IAEA symposium on international safeguards: Mirror of the times

Built upon the old, a reinforced nuclear verification system is emerging in response to new demands and rising expectations

by Lothar H. Wedekind and James A. Larrimore

If scientific meetings had theme songs, the more than 400 participants at the IAEA's safeguards symposium earlier this year might have entered the opening session to "The times they are a changin..." For some, perhaps too rapidly. For others, not fast enough.

"International safeguards has moved from a phase of consolidation in the 1980s to a phase of transition in the 1990s as we respond to dynamic political and technological developments," Mr. Bruno Pellaud, IAEA Deputy Director General for Safeguards, said in opening the meeting. "Verifying activities in countries having extensive nuclear programmes has led to actions and ideas for new verification activities designed to reinforce the conventional safeguards system." *(See the article beginning on page 2.)*

In many respects, the international safeguards community is carefully bridging its past and future in response to new demands and rising expectations. Yesterday's exclusive focus on safeguarding *declared* stocks of nuclear material is being linked to today's need to detect *undeclared* nuclear activities and to tomorrow's possible demand to verify nuclear material once contained in nuclear weapons.

Exactly where the changing times lead the IAEA as the world's international nuclear safeguards inspectorate remains to be seen. So far, over the past 4 years, they have taken nuclear inspectors on different assignments to some highly publicized places: Iraq, under mandate of the UN Security Council to oversee dismantlement of a clandestine nuclear-weapons programme; South Africa, to examine sites connected to a terminated nuclear-weapons programme; the Democratic People's Republic of Korea (DPRK) to verify declared nuclear activities and clarify associated ambiguities; to Argentina and Brazil, to prepare for safeguards under a comprehensive quadripartite safeguards agreement; and Belarus, Kazakhstan, Ukraine, and other countries of the former Soviet Union to lay the groundwork for verifying the peaceful nature of their large nuclear programmes.

On the horizon, new destinations and tasks are coming into view. Discussions in Geneva and elsewhere include talk of the IAEA's potential role concerning, among other things, verification of a comprehensive nuclear test ban treaty and of a treaty prohibiting production of plutonium and highly enriched uranium for nuclear explosives.

During the week-long symposium at IAEA headquarters in March 1994, experts from 42 countries examined technological and political sides of these subjects — and more. In all, some 200 papers were presented at 20 sessions on safeguards technologies, monitoring systems, analytical methods, operational criteria and approaches, and other topics. Nuclear safeguards is a broad field encompassing an array of technical and scientific disciplines. The highly integrated verification system is applied to nuclear material in more than 800 facilities around the world. Key elements are inspectors, who conduct on-site inspections, and various types of instrumentation and computerized equipment, which are used for verifying operator records; monitoring and analyzing nuclear material; and for evaluating safeguards information.

Many of the new safeguards systems and approaches are in various stages of research and development, including application at specific facilities. Invariably the systems illustrate the growing impact of computerization in the safeguards field. Unattended computer-based verification systems, for example, have been developed for use at complex, highly automated nuclear facilities for measuring and monitoring

Mr. Wedekind is Chief Editor of IAEA Periodicals and an information officer in the IAEA Division of Public Information. Mr. Larrimore — a senior staff member in the Office of the Deputy Director General for Safeguards — was the Scientific Secretary of the safeguards symposium.

materials. Digital imaging, processing, and storage of data also are seen as having a fundamental impact on the IAEA's surveillance measures. Additionally, techniques of environmental sampling are being tested and applied for verification purposes, as in Iraq, for example, where the method is part of the IAEA's long-term monitoring plan. The techniques allow for chemical and isotopic analysis of minute samples of water, soil, biota, and other materials. *(See the article beginning on page 20.)*

More informally, the safeguards symposium offered insight into the thinking of leaders in the field of nuclear non-proliferation and verification. Mr. Pellaud and four former heads of the IAEA's Department of Safeguards reflected upon the system's evolution and changing operational priorities over the past three decades *(see box, page 13)* while a final panel session of distinguished experts looked to the future from political, financial, and policy perspectives. *(See "Viewpoints", page 16.)*

By week's end, participants had gained valuable insights into the "old" and "new" sides of safeguards, from political, economic, and technological perspectives. One message seemed clear: However the vision for the future unfolds, there appears to be no turning back.

A selective topical overview of the symposium follows:

Safeguards experience

In reviewing the IAEA's safeguards experience since 1986, three senior Agency officials — Messrs. D. Schriefer, D. Perricos, and S. Thorstensen — looked closely at operational demands being faced in response to what they described as "an entirely new scenario of events". More States have placed facilities and nuclear material under international safeguards, and new approaches have had to be devised for new types of facilities, all done under "severe contraints" from the IAEA's budget. Over the 1986-92 period, they noted, the amount of nuclear material under safeguards, in terms of significant quantities (SQs), almost doubled, reaching 65 878 SQs in 1992. Plutonium, both separated and that contained in irradiated fuel, makes up most of these SQs.

The growth is expected to continue through this decade, as nuclear programmes in Argentina, Brazil, Belarus, Kazakhstan, and Ukraine, for example, come under comprehensive IAEA safeguards. Estimates of nuclear material under safeguards up to 1999 indicate an increase of about 60% for plutonium, 40% for low-enriched uranium, and 35% for source material. Projected increases for highly enriched uranium depend upon how much material from former weapons programmes is placed under IAEA safeguards. Additionally, in terms of facilities, about 40 more power reactors will begin operating under safeguards before the end of 1996, they reported. Other, more complex nuclear installations, including reprocessing and enrichment plants, also are coming under IAEA safeguards.

Encouraging progress in reducing the IAEA's inspection effort in the European Union was reported by Mr. Thorstensen and Mr. K. Chitumbo of the IAEA Department of Safeguards. This is occurring through a programme for greater co-operation between the IAEA and Euratom called the New Partnership Approach.

In an informative session on systems for accounting and control of nuclear material, a number of presentations offered insights from national and regional perspectives. Mr. W. Gmelin of the Commission of the European Communities (CEC) reviewed the role of the Euratom inspectorate in international safeguards; Mr. Y. Motoda, Executive Director of Japan's Nuclear Material Control Centre, updated its activities and looked at Japan's expectations from the IAEA's work to strengthen and streamline safeguards; Mr. Dong-Dac Sul, Director of the Nuclear Control Division in the Republic of Korea's Ministry of Science and Technology, reviewed the country's substantial inspection effort and noted that a technical centre had been set up to interface with the IAEA and to interact with the Democratic People's Republic of Korea; and Mr. Jorge A. Coll, Secretary of the Brazilian-Argentine Agency for the Accounting and Control of Nuclear Material (ABACC), reported on ABACC's role and activities. *(See related article beginning on page 30.)*

Experience in Iraq. The IAEA's activities and experiences in Iraq under terms of United Nations Security Council resolutions were reviewed by Prof. Maurizio Zifferero, Head of the IAEA's Action Team. After more than 20 inspections in Iraq since May 1991, the emphasis now has shifted to preparing for, and gradually implementing, elements of the IAEA's long-term monitoring plan. *(See the article on nuclear inspections in Iraq beginning on page 24.)*

Verification in South Africa

When South Africa in March 1993 announced its dismantlement of a former nuclear-weapons programme, the IAEA's ongoing verification of the country's extensive nuclear programme took on an added dimension, reported Messrs. Garry Dillon and Demetrius

Perricos, senior IAEA safeguards officials. IAEA inspectors already had been verifying South Africa's declared nuclear inventory under a safeguards agreement concluded in 1991 pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). When the former nuclear-weapons programme was disclosed, the IAEA's role was extended to assess the abandoned programme's status and to ascertain that all related nuclear material had been recovered and placed under safeguards. With the co-operation of South African authorities under its stated policy of "transparency", the IAEA augmented its verification teams with nuclear-weapons experts and other specialists from outside the Agency. Teams visited all facilities identified as having connection with the former nuclear-weapons programme. They found "no indication to suggest that there remained any sensitive components of the nuclear-weapons programme which had not been either rendered useless or converted to commercial non-nuclear applications or peaceful nuclear usage."

From the South African perspective, the verification was an exercise in the application of "post-Iraq safeguards". Messrs. N. von Wielligh and N.E. Whiting of South Africa's Atomic Energy Corporation said that "the totally changed safeguards environment" following the discovery of a clandestine nuclear-weapons programme in Iraq influenced the verification process in South Africa. In offering a number of "lessons learned", they emphasized the importance of openness and transparency for both the State and the international inspectorate. "A situation of mutual trust should and can be built up in a spirit of complete openness and co-operation by both sides," they said. "The international community should visibly support an impartial and independent IAEA — South Africa will surely do its part."

Safeguards in newly independent States

No fewer than 13 newly independent States of the former Soviet Union have substantial nuclear activities: Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Khyrgistan, Latvia, Lithuania, Russia, Tajikistan, Urkraine, and Uzbekistan. With the exception of Russia, all have declared their intention either to become or to remain non-nuclear weapon States.

Since 1992, the IAEA has been working with newly independent States to help them establish or further develop their State Systems for Nuclear Accountancy and Control (SSACs), and to strengthen the physical protection of nuclear materials and facilities and the regime for import and export control. Mr. Thorstensen of the IAEA reported that the work has included 24 fact-finding missions/technical visits, 16 training events, and co-ordinated technical support in specific areas. He noted that several countries, including Canada, Finland, Germany, Hungary, Japan, Sweden, United Kingdom, and United States, have expressed their intention to help newly independent States improve their SSACs by supporting, for example, training and equipment needs.

"The IAEA is fulfilling a vital function in institution and capacity building in the newly independent States," reported Mr. Thorstensen. "Much remains to be done, but much is already under way."

The situation in Ukraine was updated by Messrs. A. Glukhov and N. Steinberg of the Ukrainian State Committee on Nuclear and Radiation Safety, whose responsibilities include the implementation of domestic and international safeguards. They noted the progress made on a comprehensive safeguards agreement with the IAEA covering all nuclear material in all peaceful nuclear activities. This agreement would remain in force until superseded by an agreement pursuant to the NPT once Ukraine fulfills its pledge to join the Treaty as a non-nuclear weapon State. (The agreement was concluded in June 1994, and now goes to the IAEA Board of Governors for approval.)

Improving technical capabilities

Early in 1995, the IAEA is expected to present results to its Board of Governors of a 2-year programme — known as "93+2" — to strengthen the safeguards system and make it more cost effective. In describing efforts, Mr. Richard Hooper, who is heading the IAEA programme, noted that a number of countries are hosting field trials of possible new elements, including environmental monitoring. The programme has two basic objectives. One is to strengthen the system's capability to detect undeclared facilities and activities in States having comprehensive safeguards agreements, in particular through the use of more sources of information and greater access for inspection. The other is to improve the cost effectiveness of conventional safeguards through the introduction of new technology and possible changes in approaches and procedures.

Among specific areas of emphasis for the future development of safeguards are advanced systems for information management and remote monitoring; environmental monitoring; and the use of commercial satellites.

Information management. Advanced tools for managing the large volume and diversity of

safeguards information are being developed and evaluated. Extensive safeguards information is needed by the IAEA, noted Mr. John Rooney of the US Department of Energy. "The ability to acquire, review, store, analyze, validate, and retrieve large volumes of such information will provide a challenge to the existing IAEA information management system," he said. An enhanced system now is being designed for monitoring nuclear activities on a global scale by making better use of information obtained through safeguards inspections as well as from other sources, he said.

Remote monitoring. The technology for transmitting a wide variety of information to off-site locations, generally known as remote monitoring, is in widespread industrial use, and not new to safeguards. The fast pace of technological advances, however, has opened up possibilities, reported Messrs. Cecil S. Sonnier and Charles S. Johnson from Sandia National Laboratories in the United States. They specifically looked at the integration of video surveillance and electronic seals with a variety of monitors. Such advanced systems are installed in several nuclear facilities in France, Germany, Japan, the United Kingdom, and the United States, they noted. Remote monitoring systems are being tested in field trials involving the United States and Australia, and future trials are expected to involve several facilities in Europe, North America, and the Far East. The aims are to demonstrate that the systems can save inspection resources while maintaining safeguards effectiveness, and to promote international acceptance of such systems for safeguards applications. While the technology itself presents "a rather minimal challenge," they pointed out that the situation is "complicated by policy issues related to State rights, transparency, safeguards criteria, and other issues."

Environmental monitoring. In looking at the prospects of environmental monitoring for the detection of undeclared production of plutonium and highly enriched uranium, Mr. G. Andrew of the United Kingdom's Department of Trade and Industry drew upon the technical advice, recommendations, and conclusions of a consultants' group meeting convened by the IAEA in March 1993. The approach involves the analysis of environmental samples to detect releases of radionuclides and other signs that provide "signatures" of key nuclear fuel cycle activities. The results of such monitoring are then compared with known activities that have been declared by States. He pointed out that the evaluation of environmental monitoring techniques should take into account possible complicating factors. These include the presence of radionuclides in the environment from nuclear-weapons testing and from commercial nuclear operations.

"Environmental monitoring, and indeed other sources of information, is unlikely to be able to deliver definitive proof one way or the other as to the existence of undeclared activities," he cautioned. "While the techniques are powerful, they will not provide an absolute guarantee that no undeclared facilities exist in a State. Subject to confirmation by the IAEA's ongoing evaluation programme, environmental monitoring should, however, provide the Agency with a range of potentially powerful tools to allow reasonable questions to be raised, and hopefully resolved, with a State about its nuclear programme."

Commercial satellites. The photographic data from commercial satellites may be useful in safeguards, yet there are political and technical

Sweden and other countries have invited field trials under an IAEA safeguards project on environmental monitoring.
(Credit: Hosoya, IAEA)

questions that remain to be solved, according to Mr. W. Fischer, W.-D. Lauppe, B. Richter, and G. Stein of the Jülich Nuclear Research Centre in Germany, and Mr. B. Jasani of King's College in London. Currently, they reported, six countries, including the United States, France, Russia, India, and Japan, have launched and operated civil remote sensing satellites, with a combined nine long-term satellites in orbit. While their possible use for safeguards holds limitations, preliminary evaluation of some commercial satellite images has demonstrated that known nuclear facilities can be readily observed, which suggests a potential for detecting undeclared nuclear activities.

These are just some areas drawing attention in the ongoing research and development (R&D) side of IAEA safeguards. All told, the Agency's R&D needs comprise 66 main items that are primarily being met through Member State Support Programmes, reported Mr. V. Pouchkarev, who heads the Systems Studies Section of the IAEA Safeguards Division of Concepts and Planning. More than 200 specific tasks are under way.

Possible new verification tasks

Some new verification tasks for the IAEA are closer in view than others. Beginning this year, the United States intends to submit excess fissile material to safeguards under its voluntary offer agreement with the IAEA, reported Ambassador John Ritch III. He pointed out that this will be the first instance in which the IAEA will play a role in verifying certain aspects of the disarmament process. The material will be in various forms, including weapons components. The projected schedule foresees several tons in non-sensitive forms of highly enriched uranium at Oak Ridge submitted in 1994, followed by plutonium in non-sensitive oxide and metallic forms at Hanford and Rocky Flats. Approaches for future inspections of weapons components are under study. He also noted that the US and Russia have signed a joint declaration regarding the placement of excess weapons material under IAEA safeguards.

The Ambassador further outlined features of President Clinton's proposal of September 1993 for an international treaty prohibiting the production of highly enriched uranium and separation of plutonium for nuclear explosives, which the United Nations General Assembly endorsed in October 1993.

"The United States does not envisage the treaty as prohibiting the production of highly enriched uranium or the separation of plutonium for civil nuclear activities under safeguards, nor does it see the convention as requiring full-scope safeguards," he said. "It would, however, have the important effect of imposing a 'cap' on the fissile material available to the treaty's members — both nuclear-weapon States and non-nuclear weapon States — for nuclear explosives." In emphasizing the importance of verification, he said that the United States "sees the IAEA as the appropriate agency to carry out this role."

Non-proliferation policies

How the IAEA's safeguards system evolves during this decade will depend in no small measure on the outcome of the 1995 Conference on the review and extension of the NPT, which will take place in New York 17 April to 12 May 1995.

In reviewing major policy and institutional issues before the Conference, Mr. Mohamed El-Baradei, IAEA Assistant Director General, noted that most of the parties already have declared themselves in favour of the Treaty's indefinite extension, while others have advocated extension for a fixed period of time, accompanied by a mechanism to enable further extensions.

"The IAEA has a major interest in the outcome of the 1995 Conference because of the impact on the application of Agency safeguards," he said. "The majority of the safeguards agreements under which the Agency implements safeguards are those pursuant to the NPT...It is to be hoped that whatever the outcome of the Conference, it would be one that fosters the cause of non-proliferation and efforts for its universalization." ❐

The symposium was the seventh in a series on the subject that the IAEA has convened since 1965. The 1994 meeting was organized by the IAEA in co-operation with the American Nuclear Society, the European Safeguards Research and Development Association, the Institute of Nuclear Materials Management, and the Russian Nuclear Society. It had the twin objectives of encouraging and assisting safeguards-related R&D at the national level, and of providing an impartial, factual technical basis to help guide discussions and the formulation of nuclear non-proliferation policies by governments and international organizations. The IAEA expects to return to a 4-year frequency for safeguards symposia, with the next one foreseen for early 1998, unless developments call for an earlier schedule. Proceedings of the 1994 symposium are available for purchase from the IAEA or its sales outlets in Member States. See the Keep Abreast section for ordering information.