For detecting the diversion of small amounts of material over a protracted period, destructive analysis (DA) techniques are used to achieve the highest possible accuracy ("bias defect testing"). This involves the independent sampling of some items and chemical analyses which may destroy the physical form of the sample. Samples are analyzed at the IAEA Safeguards Analytical Laboratory located in Seibersdorf near Vienna and/or or at certified laboratories in Member States.

■ **Containment & Surveillance Techniques.** IAEA inspectors also apply containment and surveillance (C/S) techniques to nuclear and other material, devices and samples at safeguarded facilities. C/S techniques are used for many reasons, including verifying that nuclear material follows predetermined routes, that there is no unauthorized access to safeguards equipment or relevant information and that the material or other safeguards items are accounted for at the correct measurement points.

A variety of C/S techniques is used, primarily sealing systems and optical surveillance systems. A sealing system typically comprises the containment enclosing the nuclear material to be safeguarded, the means for applying the seal (e.g., a metal wire) and the seal which may be metallic, fibre optic or electronic by design. All components are examined to verify that the sealing system has ensured the continuity of knowledge on the nuclear material concerned.

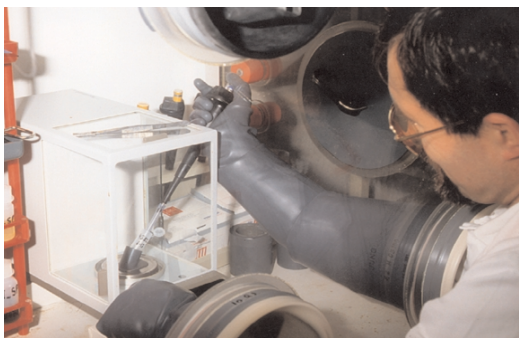
The optical surveillance systems are usually applied in storage areas (such as spent fuel storage ponds) and generally consist of two or more cameras positioned to completely cover the area. The field of view is such that any movement of items can be easily identified and the images can be recorded during movement.

■ **Unattended & Remote Monitoring Systems.** Optical surveillance systems, for example, are

date, the Agency has received approximately 2600 reports on the production of nuclear material and the export of certain nuclear materials and approximately 450 reports on exported equipment and non-nuclear materials.

Additional Protocol-Related Information. Both for the Agency and for States that accept the provisions of the Model Additional Protocol, the preparation and handling of the related information is a new endeavor. For the Agency, the computerized Protocol Data Information System (PDIS) is being used to properly treat all information supplied by States pursuant to their Additional Protocols. To assist States in preparing their declarations pursuant to their Additional Protocols, the Agency has developed a system, known as the PDIS Reporter. Several States are now making trial use of this system, after which it will be made available to all States with Additional Protocols in force. In addition, in late 1997 the Agency issued guidelines for assisting States in preparing and submitting the information pursuant to Articles 2 and 3 of the Model Additional Protocol. As of late 1999, six States have submitted such expanded declarations pursuant to their Additional Protocols.

These guidelines for the submission of such expanded declarations were designed mainly for States having substantial nuclear fuel cycles. However, many States with comprehensive safeguards agreements have little or no declared nuclear material and/or nuclear activities. Such States have usually concluded a "Small Quantities Protocol" which holds in abeyance most of the detailed provisions of the second part of a comprehensive safeguards agreement. The



unattended systems since their prime function is to survey an area for safeguards relevant activities over extended time periods. Contemporary unattended monitoring systems employing radiation detection sensors are increasingly being used to detect nuclear material flows past key points in the facility process area. For complex nuclear facilities where the plant is automated, unattended assay and monitoring techniques are an integral part of practicable safeguards implementation, resulting in improved verification coverage and accuracy.

Unattended and remote monitoring is a special mode of applying NDA or C/S measures, or a combination of these, that operates for extended time periods without the presence of the IAEA inspector. Remote monitoring in the safeguards context is generally considered to mean the real-time or near-real-time transmission off-site of data on nuclear material movements. During field tests of remote monitoring systems in several Member States, images and data were transmitted to IAEA headquarters via communication satellite and ultra-small aperture terminal satellite transceivers. The data were then stored in computers at IAEA headquarters; periodically, they were transferred to a local area network for review, upon demand, by authorized persons.

■ **Environmental Sampling & Analysis.** The collection of environmental samples at or near a nuclear site, combined with ultrasensitive analytical techniques, such as mass spectrometry, particle analysis and low level radiometric techniques, can reveal indicators of past and current activities in locations handling nuclear materials. Environmental sampling was introduced in 1996 as a strengthening safeguards measure which can be applied under safeguards agreements and, under Additional Protocols, more broadly at other locations. Samples are received, screened, and analyzed at the IAEA Clean Laboratory located at Seibersorf near Vienna; they may also be analyzed in laboratories belonging to the network of certified laboratories in Member States.

Photos: Safeguards inspectors are being supported by a range of advanced verification techniques. At the IAEA Clean Laboratory, environmental samples are analyzed. For more information, see the IAEA booklet, Safeguards Techniques and Equipment, published in the International Nuclear Verification Series and available from the IAEA Division of Conference and Document Services or Division of Public Information.

conclusion of Additional Protocols by such States is important and, in April 1999, the Agency issued simplified guidelines for use by States whose comprehensive safeguards agreements includes a Small Quantities Protocol.

Information Confidentiality. The confidentiality of sensitive information supplied by States pursuant to their safeguards agreements and Additional Protocols is maintained under the Agency's stringent regime for the protection of confidential information. In endorsing this regime, in 1997 the Board of Governors emphasized the importance of confidentiality and decided to periodically review the regime. The most recent review occurred in June 1999.

Evaluation & Review. New procedures, analytic methods, software tools and the associated staff capabilities are being put in place for the evaluation and review of information about State's nuclear and nuclear-related activities, within the context of State's declarations.

For the safeguards analyst, the problem is one of recognizing what information is important and synthesizing the information into a coherent picture. Methods are available to support -- but not supplant -- the analyst. A key methodology for analyzing the information on a State's nuclear programme builds on a "physical model" of the nuclear fuel cycle, which was developed collaboratively by the Agency and experts from several Member States. The physical model identifies, describes and characterizes every known technical process for converting nuclear source material to weapons usable material and identifies indicators for each process in terms of equipment, nuclear material and non-nuclear material.

Software programmes for sorting and examination of information are being used to retrieve and examine open source information. These tools include a set of "topic trees" for all steps of the nuclear fuel cycle developed on the basis of the "physical model"; a search software programme for accessing information stored at remote sites on the Internet; and a software programme that supports the visualization of information.

IAEA safeguards staff regularly evaluate the information and their findings are independently reviewed by senior officials of the IAEA Secretariat, who may make recommendations to the Deputy Director General of Safeguards, where appropriate, for follow-up action. Information evaluation and review are integral to the overall process of safeguards assessments whereby the Agency draws safeguards conclusions about the non-diversion of declared nuclear material and about the absence of undeclared nuclear activities in States having comprehensive safeguards agreements with Additional Protocols in force. *(See box, page S-9.)*

To provide a comparative baseline for such safeguards State assessments that include the expanded declarations submitted under Additional Protocols, the nuclear programmes of States with comprehensive safeguards agreements in force are now being evaluated and the findings are being reviewed. As of late 1999, baseline evaluations of the nuclear programmes of 25 States have been reviewed. As more States submit their expanded declarations, these baseline evaluations will enable the Agency to identify areas where further amplification or clarification of the information submitted may be needed or where there are questions or inconsistencies to be resolved through discussion with the State and/or through complementary access to a State, as described below.

■ **Increased IAEA Inspector Access.** Several elements are involved.

Complementary Access. The Model Additional Protocol provides the authority for increased IAEA inspector access to relevant locations in a State to confirm the exclusively peaceful intent of that State's nuclear programme. This legal instrument also provides the mechanism for the Agency to exercise that authority -- i.e., complementary access. As of late 1999, complementary access has taken place in two States -- namely, Australia and Uzbekistan. In addition, hands-on experience in performing complementary access to complex nuclear sites is being gained through the Additional Protocol implementation trials that are under way in a number of States.

For a State with an Additional Protocol in force, the Agency may request complementary access to any nuclear site or place in that State which has or is producing or is storing nuclear material, the purpose being to assure the absence of undeclared nuclear material and activities. Complementary access may also be requested to resolve a question relating to the correctness and completeness of the information submitted or to resolve an inconsistency relating

DERIVING SAFEGUARDS CONCLUSIONS

The Agency's safeguards conclusions for a State are derived from the IAEA Secretariat's independent assessment of information — information provided by the State pursuant to its reporting obligations, information generated by the Agency from its verification activities and information from other, open sources. If after such an assessment the Secretariat were unable to conclude that there has been no diversion of nuclear material and/or that there are no undeclared nuclear material and activities in that State, the Board of Governors would be promptly informed.

■ **For a State having a comprehensive safeguards agreement but not yet an Additional Protocol in force, the conclusion covers only the non-diversion of declared nuclear material.** The quantitative and qualitative results of safeguards implementation in that State are assessed. The quantitative results relate to the nuclear material verification activities carried out at facilities across the State, as prescribed by the Safeguards Criteria, and the degree to which the performance of these activities has met the quantity and timeliness components of the "inspection goal". When all criteria relative to the nuclear material present have been satisfied and all anomalies involving a significant quantity of nuclear material have been resolved, the goal is regarded as attained. However, the non-attainment of either or both of these components does not, in itself, constitute evidence of diversion. In such a case, the Secretariat reviews the reason(s) for the situation and takes corrective action to the extent possible, which may include consultations with the facility operators and State officials.

Further, the Secretariat assesses the more qualitative information available, including the facility design features, the continuing knowledge of facility operations and information on the State's nuclear fuel cycle. Finally, it brings together the quantitative and qualitative assessment results in order to determine whether there is any indication of diversion. Where there is no evidence to the contrary, the conclusion is drawn that all of the nuclear material declared and placed under safeguards has remained in peaceful nuclear activities or was adequately accounted for.

■ **For a State having a comprehensive safeguards agreement *with* an Additional Protocol in force, the Agency is able to draw broader conclusions that provide for greater nuclear transparency for a State. These conclusions cover both the non-diversion of declared nuclear material *and* the absence of undeclared nuclear material and activities in the State.** To draw the conclusion about the non-diversion of declared nuclear material, the Secretariat uses a process similar to that described above. To draw the conclusion about the absence of undeclared material and activities, it assesses the information about that State's nuclear and nuclear-related activities, within the context of the State's declarations. In order to be able to draw a conclusion, the Secretariat must have available all of the information generated by the Agency's verification activities in that State. From this base, it determines whether there is any indication of the presence of undeclared nuclear material and activities. Where there is no evidence to the contrary, the conclusion is drawn that there are no undeclared nuclear materials and activities in the State.

to that information; or to confirm, for safeguards purposes, the State's declaration of the decommissioned status of a facility or of a location outside of a facility where nuclear material was used. The activities carried out during complementary access may include visual observation, environmental sampling beyond declared locations, utilization of radiation detection and measurement devices, and the application of seals and other identifying and tamper-indicating devices.

Agency guidelines are being developed, for internal use, to ensure that complementary access is carried out in an efficient, technically effective and non-discriminatory manner. Guidelines for sites are now in use, and guidelines are being prepared for complementary access to decommissioned facilities and to other locations declared as having nuclear material. For locations other than sites and decommissioned facilities and which are declared as having no nuclear material, access will be on a case-by-case basis and, under most circumstances, will be preceded by consultations with the State.

Inspector Designations & Visas. Lifting restrictions on inspector designations and granting inspectors long-term (i.e., at least one year) multiple-entry visas would facilitate

Environmental sampling and the subsequent highly sensitive laboratory analysis of samples provide a powerful yet unobtrusive means of contributing to assurance of the absence of any undeclared nuclear activities. (Credit: Hosoya/IAEA)

physical access and thus enable more effective verification and more efficient use of the Agency's inspection resources. Administrative arrangements provided in the Model Additional Protocol support these goals. In addition, these arrangements also ensure that the Agency has access to modern means of communication (i.e., satellite) in a State or, if satisfactory means do not exist, that the State would consult with the Agency regarding other ways of meeting the latter's communication needs.

Advanced Verification Technology. The Agency has always relied on technology and equipment to complement nuclear material verification activities at safeguarded facilities. Those capabilities have seen marked improvements over the years, reflecting the efforts of technical specialists in many States. Indeed, assistance from the formal support programmes for safeguards set up by Member States and organizations representing groups of States have played an indispensable role in allowing the Agency to keep pace with technological progress and its suitability for safeguards purposes. *(See box, page S-11.)*

Recent technology advances in environmental sampling and analysis and in remote monitoring are providing the Agency with more powerful yet unobtrusive means of verifying States' declarations. Both measures can be applied under comprehensive safeguards agreements.

In addition, the Model Additional Protocol adds to the impact of environmental sampling and analysis through the provision that samples can be collected beyond the strategic points defined in facilities, when the Agency deems it necessary to confirm the absence of undeclared nuclear material and activities. Further, several Member States are technically advising the Agency on the potential benefits and related costs of using commercial satellite imagery for providing safeguards-relevant information that can complement other information sources available to the Agency relative to State's nuclear and nuclear-related activities. Over the next two years, no less than six commercial satellites are planned for launch, which among other benefits would improve the resolution of optical, infrared and radar images.

Environmental Sampling. The collection of environmental samples at or near a nuclear site, combined with ultrasensitive analytical techniques, can reveal indicators of past and current activities in locations handling nuclear materials.

After successful field trials in eleven IAEA Member States, environmental sampling is now routinely applied at facilities covered by comprehensive safeguards agreements. In 1996, the IAEA brought into full operation a Clean Laboratory, located in Seibersdorf near Vienna, which is receiving, handling, and analyzing samples as well as distributing samples for analysis at laboratories belonging to the expanded network of certified analytical laboratories. By late 1999, this international network has included laboratories in three Member States and within the European Atomic Energy Community (Euratom).

Environmental sampling concentrates currently on the collection and analysis of swipe samples in enrichment plants and installations with hot cells. This is being done in order to detect the enrichment of uranium above declared levels and to confirm that hot cell facilities are not being used for undeclared activities such as plutonium production or separation. Under safeguards agreements, sampling may be extended to other types of nuclear facilities.

By late 1999, baseline samples have been collected in 12 enrichment facilities in 7 States and 77 hot cell complexes in 40 States and Taiwan, China.

Remote Monitoring. The real- or near-real-time transmission of authenticated and encrypted data on the movements of nuclear material recorded by Agency approved remote monitoring systems could reduce the frequency of inspector visits to the facility, increase the capability for data review and evaluation, and facilitate the remote

MEMBER STATE SUPPORT PROGRAMMES FOR IAEA SAFEGUARDS

Agency safeguards implementation is strongly assisted by the funding and expertise made available through the formal safeguards support programmes established by Member States and organizations representing groups of States. As of late 1999, the following States and organizations had formal support programmes: Argentina, Australia, Belgium, Canada, Euratom, Finland, France, Germany, Hungary, Japan, the Netherlands, the Republic of Korea, the Russian Federation, Sweden, the United Kingdom, and the United States. Other States (Austria, Latvia, and Pakistan) have contributed through research and development agreements and test programmes.

During the year, 250 tasks were under way to address measurement methods and techniques; training; system studies; information processing; containment, surveillance and monitoring systems; and safeguards evaluation. In 1999, approximately US $22 million was allocated by these support programmes to finance task activities.

The IAEA's Safeguards Analytical Laboratory provides key services to the Agency's Department of Safeguards, including analysis of nuclear material samples.

detection and rapid response to a safeguards-significant event. For the facility and State, remote monitoring for safeguards purposes could be less intrusive on facility operations. Following successful field tests of remote monitoring systems at several types of nuclear facilities in nearly a dozen Member States, the Agency is preparing to incorporate remote monitoring into its safeguards applications, within available budgetary resources and on a case-by-case basis.

■ **More Effective & Efficient Use of Resources.** A number of initiatives have been taken.

Enhanced Safeguards Training. IAEA inspectors, safeguards specialists and Member State safeguards personnel are being provided with the skills and knowledge to apply the strengthening measures. Since the measures were introduced in the early 1990s, safeguards staff have been trained in the following areas: environmental sampling (14 courses), enhanced observation (10 courses), understanding nuclear fuel cycles and their proliferation pathways (nine courses), information evaluation (three courses), enhanced design information review (three courses), and the electronic transmission of encrypted data (12 courses).

Training modules of the Agency's Introductory Course on Safeguards for new inspectors have been modified to reflect these strengthening measures. Staff of the IAEA Department of Safeguards regularly receive training on safeguards information security requirements and are kept abreast of safeguards developments through seminars and international conferences. Since 1996, training courses for Member State safeguards personnel have been held in Asia, Europe, USA, and Latin America.

Closer Cooperation with State and Regional Systems. A State with a comprehensive safeguards agreement is obliged to establish and maintain a State (or regional) system of accounting for and control (SSAC) of all nuclear materials within its territory, or under its jurisdiction or control. Over the years, nearly every State with a large nuclear programme has found that its security, economic and safeguards interests are best served by having an effective SSAC. In the case of the European Union the safeguards system of Euratom fulfils this function, and in the case of Argentina and Brazil it is fulfilled by ABACC (the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials).

Safeguards strengthening measures place an even greater emphasis on working closely with State and regional authorities so as to increase verification effectiveness and help reduce the costs or the extent of these activities. The Agency is exploring with Member States how such joint and shared activities can be more widely performed while preserving the IAEA's capability to draw independent safeguards conclusions.

The "new partnership approach" that the Agency and Euratom agreed to in 1992 exemplifies close cooperation with an experienced and well-equipped regional safeguards system in order to

achieve a more effective and efficiency application of safeguards. Similar close cooperation is being developed with ABACC.

Greater cooperation can take the form of joint and shared activities that can be performed by the IAEA inspectorate and State or regional authorities. These activities may involve joint inspections using Agency procedures to meet IAEA safeguards criteria; joint use of containment and surveillance techniques; joint development of safeguards approaches, sampling plans and measurements procedures to meet IAEA technical criteria; joint performance of non-destructive assay and destructive assay measurements of nuclear material using common equipment; joint training programmes, joint research and development work; and the shared use of State or regional analytical laboratories, for example, to support analysis of environmental sampling.

THE EVOLVING PICTURE:
INTEGRATED SAFEGUARDS

In 1998, the Agency's Department of Safeguards embarked upon a programme for the development and implementation of "integrated safeguards". The term refers to the optimum combination of all safeguards measures available to the Agency, including those from the Additional Protocol, in order to achieve maximum effectiveness and efficiency within the available resources.

A consultants' meeting and two technical expert meetings held on this subject have facilitated the work of a group of safeguards specialists within the IAEA Secretariat who are developing the concept, plan and approach for integrated safeguards. The work is proceeding with the assistance of a number of Member State's Support Programmes for Safeguards and with the technical advice of the Standing Advisory Group on Safeguards Implementation (SAGSI) and outside technical experts.

The concept being developed involves a generic State-level approach, which would be adapted for application in a State, taking into account that State's nuclear fuel cycle and its nuclear-related activities. The process of defining the optimum combination of safeguards measures would be done on a non-discriminatory basis for all States that have comprehensive safeguards agreements with Additional Protocols in force.

When fully implemented in a State, the measures provided by a comprehensive safeguards agreement with an Additional Protocol will allow the IAEA to draw safeguards conclusions and provide credible assurance of the non-diversion of declared nuclear material and of the absence of undeclared nuclear material and activities in that State.

With the further integration of safeguards, the Agency's ability to provide such assurance may lead to the relaxation of certain traditional nuclear material verification measures on less sensitive nuclear material (for example, natural and low-enriched uranium and irradiated fuel) and thus to a reduction in the costs associated with such verification activities.

SAGSI, an international group of experts, provides technical advice to the IAEA Director General on matters related to safeguards. The group's members recently marked SAGSI's 50th series of meetings.

FURTHER SUPPORTING THE NON-PROLIFERATION REGIME

Beyond the internal strengthening of safeguards, the Agency's experience has extended to verifying the elimination of South Africa's former nuclear weapons programme, verifying and serving as a mechanism for implementing the nuclear component of UN Security Council resolutions to destroy, remove or render harmless Iraq's nuclear weapon programme, and verifying inventories of plutonium and highly enriched uranium declared by the United States as no longer required for its defense purposes.

These experiences have instilled confidence that IAEA verification expertise could further support the non-proliferation regime, particularly the recent initiatives for international verification of nuclear arms reductions.

At present, seven States (of which five are party to the NPT) are known to possess nuclear weapons and an eighth State is presumed to possess such weapons. As long as those weapons exist, the possibility of their use remains, whether intentional or inadvertent. International security today is largely built upon the relationships of these States, and their nuclear arsenals are fundamental to those relationships. Any change must be managed with extreme care to ensure that evolutionary arrangements foster peace and security, and that they encourage further steps towards the ultimate elimination of existing arsenals. Currently, two means are seen through which the IAEA may contribute to such undertakings.

Verifying Weapon-Origin and Other Excess Fissile Material. In an initiative taken in 1996, the Russian Federation, the United States and the Agency began work to establish a prototype verification system for weapon-origin and other fissile material declared to be excess to defense purposes. This action is linked to Article VI of the NPT that addresses the cessation of the nuclear arms race and the reduction of nuclear weapons and other nuclear explosive devices. Future IAEA verification under this initiative should promote international confidence that the material submitted by either of the two States to such verification remains irrevocably removed from nuclear weapon programmes.

As decades will be required to use or dispose of the excess materials, the prototype verification system is being designed to allow the States to submit fissile materials with classified characteristics (including nuclear weapon components from dismantled warheads) in order to accelerate the implementation of verification. In such cases, the verification system must ensure that IAEA inspectors would not gain access to information relating to the design or manufacture of such weapons.

The verification arrangements would be in conformity with the obligations of the two States under Article 1 of the NPT. The verification requirements and procedures would necessarily differ from those used for Agency safeguards, which are intended for non-proliferation purposes and are applied in non-nuclear-weapon States under the provisions of Article III of the NPT. Nevertheless, many of the methods and techniques applied for safeguards would also be applicable under the new system.

Work is progressing to develop the verification arrangements for specific facilities identified by the Russian Federation and the United States where the new agreements would apply. In the United States, discussions between US and IAEA experts are well advanced on specific methods to be applied. In the Russian Federation, preparatory arrangements have been completed and discussions are taking place between Russian and IAEA experts on verification methods.

Further, discussions are continuing aimed at the adoption of the basic technical measures associated with the verification of fissile material covered by the initiative and the approval of an appropriate model verification agreement by the IAEA Board of Governors. Once such a verification scheme is established, it is hoped that other States possessing nuclear weapons would enter into similar agreements. In the year 2000, the US Secretary of Energy, the Russian Minister of Atomic Energy and the IAEA Director General are scheduled to meet in order to plan the implementation of this verification system.

Banning the Production of Fissile Material for Use in Nuclear Weapons or Other Nuclear Explosive Devices. The second initiative for controlling the proliferation of nuclear weapons involves the negotiation of a treaty to ban the production of fissile material for use in nuclear weapons or other nuclear explosive devices. Such

a treaty would require establishment of appropriate verification arrangements in those States party to it. Its provisions remain to be defined. However, it could, *inter alia,* bring under verification all production facilities as well as facilities for storing, processing, using and disposing of fissile materials produced after the treaty entered into force. This could mean additional verification activities in those States which do not already have comprehensive safeguards agreements with the IAEA.

The responsibility for negotiating this treaty lies with the Conference on Disarmament, based in Geneva. In 1998, the Conference established an "Ad Hoc Committee" to pursue this goal. The United Nations General Assembly has requested the IAEA to provide assistance, if requested by the Conference, and the IAEA Director General has conveyed to the President of the Conference the readiness of the Agency to respond to any such request.

The IAEA Secretariat continues to participate in seminars and to respond to requests from States to exchange views on the verification of such a treaty.

SUSTAINING THE MOMENTUM

No one can predict what lies ahead in the 21st century. Since the early 1960s, international safeguards have evolved -- and continue to evolve -- stimulated by technical progress and developments in international security. The important role of IAEA safeguards is reflected, for example, in the 1995 decision to make the Treaty on the Non-Proliferation of Nuclear Weapons -- and comprehensive IAEA safeguards -- a permanent feature of the international landscape.

The IAEA safeguards system, underpinning the international non-proliferation regime, has allowed the civil nuclear industry to bring many of the benefits of nuclear science and technology to mankind.

Among other achievements, today nuclear energy accounts for 16% of the world's total electricity consumption. With the public perception of the verification effectiveness of international safeguards, nuclear power will be able to continue meeting these energy demands and, in so doing, help States to honor their commitments made in Kyoto in 1997 to reduce future emissions of greenhouse gases.

While these accomplishments are noteworthy, they should not

engender complacency. If we are to sustain the momentum that has been built up for nuclear non-proliferation and nuclear arms control, greater solidarity and continuing vigilance are needed to halt the spread of weapons of mass destruction.

Above all, progress is needed to extend the legal provisions of the Model Additional Protocol to include *all* States. Only then can the international community reap the full benefits of the strengthened safeguards system -- a system capable of providing credible assurance that declared nuclear material has not been diverted, that specified facilities and other safeguarded items are not being misused for any military purposes or purposes unknown and that there are no undeclared nuclear material and activities present in States that have comprehensive safeguards agreements with Additional Protocols in force with the Agency.

This is the promise underlying the steps taken for the newly strengthened safeguards system that can address nuclear proliferation under any guise. Ultimately, this promise can only be fulfilled where States comply with their obligations under safeguards agreements and Additional Protocols and where the international community demonstrates that it has the will to take meaningful action against a State that does not comply with its non-proliferation commitment.

In April 2000, the Review Conference of the NPT will be carried out for the first time under the provisions agreed upon in 1995 when the Treaty was extended on an indefinite basis. The world has seen many changes over the past five years, and the 6th NPT Review Conference will engage the international community in examining how the Agency safeguards system can continue to support the goal of nuclear non-proliferation. ❐

HISTORICAL PERSPECTIVE: THE EVOLUTION OF SAFEGUARDS

THE CALL FOR INTERNATIONAL SAFEGUARDS

The evolution of the Agency safeguards system began in the late 1950s and continues as the 21st century opens. The initial call for international safeguards can be traced to fear about the uncontrolled spread of nuclear weapons technology. This led the United States, the United Kingdom and Canada to declare, in 1945, that safeguards and inspections would be a pre-condition for access to the peaceful uses of nuclear energy. In 1946, the United States launched the first broad scheme to prevent nuclear weapons by proposing to assign responsibility for promoting nuclear energy to the United Nations. The scheme, known as the Baruch Plan from the name of the US delegate who presented it to the United Nations, was considered too visionary and was abandoned soon thereafter. In 1953, US President Eisenhower put forward to the United Nations General Assembly less radical proposals for achieving nuclear disarmament and promoting the peaceful use of nuclear energy. Collectively named "Atoms for Peace", the proposals were the basis for the IAEA Statute of 1957.

Created in 1957 as an autonomous intergovernmental organization in the United Nations family, the IAEA was assigned dual responsibilities. The twin role called for promoting the safe and peaceful use of nuclear energy and for providing assurances that nuclear energy is not being misused for non-peaceful purposes. The IAEA was mandated to *"establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities and information made available by the Agency or at its request, or under its supervision or control, are not used in such a way as to further any military purpose, and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy."*

The early applications of safeguards resulted from the concern that, without strict monitoring, international nuclear trade could lead to nuclear proliferation. This concern was implicit in a number of agreements of the early 1950s requiring that safeguards be applied to civilian nuclear technology transfers. As international commerce in nuclear commodities expanded, safeguards became increasingly the customary and, after the 1960s, the obligatory condition for nuclear trade.

THE EARLY SAFEGUARDS SYSTEM

While States welcomed the newly created Agency, there was some initial resistance to the implementation of IAEA safeguards. The early safeguards system (set forth in IAEA document INFCIRC/26) covered only the research and experimental reactors of that time. The IAEA Board of Governors approved the system only after divisive debate and with severe constraints on Agency safeguards implementation. From 1965-67, the Agency was able to reach agreement for the first set of safeguards measures for reactors of all sizes and, subsequently, for reprocessing plants and for fuel fabrication plants. These safeguards measures are set forth in IAEA document INFCIRC/66/Rev.2. This experience in safeguards implementation proved to be invaluable, and the international community became increasingly determined to take more comprehensive initiatives for nuclear non-proliferation.

THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS (NPT) & IAEA SAFEGUARDS

Until the late 1960s, it had been at the discretion of any State to accept or apply Agency safeguards on any nuclear transaction or activity, or to proceed without safeguards. In 1967, the nations of Latin America and the Caribbean agreed on the first treaty outlawing nuclear weapons in a region (the Treaty for the Prohibition of Nuclear Weapons in Latin America, or the "Tlatelolco Treaty", reproduced in IAEA document GOV/INF/179). The approval of the Tlatelolco Treaty required its parties to not only abjure nuclear weapons but also accept Agency safeguards on all their nuclear activities. In 1968, the arm of the United Nations that negotiates treaties on arms control and disarmament (then known as the eighteen-nation Disarmament Committee and today as the sixty-nation

Conference on Disarmament) agreed on the text of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). That year, the United Nations General Assembly commended the Treaty to the United Nations Member States, and in 1970 the NPT entered into force.

The NPT is the only global nuclear non-proliferation treaty that, *inter alia,* obliges each non-nuclear-weapon State party to renounce nuclear weapons and conclude agreements with the Agency for the application of safeguards to all source material and special fissionable material in that State's peaceful nuclear activities, within six months of its adherence to the Treaty. The Treaty also obliges the five nuclear-weapon States recognized by the NPT (China, France, the Russian Federation, the United Kingdom and the United States) to undertake negotiations in good faith towards nuclear disarmament.

Subsequently, the IAEA Board of Governors' Safeguards Committee specified in detail what safeguards should be applied pursuant to the Agency's comprehensive safeguards agreements with the non-nuclear-weapon States party to the NPT. This document, published as INFCIRC/153 (Corrected) and approved by the Board in 1971, has served as the basis for all comprehensive safeguards agreements that States have concluded with the Agency.

The document has also provided the technical elements of the voluntary offer safeguards agreements which the Agency has concluded, in time, with each of the five nuclear-weapon States party to the NPT. Under such agreements, each State has voluntarily offered all or certain civilian nuclear material and/or facilities from which the Agency may select for the application of safeguards.

SUPPORTIVE ELEMENTS OF THE NUCLEAR NON-PROLIFERATION REGIME

Controlling Nuclear Exports. A supportive element of the non-proliferation regime is the restraint that many States apply to their exports, to non-nuclear-weapon States, of nuclear commodities which could be used to produce nuclear weapons. For example, in the early 1970s the international committee chaired by Claude Zangger of Switzerland developed guidelines that list those nuclear items whose export would trigger the application of Agency safeguards. The "Zangger Committee", as it became known, is not a committee of the Agency, but its "trigger list"would eventually serve as a basis for the information on nuclear exports that major exporting States agreed, in 1993, to report voluntarily to the Agency and for the reports required from States that accept the Model Additional Protocol.

In addition, in 1977 the Nuclear Suppliers''Group (NSG) developed guidelines that incorporate the "trigger list" but go further to require that safeguards be imposed on exported nuclear technology and that its members practice restraint in exporting sensitive technologies (e.g., fuel reprocessing and uranium enrichment). Subsequently, the NSG added the requirement that comprehensive safeguards be applied as a condition for the supply of any "trigger list" item to a non-nuclear-weapon State.

Following the disclosure in 1991 of the role played by "dual-use" items in the evolution of Iraq's nuclear weapon programme, the NSG guidelines were amplified to include a separate list of more than 60 dual-use items. (Dual-use items are items that can be used for either a nuclear purpose or for another purpose or for a variety of non-nuclear purposes.) Agreement was reached among NSG members on means to ensure that the export of such items would be subject to effective controls and licensing. As of late 1999, there were 35 Member States of the NSG, representing practically all of the major nuclear exporters.

Physical Protection of Nuclear Material. Physical protection of nuclear material is also regarded as a fundamental element of the non-proliferation regime. While international safeguards are designed to detect and deter certain actions by States, "physical protection" comprises those measures that the States themselves apply to prevent or deter illegal actions taken against nuclear facilities and nuclear materials, particularly when such materials are transported across national frontiers.

The Convention on the Physical Protection of Nuclear Material, which opened for signature by States in 1980, establishes international standards for the protection of nuclear material in international transit. With increased awareness of the need to protect nuclear material from unauthorized acts, the international community is working to strengthen the physical protection regime. Discussions are under way regarding the possible broadening of the scope of the Convention. Upon request, the Agency has

provided assistance to States to enhance their efforts to prevent nuclear material and other radioactive sources from being used illegally and to detect and respond to trafficking cases, should they occur. These activities have included international assessments of State's physical protection systems and training for staff involved in physical protection at nuclear facilities and at the State level.

CHALLENGES TO NPT SAFEGUARDS

The closing decade of the 20th century brought a number of challenges for international safeguards.

The Clandestine Nuclear Programme in Iraq. In 1991, soon after the end of the Gulf War, IAEA inspectors discovered that Iraq had carried out an extensive clandestine programme for producing enriched uranium for use in nuclear weapons. The Government of Iraq had also progressed in secretly designing and constructing prototypes of such weapons. In doing so, Iraq violated its NPT commitment and safeguards obligations to place all of its nuclear material under safeguards.

Since then, the Agency's safeguards obligations in Iraq have been subsumed in the mandate assigned to it by resolutions of the United Nations Security Council, in particular Resolution 687. Under that Resolution, the IAEA Director General was asked to remove, destroy or render harmless Iraq's ability to produce nuclear weapons. This work has been carried out by a specially constituted Action Team reporting directly to the IAEA Director General. The United Nations Special Commission (UNSCOM) was also created to address biological and chemical weapons and long-range missiles.

By mid-1998, the Agency had pieced together a coherent picture of Iraq's nuclear weapons programme; having removed, destroyed or rendered harmless the elements of that programme, it was prepared to shift emphasis to the ongoing but limited monitoring and verification plan for providing assurance that the relevant capabilities were not re-established.

On 31 October 1998, Iraq ceased all cooperation with UNSCOM. Although the Government of Iraq placed no additional restrictions on the Agency's work, the IAEA Director General decided, on 16 December 1998, to withdraw Agency personnel from Iraq out of concern for the security and safety of the personnel. Under these circumstances, the Agency has not been in a position to resume the full implementation of its verification and monitoring plan and therefore to provide assurance about Iraq's compliance with its obligations under the Security Council resolutions. Nevertheless, the Agency continues to be ready to resume its activities in Iraq.

Under responsibilities entrusted to the IAEA in 1991 by the UN Security Council , the Agency carried out nuclear inspections in Iraq to remove, destroy or render harmless Iraq's ability to produce nuclear weapons. (Credit: Mouchkin/IAEA)

The DPRK and the Issue of "Completeness". One year after the discovery of Iraq's undeclared nuclear programme, the safeguards system was again challenged when IAEA inspectors sought to verify the DPRK's initial report on its nuclear material subject to safeguards. The DPRK had acceded to the NPT in 1985, but it was seven years later that the Government finally concluded a comprehensive safeguards agreement with the Agency and submitted the required initial report.

When IAEA inspectors sought to verify the presence of the nuclear material listed in the initial report and the completeness of the information with respect to all of the material subject to safeguards, they identified inconsistencies between the Government's declaration and their own findings on the characteristics and amount of plutonium reprocessed at a large radiochemical laboratory in the DPRK. These inconsistencies suggested that the Government may not have provided complete information about the quantity of plutonium it actually possessed. In addition, information made available to and assessed by the

Agency indicated that two undeclared facilities of the type normally used for storing nuclear waste were located near the officially notified nuclear facilities.

The DPRK rejected the Agency's request for physical access to these two facilities, whereupon the IAEA Director General, with the backing of the Board of Governors, called upon the DPRK to accept a "special inspection" which the Agency was authorized to conduct under the safeguards agreement. Again the Government refused, and the Board concluded that the DPRK was in violation of its safeguards agreement and reported the violation to the United Nations Security Council.

Subsequent bilateral negotiations between the United States and the DPRK resulted, in 1994, in an "Agreed Framework" under which the DPRK would "freeze" further development and operation of its key nuclear facilities.*

At the request of the Security Council, the Agency has been monitoring this "freeze". Despite numerous rounds of technical discussions, as of late 1999, the Agency is still not able to verify the correctness and the completeness of the Government's initial report and to conclude that there has been no diversion of nuclear material in the DPRK.

South Africa: Nuclear Transparency Exemplified. The verification of the completeness of an initial report is particularly challenging in the case of a State that concludes a comprehensive safeguards agreement after it has already produced (or is suspected as having produced) significant quantities of nuclear weapon-usable material. Such a situation arose in 1991, when South Africa acceded to the NPT, concluded its comprehensive safeguards agreement with the Agency and submitted an initial report on its nuclear material subject to safeguards.

Four days after South Africa concluded its safeguards agreement, the IAEA General Conference formally requested the IAEA Director General to verify the completeness of the Government's initial report on its nuclear material and facilities subject to safeguards. South Africa's extensive nuclear fuel cycle made the verification task complex, requiring considerable inspection resources.

The verification task was further complicated when, in 1993, the President of South Africa openly disclosed that, between 1979 and 1989, South Africa had made and subsequently dismantled a "limited nuclear deterrent capability" involving a number of nuclear weapons. Agency assurances would have to be given that all of the substantial quantity of highly enriched uranium formerly associated with the nuclear weapons programme had been made subject to safeguards at the time the agreement entered into force and that the material was declared as such in the initial report. In addition to such verification activities, the Agency was requested by the South African Government to assess the termination of its former nuclear weapons programme.

These activities were greatly facilitated by the full cooperation and openness of the South African authorities with respect to access to information in historical operating records and physical access to locations, including defunct facilities. Based on its extensive activities in South Africa to verify the Government's initial report and to assess the status of the former nuclear weapons programme, in 1995 the Agency concluded that the information provided on the nuclear material was complete and that the nuclear weapons programme was terminated and dismantled. These activities represented the first international undertakings to ascertain that all the fissile material produced by a State that had made nuclear weapons had been satisfactorily accounted for. As requested by the South African Government, the Agency continues to monitor those facilities associated with the former nuclear weapons programme.

PAVING THE WAY FOR A STRENGTHENED SAFEGUARDS SYSTEM

Iraq's violations of its comprehensive safeguards agreement vividly demonstrated that, although the safeguards system was effective with regard to declared nuclear material, it was not sufficiently equipped to detect the presence of undeclared nuclear material and activities. To do so, the Agency would need substantially stronger safeguards measures and the expanded legal authority to apply these measures beyond that provided under comprehensive safeguards agreements. Starting in 1990, the Agency and its Members States took actions that paved the way for the strengthened safeguard system. *(See page S-20.)*

For example, following language agreed upon by members of Committee II of the 4th NPT Review Review Conference, the Agency studied the procedures for special inspections in States with comprehensive safeguards agreements, where uncertainty existed about whether a State had declared all of its nuclear material subject to Agency safeguards. The outcome of this examination was reported to the Board, which in 1992 endorsed a more vigorous use of the Agency's right under comprehensive safeguards agreements to carry out a special inspection to any location within the

territory of a State or under its control, if the Agency judges that the State has not provided all the required information about its nuclear material or, more generally, when the Agency requires more information to fulfil its responsibilities under the safeguards agreement.

Further, in 1992, the Board affirmed that the scope of a comprehensive safeguards agreement is not limited to the nuclear material declared by a State but includes all of the State's nuclear material that should have been declared. The Board also reaffirmed the Agency's right of access to the United Nations Security Council, which is the sole international authority to enforce safeguards agreements. The cases of Iraq and the DPRK each had elicited responses from the Security Council.

The Board also stipulated that States supply, in a more timely manner, safeguards relevant design information for new facilities and for changes or modifications to existing facilities, and it confirmed the Agency's right to verify the validity of the design information over the lifecycle of a facility. The Board also endorsed the reporting scheme by which major nuclear suppliers would voluntarily provide the Agency with information (not required under comprehensive safeguards agreements) about their exports and imports of nuclear material, specialized nuclear equipment and non-nuclear material of nuclear interest.

The strengthening process received further impetus in 1993 when, at the request of the IAEA Director General, SAGSI (the group of international experts providing advice on safeguards implementation) made a series of recommendations, particularly for providing assurances about the absence of undeclared nuclear activities in States having comprehensive safeguards agreements. As requested by the Board, the IAEA Secretariat systematically studied the technical, legal and financial implications of these recommendations, launching a development programme that became known as "Programme 93+2". A number of Member States provided assistance, for example, by conducting field tests of environmental sampling and other proposed strengthening measures as they were developed by the Secretariat.

In June 1995, the Board approved the Secretariat's proposals for strengthening the effectiveness and improving the efficiency of safeguards. The Board agreed to the IAEA Director General's plan to proceed with the implementation of those measures deemed to be within the legal authority provided by comprehensive safeguards agreements. Work in this direction began in early 1996.

At the 1999 IAEA General Conference, States reaffirmed their support for the development of an integrated safeguards system. (Credit: D. Calma/IAEA)

Negotiation & Approval of the Model Additional Protocol. The Board also set itself the task of securing the legal basis for applying other strengthening measures aimed at providing the Agency with substantially more information than hitherto available about the nuclear programmes of States, and with the right of IAEA inspectors to have access to relevant locations in a State in order to confirm the exclusively peaceful nature of that State's nuclear programme.

In June 1996, the Agency, the Board and its "Committee 24" (with representatives from some 70 Member States and two regional inspectorates) drew up the model text of a protocol additional to safeguards agreements. The final product, known as the Model Additional Protocol, was approved by the Board on 15 May 1997; it was published as IAEA document INFCIRC/540 (Corrected). To promote widespread adherence, the Board requested the IAEA Director General to negotiate and conclude Additional Protocols or other legally binding agreements with all States that are prepared to accept measures provided for in the Model Additional Protocol.

Thereafter, the Agency began preparations for the implementation of the strengthening measures to be applied under the legal authority conferred by Additional Protocols concluded on the basis of the Model Additional Protocol. ❐

PAVING THE WAY FOR THE STRENGTHENED SAFEGUARDS SYSTEM: A CHRONOLOGY OF EVENTS

1990

■ The 4th NPT Review Conference (Committee II) agreed to language welcoming an IAEA study of procedures for special inspections in States with comprehensive safeguards agreements where uncertainty existed about whether a State had declared all nuclear material subject to Agency safeguards. Subsequently, the IAEA Secretariat undertakes such an examination and reports to the IAEA Board of Governors on the outcome.

1991

■ The IAEA General Conference confirms the Agency's obligation to provide assurances regarding the completeness of South Africa's initial report on its nuclear material and facilities subject to safeguards under its IAEA comprehensive safeguards agreement.

1992

■ The IAEA Board affirms the scope of comprehensive safeguards agreements is not limited to the nuclear material declared by a State but includes all nuclear material subject to safeguards.

■ The IAEA Board confirms the Agency's right under comprehensive safeguards agreements to carry out a special inspection to any location within the territory of a State or under its control, when it judges that the State concerned is not providing all the required information about its nuclear material or, more generally, when the IAEA needs more information to fulfil its responsibilities under the safeguards agreement.

■ The IAEA Board reaffirms the Agency's right of access to the UN Security Council, which is the sole international authority to enforce safeguards agreements.

■ The IAEA Board approves measures related to State's early provision of design information for facilities handling safeguarded material and confirms the Agency's right to verify the design information over the facility lifecycle, including decommissioning.

1993

■ The IAEA Board endorses the scheme for voluntary reporting by States on their imports and exports of nuclear material and exports of specified equipment and non-nuclear material

■ The Standing Advisory Group on Safeguards Implementation (SAGSI), as earlier requested by IAEA Director General, makes recommendations for strengthening safeguards, particularly for providing assurances about the absence of undeclared nuclear activities in States.

■ The IAEA Board requests the IAEA Secretariat to study the technical, legal and financial implications of SAGSI recommendations and to make proposals for more effective and efficient safeguards.

■ The IAEA Secretariat begins work on developing possible strengthening measures, assisted by a number of Member States.

1995

■ The 5th NPT Review and Extension Conference reiterates its support for a strengthened safeguards system as an fundamental element of the international nuclear non-proliferation regime.

■ The IAEA Board, and then the General Conference, approve the IAEA Secretariat's proposals for a more effective and efficient safeguards system. The Board agrees to the Director General's plan to proceed with implementation of strengthening measures deemed to be within the legal authority provided by comprehensive safeguards agreements.

1996

■ The IAEA starts implementing the strengthening measures provided under comprehensive safeguards agreements.

■ The IAEA Board's "Committee 24" begins developing the legal instrument for implementing the strengthening measures that are not provided for under safeguards agreements.

1997

■ The IAEA Board, in May, approves the text of the Model Protocol Additional to Safeguards Agreements, subsequently published as INFCIRC/540 (Corrected); it requests the Director General to negotiate and conclude Additional Protocols or other legally binding agreements with all States that are prepared to accept measures provided for in the Model Additional Protocol.

■ The IAEA Secretariat begins implementing the strengthening measures provided under the Model Additional Protocol.

DECEMBER 1999

■ The IAEA Board has approved 46 Additional Protocols; eight of these have entered into force.