Nuclear Safeguards in Challenging Times

by Wan Sou Park and Jan Hillerman

Experts on nuclear safeguards and verification assess the global picture.

Meeting at the IAEA's International Safeguards Symposium in October 2006, more than 500 experts from 60-plus countries and organizations addressed current and future challenges related to safeguards concepts, approaches, technologies, and experience. Sessions addressed five main issues driving developments:

❶ Current challenges to the safeguards system;

❷ Further strengthening safeguards practices and approaches;

❸ Improving the collection and analysis of safeguards information;

❹ Advances in safeguards techniques and technology; and

❺ Future challenges.

Every four to five years, the IAEA brings together safeguards experts from all over the world at international symposia. In October 2001, they met in the shadow of '9/11' and the symposium included a special session on the prevention of nuclear terrorism.

A Changing Scene

Five years later, in 2006, the focus was on the fast-changing and challenging global environment of international safeguards. Opening and keynote speakers set the scene: IAEA Director General Mohamed ElBaradei; Ms. N.J. Nicholas, President of the Institute of Nuclear Materials Management and Mr. J. Joly, President of European Safeguards Research and Development Association, co-sponsors of the meeting; H.E. Mr. A.S. Minty, South Africa's Governor on the IAEA Board of Governors; H.E. Mr. A. Piebalgs, Commissioner for Energy of the European Commission; H.E. Mr. S. Kislyak, Deputy Foreign Minister of the Russian Federation; H.E. Mr. R. Ekeus, Chairman of the Stockholm International Peace Research Institute; and Mr. Y. Matsuo, Managing Director of Japan Nuclear Fuels, Ltd.

The speakers made clear that the nuclear non-proliferation regime, centered on the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), is under stress and facing new challenges. The political and non-proliferation landscape has changed dramatically over the years. One significant factor is increasing globalization, which complicates the already difficult task of seeking to ensure that nuclear material and infrastructure are used exclusively for peaceful purposes.

In this respect, although the IAEA safeguards system has been strengthened, safeguards constantly aim at 'moving targets' and the system will have to be even more robust to 'stay ahead of the game', as some speakers put it. Particularly significant is the expected resurgence and future expansion of nuclear energy. This is to be welcomed, from the perspective of economic and social development, but will result in wider dissemination of nuclear technology—some of it highly sensitive.

This strikes a somber note at a time when concerns over nuclear proliferation and the threat of nuclear terrorism loom large. The root causes of the tensions underlying such developments need to be addressed and solutions are largely outside the remit of the IAEA. The symptoms, however—some of which certainly fall within the scope of the IAEA's mandate—also need to be addressed.

The speakers emphasized the vital importance of supporting the IAEA's verification mandate, especially through the provision of adequate political support and resources. In that context, it is crucial further to strengthen the IAEA's ability to detect undeclared nuclear material and activities in contravention of safeguards agreements.

A technical plenary session further developed the opening themes. Some speakers stressed that the entry into force of comprehensive safeguards agreements and additional pro-

tocols for all non-nuclear weapon States party to the NPT is fundamental to tackling current and future challenges. Others said that the slower than hoped for progress in this regard was because nuclear disarmament was moving so sluggishly.

Other topics raised included:

❖ The Global Nuclear Energy Partnership (GNEP) which was launched by the US as a comprehensive strategy for restructuring the nuclear fuel cycle.

❖ The importance of a shared understanding of the IAEA safeguards mission, which still attracts debate, after nearly five decades of implementation, over issues such as safeguards objectives, IAEA inspection authority and the nature and scope of safeguards conclusions.

❖ Safeguards activities — notably requests for additional safeguards-relevant information and access—from the State perspective. One view expressed was that although the IAEA safeguards system should continue to function as an effective early warning mechanism, the practical implications of safeguards implementation on States should be taken more fully into account.

The range and scope of the Symposium—reflected in 189 papers and 21 sessions—will be covered in the Symposium proceedings which will be published by the IAEA. Following is a selected, topical overview.

Current Challenges

Participants emphasized the importance of strengthening the overall framework of safeguards. This includes encouraging States to bring additional protocols into force and, as appropriate, to adopt the recently modified provisions of the model Small Quantities Protocol, which applies to States having little or no nuclear material.

Other current challenges include identifying potential pathways for the transfer of sensitive nuclear technology and addressing adequately the educational aspects of non-proliferation.

Some speakers identified steps that could be taken to address current challenges. They include strengthening the nuclear non-proliferation related agreements that are in place and bringing all players, large and small, into the non-proliferation regime; learning from past success and using appropriate technologies to ensure that the nuclear non-proliferation treaties already in force are respected and that future ones are verifiable; developing tools and methods to help to identify sources of clandestine transfers of sensitive nuclear technology and components; and fostering greater awareness and understanding of safeguards and non-proliferation through education.

Safeguards Practices & Approaches

Five sessions covered developments related to 'traditional' safeguards, the implementation of strengthening measures, including under integrated safeguards (which combine traditional and strengthened safeguards measures in an optimal way) and safeguards at new, complex and/or future types of facilities.

Particular emphasis was placed on improvements that States expected to see in safeguards effectiveness and efficiency; on new general criteria to guide safeguards implementation; and on new verification tools.

Environmental sampling has become a cornerstone of international safeguards. Here, a technician at the IAEA's Clean Laboratory for Safeguards in Seibersdorf, Austria, examines uranium particles under an optical microscope.

Photo:D.Calma/IAEA

Progress was noted in implementing short notice random inspections in several States, and in implementing integrated safeguards for two States with large nuclear programmes. Key to success has been the active involvement of all of the parties concerned — the IAEA, the appropriate government authorities and institutions, and facility operators.

Presenters also emphasised the importance of a State's nuclear non-proliferation commitments and of State and regional systems of accounting for and control of nuclear material (SSACs and RSACs). Close, cooperative interac-

tion between SSACs, RSACs, and the IAEA is essential, not only for day-to-day safeguards implementation but also in seeking to identify scope for enhanced effectiveness and efficiency. Speakers also attached importance to the training and other support that the IAEA could give to States to help them to meet their safeguards obligations.

Regarding safeguards at complex and/or new facility types, experience in Japan was highlighted. Safeguards at the country's Rokkasho Reprocessing Plant represent one of the IAEA's largest ever verification endeavors in terms of the quantity of nuclear material being safeguarded, equipment costs and human resource requirements. The IAEA initiated a continuous inspection regime at the Rokkasho Reprocessing Plant in March 2006 as plant start-up progressed to the process areas. The plant is expected to move towards full operation in 2007.

IAEA Director General ElBaradei speaks to participants at the Safeguards Symposium in October 2006. He is joined by (from left) Ms. Jill Cooley, Director of Division of Concepts and Planning, IAEA Department of Safeguards; Ms. M. J. Nicholas, President of the Institute of Nuclear Materials Management; Mr. Olli Heinonen, IAEA Deputy Director General for Safeguards; and Mr. J. Joly, President of the European Safeguards Research and Development Association. (Photo: IAEA)

Information Collection & Analysis

Sessions highlighted that data collection, analysis and evaluation are central to modern, 'information-driven' safeguards. In this context, the IAEA Safeguards Information System Re-engineering Project, a multi-year, multi-million dollar project, is fundamental to the transformation of diverse data into accessible, lasting knowledge for safeguards staff.

Information required from States has changed significantly over the years, bringing new challenges. Fresh approaches are being developed to address the accuracy and reliability of information, to enhance the quality of information obtained from States, to provide States with software support and to offer training in quality control.

Open sources of information are highly relevant to strengthened safeguards. Research focuses on such challenges as the variety of formats in which information appears, on non-English language information sources, on 'grey literature' (typically brochure and other publications produced by companies and organizations) and on filtering duplicate information.

The indicators that guide searches and evaluations need to be kept up-to-date. Issues being looked into include information overload, open versus closed societies, continuous, contextual awareness and responding to urgent information requests.

The IAEA is developing tools to meet the needs of advanced information analysis. Major issues are the large volumes of information involved, distributed databases and the availability of specialized, analytical resources. It is also further developing its system for the analysis of data related to nuclear trade. This will take account of varying information formats, languages, security needs, and data storage. The system will also provide user-enhanced information extraction mechanisms, including visualization and analysis tools.

Techniques & Technology

Sessions illustrated how strengthened safeguards enable analytical sciences to make greater contributions to verification objectives. The IAEA continues to benefit from technological progress in computing power and software, cost effectiveness, miniaturization and portability.

Environmental sampling has become a cornerstone of international safeguards. Improvements were reported in the high standards already achieved by the IAEA's Network of Analytical Laboratories and in further developing analytical techniques. These include multi-technique approaches, that enable several kinds of analysis to be carried out on a single particle and evaluation methodologies, such as cluster analysis, that can be used to determine if particles in different samples have the same origin.

As for safeguards equipment, the next generation of unattended and remote monitoring equipment, as well as containment and surveillance devices, will have enhanced integrity and authenticity against high threat levels — for example, through secure tamper-indicating enclosures and devices, and additional instrument functionality such as location stamped information.

Other topics addressed included improved verification techniques for enrichment plants and plutonium handling facilities and 'intelligent' data evaluation packages. Some pre-

senters noted that commercially available satellite imagery is being used increasingly in safeguards applications. Reference was made to such enhancements as object-based analysis and the use of thermal infrared and hyper spectral imagery.

In the area of destructive analysis, development work is directed towards obtaining more information on the nature and the history of samples through the analysis of characteristic parameters (e.g. impurities, isotope abundance and microstructure). It was noted that the analysis of micro-particles requires highly skilled analysts with state-of-the-art equipment. For data interpretation, the further development of databases containing parameters from materials originating from known processes is vital.

Also described was progress in non-destructive assay methods and advanced verification tools for spent fuel in wet storage. One point made was that the IAEA needs further to improve its non-destructive assay equipment for complementary access purposes and for investigations related to illicit trafficking in nuclear material.

Regarding future tools, the Novel Technologies Project was discussed. The project provides a mechanism to help the IAEA to identify innovative technologies with potential for safeguards application. A promising example is optical stimulation luminescence, which would use the radioluminescent qualities of building materials to identify locations where radioactive materials have been stored.

Looking Ahead

The Symposium considered how the international community might support the expanded, peaceful use of nuclear energy, consistent with non-proliferation objectives.

In this context, the goals and benefits of the Global Nuclear Energy Partnership (GNEP) were touched on, as was the IAEA's role in such initiatives. Endeavors like these could have a fundamental impact on the future expansion of nuclear energy and would incorporate, by design, reduced proliferation risk and enhanced verification ability.

A presentation on clandestine procurement networks and trade in sensitive equipment and technology suggested solutions to these phenomena, but acknowledged that there was no fail-safe approach. Also on this theme, the IAEA described the goals and functions of the Trade and Technology Analysis Unit (formerly the Nuclear Trade Analysis Unit, NUTRAN), located within the Department of Safeguards.

Turning to improvements in safeguards working methods, progress was reported towards implementing a comprehensive Quality Management System (QMS) based on the ISO 9001:2000 standard. The process approach being followed under the QMS will contribute to soundly-based safeguards conclusions and thence to credible assurance that States are complying with their safeguards obligations.

In closing the Symposium, speakers highlighted key developments and future directions. Speakers included Mr. J. Carlson, then Chairman of the Standing Advisory Group on Safeguards Implementation; Mr. R. Schenkel, Director General of the Joint Research Centre of the European Commission; Ms. J. Cooley, Director of the Division of Concepts and Planning, Department of Safeguards, and Mr. O. Heinonen, IAEA Deputy Director General for Safeguards.

Multilateral approaches and robust verification mechanisms are seen as crucial to the successful resolution of nuclear proliferation-related problems. In his summary remarks, Mr. Heinonen agreed that the nuclear non-proliferation regime is being tested and that the IAEA must stay ahead of the game. Today's concerns included the wider dissemination of nuclear technology, the wish of some States to acquire nuclear weapons capability and clandestine, nuclear procurement networks.

In the face of these challenges, the IAEA had identified clear priorities further to strengthen the efficiency and effectiveness of the safeguards system. Important ones are the implementation of new safeguards approaches; the optimization of safeguards technology; following up promising, novel technologies; enhancing environmental sampling analysis capabilities; expanding satellite imagery acquisition and analysis capabilities; more intensive information collection and analysis, and, underpinning the whole, a reliable and secure information infrastructure.

The work ahead will require the continued support and active engagement of all States if the nuclear proliferation challenges of an ever more complex global landscape are to be met successfully.

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The 2006 IAEA Symposium on International Safeguards from 16-20 October 2006 was the tenth symposium since 1965. It was organized in cooperation with the Institute of Nuclear Materials Management (INMM) and European Safeguards Research and Development Association (ESARDA). The proceedings will be published by the IAEA and made available for purchase. The next Symposium is envisaged for 2010.