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Change in Europe

By John C. Matter
INMM President

Learning, by nature, is an open and ongoing process. A period of change presents an especially dynamic learning environment, a learning laboratory. Those living through the change are commonly presented with significant challenges and opportunities. Those observing the changing world of others also have an opportunity to learn and plan ahead.

Europe, especially the European Union (EU), is in a period of change. The EU expanded on May 1, 2004, with the addition of ten countries. (How many can you name?) No one knows the full extent of the resultant significant changes and impacts, positive and negative. These changes are reaching into the European safeguards community too. Six U.S. INMM members had a recent window into this world during the internal 2004 European Safeguards Research and Development Association (ESARDA) annual meeting, June 1–4, 2004, in Luxembourg.

The European Commission (EC) Directorate General for Energy and Transport, Direction I Nuclear Safeguards (DG TREN-I), is living through this period of European and global change and is re-examining its safeguards approach. The intent of DG TREN-I is to proactively respond to the current and anticipated global threats of nonproliferation and nuclear terrorism. Economic and financial factors are doubtlessly another driver for the anticipated redefinition of European safeguards implementation. Some also believe there is a link to the perception that the nuclear industry in Europe is entering a period of decommissioning and disposal (prior to Generation IV?).

At the time of the ESARDA meeting a few basic precepts, but few details, of this new safeguards approach were emerging. There is an expectation of fewer resources being devoted to nuclear safeguards and more to external security. There is talk of fewer regular inspections replaced by a few unannounced inspections. This could obviously have a potential significant impact on the IAEA safeguards approach and implementation in Europe and on the state regulators and facility operators. These recipients of the revised EC policy are anxiously awaiting the imminent, formal, official requirements and guidance. Those of us in the remainder of the domestic and international safeguards community can no doubt benefit from learning about the forthcoming changes in European safeguards.

The EC and ESARDA are also in the midst of redefining their relationship. In terms of mission, ESARDA is the most similar international professional society to the INMM. Organizationally, ESARDA is radically different. Its existence and relationship is formalized in an agreement with the EC, due to expire at the end of 2004. Their members are organizations, not individuals, and there are no member dues.

The EC is driven to change its relationship because it will no longer accept any legal (financial) liability through agreements with legal entities. (A legal entity is one that conducts financial transactions.) An ESARDA focus group has completed a study and produced a report with recommendations regarding the organization and functions of a new ESARDA. They are planning a loose network of organizations that conducts no financial business, yet will continue to provide leadership to the European safeguards community. We wish ESARDA well. Some of this transformation could be a learning opportunity for INMM.

ESARDA, like the INMM, has recognized the next generation nuclear professional staffing issue. It has started down the path of developing a modular safeguards training course to be made available on the ESARDA Web site, http://www.jrc.cec.eu.int/esarda/. INMM has begun exploring a common training activity with ESARDA.

This is my last column as the president of INMM. Being president has certainly provided a major learning opportunity for me, both personally and professionally. More importantly, I hope I have been able to successfully lead INMM into some new areas that will help our Institute and profession grow, but others will be the judge of that. I recall columns from past presidents that seemed to frequently address the value of volunteers. After two years as president I have a much greater appreciation of that. I would like to personally thank and recognize the many faithful volunteers of the INMM, certainly including the other officers and Executive Committee, members-at-large; the division, committee, and chapter chairs and their committees; and the INMM executive directors, Rachel Airth (retired) and Leah McCrackin, and all the Sherwood Group Inc. management and staff who so ably serve the INMM. There is always a need and place for new, active INMM volunteers. What are you doing to support the INMM and our nuclear materials management profession?

Best regards,
John Matter
President, 2003–2004

INMM President John C. Matter may be reached by e-mail at jcmatte@sandia.gov.

JNMM Presents Special Issue on Integrated Safeguards and the AP

By Dennis L. Mangan
Technical Editor

This very special issue of the *Journal* is the result of efforts of Jim Larrimore, the chair of the International Safeguards Technical Division, and, the authors. Jim believed an update on the international community's efforts in pursuing integrated safeguards would be an appropriate theme. Each of the articles brings a slightly different perspective or theme, and all of them are interesting to read.

The Foreword, by Pierre Goldschmidt, the deputy director general for safeguards at the International Atomic Energy Agency (IAEA), sets the stage. He provides history, discusses comprehensive safeguards agreements (CSAs), and the Additional Protocol (AP), and introduces the concept of optimized or integrated safeguards (IS). He highlights that CSAs were focused on specific facilities, but with the adoption of the AP, the strengthened, or integrated, safeguards, are at the state level. His paper is followed by one by Jill Cooley, also of the IAEA, who provides an update of the IAEA's thoughts and efforts toward the integrated safeguards vision.

Japan's experience in fulfilling the goals of the AP and preparing for implementing IS is provided in the article by Kaoru Naito and his colleague, Koji Saeki. I found this paper to be an apparently good description of "where the rubber meets the road." In fulfilling the AP requirements for additional declarations on facilities and sites, the authors state in referring to the declarations made in 2003 that Japan has "…5,349 buildings on 167 sites…" In the Canadian paper by James Casterton and his colleagues, it becomes apparent that Canada has made much progress toward implementing IS. I found one of their comments very provoking.

If one wonders how much energy is put into a state ratifying the AP, you will really wonder about the situation in the European Union (EU). U.Blom-Hieber, S. Tsalas, and F. MacLean of the European Commission describe how the European Union, with two nuclear weapon states, thirteen non-nuclear weapons states, and the European Atomic Energy Community (ESARDA) proceeded in having the three APs (one for each weapon state and one for the thirteen non-weapon state) enter into force before May 1, 2004, when ten new states joined the EU. They accomplished this feat on April 30, 2004. The following paper is also EU related, authored by Arnold Rezniczek and his colleagues, that discusses the efforts that ESARDA put forth to assist the EU states in preparing for entry into force of the APs.

John Carlson of the Australian Safeguards and Nonproliferation Office provides insight into some issues associated with IS. One is extremely intriguing. In traditional safeguards, every facility of a particular type has the same safeguards applied. In IS, the system is at the state level, and thus could vary from state to state. Rezniczek, and his colleagues Gotthard Stein, Bernd Richter, and Hans Remagen, discuss how the implementation of IS in Germany will be a demanding task, although Germany has decided to phase out the use of nuclear energy for electricity production and to terminate government funding of R&D in this field.

Sonia Fernandez Moreno of Argentina provides insights into the issue of the possibility of implementing safeguards differently at similar fuel cycle facilities in different states without affecting the nondiscriminatory principle governing international safeguards having the same safeguards obligations, a principle she states is vitally important. The paper by Ron Cherry, Dunbar Lockwood, Jonathan Sanborn, and Susan Pepper highlights the United States' strong endorsement of the AP and IS and U.S. technical contributions.

Mike Beaman, Glen Hawkins, Lawrence Johnson, and Bill McCarthy of the United Kingdom Safeguards Office bring the dictionary to terms such as integration, transparency, understanding, and credible judgment, all of which are important in the AP and IS. In the final paper by Marius Stein and his colleagues (including his father), the old International Nuclear Fuel Cycle Evaluation (INFCE) is revisited in today's environment. They conclude that multinational nuclear facilities/fuel cycles are feasible, and discuss the role that the IAEA might play in such endeavors.

I believe Jim Larrimore and his authors have done an outstanding job. Part of me worries about the need for nuclear energy to help fill the needs in the out years, such as fifty years from now, and the concern for the proliferation that exists. If done right, I believe that IS can help significantly to mitigate such concerns.

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The Additional Protocol and the Road to Integrated Safeguards

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Effective International Atomic Energy Agency safeguards remain the cornerstone of the nuclear nonproliferation regime, based upon the Treaty on the Nonproliferation of Nuclear Weapons (NPT), which is aimed at preventing the spread of nuclear weapons and moving toward nuclear disarmament. There have been many challenges to the nonproliferation regime over the years, however its continued success has been, to a great extent, dependent on the ability of the IAEA's safeguards system to adapt in response to those challenges.

Events in the early 1990s—including the discovery that Iraq pursued a completely clandestine nuclear weapons program despite the IAEA's successful verification of declared nuclear material—underscored the importance of strengthening the IAEA's capability to detect undeclared nuclear material and activities. With the support of the international community, a concerted effort was made in the 1990s to identify and implement measures to strengthen the safeguards system. This effort focused on two aspects: measures that could be introduced under the legal authority of comprehensive safeguards agreements (CSAs), and additional rights that were incorporated into a Model Protocol Additional to safeguards agreements (INFCIRC/540 [Corr.]), approved by the IAEA Board of Governors in 1997.

Nuclear material accountancy remains of fundamental importance in the implementation of strengthened safeguards, and the IAEA, by implementing a focused action plan to address safeguards implementation difficulties, has continued to improve its attainment of inspections goals for declared nuclear material and now maintains that attainment at a high level.

The strengthening measures under the legal authority of CSAs include increased access to and evaluation of information, including early provision of nuclear facility design information and voluntary reporting of exports of specified non-nuclear material and equipment by states; the use of advanced technology such as environmental sampling and unattended monitoring systems; and the review and strengthening of safeguards approaches, where needed.

Under an Additional Protocol (AP), a state with a CSA is obliged to provide the IAEA with a wider range of information regarding all aspects of its nuclear fuel cycle, nuclear-related R&D program, and manufacture and export of sensitive nuclear-related technologies. In addition, the IAEA has the right to access a wider range of nuclear-related locations to assure the absence of undeclared nuclear material and activities, verify the status of decommissioned facilities and locations outside facilities, and resolve questions or inconsistencies with regard to the state's declarations.

With the introduction of the safeguards strengthening measures, including APs, the safeguards system has changed fundamentally since 1992. Whereas the focus was on declared nuclear material at the facility level, the strengthened safeguards system is now based on a *state-level* approach, under which the IAEA evaluates the results of its verification activities and all other available information about the state's nuclear and nuclear-related activities in order to draw safeguards conclusions and to plan safeguards activities. Safeguards activities seek not only to assure the accuracy of state reports on declared nuclear material, but also to ascertain whether a state with a CSA in force has declared to the IAEA all that it is required to declare. In order to implement information-driven safeguards based on state evaluations, the IAEA has developed a robust capability to collect, process, analyze, evaluate, and archive information, supported by the needed training and technological infrastructure.

To ensure the measures of the AP are not simply superimposed as a new layer of activity on top of the *traditional* safeguards measures that have been applied to declared nuclear material and facilities, the IAEA has developed and begun to introduce optimized, or *integrated* safeguards approaches for specific states. In states with CSAs and APs for which the IAEA Secretariat has found no indication of the diversion of nuclear material placed under safeguards and no indication of undeclared nuclear material or activities, the broader conclusion can be drawn that all nuclear material within the territories of those states, under their jurisdiction or under their control anywhere had been placed under safeguards and remained in peaceful nuclear activities or was otherwise adequately accounted for. Once such a broad conclusion is drawn, it is possible to modify the state-level safeguards approach based on the increased safeguards assurances thereby reducing, in some cases, in-field verification activities on declared nuclear materials.

The IAEA has developed a conceptual framework[1] for integrated safeguards and has begun to implement integrated safeguards in some states. Currently, state-level integrated safeguards approaches are under development for several more states and are expected to be implemented in the near term, including in states with large nuclear programs, where more significant savings are expected to be realized.

Although many new measures have been implemented to strengthen the IAEA's capabilities and credibility, the IAEA continues to strive for further improvements both to the effectiveness of safeguards measures and their cost efficiency.

Over the last several years, the commercial knowledge and technologies necessary to conduct a covert nuclear weapons program have become more accessible, and the means to implement procurement, deception, and concealment strategies have become increasingly sophisticated. This is evidenced by the uncovering of clandestine nuclear programs in Iran and Libya, and the recently revealed information on the extensive covert networks of supply of sensitive nuclear technology. It is therefore necessary that the IAEA continue to develop and implement increasingly sophisticated means of detecting undeclared nuclear material and activities.

It is clear that universalization of the AP would greatly contribute to international nuclear nonproliferation assurances. Despite the safeguards strengthening measures introduced under the legal authority of CSAs, unless a state has an AP in force, the IAEA does not have a sufficient basis on which to draw conclusion on the absence of undeclared nuclear material and activities for the state as a whole. The number of states that have an AP in force is far below what was expected in 1997. As of 1 May 2004, APs were in force or otherwise applied in fifty-seven states.[2]

Even for states with CSAs and APs in force, there are limitations on the types of information and locations accessible to IAEA inspectors. Although there are mechanisms for obtaining the information needed to ascertain the completeness of state-supplied information, either from the state or from other sources, the process of completing the consistency analysis needed for drawing credible conclusions may require an extended period of time. Based on the IAEA's experience, there is no doubt that the close cooperation of the state in overcoming limitations that impact on the IAEA's ability to draw safeguards conclusions saves time and resources and bolsters confidence in the results. These measures include, but are not limited to, the timely provision of accurate reports, declarations, and other information required under their safeguards agreements; provision of one-year multiple entry/exit visa for designated inspectors; and granting unfettered access to facilities and locations for verification purposes. Further transparency commitments on the part of the state to provide information and access rights would further increase the efficiency, effectiveness and overall credibility of the NPT regime. Such information could include for instance exports of dual use equipment, export denials, and related information. Access rights would allow IAEA inspectors to go anywhere, and interview anyone, at any time.

Implementation of the safeguards strengthening measures, the most significant of which are APs, has dramatically altered the way that safeguards are implemented and has increased the nonproliferation assurances that can therefore be derived. Based on the increased assurances, state level safeguards approaches can be made more efficient through the introduction of integrated safeguards. It is important that a dynamic safeguards system, which identifies and addresses safeguards implementation issues as they arise, be maintained in order to respond to further nonproliferation challenges in the future. It is expected that the safeguards system and the IAEA's verification rights will have to be adapted as necessary.

The implementation of APs and the introduction of integrated safeguards have provided valuable new capabilities and experience in the IAEA's ability to respond to safeguards challenges. It is therefore fitting that, seven years after its approval by the IAEA Board of Governors, this issue of the *Journal of Nuclear Materials Management* takes stock of the experience and expectations in implementing APs and introducing integrated safeguards.

Notes

1. The framework comprises the safeguards concepts, approaches, guidelines, and criteria that govern the implementation of integrated safeguards, defined in paragraph 4 of GOV/INF/200/26 as "the optimum combination of all safeguards measures available to the Agency under comprehensive safeguards agreements and additional protocols which achieves the maximum effectiveness and efficiency within available resources in fulfilling the Agency's right and obligation in paragraph 2 of INFCIR/153 (Corr.)."
2. Including Ghana, which is implementing an AP on a provisional basis, and Iran and Libya, which have agreed to implement the measures foreseen in the Model Additional Protocol pending the entry into force of their APs. In addition, the measures foreseen in the Model Additional Protocol are being implemented in Taiwan, China.

Progress Toward More Effective and Efficient Safeguards: An IAEA Status Report

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Abstract

In the seven years since the International Atomic Energy Agency Board of Governors approved the Model Protocol Additional to Safeguards Agreements, great progress has been made in establishing the necessary infrastructure, implementing the additional strengthening measures, and drawing broader safeguards conclusions regarding both the non-diversion of nuclear material and the absence of undeclared nuclear material and activities for states as a prerequisite to the implementation of integrated safeguards. As of the end of March 2004, forty states had Additional Protocols in force (or being provisionally applied), broader safeguards conclusions had been drawn for thirteen of these states, and integrated safeguards were being implemented in three. This paper outlines the basis for drawing the broader safeguards conclusions, details progress in implementing Additional Protocols, and describes the status of development and implementation of integrated safeguards.

Drawing Safeguards Conclusions

For a state with a comprehensive safeguards agreement (CSA) in force, the International Atomic Energy Agency (IAEA) has the right and obligation to ensure that safeguards are applied in accordance with the terms of the agreement on all source or special fissionable material in all peaceful nuclear activities within the state, under its jurisdiction, or carried out under its control anywhere (paragraph 2 of INFCIRC/153 [Corrected]). This requirement means that the agency should, in principle, verify that a state's declarations are both correct (i.e., that the type and quantities of nuclear material are declared accurately) and complete (i.e., that all nuclear material in the state has been declared). The safeguards strengthening measures implemented under the legal authority of a CSA have increased the IAEA's ability to detect undeclared nuclear material and activities. However, under a CSA alone, the activities that the agency may conduct in this regard are limited. Thus the safeguards conclusion that can be drawn for a state with a CSA alone relates mainly to the nuclear material that has been placed under safeguards. For a state with a CSA and an Additional Protocol (AP) in force (concluded on the basis of the Model Additional Protocol, INFCIRC/540 [Corrected]), the measures provided under an AP have increased the agency's ability to detect undeclared nuclear material and activities such that the IAEA is able to draw the broader safeguards conclusion for the state that all nuclear material has been placed under safeguards and remains in peaceful nuclear activities.

The State Evaluation Process

The shift of emphasis toward *completeness* has involved a significant change in the way in which safeguards are implemented; follow-up activities are planned and conducted; and safeguards conclusions are drawn and documented. The framework for the overall process, the safeguards state evaluation, seeks to integrate and assess the totality of information available to the agency about a state's nuclear activities and plans, whether provided by states themselves under safeguards agreements, APs, and voluntarily; deriving from the implementation of in-field verification activities; or obtained from open and other sources of safeguards-relevant information. Information provided by a state is reviewed for internal consistency, for coherency with results of safeguards verification activities, and for compatibility with all other available information. When there are questions or inconsistencies, more information is sought from open or other sources, from the state itself, or through verification activities in the field, including complementary access under the provisions of a state's AP.

Evaluations are performed for individual states by the responsible state evaluation group within the IAEA Department of Safeguards headed by a member of the relevant operations division (generally the country officer) and with participation of other divisional staff and experts from the support divisions. The senior inspector, a new post established in each operations division, coordinates the evaluation work of the division. Periodically the state evaluation is documented in a state evaluation report (SER). The SER summarizes the relevant information for the state, documents the evaluation results, and provides recommendations for future activities.

SERs are reviewed by an interdepartmental team. The Information Review Committee (IRC) was established in 1996 to review state evaluations, relevant methodology, and guidelines, and to make proposals for updating and improving the process. In light of the increasing number of SERs being prepared and their importance in drawing safeguards conclusions, the SER process was restructured in 2002 to ensure that state evaluations would continue to be conducted thoroughly and consistently and that the results would receive adequate attention and review. A two-tiered process was instituted to streamline the process and more clearly reflect the role of state evaluation in the process of drawing safeguards conclusions. At the higher level, the IRC, chaired by the deputy director general–safeguards, continues to ensure high-level management review of the most critical issues, endorse recommendations for key follow-up activities, and review the overall state evaluation conclusions leading to the safeguards conclusions. In addition, the IRC reviews SERs for states for which the agency would be drawing the broader safeguards conclusion for the first time. An information review subcommittee reviews all the other SERs and updates and forwards its recommendations to the IRC.

Priority for initial state evaluations has been given to: (i) states with APs in force or expected soon to enter into force, and (ii) states with significant nuclear activities. Priority for updates has been given to states where a conclusion of the absence of undeclared nuclear material and activities is to be drawn for the first time or reaffirmed. Since 1997, a total of 224 SERs have been produced and reviewed covering ninety-five states, sixty-two of which have significant nuclear activities. For 2003 alone, fifty-nine SERs for fifty-nine states were completed and reviewed. Thirty-four of these reports covered states with APs in force or being provisionally applied.

Additional Protocol Implementation

Interaction with States

Since 2001, the IAEA has stepped up its efforts to encourage and facilitate the conclusion of safeguards agreements and APs by organizing numerous interregional, regional, and national seminars. State-specific policy, legal, and technical issues are addressed in bilateral consultations held between individual states and the IAEA at the various seminars and in other venues. Topics discussed with states without APs in force center on the work needed to prepare for AP implementation such as: ensuring that the necessary legal infrastructure and legislative framework are in place; how best to equip state systems of accounting and control (SSACs) with the capacity and expertise required to underpin and to co-operate with the IAEA in AP implementation; and the importance of full support in this endeavor by government authorities and nuclear facility operators. Consultations with states with APs in force, but which have not yet submitted the initial declaration required of them by Articles 2 and 3, clarify the requirements for timing, content, and formatting of declarations. In addition, the IAEA conducts seminars and training courses for SSACs on agency safeguards, strengthened safeguards, and in particular, implementation of APs.

State Declarations under an Additional Protocol

The timely, complete, and accurate submission of information requested from states about their nuclear programs and activities under an AP is vital to the process of information evaluation and thus to drawing the broader safeguards conclusions. Guidelines to assist states in preparing their AP declarations were developed by the IAEA and issued in 1997; a simplified set of guidance was subsequently produced for states whose safeguards agreements includes a small quantities protocol. The 1997 reporting guidelines have been recently revised based on experience gained in the implementation of APs. Attention has focused on further clarifying the requirements under Articles 2.a.(i), on nuclear fuel cycle-related R&D activities, 2.a.(iii), on site definitions, and 2.a.(v), on mines and concentration plants. The revised guidelines will be issued in 2004.

To further assist states with preparation of their AP declarations, the agency has developed a software program called the "Protocol Reporter." Based on the reporting guidelines, this tool is available to all states upon request. The program can be tailored to a customized structure by a state and can support a decentralized process for the preparation of a submission. The program enables the merging of information from various sources within the state and the preparation of computerized declarations for submission. By the end of 2003, more than forty-two states had requested and received the software; however, to date, only eleven states are actually using the Protocol Reporter for submissions. The processing of declarations submitted in hard copy only imposes a considerable workload on the agency. The need to validate information after scanning and before loading it into the electronic database system is particularly labor intensive.

In 2003, submissions pursuant to APs were received from thirty-one states. Of the 250 submissions received, sixty-five were more than thirty days late, with delays of up to 735 days. The review of the declarations often requires further contact with state authorities to obtain clarification of the information required. Additional protocol submissions under Article 2.a.(iii) and 2.a.(v) have generated the largest number of requests for supplementary information under Article 2.c. Where necessary, the agency raises questions or inconsistencies with state authorities pursuant to Article 4.d. In the majority of these communications, states provided timely and satisfactory responses to the agency's enquiries or requests for further information. However, in some instances responses were incomplete, generated further questions, were received late or are still awaited. On balance, the experience has been good, but it has shown that states need to pay careful attention to all of the information required under an AP and that the agency needs to be as clear as possible in the guidance it makes available to states for these purposes.

Implementation Trials

Field trials to test various elements of AP implementation in states before their protocols come into force are providing good experience for such states, facility operators, and the agency. An extensive implementation trial at two large nuclear sites in Japan, completed in 1999, provided practical experience in complementary access on complex nuclear sites, including logistical aspects, managed access and environmental sampling. Implementation trials at research centers in Finland and in the Netherlands, designed specifically to test the roles and reporting responsibilities of the states and Euratom, were conducted during the period of 2000-2002.

Complementary Access

Complementary access performed under an AP is playing an important role in the process of drawing and reaffirming conclusions of the absence of undeclared nuclear material and activities. Internal complementary access guidelines by location type and at the state level were produced in 2001 to ensure that complementary access is carried out in an efficient, technically effective, and non-discriminatory manner. Standardized documentation packages, software, and equipment sets have been produced for use by inspectors. In most cases IAEA inspectors have not encountered difficulties in conducting complementary access and have benefited from good cooperation with state authorities and facility operators.

In 2003, complementary access was conducted ninety-two times in twenty-one states (eighty-six times in seventeen states in 2002). In most instances (84 percent), it was carried out on nuclear sites to ensure the absence of undeclared nuclear material and activities. A further 9 percent were conducted for the same purpose at mines, concentration plants, and locations with source material or with material exempted from safeguards. The remaining instances of complementary access were conducted at several decommissioned facilities and LOFs to confirm, for safeguards purposes, the decommissioned status of the installations, and at locations with nuclear fuel cycle-related R&D and at other specified locations to resolve a question or inconsistency.

Supporting Infrastructure

Information Analysis

The IAEA has continued to expand the sources of safeguards relevant information utilized in the evaluation process and enhance its capabilities for data analysis. Computerized systems have been successfully implemented to manage and archive the large amounts of data being collected and evaluated. An AP information system manages the integration of states' declarations into databases and provides a web-based interface to navigate through declarations, link declaration entries and capture results of reviews and analyses. The open source system, comprised of free text storage and powerful search tools for accessing and filtering data, is populated by information from numerous subscription databases as well as real-time and near-real-time feeds from news services. In 2003 the use of open source information about states' nuclear programs was further enhanced through the introduction of new software with greatly expanded capabilities to search Internet sites and through more use of scientific and commercial data. This enables the IAEA to better assess the technological capability of states to pursue nuclear programs, including those with proliferation-sensitive technologies. The use of satellite imagery as a complementary open source of information continues to grow.[1] In 2000 a commercial satellite imagery database was designed and in 2001 a satellite imagery analysis laboratory was established for the interpretation of commercial satellite images and the production of reports on analyzed imagery.

A key methodology for maintaining and evaluating all the relevant information builds on the *physical model* of the nuclear fuel cycle that was developed by the agency in collaboration with experts from several member states. Originally developed in 1997-1998, the physical model has been expanded to include spent fuel management, waste management, and hot cell operations. In 2003 the chapter on reprocessing was reissued; in 2004 the enrichment chapter will be revised. Guidelines have been prepared for making use of the physical model and software based on the model is in regular use for searching for and examining the large amount of information available from open sources.

To assist the state evaluation process, a SER template was developed in 1997 as a guide to content and format of the report. During 2002 the template was substantially revised in the light of experience to incorporate changes designed to achieve greater clarity of content and presentation of reports, and to ensure that the analytical process fully supports the recommendations made and conclusions drawn.

Safeguards Training

The safeguards training curriculum continues to be enhanced and refined to provide inspectors, safeguards support staff, and member state personnel with the knowledge and skills needed for safeguards implementation under safeguards agreements and APs. Training courses dealing with the collection and handling of environmental samples; enhanced observational skills, the nuclear fuel cycle, and proliferation indicators; the performance of state evaluations; the conduct of complementary access; and the application of satellite imagery are now part of the Department of Safeguards regular training program. Modules of the Department's Introductory Course on Agency Safeguards for new inspectors are being added or modified to reflect the new implementation initiatives. Similar changes have been made in the training course for SSAC personnel.

Integrated Safeguards

The measures of the Model Additional Protocol were never intended to be simply superimposed as a new *layer* of activities on top of safeguards as implemented under CSAs. Given the additional assurances provided under an AP, the need to avoid undue burden on states and facility operators, and the need for maximum efficiency in the light of the prevailing resource constraints, the new measures were to be *integrated* with existing ones. Late in 1998, the agency embarked on a program for the development and implementation of integrated safeguards. The term refers to the optimum combination of all safeguards measures available to the agency under CSAs and APs to achieve maximum effectiveness and efficiency within available resources in meeting the agency's safeguards objectives. The process of defining the optimum combination of measures has been developed on a non-discriminatory basis for all states that have CSAs and APs in force and for which a conclusion of both the non-diversion of safeguards nuclear material and the absence of undeclared nuclear material and activities has been drawn. The development program was conducted by the agency with assistance from a small group of outside technical experts, advice from the Standing Advisory Group on Safeguards Implementation and support from a number of member state support programs.

In 2001, the development of a conceptual framework for integrated safeguards was completed as a priority item.[2] The conceptual framework comprises the set of safeguards concepts, approaches, guidelines, and criteria that govern the design, implementation, and evaluation of integrated safeguards. This framework helps to ensure consistent, non-discriminatory implementation of integrated safeguards in states with similar types of facilities and fuel cycles. The basis for implementation of integrated safeguards is a state-level approach, designed specifically for each state by adapting model integrated safeguards approaches for the specific facility types present in the state combined with the implementation of measures of the AP, taking into account the state's nuclear fuel cycle, the interaction between facilities, and other State-specific features.

To date, facility-type-specific integrated safeguards approaches have been developed for light-water reactors (LWRs), both with and without fresh mixed oxide fuel, research reactors, on-load refueled reactors, spent-fuel storage facilities, and low-enriched uranium (LEU) fuel fabrication plants. To facilitate the implementation of integrated safeguards, the IAEA has developed guidelines for the use of unannounced and short notice inspection, enhanced cooperation with SSACs, and dealing with anomalies, and questions and inconsistencies; procedures for random selection of facilities for inspection; and a methodology for estimating costs of integrated safeguards implementation. The IAEA has also formulated provisional implementation criteria for LWRs, research reactors, and spent fuel storage facilities based on the relevant integrated safeguards approaches developed.

Substantial progress has been made in designing state-level integrated safeguards approaches and preparing for implementation in states with APs in force. Australia was the first state in which integrated safeguards were implemented in 2001. Trials to test the short-notice inspection regime were conducted there in 2001. Trials were carried out in Norway of unannounced inspections performed as foreseen in the integrated safeguards approach, and implementation of integrated safeguards began in 2002. In preparation for implementing the integrated safeguards approach now in place in Indonesia, surveillance systems were upgraded, and procedures for short notice random inspections at a research reactor facility were tested. State-specific integrated safeguards approaches are under development for a number of states. For states with large nuclear fuel cycles, model integrated safeguards approaches that were developed for LWRs, research reactors, on-load refueled reactors, storage facilities, and LEU fuel fabrication plants are being incorporated into the state-level approaches.

Next Steps

The development of integrated safeguards is an evolutionary process. As experience is gained with implementation, approaches, guidelines, and criteria will be further developed or refined. Development will continue on (i) integrated safeguards approaches for additional facility types (e.g., enrichment plants, storages, locations outside facilities) and for particular verification activities (e.g., transfers of spent fuel to dry storage); (ii) completing and updating supporting guidelines; and (iii) integrated safeguards implementation criteria and evaluation of results to support reporting. The goal is to widen the scope of integrated safeguards implementation as more APs enter into force and the requisite safeguards conclusions can be drawn. The savings resulting from implementation to date have been small because of the limited fuel cycle activities in the states where integrated safeguards are currently being implemented. Greater savings from reduced verification activities in the field are expected once integrated safeguards can be implemented in states with larger fuel cycles.

Conclusion

In the seven years since the IAEA Board of Governors approved the Model Additional Protocol, great progress has been made in establishing the necessary infrastructure, implementing the additional strengthening measures, and drawing broader safeguards conclusions for states as a prerequisite to the implementation of integrated safeguards. Key to drawing and maintaining conclusions of the non-diversion of declared nuclear material and of the absence of undeclared nuclear material and activities for a state as a whole is the evaluation of all information available regarding a state's nuclear program. The state evaluation process has been strengthened considerably with the formation of state evaluation groups, revision of the template and guidance used for documenting such evaluations, and restructuring of the internal process for reviewing state evaluation reports. Improving the internal infrastructure has also involved the use of new information technology tools for collecting, processing, and storing data; establishment of a satellite imagery laboratory and database; and development of new inspector training courses. Support to states has included revised AP reporting guidelines, a software program to assist states in preparing and submitting their declarations, and select field trials to test elements of the AP such as complementary access.

Implementation of integrated safeguards is being guided by the conceptual framework that was completed in 2001. Elements of the framework continue to be developed in light of experience, further evaluation, and technological developments. In addition to the three states where integrated safeguards are being implemented, state-level approaches are being developed for more than ten others where the broader conclusion has been or is expected soon to be drawn. As with preparing states for AP implementation, trials of various aspects of the state-level approaches (e.g., unannounced inspections) are proving to be extremely useful in preparing states, facility operators, and the IAEA for integrated safeguards.

However, the rate at which APs are entering into force in states is falling short of expectations and is constraining the agency's ability to implement safeguards with maximum effectiveness and efficiency. As of the end of March 2004–almost seven years after the Board of Governors approved the Model Additional Protocol–only eighty-two states had signed APs and only forty–less than half–had brought them into force or were applying them provisionally. This number is even more in contrast with the number of states party to the NPT (189) and, of those, the number of states with safeguards agreements in force (146). Extensive efforts have been and are being made to encourage wider adherence to CSAs and APs. The full potential of the strengthened safeguards system can be realized only through universal adherence to the strengthening measures, including those of the Model Additional Protocol.

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The Additional Protocol and the Road to Integrated Safeguards: Japan's Experience

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Abstract

Japan, the only nation in the world that has suffered an atomic bombing, has been firmly committed to nuclear disarmament and nonproliferation, attaching great importance to nonproliferation efforts in order to contribute to the enhancement of global and regional peace and stability. Ratifying the Nuclear Nonproliferation Treaty (NPT) in 1976, it placed itself under obligation, as a non-nuclear weapons state, not to produce or acquire nuclear weapons. Further, Japan has been upholding the NPT regime and exerting its efforts in materializing efficient and effective International Atomic Energy Agency (IAEA) safeguards.

Since the discovery of a clandestine nuclear weapons program in Iraq in 1991, Japan has been actively involved in the program for strengthening and streamlining IAEA safeguards both within the framework of INFCIRC/153 and through additional measures under the Additional Protocol (AP). Being one of the first countries with an extensive peaceful nuclear fuel-cycle program, Japan ratified its AP on December 16, 1999. For the sake of early realization of integrated safeguards (IS), the Japanese government is working closely with the IAEA and is making active contributions toward the establishment of IS and its implementation in Japan.

This paper describes Japan's experience in bringing the AP in force, including various legal and institutional arrangements for the preparation of its ratification, and actual experience in its implementation, e.g., the provision of expanded declarations and facilitating complementary access. Some issues and lessons learned in the course of AP implementation will also be provided. It further describes Japan's efforts towards the establishment of IS and some of its expectations of it.

Introduction: Japan's Commitment to Nonproliferation

Japan, as the only nation in the world to suffer atomic bombing, has been firmly committed to nuclear disarmament and nonproliferation, being inspired by the strong national sentiment calling for the total elimination of nuclear weapons. Ratifying NPT in 1976, Japan placed itself under obligation, as a non-nuclear weapons state, not to produce or acquire nuclear weapons. Furthermore, Japan's domestic law, the Atomic Energy Basic Law, requires that Japan's nuclear activities to be conducted only for peaceful purposes. These points clearly testify that Japan has no intent to possess nuclear weapons.

Japan has been upholding the NPT regime and considers the strengthening of international and regional/national safeguards is a vital element for improving the global nonproliferation regime. Accordingly, Japan has been actively involved in various programs and has also taken necessary measures for achieving and facilitating the efficient and effective IAEA safeguards under NPT. For example:

- Japan has been actively participating in international/multilateral safeguards projects as TASTEX, HSP, and LASCAR to develop/demonstrate effective and efficient safeguards technologies for the Tokai Reprocessing Plant or to develop effective and efficient safeguards approaches for a centrifuge enrichment facility and a large-scale commercial reprocessing facility.
- The Japanese government has been successful in gaining the cooperation of facility operators to use their facilities as test beds for advanced safeguards equipment and methodologies, and to provide some of their equipment and instrumentation for safeguards use with necessary authentication requirements.
- With the cooperation of the Japanese government, the IAEA has set up and is operating the Tokyo Regional Office for the efficient and effective implementation of IAEA safeguards in the Far East.
- In order to improve inspection goal attainment in Japanese facilities, the Nuclear Material Control Center (NMCC) has been organizing *SIR Seminars* for facility operators, with the cooperation of the Ministry of Education, Culture, Sport, Science, and Technology (MEXT) and the IAEA, to better understand the causes of non-attainment of inspection goals at their facilities, if any, and to take remedial measures to prevent recurrence as appropriate.

Among the countries with fully developed fuel cycles, Japan was the first country to ratify the AP, putting it into effect on December 16, 1999. For the sake of smooth AP implementation, Japan initiated a range of actions to help the IAEA obtain practical experience in conducting new measures provided in the AP.

Ratification and Implementation of the Additional Protocol

Actions Taken for Early Entry-into-Force and Smooth Implementation of the AP

Japan was in the forefront in ratifying the AP among the countries with fully developed fuel cycles and Japan initiated several initiatives for its early entry-into-force and smooth implementation.[1] These include:

- The relevant law and regulations have been revised to accommodate the requirements of the AP, *inter alia* to collect and provide the necessary information to the IAEA on Annex I activities that is required under Article 2.a. (iv) of the AP as well as to facilitate complementary access by the IAEA to relevant places or locations as proscribed in Article 5 of the AP.
- In anticipation of further closer cooperation between Japan's SSAC (State System of Accounting for and Control of Nuclear Material) and the IAEA, Japan strengthened its SSAC by designating the NMCC as the official entity to perform national safeguards inspections on behalf of the Japanese government.
- Before its entry-into-force, a series of AP implementation trials was carried out at two large research centers to cover the measures contained in the Model AP, including complementary access (CA) and managed access (MA) in order to provide relevant implementation experience for the IAEA, facility operators, state authorities, and eventually other states.[2]
- Immediately after its entry-into-force, the government of Japan organized a detailed briefing to nuclear facility operators and other related organizations, such as manufacturers of nuclear equipment/components, about the additional declaration to be made to the IAEA. These briefings were essential for the initial expanded declaration to be submitted to the IAEA within the time set out in the AP. The initial declaration was made in June 2000, providing the IAEA with a vast amount of information including those related to 4,885 buildings on 151 sites. Subsequent updates are done in May each year, reflecting the prevailing situation as of the end of the preceding year. The situation updated in 2003 covers 5,349 buildings on 167 sites, about sixty research and development activities related to the nuclear fuel cycle but without involving nuclear material and about thirty-nine activities specified in Annex I of AP.

AP Implementation Experience

Japan's initial declaration and subsequent updates are being evaluated by the IAEA with additional questions raised to Japan for clarification. By the end of 2003, the IAEA had conducted 106 CAs over three years. In the course of AP implementation, Japan had the following experience that may be interesting to other countries in the process of ratifying and implementing APs.

- In preparing the initial and subsequent declarations, Japan's MEXT Safeguards Office (JSGO) encountered some difficulties due to lack of clear definition, in the AP and the IAEA's guideline, of a site and "installations which provide essential services." For example, in the case of a large university complex with a small LOF (location other than facilities), designating its whole campus as a site is not practical. The boundary should correspond to the periphery of the area clearly defined by the domestic regulation so that the operators' submissions of the required information become mandatory. In principle, JSGO utilizes existing regulated areas, namely "radiation-controlled area" and "radiation-monitoring peripheral area" as the definition of a site. There have been several occasions when the IAEA requested information about buildings adjacent to sites in view of "installations which provide essential services." JSGO prepared the necessary information and sometimes arranged inspector visits to these buildings. Consultations between the IAEA and JSGO, and Japan's policy of openness, have contributed to the solution of issues arising from ambiguities in site definition.
- Consideration should be given to the difference between declared information of buildings and actual features at the time of CA. Sometimes the actual feature is more advanced than the declared information because a new development occurred. This results in a matter for discussion in the field.
- Another area of difficulty is collecting and declaring information on nuclear fuel cycle-related research and development. The definition of *basic research* that is exempted from declaration is always controversial. Sometimes researchers stress and advertise the possible application of their research in order to attract the attention of funding agencies, leading to misunderstanding by third parties, including the IAEA.
- A large portion of CAs has been conducted in research institutes recently. In 2001, twelve out of forty CAs were conducted in LWRs, whereas none were conducted at LWRs in 2003. There were thirty-three CAs last year, where thirteen CAs were conducted in JNC and JAERI, and six CAs in universities. Most of CAs have been conducted in order to assure the absence of undeclared nuclear material and activities. By the end of 2003, seven CAs were conducted as a "managed access" without any difficulties.
- During CAs in 2003, twenty-one environmental sample kits (four samples/kit) were used. In addition, fourteen sample kits were used in 2003 during LFUA (Limited Frequency Unannounced Access) to enrichment facilities and DIVs. The total number of spent sample kits increased from twenty-seven in 2002 to thirty-five in 2003. The results of environmental samples demonstrate the power of this tool. Traces of small amounts of nuclear material were evident in the

results due to, e.g., contamination from historical archives.

It is the strong wish of the Japanese government that, in order to shift to the IS regime in Japan, the IAEA will complete at an early date the state evaluation of Japan and draw the initial conclusions of the non-diversion of declared nuclear material and of the absence of undeclared nuclear material and activities in Japan.

The Road to Integrated Safeguards

For a state under a comprehensive safeguards agreement (CSA) with an AP in force, the possibility that undeclared nuclear activities exist undetected is significantly reduced. AP measures can draw safeguards conclusions regarding the absence of undeclared material and activities in the state as a whole. Assurance of the absence of undeclared nuclear activities leads to the potential for changes in implementation parameters and reductions in verification effort for declared nuclear material. The new measures are *integrated* with existing measures, establishing IS.

Several model IS approaches for facility types have been developed and updated. For specific types of facilities in a state, IS approaches are established by adapting model IS approaches to optimize effectiveness and efficiency. State-level safeguards activities and safeguards measures at facilities are defined in an IS approach for each state whose earlier draft has been formulated but still needs further refinement.

Model IS approaches for facility types contain various aspects, but some features are common,[3] for example, the extension of timeliness goals from three months to one year for irradiated fuel and from one to three months for fresh MOX fuel assemblies; utilization of random interim inspections (RIIs) to detect and deter undeclared activities and provide the capability for early detection of diversion (performed *unannounced* where possible and cost effective); and the reduction in verification requirements for less proliferation-sensitive material.

The actual savings from the introduction of IS is not yet clear. It is estimated that some 600 person-days of inspection (PDIs) would be saved in total for LWRs, OLRs, and depleted, natural and low-enriched uranium (DNLEU) conversion and fuel fabrication facilities in Japan, Canada, and EU states, where some 2,000 PDIs are currently required. IS is currently implemented only in three countries—Australia, Norway, and Indonesia.

Model Integrated Safeguards Approaches

The IAEA has so far developed model IS approaches for LWRs with and without MOX, spent-fuel storage facilities, DNLEU conversion and fuel fabrication facilities, and RRCAs (research reactors and critical assemblies). They are outlined below for each facility type.

LWRs without MOX

The model IS approach involves an annual physical inventory verification (PIV), a small number of RIIs and random selection of facilities for inspection. RIIs will be performed unannounced, i.e., with two-hour prior notice, where they can be carried out effectively and efficiently (ISP-1), and permanently installed surveillance cameras are eliminated. Where unannounced inspections cannot be used, alternatives (ISP-2 and ISP-3) are provided involving announced interim inspections supported by surveillance. ISP-2 involves surveillance cameras triggered remotely by the IAEA at the time of inspection announcement, while they are continually running in overwrite mode in the case of ISP-3. To maintain the continuity of knowledge of the nuclear fuel in the core of LWRs, surveillance is to be used during refueling and the reactor vessel is to be sealed between refueling.

RRCAs

The model IS approach accommodates the wide variety of RRCAs under safeguards. They are categorized into four groups depending on their inventory: Group I with more than one significant quantity (SQ) of unirradiated direct use (UDU) material, Group II with total inventory of more than one SQ, Group III between 0.5 and one SQ, and Group IV less than 0.5 SQ. A PIV is to be performed annually except for Group III and IV where PIV is done for randomly selected facilities. The approach also includes a small number of unannounced inspections with a low sampling rate. At high-power research reactors capable of producing, through unreported irradiation, one SQ or more of plutonium per year (e.g., greater than 25 MWth), one additional unannounced inspection per year at each such reactor is to be performed. For Group I facilities, two different means of meeting the one-month timeliness goal for UDU material are provided—scheduled monthly inspections or the use of C/S measures with remote data transmission for the fresh fuel in combination with three-four unannounced inspections per year.

Spent Fuel Storage

The model IS approach provides for an annual PIV and a small number of RIIs. Because most of the nuclear material inventory at such facilities is in static conditions under the IAEA seal, the RIIs do not need to be unannounced. The use of unattended monitors for verification of spent fuel receipts provides additional savings of IAEA inspection effort in the field.

DNLEU Conversion and Fuel Fabrication

The model IS approach includes an annual PIV with reduced activities and the use of a small number (one-to-three per year, depending on facility-specific conditions) of short-notice random inspections (SNRIs), i.e., random inspections with an advance notice of less than the one week specified for these facility types in INFCIRC/153 (Corrected). These inspections are to be coupled with a *mailbox* system for the provision of information on the facility's planned operational program and updated accountancy data. The use of SNRIs allows effective verification of the receipts and shipments of nuclear material at the facility as well as coverage of potential *borrowing* of nuclear material amongst nuclear facilities to conceal diversion. The effectiveness of safeguards at these facility types is therefore increased as compared with current approaches without SNRIs.

Application of Model IS Approaches to Japanese Facilities

Consultations between the IAEA and Japan have been made since July 2001 in order to make the model facility-type IS approaches tailored to Japanese facilities, taking into consideration the specific features and characteristics of Japan and its individual facilities.

LWRs without MOX

Japan established a joint working group (WG) with the IAEA in November 2001 to review the proposed model IS approach. In January 2002, Japan expressed its preference for ISP-1. However, the WG concluded that Japan's requirement that its national inspectors accompany IAEA inspectors makes it practically impossible to begin inspection activities at remote LWRs within two hours notice from the IAEA.

Then the WG examined ISP-3, where the notification period became a difficult issue. With the recording capacity of surveillance cameras in over-write mode, a seven-day notification period is feasible. The IAEA insisted on the shortest period, 24 hours, claming that Japan should show *openness,* while utility companies preferred a longer notification period to facilitate the preparation for RIIs, such as arranging qualified crane operators. After lengthy consultations identifying possible difficulties that the short notice might cause and with the IAEA's acknowledgement of them, JSGO finally agreed to RIIs with a 24-hour advance notice. The decision was made to create a good precedent for the IAEA, based on the commitment of Japanese government to strengthen the nonproliferation regime.

RIIs will be conducted for selected facilities with a low sampling rate over the total population of fifty-two LWRs in Japan. PIVs will be done annually. It is calculated by a simple model that the average number of IAEA inspections per LWR would be reduced by 40 percent.

In the earlier phase of the IS review, the utility companies were reluctant to introduce IS. They tend to prefer the status quo even though inspector access and thus the interference to the facility operation is much reduced by the introduction of RIIs. They prefer predictability, or periodical announced inspections, to unpredictability, or short-notice random inspections. This is because, in the latter case, they have to make required personnel and resources readily available in order to facilitate smooth implementation of RIIs. After consultations, the preparatory arrangements required for short-notice RIIs have been agreed to at a minimum level that would not be a heavy burden to operators. The IS approach was finally agreed to in March 2004.

RRCAs

The model IS was proposed to Japan in June 2002 and general agreement was made in October 2002. RIIs with a very short notification are feasible because of the relative locations of RRCAs in Japan. For example, for Group II RRCAs, RIIs with low sampling rate will be conducted without the support of surveillance, in addition to annual PIVs. The IS approach was agreed in March 2004.

Spent Fuel Storage Facilities (SFSFs)

In January 2003, the IAEA made an initial IS proposal for a Japanese SFSF. After consultations, general agreement was reached on the proposal in May 2003, with final agreement in March 2004.

LEU Fuel Fabrication Plants

The IAEA made a specific IS proposal to Japan in May 2003. After consultations, a revised draft was provided to JSGO for review. SNRIs are already in practice in Japanese LEU fabrication facilities under the INFCIRC/153 regime an average of times per year per facility. Under IS, this number is expected to be reduced as well as the detection probability.

Other Facilities

There are not many other facilities where IS could be devised because what are left mainly involve nuclear material of high strategic value such as Pu, HEU, or MOX. However, the consideration of measures resulting in improved efficiency for these materials should not be precluded. As for MOX fabrication, the timeliness goal could be revisited and SAGSI has been given the task of conducting this review. As for centrifuge-type uranium enrichment plants, an IS approach may be considered for non-cascade areas.

IS Rehearsals

With the objectives similar to AP implementation trials, Japan has provided the IAEA with the opportunity and financial support to conduct a series of IS rehearsals, focusing on the implementation of RIIs. Inspectors from Operations A and other ops divisions, as well as the staff of support divisions, participated in them. They have proved to be very beneficial to all the parties involved, i.e., the facility operators, the IAEA, and the Japanese SSAC, by providing practical experience and better understanding of what will be done under IS.

In February 2003, Japan accepted the IAEA's proposal of three-phased IS rehearsals for LWRs without MOX. The first phase involved two pre-designated LWRs, i.e., one remote PWR in Hokkaido (Tomari #2) and one BWR close to Tokyo (Tokai-II), with pre-set dates for RIIs. The first phase was completed by March 2003, where the implementation manual for short-notice RIIs was checked in the field to see if it could be put into practice.

The second phase was conducted from mid-May to early June, involving the same LWRs, but only with a twenty-four-hour advance notice of RIIs. By the time when the second phase was completed, two short-notice RIIs had been performed for each of these two LWRs. Reflecting the results of actual implementation experience, the manual was modified accordingly.

The last phase represents the actual implementation, i.e. RIIs for any LWRs without MOX except for Tomari #2 and Tokai-II, with twenty-four-hour advance notice. It was completed in December 2003, having conducted such RIIs at one BWR (Hamaoka #2) and two PWRs (Mihama #3 and Sendai #1). The inspections were performed in accordance with the implementation manual for rehearsals.

These rehearsals went very well with good cooperation from facility operators and without any serious problems. The IS approach for LWRs without MOX and the implementation manual of RIIs are finalized in April 2004, reflecting the additional experience gained through these rehearsals.

Similarly, Japan also accepted the IAEA's proposal to conduct IS rehearsals at RRCAs and spent fuel storage facilities, which has been implemented successfully.

Summary

Generally, the ratification and implementation of AP and the establishment of an IS regime in Japan has gone relatively smoothly because of the Japanese government's strong commitment to nonproliferation, especially to the realization of effective and efficient IAEA safeguards. This has been facilitated by Japan's various initiatives including a series of AP implementation trials and IS rehearsals, active consultations with the IAEA to resolve outstanding issues, and frequent dialogues with facility operators to gain their understanding and cooperation.

We are now working with the IAEA to shift to the IS regime as soon as possible once the IAEA comes to the initial conclusions of the non-diversion of declared nuclear material and of the absence of undeclared nuclear material and activities in Japan. If everything goes well, we expect IS implementation to start for LWRs without MOX, RRCAs, and SFSF in the near future.

For further development/implementation of IS and further streamlining and strengthening IAEA safeguards, there remain some issues to be addressed, such as universal adherence to APs, enhanced cooperation between IAEA and SSAC, and the need for devising new paradigms to allocate limited IAEA inspection resources in the area where a proliferation risk is high.[4] We have to work closely together toward this end.

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Moving Toward Integrated Safeguards: The Canadian Experience

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Abstract

Canada signed the Additional Protocol in September 1998 and brought it into force in September 2000. With the signing and ratification of the Additional Protocol, Canada embarked on a new safeguards path—a path that ultimately will lead to integrated safeguards once the International Atomic Energy Agency (IAEA) is able to provide credible assurance on the non-diversion of declared nuclear material and on the absence of undeclared nuclear material and activities. The path we are on included preparations prior to signing the Additional Protocol, preparations for and the conclusion of the initial declaration, implementation of the Additional Protocol, updating declarations, and providing clarifications. These are all part of the steps necessary for the IAEA to reach a conclusion that all nuclear material has been placed under safeguards and remains in peaceful nuclear activities or is otherwise accounted for. Canada has also been preparing for the implementation of integrated safeguards in Canada by participating in the conceptualization of IS, providing technical expertise to aid in determining efficient and effective implementation and performing trials of safeguards concepts. This paper will briefly outline the Canadian experience to date, touch upon the lessons learned and provide perspectives on the future of safeguards in Canada. The ultimate goal of these new developments is to ensure that IAEA safeguards remain credible, effective, and efficient, resulting in a system that is focused and adaptable.

Introduction

Canada has a long history of cooperating with the International Atomic Energy Agency (IAEA) on safeguards matters, whether in facilitating the implementation of existing safeguards measures or as a participant in the development of safeguards strengthening measures and equipment. Canada continues to emphasize the need to ensure that safeguards are as effective and as efficient as possible. To this end, it is imperative that the IAEA maximizes the promise of the Additional Protocol (AP)—an opportunity to significantly change safeguards implementation from a quantitative criteria-driven approach to a more qualitative approach reflecting the benefits of increased information on a state's activities, increased access to a state, and increased commitment by the state. However, any significant changes in safeguards implementation can only occur once the IAEA has concluded that the declared nuclear material in the state has not been diverted and has provided credible assurance on the absence of undeclared nuclear material and activities in the state as a whole. On this basis, the agency can move to a state-level integrated safeguards approach that should maximize efficiency without undermining effectiveness.

Canada attaches great importance to achieving this broader conclusion by the IAEA and in moving to integrated safeguards. In pursuit of this objective, Canada has followed a two-track approach: (i) ensuring that we are in a position to meet the additional requirements arising from the AP; and (ii) participating in efforts to conceptualize and develop state-level integrated safeguards approaches, with particular emphasis on the Canadian context.

The Starting Point

The Canadian Fuel Cycle

The seeds of Canada's nuclear program were sown during World War II when Canada participated in the Allied war effort. Since that time, Canada has pursued the peaceful uses of nuclear energy through the development of an extensive nuclear industry that serves both domestic and export markets. Canada's nuclear power program is based upon natural uranium fuelled, heavy-water moderated reactors, commonly referred to as CANDU reactors (Canadian Deuterium Uranium). The nuclear fuel cycle includes: uranium mining and milling; refining and conversion; fuel fabrication; nuclear power reactors; research reactors; spent fuel storage; and research and development activities (see Table 1).

In addition, to the facilities noted above, there are a number of research reactors and subcritical assemblies located across the country, three shutdown reactors, and several spent fuel dry-storage facilities. This extensive array of nuclear and nuclear-related activities was established over a period of approximately sixty years.

Our Commitments

Canada has a strong and consistent commitment to nuclear non-proliferation and to IAEA safeguards. One of the first manifestations of Canada's commitment to the peaceful uses of nuclear energy appeared in the 1945 Declaration on Atomic Energy in which the United States, United Kingdom, and Canada declared a willingness to share nuclear technology for practical industrial

Table 1. Main Elements of the Canadian Nuclear Fuel Cycle

Type of Facility	Number of Facilities	Location
Mines and Mills	Numerous	Saskatchewan
Uranium Refineries	1	Ontario — Blind River (U_3O_8 to UO_3)
Conversion Plants	1	Ontario — Port Hope (UO_3 to UF_6 and UO_2)
Fuel Fabrication	3	Ontario — Toronto, Peterborough, Port Hope
Power Reactors	22	Ontario — Pickering (8), Bruce (8), Darlington (4) Quebec — Gentilly (1) New Brunswick — Point Lepreau (1)
Large Research Establishments	1	Ontario — Chalk River

applications under effective, enforceable safeguards. This international expression was paralleled in Canada by the promulgation in 1946 of the Atomic Energy Control Act (AECA), which enabled Canada to pursue nuclear nonproliferation policy objectives, both nationally and internationally, for almost fifty years, and to give effect to resultant commitments. These efforts are continued and reinforced in the new Nuclear Safety and Control Act that replaced the AECA in 2000.

Successive Canadian governments actively pursued measures, both nationally and internationally, to demonstrate Canada's continued commitment to nuclear nonproliferation. These included early support for the IAEA and its safeguards system, the establishment of bilateral nuclear cooperation agreements as a framework for peaceful nuclear commerce, adherence to the NPT and completion of the Canada/IAEA safeguards agreement pursuant to that treaty, participation in international efforts to develop guidelines to be used by major nuclear suppliers when exporting nuclear material, equipment, or technology, active participation in efforts to strengthen IAEA safeguards (Program 93+2 and Committee 24) and adherence to the AP.

Thus, for Canada, the journey along the road to integrated safeguards is greatly influenced by the presence of an extensive, well-developed nuclear industry and by a strong and consistent commitment to nuclear nonproliferation. These two factors have played a large role in our preparations for the implementation of the AP, in implementing strengthened safeguards in Canada since September 2000 and in conceptualizing a state-level integrated safeguards approach.

Before the entry into force of the AP, Canada developed and enacted the regulations necessary to implement the new measures identified in the AP. In preparation for implementation of the AP, the CNSC established its own procedures to handle complementary access, questions, and inconsistencies, and annual updates to the declaration. The CNSC worked closely with the Canadian sites to draft the initial declaration and to assist the sites establish procedures for complementary access, for dealing with questions and inconsistencies and for preparing annual updates. Before the initial declaration was submitted to the IAEA Canadian prepared a draft that was discussed with the IAEA. Those discussions helped the CNSC formulate policy on such matters as site boundaries and the reporting of changes to declarations. In March 2001, Canada submitted its initial declaration. In preparation for integrated safeguards in Canada in September 2003 Canada and the IAEA began consultations on a state-level integrated safeguards approach and has begun testing elements of an integrated safeguards approach. Canada has undertaken a safeguards support program task to develop and test an integrated safeguards (IS) approach for transfers of used fuel to dry storage at CANDU multi-unit generating stations in Canada. A two-month field trial of the major elements of the IS approach for transfers which includes such elements as a safeguards mailbox, random unannounced inspections, and the operator taking gamma signatures (fingerprints) of loaded spent-fuel dry storage containers started in April 1, 2004, at the Pickering Nuclear Generating Station and will end May 31, 2004. The approach if implemented could substantially reduce the IAEA's effort expended on transfers to dry storage in Canada without weakening safeguards on this material. We believe that the concepts and principles of the proposed integrated approach for transfers are readily transferable to other situations such as transfers to dry storage at CANDU 600 reactors in Canada.[3]

Preparing for and Implementing the AP

The Legal Basis

In June 1998, the IAEA Board of Governors approved Canada's AP with the IAEA. This document was formally signed by Canada in September of the same year. Canada did so under the option of Article 17 of the AP that allowed for Canada to complete the necessary constitutional and statutory requirements before bringing the AP into force. To this end, aspects critical to enabling full implementation were contained in the Nuclear Safety and Control Act (NSCA) and its associated regulations, which were brought into force in May 2000. Subsequently, Canada formally notified the IAEA that all its legal requirements had been met and the AP entered into force in Canada on September 8, 2000.

The NSCA sets out broad powers for the Canadian Nuclear Safety Commission (CNSC) to create regulations, to issue licenses, and to verify compliance. Canada decided to incorporate the requirements of the safeguards agreement and the AP into safeguards license conditions that are part of the relevant licenses issued by the CNSC. These conditions place obligations on the licensee covering the provision and updating of information and records, access by IAEA staff, the provision of services to IAEA staff, the provision of assistance in sampling and measurement, and the installation and maintenance of safeguards equipment.

In early 1998, Canada became the first member state to conclude an additional set of subsidiary arrangements (SA) with the IAEA. While the AP does not require a set of SA, Canada considered them necessary in light of the extensive and complex nature of its nuclear activities. The new set of SA contains the mechanisms to facilitate complementary (and managed) access and information reporting (both from Canada to the IAEA and from the IAEA to Canada) under the AP.

Outreach: A Consultation Framework

Canada decided that the early and continued involvement of the Canadian nuclear industry in the elaboration of strengthen safeguards measures was critically important. To that end, consultations with industry began in 1994 to discuss the framework of strengthened safeguards, the impact on industry, and the modalities of the implementation of the required measures. These initial meetings proved to be invaluable as they provided Canadian industry with a forum to discuss its concerns and to provide practical input regarding the feasibility and effectiveness of proposed measures. During this period, Canadian industry also participated in field trials that demonstrated to the IAEA and to the industry the feasibility of enhanced access to information and locations. Some of the measures discussed and tested in these early trilateral exercises later found their way into the strengthening measures subsequently discussed and accepted by Committee 24 and reflected in the *Model Protocol Additional to the Agreement(s) Between State(s) and the International Atomic Energy Agency for the Application of Safeguards* (INFIRC/540).

Outreach activities involving the CNSC, Canadian industry, and the IAEA continued after the successful conclusion of Committee 24. The emphasis of the outreach shifted somewhat focusing on the production of Canada's initial declarations, on the establishment of procedures for complementary and managed access, and on addressing the reporting and updating requirements necessary for the implementation of the AP. These discussions were highlighted by a trilateral meeting in April 2000 at which the IAEA DDG-Safeguards and his senior staff directly engaged the industry on the importance of the AP.

The Initial Declarations

The CNSC spent much of 2000 and early 2001 preparing the procedures and mechanisms for the collection of information for Canada's declarations under the AP. A dedicated project team was created for this purpose. The project involved industry outreach at the facility level as well as the establishment of data handling procedures and processes. The collection of information was assisted through guidance provided by the IAEA. For example, the guidelines and format document for the preparation and submission of declarations pursuant to Articles 2 and 3 of the AP, prepared by the IAEA, was distributed to all licensees in Canada during the information collection stage. In addition, the *Protocol Reporter* software was also distributed to most locations in Canada making declarations under the AP and workshops were undertaken to explain how to use this new tool.

Throughout this period, the project team held extensive discussions with the IAEA on all aspects of the protocol requirements. This included providing the IAEA with an advance draft of the initial declarations for discussion. In March 2001, using the *Protocol Reporter,* Canada submitted a set of wholly electronic declarations under Articles 3.a and 3.d of the AP. While the official declaration was hand-delivered by Canadian governmental officials in Vienna to the IAEA on a single CD containing both the textual descriptions and the site maps, the declarations (and accompanying documents and images) were also remotely transmitted unofficially to the IAEA in order to test electronic transmission of future reports.

Establishing Procedures

Considerable effort was devoted to the establishment of reliable and consistent procedures for complementary and managed access, for addressing questions and inconsistencies, and for providing the annual update pursuant to the declarations.

The procedures for access cover the entire nuclear program including mines in remote locations and shutdowns facilities. The CNSC established access procedures with both the IAEA and the industry and recorded them in a separate, internal manual. These procedures require, *inter alia*, that the operators at the locations subject to complementary access provide a post-complementary access report to the CNSC. The CNSC also assisted the industry in the preparation of procedures to accommodate individual complementary access requests. To the extent possible, the declarations under the AP attempt to highlight areas of managed access or other access considerations within the text of the declarations for individual sites or locations. The identification of site contacts and of locations requiring managed access was included in the SA.

The CNSC has also established internal procedures for handling any questions or inconsistencies arising from Canada's AP declarations. These procedures, *inter alia*, provide for the prompt distribution of questions and inconsistencies to the relevant site or location and the timely submission of appropriate answers and explanations.

Pursuant to established procedures, each year a letter is sent from the CNSC to senior management at each licensee requesting, by a specified date, an update of the information previously submitted relevant to Canada's declarations under Article 3 of the AP. The licensees use the IAEA's Protocol Reporter to prepare their individual annual updates. The CNSC has developed software to facilitate the review of newly submitted updates with previous ones. After satisfactory review, the information is assembled in the Canadian annual update for transmission to the IAEA as an encrypted e-mail attachment.

Conceptualizing and Developing IS

As early as 1990, the CNSC had created a forum for discussions with industry on the future development of safeguards in both the global and the Canadian contexts. This investigative look at the need for a strengthened safeguards regime that was efficient and effective was the beginning of Canada's deliberations on the optimization of safeguards measures. As noted above, these early considerations lead to ongoing trilateral discussions between Canadian authorities, representatives from the IAEA, and representatives from industry. This, in turn, culminated in a series of field trials to test the concepts that were under consideration. Thus, when the IAEA convened an expert group meeting on integrated safeguards in September 1998, the Canadian representative was able to bring to the table the results of Canada's experience in conceptualizing the integration of traditional safeguards measures with the new measures in the AP. This was followed by several consultative meetings between the IAEA and member states (as part of an IAEA Safeguards Support Program Task) where emphasis was placed on developing concepts for state-level integrated safeguards approaches. Again, Canada was an active participant.

In preparing the concept paper for a state-level integrated safeguards approach for Canada, emphasis was placed on openness and transparency and on maximizing, to the extent possible, the characteristics of the safeguards approaches being used at the facility-level. This was translated into an approach featuring, *inter alia,* the provision of near-real-time information on nuclear material flows throughout the fuel cycle by means of mailboxes and the remote transmission of data from installed safeguards equipment, and the use of short notice and/or unannounced access to locations within Canada to verify this information.

To a large degree, these concepts have been explored in the context of the CNSC's ongoing discussions with the industry. In one particular area, discussion is being translated into action. Specifically, Canada is undertaking a Safeguards Support Program Task to develop and test an integrated safeguards approach for transfers of spent fuel to dry storage at CANDU multi-unit stations in Canada. This approach, if successful, could substantially reduce the IAEA's current inspection effort on this activity without undermining effectiveness.

Next Steps

Although much has been achieved in the pursuit of integrated safeguards in Canada, more needs to be done. As of May 2004, Canada is still under a strengthened safeguards regime awaiting the broader conclusion from the IAEA that will permit the transition to a state-level integrated safeguards approach. Clearly, the provision of this safeguards conclusion is the most important next step in the process. Canada and the IAEA must continue to work together to ensure that the agency is in a position to draw this conclusion.

While the conclusion is necessary in order to move to integrated safeguards implementation, the creation of a state-level integrated safeguards approach is also required. Since September 2003, Canada has worked with the IAEA on the conceptualization, development, and implementation of such an approach. The IAEA should be in a position soon to take the decision on the state-level integrated safeguards approach for Canada.

The discussions with the IAEA indicate that the state-level integrated safeguards approach for Canada will rely heavily on mailbox approaches, the remote transmission of data from the installed safeguards equipment, including state-of-health data, and the randomization of inspections. It will be necessary to systematically install these capabilities across the entire Canadian nuclear fuel cycle. Although progress is being made on several fronts, completion of the exercise will require considerable time. Accordingly, the IAEA, working with the CNSC and industry, will need to determine how the transition to integrated safeguards can be undertaken. Should the transition be accomplished on a state-as-a-whole basis or can it be undertaken on a more gradual basis, concentrating, for example, on those sectors of the Canadian fuel cycle with the required capabilities in place?

Finally, the conceptualization and development of integrated safeguards is recognized as evolutionary. Undoubtedly, changes will be made as experience is gained. In this context, it will be necessary to monitor continually the implementation of agreed state-level integrated safeguards approaches to ensure that they are, in fact, accomplishing the objective of maximizing efficiency without undermining effectiveness. The end result should be a more focused and adaptable safeguards system—one that enables the IAEA to optimize its use of the safeguards measures available to it.

Conclusion

This paper has focused on Canada's experience to date on our efforts to move toward integrated safeguards. As more states sign and bring into force an AP, traffic on the road to integrated safeguards should increase dramatically. While recognizing that in several respects Canada's experience has been unique, some of the lessons learnt from that experience may be relevant to other states. Specifically,

- It is important to ensure that the necessary legislative framework to facilitate the implementation of the new measures arising from the AP is established as soon as possible;

- Early and frequent consultation and cooperation with the IAEA in both the preparation and the implementation phases is essential to facilitate the process and to communicate expectations; and
- Early and frequent consultation with industry is essential to promote understanding, *buy-in,* cooperation, and practical advice.

Preparing for and implementing the AP is manageable if appropriate groundwork is laid. Openness and transparency among all parties to this undertaking is critical both before and during implementation. Successful completion of the journey towards integrated safeguards requires commitment, communication, and cooperation. These characteristics, undoubtedly, will also be required in order for a state to maintain this goal once it has been achieved.

The Additional Protocol in the European Union as Preparation for Integrated Safeguards

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Abstract

The entry into force of the Additional Protocol (AP) in the European Union is a complex process because on the European side fourteen parties are signatories to the Non-Nuclear Weapons States (NNWS) AP (the thirteen NNWS of the EU plus the European Atomic Energy Community—usually known as Euratom). Matters were further complicated by the political wish to bring the APs relating to France and the UK into force at the same time as the NNWS AP, before the accession on May 1, 2004, of a further ten states to the EU.

The application of the APs will present a number of challenges because of the extent, nature, and evolution of the nuclear fuel cycle in Europe. The European fuel cycle was established in the late 1950s at a time when many held the view that fission energy and later fusion energy would provide the community's chief source of energy in the future. Since that time several European states have renounced the nuclear option, phasing out their nuclear research programs and reorienting their nuclear research centers toward non-nuclear purposes.

The European Atomic Energy Community (Euratom) was established in 1957 at the same time as the European Economic Community. Euratom had the task of creating the conditions for the establishment and growth of nuclear industries. Far-reaching responsibilities were given to Euratom in the areas of supply, safeguards, and ownership of nuclear materials but it was given little responsibility in relation to the control of the use of nuclear equipment. The European Commission is the body charged with execution of most of the controls and operational matters described in the Euratom Treaty.

However, the AP concerns nuclear equipment and research as well as nuclear materials. Not all EU member states shared the commission's view that the AP conferred new legal competences upon the commission in relation to nuclear equipment. As a compromise, the AP for the thirteen NNWS allows member states that so wish to transfer to the European Commission the implementation of certain tasks which otherwise would be their responsibility.

In parallel, and independent of the implementation of the AP in the EU, a root and branch review of the EU's safeguards control regime is underway. Although the review has not been completed, it is clear that the regime will be considerably streamlined and may be reduced to a level comparable to that of the International Atomic Energy Agency's (IAEA) integrated safeguards (IS)—some time before the introduction of IS by the IAEA in the EU however. The IAEA already applies IS in some of the new member states and it is hoped that Euratom will gain valuable experience on IS from the new member states' experiences.

Introduction

The three Additional Protocols (AP) to the safeguards agreements concerning France, the UK, and the non-nuclear weapon states (NNWS) of the European Union (EU), were signed on September 22, 1998. Euratom is a signatory to all three APs. Whereas the AP for the UK and France are voluntary agreements and are therefore quite specific, the AP for the thirteen NNWS of the EU[1] comprises all the features of the Model Protocol INFCIRC 540. The Euratom Treaty[2] requires that the AP enter into force at the same time in all thirteen NNWS. For political reasons, the UK and France agreed that their respective APs would enter into force on the same date as that of the NNWS.

The implementation of the AP for the EU NNWS necessarily differs from the implementation of the AP in other IAEA member states because of the fact that it concerns thirteen states and their collective conscience—the Euratom community—and because the responsibility for implementation is shared by the member states and Euratom.

The entry into force of the AP in the EU is made still more challenging by the concurrent enlargement of the EU to twenty-five states and by the revision of Euratom's safeguards control strategy.

Issues Specific to the European Union

Nature of the Nuclear Fuel Cycle in the EU

The fuel cycle was established in the European Union in the late 1950s at a time when many saw nuclear energy as constituting the community's main source of energy in the future. Nuclear energy was seen as offering a reduced dependence on imports of energy from politically unstable regions of the world while at the same time promoting high-technology research and development. The political climate in the 1950s was thus generally favorable making the necessary investments in the R&D programs required to create a nuclear industry in the European Community. Commercial production of nuclear energy in the European

Community began in the 1960s and by the late 1970s some of the first research reactors were being closed down.

By the 1980s, the initial enthusiasm for the commercial possibilities of nuclear energy had faded and was replaced by more realistic views. At the same time, the voice of environmental movements began to be heard, especially after Three Mile Island and Chernobyl. The consequence was more stringent legal requirements for the licensing, construction, and operation of new nuclear facilities. This not only rendered more difficult the construction of new installations, but also caused many research institutes and other nuclear plants to be closed down, and led some member states to renounce nuclear energy completely. Since that time many European nuclear research centers and nuclear industrial parks have been partly or completely reoriented towards non-nuclear activities.

Role of Euratom

The development of the nuclear fuel cycle in the European Union was supported through the creation of the European Atomic Energy Community (Euratom). The 1957 Euratom Treaty between the original six member states gave the European Community the task of creating the conditions for the establishment and growth of nuclear industries. In its preamble the Euratom Treaty recognizes that “nuclear energy represents an essential resource for the development and invigoration of industry and will permit the advancement of the cause of peace.”

The member states delegated important responsibilities to the European Commission. Chapters VI, VII, and VIII of the Euratom Treaty provide it with wide powers in the areas of supply, safeguards, and ownership of nuclear material. The anchoring in European law of the control of the ownership, use, and supply of nuclear materials provided non-European partners with the assurance that materials and equipment that they might provide would not be used for military purposes.

Since 1958, the European Commission has maintained a community-wide nuclear materials accountancy system and exercised controls on the use of nuclear materials. Since the entry into force of the NPT safeguards agreements with France, the UK, and the thirteen NNWS respectively, Euratom also functions as the State System of Accountancy and Control (SSAC) toward the International Atomic Energy Agency (IAEA) for all the member states of the EU.

The EU has grown to twenty-five members from the original six. Upon accession, all states that have acceded to the EU have transferred to the European Commission the responsibility for nuclear material accountancy and control, and for providing the IAEA with accountancy reports.

The powers of Euratom in relation to safeguards on nuclear materials, including measures under the AP, are unchallenged. However, some member states maintained that the AP could not provide Euratom with competence in respect of those measures of the AP that do not involve nuclear material. The European Commission’s legal service was of the opinion that all obligations resulting from the AP fell within the ambit of Art 77b[3] of the Euratom Treaty and hence the commission would be competent, whereas the legal service of the Council of the European Communities, which represents the interests of the member states, was of the opinion that the AP could not result in the commission’s acquisition of new powers in relation to the nonnuclear aspects of the AP.

In the end, a compromise was found that allows the member states either to perform the measures not related to nuclear material themselves or to transfer the implementation of these measures to the commission. This compromise was concretized as Annex III[4] of the NNWS AP. (The specific nature of the APs with the two nuclear weapons states means that this question of division of responsibilities does not arise).

Although this solution may appear to diminish Euratom’s role in the AP, the reality is that Euratom still has a major role in its implementation. The commission played and still plays the most important role in negotiating conceptual approaches with the IAEA so that reporting within the EU will be harmonized as far as is possible.

Division of Responsibilities and Work Between the Commission and the Member States

In most IAEA member states, the provisions of the AP are implemented by the national SSAC. In the European Union, however, the provisions of the AP will be implemented by the commission,[5] by the member state concerned, or by the commission and the member state acting jointly. As described previously, member states may entrust some of their own tasks to the commission in accordance with Annex III of the AP.

At the time of writing, nine of the thirteen NNWS member states had indicated that they would like to make use of the services of the European Commission for this purpose. In January 2004, the European Commission indicated that in principle it was willing to perform certain tasks on behalf of some member states.

The compromise on the division of responsibilities was accompanied by an agreement providing for full transparency between the member states and the European Commission regarding reporting to the IAEA, each party providing the other with a copy of any information transmitted to the IAEA. In reality therefore the difference between side-letter and non-side-letter member states seems rather academic.

The French and UK APs are limited to information related to activities involving NNWS; they do not include the possibility of transferring tasks to the European Commission, which will implement only those provisions of the protocols related to nuclear material, the other provisions will be implemented by the member state concerned.

Legislation and Entry into Force (EIF)

The entry into force (EIF) of the Euratom APs requires the fulfillment of the provisions of the Euratom Treaty concerning international agreements as well as the fulfillment of the provisions on EIF of the AP itself.

The AP requires the member states and Euratom to inform the IAEA in writing that their respective requirements for EIF have been met; in respect to the member states, the IAEA understands this as meaning that national procedures for ratifying the AP have been completed. Article 102 of the Euratom Treaty imposes a similar, but stricter, condition—each member state must notify the commission that the international agreement in question has become applicable in accordance with its internal laws. This means that in addition to completion of ratification, each state must also pass the national regulations and make the administrative arrangements necessary to give effect in national law to the international legal commitment that it has undertaken.

As noted above, Euratom is also obliged to inform the IAEA that its requirements for EIF have been met. One of these requirements is the passage of legislation to ensure that Euratom can meet its obligations vis à vis the IAEA. The coverage of the Euratom system of nuclear material accountancy and control was already more comprehensive than was required by the safeguards agreement with the IAEA and, with the exception of wastes, covered all the additional declarations on nuclear materials provided for in the AP. It was therefore sufficient to enact a revision of the regulation on safeguards accountancy, extending its coverage to include wastes and the requirements on site declarations. The regulation has effect throughout the European Union.

The European Community notified the IAEA on April 30, 2004, of its own readiness and of that of the fifteen member states for EIF; the AP accordingly entered into force in the EU on that date.

Implication of Enlargement

On the May 1, 2004, ten new states became members of the EU.[6] All of these new member states had safeguards agreements with the IAEA and they had all signed the AP; in seven of them the AP was already force. Upon entry to the EU the new member states are required to suspend their existing safeguards agreement with the IAEA and accede to the in its place to the safeguards agreement between the EU NNWS and the IAEA. Article 23 of the latter agreement covers the accession of new states to the agreement. However, the AP has no equivalent article. The legal services of the commission, the IAEA, and the existing member states concluded that Article 23 of the agreement also applies *mutatis mutandis* to accession to the AP. Each new member states will therefore accede to the Euratom NNWS safeguards agreement and its AP at the same time.

The fact that the AP was in already in force in seven of the ten new member states also had an effect on the EU's preparations for EIF. Had the AP not been in force in the EU at the time of accession of the new member states one of two undesirable consequences would have resulted: either the new member states would have had to suspend the AP until such time as the AP was in force in the EU as a whole or the new states' existing safeguards agreements and APs would have remained in force until the EU was ready in breach of the uniform application of EU law. The resulting political pressure helped ensure that the AP entered force before enlargement of the EU.

Technical issues

Closed and Decommissioned Facilities

Due to the historical development of the nuclear fuel cycle in Europe as outlined above, the EU has hundreds of closed facilities or closed locations outside facilities (LOF), half of them with only small or even very small quantities of nuclear material used for non-nuclear purposes. They were generally no longer inspected under the traditional safeguards regime, even though the verification of such installations is an integral part of the IAEA's *strengthening measures.* Such installations may become subject again to reporting under the AP, if prior to their closure they were involved in activities related to the nuclear fuel cycle. Many of these closed locations have been largely dismantled over the years, but only when an installation is confirmed to be decommissioned for safeguards purposes does it cease to form the core of a site under the AP.

This issue is of particular importance for the research centers and technology parks in the EU. Most of the buildings are used for non-nuclear activities. Integrating them into an AP site would place an unjustifiable burden on the users and owners as well as directing the IAEA's activities to areas of no interest for the implementation of the AP. The commission has visited many sites to confirm the status of buildings and to elaborate constructive solutions to questions as to what to include in the site.

Non-Nuclear LOFs and Exemption

Although quite a large number of nuclear fuel cycle related activities have been abandoned, nuclear material is also still used for non-fuel cycle related activities in hundreds of different locations holding less than 1 kg_{eff}. As most of this material has a non-nuclear use, most of these places would qualify for exemption or even termination of their material, i.e., the location would no longer constitute a site.

The Commission's Role in the Implementation of the Additional Protocol

There are four key players in the implementation of the AP in the European Union: the IAEA, the member state authorities, the operators or reporting entities, and the European Commission. The commission interacts with all the other partners.

Commission Activities with Member States

The commission held bilateral consultations with all member states to prepare for implementation and to assist member states, where necessary, in understanding the AP and in preparing the legal instruments.

The outcome of these discussions is reflected in a document outlining the "Arrangements for the implementation of the Additional Protocol in (member state)." These country-specific papers have been standardized to the extent that there are now only two sets: one for the side-letter member states and the other set for the non-side-letter states. All papers cover reporting under Article 2 itself, IAEA requests for clarification and amplification (Article 2c), questions and inconsistencies (Article 4d), as well as complementary access (Article 4, 5, and 6), managed access (Article 7), and the reporting of results (Article 10).

Draft subsidiary arrangements have been prepared, based on the IAEA model, for codes 11 to 18 covering the measures of the AP.

European Commission Activities with Operators

The European Commission assists the operators of complicated sites and the member states concerned with the definition of sites and the corresponding declaration. Whereas the description of a site consisting of an active facility is normally straightforward, sites containing former nuclear research centres or technology parks are very often more difficult to define.

Where installations have been decommissioned, Euratom initializes visits with the IAEA to confirm the decommissioned status.

For operators of nuclear power plants, a model site declaration had been elaborated to assist them in preparing their own site declaration and to harmonize site declarations.

European Commission Activities with the IAEA

Two field trials for nuclear sites were carried out to test all the measures of the AP: one in a state that intends to transfer tasks to the European Commission, and one in a nontransferring state. The experience gained was used to refine the *arrangement papers.*

The commission initiated a discussion with the IAEA on the treatment of LOFs under the AP; the outcome was that places with exempted nuclear material no longer constitute a site. Common site visits were organized to discuss complex site boundaries. A comprehensive plan was set up to assess the status of the closed installations to confirm their decommissioned status and if possible free them from the requirement to be declared as part of a site under the AP.

Dedicated mailboxes were set up in the IAEA and in the commission to allow encrypted data transfer. Information was exchanged on AP databases and reporting software to ensure compatibility between the IAEA and commission systems.

Own Tasks of the Commission

Training seminars on the AP have been organized for eighty commission inspectors.

The commission has developed reporting software known as CAPE (Commission Additional Protocol Editor) for EU operators. Regular meetings are held with CAPE users. In addition, a headquarters database handling all AP information within the community and the corresponding workflow tools is being developed.

In close cooperation with the European Safeguards Research and Development Association (ESARDA) Working Group on Integrated Safeguards, guidance on site definition issues and R&D declaration has been elaborated.

Four commission officials act as *country officers,* each responsible for several member states. They serve as the main contact point for the member states and for all issues prior to the first report, such as

- Establishing definitive site lists including corresponding site representatives
- Establishing a list of all organizations subject to reporting under Article 2
- Assisting with and following up the screening of LOFs and closed plants
- Assisting operators and visiting sites to define site boundaries

New EU Safeguards Strategy

Objective of Chapter VII of the Euratom Treaty

The objective of the Euratom safeguards system as created by Article 77(a) of the Euratom Treaty is to be able to report to the European public that there is credible assurance that nuclear material in the European Union has been used for the purposes declared by the holder or user. In addition, Article 77b[3] provides assurance to third parties that international obligations relating to supply or use of nuclear materials are complied with.

Safeguards must address a number of risks:

- Use of nuclear material by the state for purposes other than declared
- Theft of nuclear material by or with the help of workers in a plant
- Use of nuclear material by the operator's organization for purposes other than declared (intentional)
- False declarations made to conceal human errors, accidental losses, or process deficiencies
- A low standard of control in a facility providing the ill-intentioned with the opportunity to acquire nuclear materials

In the stable political climate of the beginning of the 21st century, the risk that an EU member state might divert nuclear material is so low as to not warrant control by Euratom. In any case, the IAEA addresses this risk in the frame of its activities in support of the NPT.

Likewise, it is the operator's task, not Euratom's, to protect nuclear materials from theft by insiders.

Hence, in the early 21st century, Euratom safeguards will focus on controlling how operators manage the nuclear materials in their possession

EU Safeguards Strategy

Under the revised Euratom safeguards strategy, traditional safeguards parameters such as timeliness, detection probability, and significant quantity take on different meanings or are derived from different considerations. Thus timeliness is concerned with reporting frequency, the detection probabilities to be applied are derived from risk considerations, and significant quantities may modulate physical verification efforts. The result will be a basic reorientation of inspection activities, which allows for a more flexible inspection scheme.

Cooperation with the IAEA

It is likely that the adoption of new safeguards approaches by Euratom will necessitate discussions on the respective roles of IAEA and Euratom inspectors during inspections in the EU.

Once the AP is in force across the whole EU and the IAEA has concluded that integrated safeguards can be generally implemented in the EU, it is anticipated that the IAEA will reduce the efforts it devotes to classical safeguards. When this time comes, it is hoped that the IAEA may draw inspiration from the revised safeguards approaches currently being developed by Euratom safeguards.

Conclusion and Outlook

The year 2004 poses major challenges for the European Commission's safeguards services and consequently also for the IAEA. The Commission has to cope with:

- The simultaneous entry into force of the AP in all thirteen NNWS member states
- The enlargement of the EU to twenty-five member states on May 1, 2004
- The revision of the commission's own safeguards strategy

The Euratom safeguards services will continue to closely collaborate with the IAEA, but both have to instil new life into this collaboration; the revised Euratom safeguards strategy should not be considered as an obstacle to the continuation of this collaboration.

End Notes

1. 1999. *Official Journal of the European Communities* L67/1 of 13/3/1999.
2. Article 102 of the Euratom Treaty states: "Agreements…shall not enter into force until the commission has been notified by all the Member States concerned that those agreements or contracts have become *applicable* in accordance with the provisions of their respective national laws."
3. "…provisions relating to supply and particular safeguarding obligations assumed by the Community under an agreement concluded with a third State or an international organization…."
4. "For the sole purposes of the implementation of this Protocol, and without prejudice to the respective competences and responsibilities of the Community and its Member States, each State which decides to entrust to the commission of the European Communities implementation of certain provisions which under this Protocol are the responsibility of the States, shall so inform the other Parties to the Protocol through a Side Letter…."
5. In line with the Euratom Treaty provisions, the European Commission carries out the tasks entrusted to the community. The commission services responsible for the implementation of the measures referred to in this document are Directorates H and I of DG-TREN.
6. Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Czech Republic, Slovakia, and Slovenia.

Preparing for the Entry into Force of the Additional Protocol in EU Member States–Activities of the ESARDA Working Group on Integrated Safeguards

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Abstract

ESARDA, the European safeguards Research and Development Association, has as a main objective assisting the European safeguards community with advancing progress in safeguards and enhancing the efficiency of systems and measures. Key bodies of ESARDA are standing working groups dealing with various technical subjects.

The ESARDA Working Group on Integrated Safeguards (IS WG) was created in 2000 with the objective of providing the safeguards community with expert advice on methodologies and approaches to integrate INFCIRC/153 and INFCIRC/540 measures, and to present a forum for the exchange of information, views and experiences in that regard. Its members represent inspectorates, national authorities, operators, and research centers active in the field of safeguards.

The working group very soon realized that a first milestone on the road to integrated safeguards is the successful and functional implementation of the Additional Protocol. Discussions and activities concentrated on actions necessary to reach this end thereby taking into account the specific situation in European states.

Among the topics discussed were issues of:

- Establishing a functional site definition for different types of installations, ranging from small locations with very small amounts of nuclear material to complex installations with a complex history
- Dealing with different and even conflicting requirements in the context of unannounced inspections

Interpreting and handle the requirements for research and development declarations considering the needs and interests of all parties involved the International Atomic Energy Agency participated in most of the meetings as an observer and provided the group with valuable background information on Additional Protocol (AP) questions and received in turn a deep insight into our considerations, motivations, and concerns. This procedure contributed much to a better mutual understanding that is not least reflected in the revised draft of the AP implementation guidelines.

Introduction

The Additional Protocol (AP) entered into force in the European Union (EU) member states on April 30, 2004, just one day before the enlargement of the union to twenty-five members. During the AP negotiating phase, and especially after the signing of the AP on September 22, 1998, activities were undertaken in EU countries to assess issues and consequences of the new AP measures for states and operators. The implementation of the protocol and the development of integrated safeguards were and still are under broad discussion within the European safeguards community.

ESARDA, the European Safeguards Research and Development Association, has given these developments and activities high attention by organizing special sessions and seminars on respective issues. Taking into account, however, that the whole nuclear and nuclear-related infrastructure including nuclear facilities, nuclear suppliers, research centers, and authorities within the European Union is affected by the measures of the AP and by the application of integrated safeguards there was a common understanding that also a permanent forum for specific and detailed discussions and for exchange of information was needed. The ESARDA Working Group on Integrated Safeguards (ISWG) was established in May 2000 to satisfy this need, i.e., to serve as a platform for information exchange and to provide assistance to operators, member states, and national, regional, and international inspectorates on the implementation of integrated safeguards (IS).

The Structure of the Working Group

Most of the members founding the group already had worked in the field of integrated safeguards, e.g., within the framework of the member states support programs to the IAEA. They were familiar with the objectives and regulations of the AP and the basic approaches for IS as developed in the IAEA.

The focal point of the constituting meeting was to define the scope of activities and the main fields of work for the group. There was a common understanding among the participants that the work should mainly be oriented toward practical issues of implementing of the AP and IS approaches taking into account the point of view of all parties involved in the implementation process, such as operators, and national, regional, and international inspectorates. It was clear from the beginning that there was no intention to develop individual approaches since the participants were well aware that the group did not have the necessary capacity and resources at its disposal to do such work. The group would rather concentrate on the assessment of documents available and draw its own conclusions.

Among the first activities after bringing the ISWG into being, was fulfilling some administrative requirements, such as establishing terms of references and an action plan, and defining success factors. These are instruments are used by the ESARDA working groups to guide the direction of the groups' activities and to survey the efficiency of their work. On the basis of the common understanding described above, the terms of reference and the action plan were discussed and set up accordingly. (See reference 2.)

During its now four years of life, the group proved to be very active and productive. The first constituting meeting had six participants present. This number quickly increased to now more than twenty members or observers from more than ten European countries, with representatives form the inspectorates of Euratom and the IAEA. This indicates a great interest in the subjects of AP implementation and integrated safeguards. Most members have strong backgrounds with practical experience in implementing and carrying out safeguards measures, since most of them are representatives of nuclear operators or national authorities. The group meets regularly—about three times a year at different locations—hosted by one of the sending organizations, and the meetings always were well attended.

Euratom representatives have participated in the meetings since the beginning and the group soon recognized that the participation of the IAEA also would be very fruitful for both sides. For the WG it is a big advantage to receive first-hand information on new considerations, concepts, and developments associated with IS; for the IAEA it is very valuable to gain a direct and unfiltered insight into and thereby a better understanding of our reflections and concerns to implement the new safeguards elements into real life under the various given circumstances in our countries. The IAEA accepted our invitation and soon became an indispensable part of our group.

Topics of Discussions

First discussions concentrated on new elements and approaches proposed for IS, which the WG examined with a view of how to implement this in practice. The group reflected aspects of how the new elements could be translated to and carried out in real life, what effects this could have on the current practices of plant operation and what administrative procedures and regulations were affected. During all these discussions the group drew up lists of open issues and questions that needed further consideration and solutions.

The Role of R/SSAC

In IS, the increased cooperation with regional and state systems of accounting and control (R/SSAC) will be an essential element that is believed to have a high potential for savings in IAEA inspection effort. The group discussed from the beginning the role the European regional and state systems could play in IS. Input to the discussion on this issue was provided in several meetings by presentations from group members. Participants from the United Kingdom presented the results of their studies on applying of quality assurance and compliance approaches used in other industries to R/SSACs; group members from Finland and Sweden portrayed their respective SSACs, and representatives from Euratom and IAEA briefed the group on the results of their considerations and expert group work.

First of all, the group considered that an extended use of R/SSAC by the IAEA had a high potential for savings. Although it is assumed that most savings can be gained when cooperating with large regional systems, such as Euratom, the IAEA, in the view of the group, could also reduce its safeguards effort considerably by cooperating with smaller state systems on a lower level.

Good experience with respect to savings in IAEA efforts has been gained through cooperation between IAEA and Euratom within the new partnership approach (NPA). It can be stated that from the three proposed levels of cooperation with R/SSAC (enabling level, joint activities level, use of inspection results) the first two are fully implemented. However, Euratom, as an independent multinational system, has the capacity to meet the highest level, i.e., to perform safeguards verification activities for the IAEA and make the findings available to the IAEA. In order to gain confidence in the Euratom activities the IAEA could rely on its accumulated experience within the NPA and adopt quality assurance (QA) and quality control (QC) techniques. In essence the IAEA would audit Euratom by applying agreed QA/QC measures by retaining the right to perform its own independent inspections. In this respect the group supports the work done by the UK describing QA/QC tools that could enable the IAEA to make use of big regional systems.

As Euratom is currently reconsidering its mission and its own safeguards approaches, discussion of the role of the R/SSAC has been put aside until the boundary conditions, such as the level of continuing Euratom inspection activity, become more clear.

Safeguards Approaches under IS

The group also closely follows the development of IS approaches for the different facility types. These approaches and the respective safeguards criteria, as far as information is available, are analyzed with respect to its consequences and effect to the operators and the authorities.

Starting with the IS approach for light-water reactors (LWR) without MOX, the group exchanged views on different elements, such as timeliness, C/S application, and unannounced inspections. In principle there was a positive response to the base LWR approach since it provides for a reduced number of inspections and lower the risk of instrument failure, because C/S will be used only during the reloading of the reactor. However, implementation difficulties became apparent regarding unannounced inspections (UI), which are seen as a key element of the integrated safeguards approach in these facilities. The group recognizes the attractiveness of UI for safeguards concepts. They will allow the IAEA much faster access to relevant locations in a facility than any other type of inspection. They will place a potential diverter in a permanent state of uncertainty and can be used to detect and deter from undeclared activities in a facility and, thus, can be an efficient and cost effective tool to cover a range of diversion scenarios. However, UI imposes additional burden to facility operators and increases the danger that inspections may interfere with planned operational activities. Unannounced inspections are already provided for in the INFCIRC/153-type safeguards agreements. They are also used in the concept of *limited frequency unannounced access* (LFUA). This concept was developed for the access to cascade halls in gas-centrifuge enrichment plants and is now successfully applied for many years in the URENCO enrichment plants in the EU. A presentation from a group member working within the URENCO company outlined the details of application and the experiences gained with UI in the LFUA safeguards schema.

The issues were, together with the feedback collected from reactor operators, summarized in a detailed list of questions that was presented and handed over to the IAEA. This list served as a contribution from the group to support the IAEA in defining the conditions for unannounced inspections. The results of our discussions are summarized in a topical paper worked out by the group (see reference 4).

AP Implementation

In their own organizations, many WG members were involved in practical work to prepare for the implementation of the AP in their countries and this common interest also directed our activities. Within the EU member states, there exist three different APs concluded with the IAEA: the two nuclear weapon states (NWS) have each their own type of AP and the remaining non-nuclear weapon states (NNWS) have a common AP. The AP for the European NNWS contains a third annex that foresees the possibility that states entrust Euratom with tasks assigned to the state in the AP. The majority of the EU member states make use of this possibility and therefore Euratom has to play a big role in the implementation of the AP in our countries as well.

The task requiring the most effort in all countries working out the initial declaration according Article 2 of the AP. The UK has submitted a voluntary Article 2 declaration since 1999 and has gained a lot of experience. It could provide the group with very valuable information on the procedures chosen, the effort required, the problems encountered, and the results achieved. Because the UK is a nuclear weapon state, its voluntary declarations clearly identified the areas where difficult problems are to be expected. Additional stimulations for our in-depth discussions of AP implementation issues came from briefings given by the inspectorates, from presentations made to group about field tests conducted in Finland at the VTT and in the Netherlands at Petten, and, at the beginning of this year, we had the opportunity to hear about and discuss experiences gained in Japan with the AP implementation.

Site Definition

One of the most important practical issues when preparing for the implementation of the AP is the definition of the site under the Article 2a(iii) declaration. The WG discussed this issue in length since there are many aspects to be considered. The site should be carefully defined as it has a direct influence on the amount of information to be provided to the IAEA, the IAEA 's rights for complementary access (CA), and the building owner's obligations to grant this access often with very short notice. Sites should be large enough to meet the objectives of the AP. They should also be set in such a way that they do not include buildings not contributing to the nuclear mission of the site so that no unneeded information is collected. The site boundaries should, therefore, be set in such way that no unnecessary burden is put on building operators that have no functional relationship with nearby nuclear activities. This topic was one of the central points of our discussions in the last three years. The problems considered and the solutions found are discussed in detail in a topical paper worked out by group members. (See reference 3.)

R&D Declaration

Without a doubt, the declaration of R&D activities is one of the most sensitive aspects of the AP. R&D declaration were treated intently by the working group and it is very likely that it will take some time to reach a universally accepted interpretation of its obligations. A clear understanding of a state's commitments and the IAEA 's rights in relation to the declaration of R&D activities not involving nuclear materials are key elements for adequately addressing the requirements of the AP. Misinterpretation of the AP obligations could lead either to excessive burden for states and operators or to incomplete declarations, which may weaken the objectives of the AP and deserve further inquiry from the IAEA. While the latter is true for most AP provisions, it is particularly relevant to R&D activities for several reasons, which were discussed in depth in our group:

i) The wording of the AP requirements is open to interpretation, mainly due to the broad concepts embedded in the definition of nuclear fuel cycle-related R&D activities.
ii) The role of the state needs to be discussed, in order to understand when it has a genuine control or knowledge of the specific research activities carried out by the involved players.
iii) The declaration should focus on added-value information

for the IAEA 's strengthened safeguards mission. Excessive R&D declarations would be an unnecessary burden for states, operators, and the IAEA.

The critical points of the R&D declaration as identified in our discussions and the solutions contemplated are in detail described in a topical paper worked out by group members. (See reference 6.)

Other Topics and Activities

Besides the topics mentioned above, there were quite a lot of other issues touched on in the meetings. It soon became a sort of a ritual to start the meeting with a "tour de table" where members from each country represented in our group and the inspectorates gave a status update of current developments, activities, and other issues encountered in the process of preparing for the AP implementation. Within the framework of integrated safeguards, we discussed other subjects that not yet demanded our attention with the same urgency like the preparation of the initial AP declaration. Among these subjects were the IS evaluation criteria, the role of C/S in IS, and the procedures for the resolution of anomalies. But among the subjects we felt it necessary to spent more attention were the analysis of IS boundary conditions and the contribution to the revision of the IAEA AP guidelines.

Discussion of Boundary Limits

The WG also worked on analyzing integrated safeguard' overall framework and its consequences. The Integrated Safeguards Conceptual Framework was established after taking into account a bottom-up approach, starting from facilities, and with a number of self-imposed boundary conditions such as one physical inventory verification (PIV) per year, recoverability to classical criteria within existing timeliness goal, no change in safeguards levels on unirradiated direct use material, and nondiscrimination between states exclusively based upon quantitative parameters. Looking back at what was expected from IS and considering the current framework and the proposed approach, the design logic looks closer to combination than integration, and the above mentioned boundary conditions clearly put limits on what can be reasonably achieve. Consequently it puts a strong limitation on savings expected from *classical* safeguards verification measures, it constrains the value expected from a greater use of AP measures, it undervalues the synergy of AP and *classical* verification of nuclear material. The WG discussed some of those boundary limits and suggestions to reach a better balance between quantitative and qualitative tools and provided examples where real integration could be implemented and could bring more benefits than juxtaposition. The ultimate goal, in our view, is to grant integrated safeguards the strength of a real flexibility to enhance effectiveness and efficiency.

The considerations and suggestions of the working group are summarized in a topical paper prepared by group members. (See reference 5.)

Input for the IAEA AP Guidelines Seminar

In October 2003, the IAEA organized a seminar in London to discuss the proposed revised text for the AP guidelines. The working group contributed a good deal the revision of the original text that was issued in 1997. One of the characteristics of this group is that problems are encountered under very different conditions in different countries. Thereby, a wide spectrum of possible circumstances is covered by the different conditions existing in our countries. The IAEA was present and participated actively in our discussions of AP issues und thus gained a profound understanding of the problems. The group members produced a large effort to document the discussions and to prepare topical papers on all relevant issues. These documents were also handed over to the IAEA for the revision of the guidelines. We were very glad to note that many of our views and suggestions were taken over in the revised version of the guidelines.

Conclusion

In our view, the working group on IS met the expectations that called for the establishment of the group. The group proved to be very active and productive and makes the results of its work available to the safeguards community. A key output is the intense information exchange between the group members that also leads to the emergence of an harmonized view on key issues related to the implementation of the AP and the development of IS. The relationship developed with the IAEA allows a very open discussion and thus a good mutual understanding. It has always been our endeavor to find harmonized solutions that take into account the view of all parties involved in the implementation process, including operators, and national, regional, and international inspectorates.

With the AP now in force in European countries, a milestone of our work has been accomplished, but our task is not at all complete. The need for an intensive information exchange continues with the establishment and later adjustment of the real initial declarations and the preparation for the complementary access visits of the IAEA. All this belongs to the necessary groundwork on which the development of the integrated safeguards approaches can be based. It then still will take some time until the implementation of integrated safeguards in our countries will take place.

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Integrated Safeguards—Progress and Issues

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Abstract

As the program to strengthen safeguards gathers pace, the concept of integrated safeguards is assuming increasing importance. With the Additional Protocol (AP) entering into widespread application, strengthened safeguards—the combination of a comprehensive safeguards agreement and the AP—are becoming firmly established as the Nuclear Nonproliferation Treaty (NPT) safeguards norm. Integrated safeguards takes this process further. Rather than being determined mechanistically, by number of facilities and quantities of material, safeguards effort can be rationalised so as to focus on areas of greatest proliferation significance.

By early April 2004, APs have already been ratified or signed by three-quarters of states with comprehensive safeguards agreements that have significant nuclear activities. When the EU members ratify their APs—expected shortly—more than 70 percent of all nuclear facilities under comprehensive safeguards will be in states with APs in force. Most AP states can be expected to qualify for integrated safeguards (IS)—IS should be in widespread application within the next two-three years.

To date most of the development of IS has been in the conceptual framework, and in facility-level approaches that take advantage of redundancies between traditional and strengthened safeguards to reduce routine safeguards effort. The outcome is a substantial improvement in cost-effectiveness, but currently it still resembles the *one-size-fits-all* approach of *traditional* safeguards. The next major phase is the development of genuinely state-level safeguards approaches, based on the characteristics of each state.

This paper discusses some of the major issues involved, including:

- Developing an appropriate methodology for tailoring safeguards effort to individual states
- Whether the current *threshold* assumption, that states of proliferation concern are unlikely to qualify for is, is soundly-based—and what to do if this is not the case
- Ensuring that is are sufficiently robust to deal effectively with changing circumstances
- Implications for the International Atomic Energy Agency (IAEA)

Introduction

Integrated safeguards (IS) comprise the optimum combination of safeguards measures available under both the standard Nonproliferation Treaty (NPT) safeguards agreement—INFCIRC/153—and the Additional Protocol (AP) which achieves maximum effectiveness and efficiency within available resources. For a state to qualify for IS requires that an AP is in force and that the International Atomic Energy Agency (IAEA) has been able to reach an initial conclusion on the absence of undeclared nuclear activities. Thus, progress to IS requires in the first instance conclusion of an AP.

Viewed in terms of total NPT membership, the rate of uptake of APs remains disappointing—to date, less than half the parties to the NPT have ratified or signed an AP. This delay in accepting the AP has adverse consequences for strengthening the safeguards system—e.g., in terms of access to confirm absence of significant nuclear activities, or availability of import/export information—and every effort must be made to improve the situation. Nonetheless, in terms of safeguards implementation in states known to have *significant nuclear activities,*[1] the situation is more positive—APs have now been ratified or signed by *three-quarters* of such states. Most of these can be expected to qualify for IS.

Already more than 90 percent of all nuclear facilities subject to comprehensive safeguards are in states that have at least signed an AP. When the EU members ratify their APs—expected shortly, perhaps before this paper is published—over 70 percent of nuclear facilities under comprehensive safeguards will be in states with APs in force. IS should be in widespread application within the next two to four years.

Challenges in the Development of Integrated Safeguards

The development of IS faces two major challenges:

1. How to adjust safeguards intensity for state circumstances, to ensure the realization of *efficiency* gains—through reducing routine inspection effort—without compromising *effectiveness*—the validity of the assurance delivered by the safeguards system.
2. Closely related to the first point is—how to effectively address the issue of *undeclared* nuclear activities. This issue—of critical importance to the credibility of the safeguards system—has been highlighted by the illicit spread of centrifuge enrichment technology.

While detection of undeclared activities might seem primarily an issue for states outside IS—states that do not conclude an

AP or do not qualify for IS—such a perception would be incorrect. As will be discussed, IS must be developed with sufficient robustness to deal with the possibilities of: (a) a state qualifying for IS that has undeclared activities that at that time have escaped detection; or (b) a change in a state's commitment to Nonproliferation some time after qualifying. Safeguards are built on the maxim "trust but verify"—under IS trust increases, but effective verification is still necessary—it is a question of finding the right balance.

Tailoring Safeguards Effort to State-Specific Circumstances

A feature of the traditional safeguards system is *uniformity*—inspection activities at similar facilities in different states are similar, with limited differentiation between states. This has resulted in substantial safeguards effort being concentrated in a few states, driven primarily by quantities of nuclear material and numbers of facilities. IS is intended to redress this situation. A key principle of IS is that safeguards implementation is to be based on a specific *state-level approach*—an approach developed to reflect factors pertinent to the state concerned.

Safeguards implementation under IS, generally speaking, is less rigorous than under traditional safeguards—some timeliness goals are extended, in some cases lower detection probabilities apply, and—most importantly—not all facilities are inspected: IS provides for some inspections to be performed on a sample of facilities (e.g., interim inspections are to be performed at only 20 percent of light-water reactors [LWR]). Beyond these savings, however, it is also intended that the safeguards effort in the state will not simply be an aggregation of the standard facility approaches, and that adjustments will be made for state-specific factors.

How will a state-level approach be determined? Provision to take account of state-specific factors is already made in INFCIRC/153, paragraph 81—albeit currently applied only to a limited extent—fuel cycle characteristics, international interdependence, verification of flows, and effectiveness of the SSAC (state system of accounting and control). These are developed further in the IS Conceptual Framework, which refers to:

1. The nature and scope of the state's nuclear fuel cycle and related activities including:
   a. The structure of the nuclear fuel cycle, from uranium mines to nuclear waste
   b. The number and types of nuclear facilities and LOFs (locations outside facilities) and associated activities conducted on nuclear sites
   c. The safeguards relevant characteristics of the facilities and LOFs
   d. The inventory and flow of nuclear material within and between facilities
   e. Fuel cycle-related research and development
   f. The manufacture and export of sensitive nuclear-related equipment and materials
   g. The correlation of all the above information
2. The possibility for use of advanced safeguards technology in the state
3. The possibility for effective use of unannounced inspections in the state
4. Increasing cooperation between the IAEA and the state/regional safeguards system.

It remains to be seen how the state-level approach will work in practice—IS have not yet been applied in states with large fuel cycles. For some time development and refinement of state-level approaches is expected to be an iterative process.

A potential problem in the current IS scheme may be lack of sufficient flexibility—e.g., instead of the fixed value currently provided for selection of facilities for inspection (e.g., in certain cases 20 percent), it would be preferable to apply a range (say 10 percent to 30 percent), and to make it clear this range is only indicative. Further, in many cases there appears to be no flexibility—e.g., a PIV (physical inventory verification) is to be performed at every LWR in a refueling year.

Allowing for greater flexibility is one thing—establishing an appropriate basis for applying flexibility is another. Factors of the kind outlined above—*technical* factors related very directly to the fuel cycle—may be too narrow to allow significant differentiation between states. Without broadening the factors that can be taken into account, there is the risk that ultimately IS will suffer from the same problem as traditional safeguards, that the drivers of safeguards effort will still largely be quantities of nuclear material/numbers of facilities.

Governments evaluate each other on a very broad range of information, including: the way a state conducts its foreign relations; its military capability and posture; its alliances; its strategic interests and circumstances (e.g., whether located in a region of tension); its observance of treaty commitments; its past practice in these areas; its public pronouncements; and so on. Many of these considerations are regarded as political—yet many of them give rise to objective indicators (e.g., military procurement), and are capable of objective analysis.

Is it possible to develop an objective, sufficiently rigorous-and politically acceptable—process for considering some of these factors in decisions on safeguards intensity? The idea of doing so should not be dismissed out of hand—some broadening of the information used in safeguards will be necessary if safeguards are to meet the major objectives of greater efficiency and greater effectiveness.

Qualifying for Integrated Safeguards

Under the IS concept, either a state qualifies for IS—in which case the optimization of safeguards measures applies—or it does not—in which case INFCIRC/153 measures and AP measures apply cumulatively.

For a state to qualify for IS, the IAEA must have reached satisfactory conclusions under both traditional safeguards—that there has been no diversion—and the AP—that there are no indications of undeclared nuclear activities or material. In the case of a state about which there are proliferation concerns, it is assumed there will be significant questions and inconsistencies that cannot be satisfactorily resolved—so the state will not qualify for IS.

Is this a valid assumption—will there always be significant unresolved questions and inconsistencies? This very much depends on the capacity of the information review and evaluation process to identify questions capable of being tested by the IAEA (e.g., through complementary access to specific locations)—mere suspicion will not suffice.

Safeguards planning must take into account the possibility that at the time a state is being evaluated for IS no specific unresolved questions will be identified. There could well be political pressure to qualify a state for IS even where there are concerns about the prudence of doing so. This leads to the topic discussed in the next section, how to ensure IS are sufficiently robust to deal with a situation of this kind.

It is to be hoped that states that do not qualify for IS will be a small minority. It is likely a state-level approach will be needed, not only for states under IS, but also for states that fail to qualify. Rather than a simple accumulation of AP measures and INFCIRC/153 measures at routine intensity, safeguards intensity may need to be *increased* for particular segments of the relevant acquisition paths—but might be reduced in less relevant segments. Paragraph 81 of INFCIRC/153 can be applied in either direction—not only to reduce, but also to increase safeguards intensity.

Thus, safeguards implementation outside the IS framework will also involve development of an *optimum combination* of measures—a combination specifically designed to address the concerns relating to the particular state.

Ensuring Integrated Safeguards are Effective

"Absence of evidence is not evidence of absence." States may qualify for IS simply because indicators of undeclared activities have not come to light. Even for states that currently are exemplary members of the nonproliferation regime, it must be recognized that over time political commitment can change. Thus, it is essential for IS to be sufficiently robust to provide the assurance needed by the international community.

This requires action at a number of levels:

- *The state-level approach*—tailoring an approach to the circumstances of the particular state. As discussed earlier, it is essential that IS move away from the uniformity of traditional safeguards, and that safeguards intensity is based on expert judgment taking proper account of all relevant circumstances. This will mean significant differentiation between states—and the possibility of significant adjustment from time to time for a particular state—i.e., the safeguards approach for each state should be subject to regular review and adjustment as questions arise (or as assurance increases).
- *Ongoing development of safeguards procedures*—particularly greater use of unpredictability in inspection timing and selection of facilities for inspection (e.g., through unannounced inspections). As a further development of unpredictability, the concept *of infrequent intensive verification* may be of particular value. As an efficiency measure, this concept would involve trading-off additional reductions in routine inspection efforts against acceptance of occasional unpredictable intensive inspections. As an effectiveness measure, the concept could be used to revalidate the reductions in routine inspections introduced under IS.
- Development of *new detection methods* for undeclared activities—particularly identification and detection of indicators for centrifuge enrichment activities. This is an area where close collaboration between states having relevant technical expertise and the IAEA is especially important.
- Building on *information collection and analysis* skills—and *broadening* the range of information taken into account in judgments on appropriate safeguards intensity—discussed above. Also important is *information-sharing*—a greater preparedness of states to make information available to the IAEA (e.g., intelligence information, and information on dual-use exports).

Implications for the IAEA

Safeguards implementation under IS will be very different to traditional safeguards. The latter placed emphasis on uniformity, a set routine for inspectors, and a quantitative system for evaluation. Under IS, in addition to adaptability in developing state-level approaches, the broadening of available verification measures will require greater adaptability at the implementation level—more options will be available to inspectors, there will be less emphasis on routine inspection activities, and much more emphasis on observation skills. Verification activities directed at the possibility of undeclared activities will involve new ways of thinking.

Major change will also be involved in safeguards *evaluation*—quantitative methods are not possible where qualitative judgments are being made. Evaluation will need to develop along quality management lines—was the state-level approach appropriate to meet the safeguards objectives; was the approach implemented as planned; if not, were appropriate alternatives taken, and what are the implications for the safeguards conclusions?

A particular challenge will be caused by the need to differentiate between states—this has to be done in a way that is accepted as being objective and non-discriminatory.

Conclusions

After years of careful preparation for IS—development of the conceptual framework and facility-level approaches, building up the necessary capabilities in information collection and analysis, inspectors' observational skills, etc.—the IAEA is now on the threshold of the widespread introduction of IS. This is a very positive development—the great majority of safeguarded nuclear material and facilities can be expected to be under IS within the next two-three years.

The extra workload during the evaluation/qualification phase, however, will place considerable stress on the IAEA. States must be prepared to assist where they can, and to show patience and understanding during what will be a demanding period for IAEA inspectors and management. In the general euphoria of progressing IS, it must not be overlooked that *effectiveness*—capability for timely detection—remains the primary objective for safeguards—and it cannot be assumed that simply because states qualify for IS the IAEA's capability for detection of undeclared activities—and for that matter diversion—becomes less important.

This is an exciting and challenging period for safeguards practitioners—one that will define the safeguards system and the state of the nonproliferation regime for years to come.

Note

1. The IAEA definition of a state with "significant nuclear activities" is a state having any amount of nuclear material in a facility or location outside facilities (LOF) or nuclear material in excess of the exemption limits in INFCIRC/153 paragraph 37.

Looking Ahead to Integrated Safeguards in Germany

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Abstract

More than four years ago, in February 2000, Germany completed the necessary legal steps to prepare for the entry into force of the Additional Protocol (AP). Together with the Euratom Safeguards Office, as Germany does not have a domestic safeguards authority, a series of actions was initiated and carried out to enable German operators to understand and accomplish their new duties under the AP.

Now, with the AP entering into force on April 30, 2004, it is time to look ahead to shape the prospective integrated safeguards system. As we hope and expect, the new integrated safeguards system will be a thoroughly revised and optimized system that grants the International Atomic Energy Agency (IAEA) the necessary scope and flexibility to focus on areas of real concern and to respond to alarming events in an adequate manner, such as significant unresolved questions and inconsistencies, significant anomalies, and safeguards implementation problems. Our expectations with regard to the general structure of integrated safeguards aim more at an event driven and less at a procedure driven system like the present system.

Though Germany is phasing out of nuclear energy use for electricity production, the related safeguards tasks are not phasing out in the foreseeable future. About one-half of German nuclear power plants have a license to use MOX fuel. Most of the power plants build or intend to build on-site interim dry-storage facilities for spent fuel. Therefore, a lot of work will have to be done towards the implementation of concrete approaches and measures under integrated safeguards in the German facilities.

Introduction

In Germany, R&D activities in the safeguards field are the responsibility of the Federal Ministry of Economics and Labor (BMWA). Also, the BMWA is in charge of implementing the Additional Protocol (AP).

From the beginning of a nuclear program in Germany, the operative responsibility for safeguards in Germany has been completely assigned to the European Commission. Therefore, Germany has no national safeguards office of its own. The respective departments of the European Commission execute these tasks. Moreover, the operators of facilities subject to safeguards are obliged to directly report to the safeguards department of the European Commission (Euratom) under the Euratom Treaty, and Euratom forwards the necessary reports to the IAEA. Euratom deals directly with the organizations and operators concerned without interacting with a state organization.

The specific protocol signed by the EU non-nuclear weapons states is based on the Model Additional Protocol INFCIRC/540 and takes the EU specific situation of a single nuclear market and the responsibility of Euratom into account, and, therefore, contains a third annex. The last paragraph of this annex is of special importance for Germany. According to this paragraph Germany can transfer certain responsibilities under the AP to the EU Commission. To a great extent, Germany makes use of this option laid down in Annex III and has—like other member states—entrusted the EU Commission with the implementation of provisions under the AP. The German parliament has passed two bills to establish the legal framework for the implementation of the AP. The first bill, published in the official federal gazette on February 7, 2000, covers the formal consent to the AP. The second bill, published one day later, covers the implementation regulations.

The allocation of the duties resulting from the AP, i.e., which provisions the EU Commission will be entrusted with and which provisions will remain with the German government, is laid down in the implementation law. For instance, all reporting tasks under Article 2 of the AP are assigned to Euratom with the exception of Article 2.a.ix (reporting on exports and imports of Annex II items) and Article 2.a.x (the general plans for the succeeding ten-year period). As a result, the implementation bill obligates the facility operators to directly transfer to Euratom the relevant information, and Euratom will collect, prepare, and finally submit this information to the IAEA. In the initial phase, BMWA will support Euratom in carrying out this work and will execute enforcement, where necessary.

The History of Nuclear Activities in Germany

Research and development in the field of civil use of nuclear energy was initiated in Germany in 1955, after the Federal Republic of Germany officially had renounced the acquisition, development, and possession of nuclear weapons and had become a sovereign state. From the beginning, the research and development program was based on a broad international cooperation and included the construction of several prototype reactors, the elaboration of concepts for both a closed nuclear fuel cycle and the final storage of radioactive waste in deep geological formations.

The following year, four nuclear research centers were founded and many universities were equipped with research reactors. In 1958, the first German nuclear power plant, the 15-MWe experimental nuclear power plant (VAK) in Kahl, was ordered from General Electric and AEG. It went into operation in 1960. Another reactor concept was the 15-MWe high-temperature pebble-bed reactor (Arbeitsgemeinschaft Versuchsreaktor (AVR) in Jülich, which went into operation in 1967.

A period of intensive activities in research and development of different reactor types began and the construction of large capacity units for industrial power production started. In 1969, Siemens and AEG founded the Kraftwerk Union (KWU) by merging their respective nuclear activities. Here, the development of German pressurized water reactors began, and it ended after several steps with the standardized 1,300-MWe PWR, the *convoy.* The last nuclear power plants built in Germany were three of these convoy-type plants, which started operation in 1988.

In the Federal Republic of Germany, one demonstration prototype of each was built for the high-temperature reactor (THTR-300) and the fast-breeder reactor (SNR-300) with a capacity of 300 MWe each. The THTR-300 in Hamm-Uentrop reached criticality in 1983, and was shut down for decommissioning in 1988 having achieved 220 days of full-load operation only. The SNR-300 project in Kalkar was terminated in 1991 without reaching criticality.

In the former German Democratic Republic, a nuclear research center was set up in 1959 with a research reactor of Soviet design. A 70-MWe prototype reactor went commercial at Rheinsberg in 1966, and four PWRs of the WWER type with 440 MWe each followed in the 1970s at Greifswald. All reactors were shut down after the German Reunification in 1990. Six more units under construction were discontinued.

Starting in the 1970s, at the latest after the Harrisburg accident in 1979, and then finally after the disaster of Chernobyl in 1986, skepticism about nuclear energy grew in parts of the German population and led to massive protests against nuclear projects. In the following years, this contributed to a decrease in the engagement of the German government and industry in nuclear activities.

After the general elections in September 1998, the new German government declared its intention to phase out the use of nuclear energy for electricity production and to terminate governmental funding of R&D activities in this field. An arrangement between the government and the power utilities was achieved on June 14, 2000, (signed on June 11, 2001), paving the way for the gradual closing down of the currently operating nuclear power stations.

Part of this arrangement is the clear obligation that the dynamic damage precaution according to the state-of-the-art in science and technology required by law, and thus also the internationally required high level of safety have to be maintained during the remaining operating lives of the nuclear power plants. This justifies at least R&D in the nuclear safety field.

The Present Status of Nuclear Installations in Germany

Currently, nineteen nuclear power plant units are in operation at fourteen different sites. Altogether, twenty-two nuclear power plants have been decommissioned or abandoned as projects during the construction phase. Of these, fourteen units were closed down for decommissioning after operating lives between 0.5 and twenty-five years. They are currently being dismantled with the aim of complete removal or prepared for safe enclosure, or they are safely enclosed. The majority of these reactors are low-power reactors from the early days of nuclear energy use. Two more nuclear power plants already have been dismantled completely, and the respective sites have been recultivated and became a *green meadow.*

The other nuclear installations are research reactors, facilities of the nuclear fuel cycle, and facilities for the treatment and final disposal of radioactive waste. A uranium-enrichment plant at Gronau and a fuel-fabrication plant for LWR fuel elements at Lingen are in operation. The former NUKEM and HOBEG fuel fabrication plants, for research reactor fuel and for THTR/AVR fuel, and the former Siemens uranium and MOX fuel fabrication facilities at Hanau as well as the pilot reprocessing plant at Karlsruhe (WAK) are under decommissioning up to complete dismantling. The licensing procedure for the pilot spent fuel conditioning plant (PKA) at Gorleben was completed in December 2000 with the granting of the third partial construction license including the operation license. According to the arrangement between the government and the power utilities of June 14, 2000, the use of the plant shall be limited to the repair of defective containers.

The government, Euratom and the industry associations concerned have undertaken efforts, since the signing of the AP, to inform the facility operators about and to support them in fulfilling their new obligations and thus to make sure that all parties involved are well prepared for the entry into force of the AP, which occurred on April 30, 2004. We are now, together with Euratom, working on the declaration according to Article 2 of the AP, which has to be transmitted to the IAEA before the end of October 2004.

Due to the complex history of Germany's nuclear activities, it will take the IAEA some time to analyze the information and start the development and implementation of an integrated safeguards approach for Germany.

Reflections on the Role of the IAEA in International Nonproliferation Efforts

From the beginning, the IAEA has always expanded its involvement in international efforts to prevent the spread of nuclear weapons. Finally, with its assignment as the monitoring agency of the Nonproliferation Treat (NPT), the IAEA became the most important custodian of the international nonproliferation regime.

The IAEA has concluded safeguards agreements with nearly every country in the world that has more than negligible nuclear activities. With now more than four decades of verification experiences under quite different types of agreements, it has to be seen as the most competent body the international community has at its disposal to monitor and verify the compliance of contracting parties in nuclear nonproliferation commitments.

The IAEA has shown that it can master its verification tasks even under quite hostile conditions, with its participation in the UNSCOM and UNMOVIC operations in Iraq. It seems that within these operations, the IAEA has acted in a professional and efficient way, despite the adverse working conditions. It has learned many lessons about the difficulty of conducting effective and efficient verification in face of deliberate and systematic deception and political machination.

New verification demands may arise from future developments in nuclear arms control. Fissile material released from defense programs and assigned to civil use will need to be put under safeguards to assure that it remains irreversibly removed from nuclear weapons programs. The Trilateral Initiative illustrated this. Further verification demands may result from the efforts to ban the production of fissile material for nuclear weapon purposes. Once these efforts will lead to an agreement, these commitments will have to be verified and, in our view, the IAEA has to be seen as the first choice to be assigned this task to.

One of the preconditions to successfully carry out a verification task is a strong and lasting political support of the verifying organization. The effectiveness of verification is not only determined by the monitoring techniques and technologies but also largely by the amount of political support given to the verification system. This is a task the IAEA member states have to accept and to sustain.

The IAEA, too, can contribute to maintaining this support. Besides the fostering of political and public stakeholders and good public relations work, an efficient and flexible management and an economical handling of resources are essential to keep the public awareness ob being the custodian in the international nonproliferation regime.

Principles to be Applied to Integrated Safeguards

Developing and applying safeguards against the misuse of nuclear material has always been a major part of the IAEA's activities. The development of the present safeguards system has been an evolutionary process, in which integrated safeguards now is the most recent development stage. We think that this stage is still evolving and has not yet reached its final shape.

The AP provides the IAEA with a set of new tools to overcome drawbacks that were recognized in the classical safeguards system. But the AP is not just an additional layer to be superimposed on top of the current safeguards measures. It has a much greater potential—the potential to allow a profound change in the safeguards culture. We feel that there is a need for this change in culture and that the opportunity now given by the AP should not be missed.

The AP allows for the design of a cooperative safeguards system. The basic assumption here is that the vast majority of the contracting parties will try to comply with their commitments because they share the underlying nonproliferation goals and understand the necessity of the burden assigned to them and that only a few parties in the world might misbehave and violate the commitments.

The general characteristics of such a cooperative safeguards system approach follow the principle of openness and transparency:[1]

- Reporting and disclosing of relevant information by the states to document compliance with the safeguards obligations
- Routine evaluation and cross-check with other available information by the IAEA to conform or question the correctness and completeness of disclosed information
- Actions to resolve inconsistencies and clarify suspicious situations

The AP provides for exactly such an approach. A cooperative system approach would allow eliminating another drawback of the classical safeguards system, the mechanistic application of resources on a proportional basis according to the amount of nuclear material present in a state. The yardstick to apply inspection effort in a cooperative system should be no longer the amount of nuclear material but the lack of openness and transparency.

In the classical safeguards systems, inspections were required to gather information about compliance. They were the main tool used to gather the information needed to allow a judgment whether the material present conformed in its quantity and attributes to the material declared. The AP has now broadened the scope and allows consulting a wide range of diverse information to make this judgment.

If we assume that 99 percent of the material under safeguards is held by states that comply and actively pursue the nonproliferation goal and the remaining 1 percent is held by misbehaving states, what sense does it make to tie the number of inspections to the amount of nuclear material in a state? It would be a waste of

99 percent of the inspection resources. The risk of non-compliance is not related to the amount of material; it must be attributed to a variety of other factors or even unknown reasons. Inspection efforts would be much more efficiently used to investigate and clarify situations where there is any doubt about compliance.

If we look at the most recent cases where doubts about the compliance with the nonproliferation commitments became public, namely North Korea, Iran, and Libya, the doubts were not generated as a result of inspections but through announcements made by the states themselves and through national technical means. This underlines that the inspections should be primarily used to investigate unclear situations and be used less as a tool to gather basic information in a non-specific manner. One of the limiting factors in the current framework of integrated safeguards is the role of inspections within the verification process.

In a broad definition, verification can be seen as any process that is used to assess compliance with obligations. We all hope and expect that the synthesis of the evaluation of diverse sources of information will be capable to take on the base load of the verification process and will allow for a clearer picture of a state's activities with regard to non-proliferation. We should not cement the function of inspections in IS as to be the same as in classical safeguards. We should not in any case insist on an annual PIV (physical inventory verification) and a fixed number of inspections for the reason of continuation of the classical safeguards approach. It took about ten years after the start of Program 93+2 to reach the first implementations of IS, and we should, therefore, not unnecessarily hamper the future evolution of integrated safeguards making the role and number of inspections into dogma.

Once the IAEA has evaluated the records of a country and come to the conclusion that integrated safeguards can be applied, in our opinion only a fraction of the available inspection resources should be spent on a routine basis to carry out traditional inspection activities or to check the information given in the expanded declarations required under the AP to maintain the validity of the compliance conclusion.

The remaining resources should be devoted to investigative actions to resolve inconsistencies and clarify suspicious situations. This, in our view, is the most efficient use of inspection resources. These investigative actions, too, should be conducted in a cooperative and transparent manner. The IAEA should inform the state about the reasons for concern and try to find a way to resolve the problem or clarify the situation. As the vast majority of parties will try hard to demonstrate treaty compliance, a consensual solution will be found in most cases. In the other cases, the investigations will be increasingly intensified, until the problem is resolved or the evidence of noncompliance is provided, which is needed for an effective response by the United Nations Security Council.

Such an approach would not be discriminatory. The rules applied are identical for all states, and so are the procedures to evaluate information. Differences are based on different results of the assessment. As long as we can assume that the IAEA acts as an impartial institution, differences in the application of verification measures are based on facts and not on prejudices.

The transition from the currently procedural system, where the amount of nuclear material is the main factor for the allocation of inspection resources, to an event-driven system, where the level of concern controls the resource allocation, is a fundamental change in the safeguards culture. It provides the flexibility the IAEA will need to manage the transition to integrated safeguards and to be prepared for additional verification tasks it may be confronted with in the future. We do not expect that this change in culture will be realized immediately but we expect that these prospects for the future be not spoiled today through too rigid boundary conditions set in the conceptual framework for integrated safeguards.

Another pillar of the AP, in addition to the broader range of information on nuclear activities and more access to nuclear sites, is the use of advanced techniques and technology. The provisions of the AP foresee the use of such advanced safeguards technology as the remote transmission of safeguards data from unattended containment and surveillance (C/S) devices or measurement devices. In Germany, about one-half of the reactors have a license to use MOX fuel. In order to avoid transport of spent fuel over long distances to away-from-reactor storage facilities, most of the German power plants build or intend to build on-site interim dry-storage facilities for spent fuel. Although ready-made advanced solutions for both cases, i.e., the presence of fresh MOX fuel and the transfer of spent fuel from the reactor pond to on-site dry-storage facilities, are not yet in sight, we hope that advanced techniques will be available to facilitate these tasks when integrated safeguards are implemented in Germany.

Conclusion

After extensive activities in the nuclear field in the past, Germany has made the decision and taken the first steps to phase-out the use of nuclear energy for electricity production and to terminate governmental funding of R&D activities in this field. An arrangement with the power utilities was achieved, paving the way for the gradual closing down of the nuclear power stations currently operating.

Nevertheless, the implementation of integrated safeguards in Germany will remain a demanding task. What we expect from integrated safeguards is not less than a fundamental change in the culture of present safeguards: the transition from a procedural system to a cooperative, event-driven system. The allocation of inspection resources should no longer be based on the amount of nuclear material under safeguards but on the lack of openness and transparency the IAEA is faced with in the state party to the NPT.

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Integrated Safeguards: Expectations and Realities

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Abstract

The IAEA's safeguards system is a fundamental pillar of the nuclear nonproliferation regime. The existence of credible international safeguards is more important today than ever. In essence, international safeguards constitute a system of confidence building. This concept indicates that the system must be based on international cooperation and it must stand on technical independent competence, expert judgment, and a nondiscriminatory basis, and it must be widely endorsed by the international community.

In recent years, the International Atomic Energy Agency (IAEA) in cooperation with its member states, has significantly progressed in designing and implementing integrated safeguards (IS). A *Conceptual Framework* to combine safeguards measures and technologies has already been established and the IAEA is giving priority to the completion of IS approaches for generic facility types and at the state level.

There is a broad range of views and expectations of what IS should be. In general, it is recognized that IS provides a unique opportunity to design at the state level a strengthened and more efficient safeguards system. It is also recognized that IS allows for the greatest degree of adaptation and reduction of traditional safeguards measures and that safeguards implementation and evaluation should be less prescriptive and rigid in comparison to today's approach. Another important aspect of IS is the role of review and evaluation by the IAEA of all relevant information in drawing safeguards conclusions. The existence of a well-understood, transparent, and objective methodology to perform this activity is of fundamental importance to maintain the credibility of the verification system.

The introduction of modern technologies coupled with the intensification of the use of short notice, unannounced inspections, randomization, and unpredictability together with the increasing cooperation between the IAEA and the State Systems of Accounting and Control or Regional Systems of Accounting and Control of nuclear materials (SSAC or RSAC) are important elements of this new safeguards system.

This paper discusses a number of issues and expectations surrounding IS, in particular the analysis of the current state of the development of IS, the expectations of what IS should be, and the challenges that still need to be addressed.

Important Considerations for the Future Development of IS

In the area of strengthened safeguards, *a Conceptual Framework for Integrated Safeguards* to combine safeguards measures and technologies in an efficient and effective manner has already been established. The International Atomic Energy Agency (IAEA) has completed integrated safeguards (IS) approaches for generic facility types and has developed and implemented IS at the state level for those that have an Additional Protocol (AP) in force and for which the IAEA has drawn the first conclusion on the completeness and correctness of their declarations.

Yet there is a broad range of views and expectations of what IS should ultimately be. Perhaps, one of the most noteworthy issues still being debated is the definition of IS at the state level and the idea that under this approach further consideration should be given to the possibility of implementing safeguards in a different manner in states with the same safeguards obligations and similar fuel cycle facilities without affecting the nondiscriminatory principle that governs international safeguards.

Before discussing this particular expectation, it could be useful to highlight some commonalities from the different views and expectations surrounding IS:

- IS provides a unique opportunity to design a strengthened and more efficient safeguards system at the state level.
- Under strengthened and integrated safeguards, the importance of the review and evaluation of safeguards relevant information by IAEA is also acknowledged. The existence of a well-understood, transparent, and objective methodology to perform this activity is of fundamental importance to maintain the credibility of the verification system.

Under strengthened and integrated safeguards the need to fully respect the principle of nondiscrimination of international safeguards for states with the same safeguards obligations is vitally important.

A Review of IS Principles: Proposal of a New Approach

The design of IS has been mainly based on a *bottom-up approach.* A great effort has been devoted to the definition of new safeguards approaches for generic facilities as the basis from which states' factors would be added for each individual state. In addition to this effort, guidelines to design specific state-level approaches to ensure consistency among states have also been developed.

Although this direction might not fully satisfy the expectation of some, people believe IS offers the possibility of building up the system from the state-level perspective, it should be recognized that this approach has made this complex task easier and in principle, although it is a bit early to say, the existing framework should not prevent this broader perspective to be fully reflected in the design of IS states approaches.

However, it is still pertinent to stress that the emphasis being given to the facility level should not undermine the importance of a broader perspective. Therefore, at this juncture, IS conceptual framework, approaches, guidelines, and criteria should be further developed in a way to ensure that such perspective is not lost in the implementation of IS in each individual state. In order to assess the extent to which fuel cycle and other objective characteristics of states have been duly considered, it is important that the methodology applied to design state-specific IS approaches contains the necessary flexibility to ensure their inclusion.

Thinking in terms of a possible far-reaching evolution of IS that further considers the assurances provided by the strengthening measures over time, the growth of nuclear energy worldwide, and the existence of limited resources to apply to safeguards, it is important to keep IS concepts under review as experience in its implementation is gained.

In fact, through the consideration of certain principles and guidelines contained in the above-mentioned *Conceptual Framework* in a broader sense, it should still be possible to further develop IS from the state perspective rather than on the generic facility concept.

It could be helpful to provide few examples of what could be a broader interpretation of certain principles. For instance, the principle related to the coverage of all plausible acquisition paths by which a state might seek to acquire nuclear materials for a nuclear explosive device states that when an acquisition path involves undeclared activities and diversion of declared nuclear material, IS for a state should be designed to cover both; such coverage will include verification measures on nuclear material in declared activities. At present, the way this principle and others are understood seems to give too much emphasis to each specific facility and the diversion scenarios associated with such facilities.

However, this principle can be interpreted in a broader sense and therefore consider the *Model IS Approaches for Specific Facilities* as general guidelines rather than a requirement in each particular facility or group of facilities. Such an approach would allow taking into account the fuel cycle and other objective characteristics of states, so that safeguards verification activities and their technical goals regarding declared nuclear material could be achieved by verifying sectors of the fuel cycle without sacrificing safeguards effectiveness. This implies that in a given year the IAEA would select some facilities for inspection and the next year, it would select others. This interpretation would not undermine the importance of nuclear material accountancy and other equally important principles. Unpredictability and randomization could be important tools.

The review of IS concepts should also include an assessment of the impact of some conditions or principles set forth in the model IS approaches for specific facility types (e.g., the requirement that the verification effort should allow the IAEA to re-establish nuclear material inventories at traditional timeliness periods or the requirement of keeping containment and surveillance at certain facilities).

Among the benefits of following this approach we note are that IS would be designed and perceived in a broader perspective than the facility level one. It would avoid keeping some measures at declared facilities to satisfy a too rigid interpretation of certain principles and it would allow the concentrating of inspection activities and resources more selectively.

In addition, this review would facilitate the adaptation of IS to respond to changes in technology, to be kept abreast of modern techniques, and to adequately address some of the new initiatives that are being discussed by the international community in the field of nonproliferation that could have an impact on the implementation of safeguards.

Implementation of International Safeguards: Is it Possible to Differentiate Without Discriminating?

As said before, one of the issues still subject to debate is that under IS further consideration should be given to the possibility of implementing safeguards differently at similar fuel cycle facilities in different states without affecting the nondiscriminatory principle governing international safeguards for states having the same safeguards obligations.

The *Conceptual Framework* for IS has already been designed in a way to ensure consistency in the implementation of IS in states with similar facilities and to provide some flexibility to take into account specific features of states with the aim of ensuring maximum safeguards effectiveness and efficiency. This approach ensures the fulfillment of the principle of nondiscrimination: the safeguards approach for all facilities of a given type will be the same in any state where integrated safeguards is being applied, but the specific measures used in such an approach may differ according to any state-specific factors considered relevant for the integration of safeguards.

In designing IS for specific states under the current framework, the IAEA will apply its experience and expert judgment to make full use of the objective features of a state to ensure the maximum safeguards effectiveness and efficiency. In doing so, the implementation of IS at similar facilities will differ from one state to another under certain boundary conditions.

In addition to what the IS framework already envisions for the adaptation of generic facility approaches to state-specific factors, some audiences would favor another step in the direction of further differentiating between states without affecting the above-mentioned principle by giving more prominence to the states' factors and to the information review and evaluation process.

As noted before, IS approaches for generic facility types seem to be too predominant in the development of IS, so there is a legitimate concern that at the end the flexibility built into the existing framework will not be exploited fully. In fact, the extent to which such flexibility will be reflected in specific state approaches, in particular those with significant nuclear activities, remains to be seen. We could end up with a product very similar to traditional safeguards in which approaches and criteria for declared nuclear materials and activities are implemented rather rigidly.

There are also other views that favor the consideration of other factors of the states in addition to the ones already identified (e.g., the state's political and social infrastructure: openness of the society, legislative framework, etc.). This more complex idea would require the definition and agreement of the factors that can be considered relevant for the implementation of IS and it would also need a clear, objective, and well-known methodology to evaluate them in designing IS states approaches. The discussion of such an idea would make sense only in an environment in which all states undertake the same safeguards verification commitments and standards.

Considering the present state of the development of IS, it seems reasonable to fully exploit the flexibility built into the existing framework to give more prominence to the objective factors such as those described in Article 81 of INFCIRC/153 and of the state evaluation in designing the state-specific approaches. The review of the framework for IS would allow further adjustments to these approaches as experience is gained. Nondiscrimination would be maintained by applying the same safeguards goals and the same evaluation methodology and criteria for all states.

This approach would permit the IAEA to further use the information available to it and to define different verification efforts to similar facilities in different states with the same safeguards commitments, without affecting the nondiscrimination principle and it would facilitate the further adaptation of IS for specific states, a better use of existing resources, and ultimately a more responsive and effective safeguards system.

The Role of Increased Cooperation with State Systems of Accounting and Control of Nuclear Materials

Increased cooperation with SSACs (state or regional systems of accounting and control of nuclear material) is one of the measures identified in Part I of Program 93+2 to improve safeguards efficiency and effectiveness. This measure is based on the understanding that increased cooperation with SSACs could bring further efficiencies while maintaining or improving safeguards effectiveness for both traditional and integrated safeguards. The IAEA Board of Governors approved Part I measures in 1995 with the understanding that they can be applied under existing safeguards agreements. Although the IAEA has taken various steps to define guidelines for increasing cooperation with SSACs, there is a valid perception that this is an area that still needs to be addressed in a more comprehensive and systematic manner.

In recent years, the IAEA Secretariat has developed a framework for enhanced cooperation with SSACs and it has carried out studies in cooperation with member states to progress toward increased cooperation with such systems. The increased cooperation is also one of the important elements of IS approaches for generic facility types and is one of the state factors that will certainly influence the design of IS approaches for specific states.

Given the impact in both effectiveness and efficiency that increased cooperation with SSACs can bring to IS, it is important to further progress in defining the framework through which this cooperation could be expanded to the maximum extent possible based on the technical capabilities of the SSACs, on a broader interpretation of the phrase "findings of the SSAC" referred to in Article 7 of INFCIRC/153, and on the review of the current approach to other related provisions of this model agreement, in particular Article 81.

IS offers the greatest scope for reducing the intensity of the verification effort on declared nuclear material and activities at the state-level due to the assurances on the absence of undeclared nuclear materials and activities. In this context, further cooperation with SSAC could bring additional efficiencies and to improve safeguards effectiveness at the facility level. Under an IS state approach it should be possible to increase the cooperation with SSAC, including the use by the IAEA of SSAC's inspection results in lieu of its own verification activities. A key point is to define "the minimum verification effort" the IAEA judges it has to exercise on its own to draw appropriate conclusions in connection with declared nuclear material and activities. In doing so, the increased assurance provided by strengthened safeguards measures should be fully taken into account.

On a case-by-case basis, this would imply a further reduction of the verification effort the IAEA would perform on its own for declared nuclear materials and facilities in a specific IS state approach without hampering the overall safeguards effectiveness. This would also permit the IAEA to focus its verification effort more selectively.

Conclusions

This paper has the main objective of offering some views to the process of reflection that is taking place in the context of the development of integrated safeguards.

There is a legitimate expectation that IS is developed in a way to ensure maximum effectiveness and efficiency at the state level. This is an area that requires further attention since IS offer a great opportunity to build up a new safeguards system that enjoys consensus. A periodic review of the current *Conceptual Framework for IS* needs to be conducted to ensure the maximization of safeguards effectiveness and efficiency.

The further use of modern techniques, procedures, and concepts as well as an enhanced role of containment and surveillance will also contribute to improving the effectiveness and efficiency of IS.

Fully respecting the principle of nondiscrimination of international safeguards in states having the same safeguards obligations is vitally importance. Having in mind the present state of the development of IS, differentiation of safeguards implementation in similar facilities in different states with the same safeguards obligations should be pursued further by taking full account of the objective factors of specific states. Adjustments should be made as experience in implementing IS is gained.

The potential benefits of increasing cooperation with the SSAC to the maximum extent possible, including the use of the inspections results and any other relevant data and activities that a technically competent SSAC can provide should be fully considered in designing IS approaches for states.

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Advancing Integrated Safeguards—U.S. Perspective

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Introduction

The Nonproliferation Treaty (NPT), which enjoys worldwide support and has played a central role in limiting the spread of nuclear weapons, is now facing unprecedented challenges. These include the discovery of Iraq's clandestine nuclear weapons program more than a decade ago and, more recently, developments in the DPRK and Iran and revelations about A.Q. Khan's nuclear black market. The international community and the International Atomic Energy Agency (IAEA) have made considerable progress in strengthening international nuclear safeguards, but we must do more to address these new challenges.

Universal adoption of the Additional Protocol (AP) is a key step that NPT parties can take to strengthen the international nuclear safeguards regime to meet the proliferation challenges of the 21st century, in particular the threat posed by undeclared nuclear activities. The United States has stressed the importance of the widest possible adherence to the AP. On February 11, 2004, President Bush proposed several major initiatives to address systemic weaknesses in the nonproliferation regime. Among those initiatives, the president proposed that, "Only states that have signed the Additional Protocol be allowed to import equipment for their civilian nuclear programs." He added that, "Nations that are serious about fighting proliferation will approve and implement the Additional Protocol." Shortly after the president's speech, the U.S. Senate gave its overwhelming consent to ratification of the U.S. Additional Protocol.

As APs come into force, the IAEA is transitioning to a new system: integrated safeguards (IS). The United States will continue to support the IAEA in this transition. In so doing, we will stress the need to carefully analyze and identify the most effective technologies, procedures, and methods to strengthen safeguards. This paper describes U.S. views concerning some of the key issues that the IAEA will need to address in order to make the transition to integrated safeguards successfully. In addition, it will describe U.S. programs supporting the development of this new system.

Integrated Safeguards Objectives

The United States seeks a safeguards system that is effective, efficient, and flexible. As the IAEA Director General has noted, it is important that safeguards "be driven primarily by considerations of effectiveness and not by cost considerations.... It is vital that safeguards approaches continue at all times to be technically sound and not be compromised by financial constraints."[1] For safeguards to be effective, the IAEA must have the flexibility to apply resources appropriately as problems arise, while at the same time maintaining existing credible and effective safeguards worldwide. In order for integrated safeguards to be politically accepted and sustainable, it is important that the new system of safeguards be universally applied.

Integrated Safeguards Principles

Effectiveness: To be effective, integrated safeguards should: (a) retain nuclear material accountancy as a safeguards measure of fundamental importance; (b) be based on a comprehensive approach for the state as a whole; and (c) be designed to provide coverage of all plausible acquisition paths. The United States has repeatedly stressed that to remain credible, safeguards at declared facilities cannot rely entirely on a conclusion of the absence of undeclared activities—safeguards at declared facilities must include effective detection capabilities able to address all plausible diversion scenarios.

Efficiency and Flexibility: Given the necessity of maintaining effectiveness, the United States and other member states are pressing the IAEA in the direction of more efficiency and flexibility. Questions of efficiency and flexibility have been fundamental elements of the recent safeguards reviews by the Office of Internal Oversight Services (OIOS) External Review Panel and the Standing Advisory Group on Safeguards Implementation (SAGSI). Although the need for *efficiency* is undisputed, it is not obvious how to go about it—even defining *efficiency* presents some problems. (This is discussed in more detail below.) Even more difficult is the concept of *flexibility.* What seems clear is the desire to move away from a rigid system in which identical safeguards measures, and check-box evaluation procedures, must be applied to similar facilities regardless of facility- or state-specific conditions. However, defining an alternative, more *flexible* system, which retains effective and transparent safeguards, will require a continuing development effort.

Developing Efficient Safeguards

While effectiveness is the primary goal in strengthening safeguards, the driver for many of the recent efforts to review safeguards is the concept of efficiency: optimal utilization of the IAEA's resources. We believe that the IAEA will continue to be resource-constrained despite the recent decision by member states to increase its budget, and will need to spend its limited resources carefully to achieve its objectives. But the search for efficiency has been hampered by significant shortcomings in the current system: There is no real metric or measure of safeguards resource expenditure, and the IAEA does not have enough data on how and where resources are expended. Recent efforts within the IAEA to gather such data are commendable and should be accelerated.

The metric generally used to describe IAEA inspection effort is the *person-day of inspection* (PDI) as defined in INFCRC/153. While it is clear that an inspector's time is a valuable, constrained resource, the PDI is a notoriously poor measure of it. PDI measures only time spent at inspection locations (when in fact most of inspectors time is spent elsewhere) and even correlates only loosely with that.

It is important for the IAEA to develop a better model of how resources are expended in the performance of its various safeguards functions. It makes more sense to search for efficiencies by identifying where resources are being expended, and seeking strategies for reducing those expenditures *while maintaining effectiveness,* than to look at cutting back on safeguards effectiveness goals, hoping that savings may accrue in the process.

Elements of Effective and Efficient Safeguards Systems

Safeguards methodology has in fact been evolving in the direction of more effectiveness and efficiency. Whereas historically safeguards depended on resource-intensive approaches that stressed regular, periodic inspections to verify material balances, safeguards now make more use of unattended and remotely monitored equipment and randomly timed inspections. (Specific U.S. technical support to the IAEA to develop and implement new safeguards techniques and technology is described later in this paper.) At facilities containing large quantities of direct-use material, such as reprocessing plants and MOX fabrication facilities, nuclear material is monitored continuously through a combination of solution monitoring systems, nondestructive assay (NDA) systems, and containment and surveillance (C/S). Many of these systems, with appropriate controls, can be shared between the IAEA and the operator or state system. Although such systems are not inexpensive, it is clear that effective safeguards at such facilities without intensive instrumental monitoring of the process would be prohibitively manpower intensive, and probably less effective.

At other types of facilities, we believe that effective and efficient safeguards systems should be developed from a carefully designed systems approach involving randomly timed inspections, unattended or remotely monitored NDA or C/S devices, and enhanced reporting strategies (e.g., mailbox declarations). The mix of these elements may be state- or facility-specific and would depend on the specific diversion scenarios to be covered and the tools available in the particular circumstance.

It is becoming clear that the unpredictability inherent in randomly timed inspections (whether short-notice or unannounced) gives the IAEA the potential to: (1) address a wider range of diversion scenarios; (2) achieve a detection capability over a wider range of timeliness values; and (3) reduce the numbers of inspections without leaving gaps in the safeguards approach. Randomly timed inspections have been used at enrichment plants and fabrication facilities, and will be used for interim inspections at reactors. Such inspections should not be regarded as a panacea, but should rather be applied where they can effectively provide meaningful capabilities of detection for the appropriate diversion scenarios. Particular attention needs to be paid to the question of how much notification time an operator would realistically have of an inspection (in relation to how quickly the evidence of diversion of misuse can be hidden), and how likely a randomly timed inspection is to catch scenarios that are observable for only short periods of time. Because of such considerations, we believe that there are important synergies in combination strategies involving randomly timed inspections, installed equipment, and mailbox-type declarations.

Integrated Safeguards Criteria and Evaluation

Current, highly prescriptive safeguards criteria provide strong guidance to operations sections of the IAEA and are a means of achieving nondiscrimination, but they do not always result in the most cost-effective application of safeguards. The IAEA will continue to be resource-constrained and will need to apply safeguards in the most cost-effective manner. It is therefore appropriate to seek efficiencies under integrated safeguards, particularly given the added assurance of the absence of undeclared activities. The LEU fuel cycle should be the primary focus of these efficiencies, but consideration can also be given to safeguards at other types of facilities.

Although there appears to be strong support for more flexibility under integrated safeguards, it is not clear how that flexibility is to be achieved or what mechanisms can (or should) be employed to achieve it. The United States supports a number of concepts that would provide for more flexibility and efficiency in the application of integrated safeguards.

- Under IS, responses to anomalies, questions, and inconsistencies can be made less mechanical (more efficient and equally effective) by considering all relevant information regarding the state.
- Given the fact that AP measures provide increased assurance

of the absence of undeclared activities, detection probabilities at declared facilities can be reduced, particularly for depleted natural low enriched uranium (DNLEU) materials.

- Under IS, alternative safeguards approaches should be used to maximize effectiveness and efficiency based on state- or facility-specific technical circumstances. These circumstances would include the willingness of the state and the IAEA's ability to use remote monitoring or unannounced inspections, the nature of the state's fuel cycle activities, the extent of information provided under 2(a) ii of the protocol, and the nature of the state or regional system of accounting and control (SSAC or RSAC). However, IS should take advantage of such advanced techniques, including coordination with the SSAC or RSAC, to enhance flexibility and efficiency only so long as the IAEA can maintain the independence of its conclusions.
- Integrated safeguards ought to be based on a state-wide approach. This involves taking into account elements identified in INFCIRC/153, paragraph 81,[2] as well as the broader measures allowed by the AP. We must continue to recognize, however, that, in some cases, a state may not be aware of all activities taking place within its jurisdiction, e.g., black market sales.

As SAGSI has advised in the past, the IAEA should look into less prescriptive formats for its safeguards criteria to allow such flexibility. In developing more flexible criteria, one should not lose sight of the fundamental principle of nondiscrimination, or the need to maintain agency-wide standards of effectiveness. A system that appears to be based on subjective judgments, which could be interpreted as biased in favor of or against a state, will not be politically sustainable. Thus, any new criteria for safeguards should be based on and linked to a set of objectives derived from the diversion and misuse scenarios the IAEA is required to detect.

United States Technical Contributions to Integrated Safeguards

Supporting strengthened and integrated safeguards is one of the top priorities of the United States Support Program (USSP). Since 1993, when the IAEA established Program 93+2, the USSP has provided more than $100 million to support the strengthening of the safeguards system. In 2004, the budget of the U.S. Program of Technical Assistance to IAEA Safeguards (POTAS) is $13.2 million. The 2004 U.S. Voluntary Contribution to the IAEA includes an additional $4.4 million for procurement of commercially available safeguards equipment and $2 million to support the ISIS Re-engineering Project.

The USSP supports many projects that are directly relevant to the development of IS. These projects are designed to improve: 1) the IAEA's ability to detect undeclared nuclear materials and activities; 2) the effectiveness and efficiency of IAEA safeguards; 3) infrastructure; and 4) training.

Detecting Undeclared Materials and Activities

a) Environmental Monitoring. The USSP has supported the IAEA's efforts to begin an environmental sampling program since the early 1990s. In 1994, the United States provided funding for the construction of a Class 100 clean laboratory at the Seibersdorf Analytical Laboratory. The United States also provided funding for the equipment required to analyze environmental samples and for a laboratory upgrade in the late 1990s. The USSP assisted with the initial training of IAEA inspectors in sample taking. Oak Ridge National Laboratory representatives continue to participate in consultants' group meetings to discuss and resolve technical issues related to sample collection and analysis. Today, the IAEA is self-sufficient in the area of environmental sampling and analysis. The United States continues to participate in the Network of Analytical Laboratories, which supports the IAEA by providing unbiased analysis of anonymous unmarked samples.

b) Satellite Imagery and Information Analysis. Detecting undeclared materials and activities is one of the central objectives of strengthened safeguards and the AP. USSP support in information technology helps the IAEA in traditional safeguards activities such as collecting state declarations and safeguards data in the field, as well as establishing new capabilities in the collection and analysis of open source information, including satellite imagery. The USSP provides significant support to the IAEA's Section for Information Support Services to build the capability to collect and analyze open sources of information. The USSP has funded numerous cost-free experts and consultants who developed policies and procedures for open source information collection and analysis. Since 1999, up to five U.S.-funded interns per year have helped the IAEA with the labor-intensive information collection process. Through the Nonproliferation and Disarmament Fund, the United States provided funding for the procurement of equipment needed for the Satellite Imagery Analysis Laboratory (SIAL). The SIAL is now a new unit in the Section for Information Support Services. Imagery analysts from Space Imaging and a series of information analysts from U.S. Department of Energy national laboratories work with the IAEA on special projects. In 2004, the USSP approved funding for upgrading the SIAL to include four more workstations and improved image processing.

Improving Effectiveness and Efficiency

a) Unattended and Remote Monitoring (UNARM). The USSP sponsors tasks aimed at the implementation of unattended and remote monitoring (UNARM) systems aimed at reducing the IAEA's workload. Unattended systems involve NDA and C/S instrumentation that is installed at safeguarded facilities and continues to take measurements in the absence of IAEA inspectors. Remote monitoring systems add a communication component that allows the IAEA to transmit data from the facility to IAEA Headquarters. The USSP is currently sponsoring the development of UNARM systems for the Rokkasho Reprocessing Plant

(RRP) in Japan and the Chernobyl Nuclear Power Plant in Ukraine. These systems, which monitor nuclear material movements within the sites and facilities, will save the IAEA very significant levels of inspection effort. (At Chernobyl, for example, the implementation of unattended systems will obviate the need for three-shift coverage by the IAEA. Manpower requirements at RRP will be reduced by the implementation of unattended systems that will collect, process, and analyze data for inspector review at the IAEA's on-site office.) In addition to the design and implementation of specific systems, the USSP has worked with the IAEA to improve the reliability of equipment so that it will operate unattended for long periods of time. The USSP has also in some cases upgraded instruments, such as the VACOSS seal, to make them compatible with the requirements of remote monitoring. For the past two years, the USSP funded a course taught by Los Alamos and Sandia national laboratories and Aquila Technology Group in the use and maintenance of UNARM instrumentation.

b) CANDU Reactors Spent Fuel Transfer. The USSP is collaborating with the support programs of Canada and South Korea to develop an integrated safeguards approach for transfers of spent fuel at CANDU reactors. One objective of this project is to reduce the inspector effort associated with safeguarding spent fuel transfers. U.S. representatives attended meetings in Vienna in December 2003 and in Seoul, Republic of Korea, in September 2003 to discuss this project. The techniques under investigation include mailbox declarations, unannounced and short notice random inspections, surveillance and NDA equipment, and cooperation with SSACs.

c) ISEM. In an effort to provide a systematic approach to evaluating integrated safeguards proposals, the USSP funded Los Alamos National Laboratory (LANL) and Brookhaven National Laboratory to develop the Integrated Safeguards Evaluation Methodology (ISEM). The methodology was presented at Integrated Safeguards Member State Support Program meetings and it was employed to compare alternative integrated safeguards proposals, primarily for LWRs. LANL also conducted expert elicitation sessions to estimate the detection probabilities for certain undeclared activities. This work was completed in 2003. While not implemented operationally, the project provided the USSP and the IAEA with insights into analyzing integrated safeguards approaches and estimating detection probabilities.

Improving Infrastructure, Providing CFES

a) ISIS. The IAEA Safeguards Information System (ISIS) Re-engineering Project (IRP) is critical to enabling the IAEA to become more efficient at processing the large amounts of data resulting from inspection activities, UNARM systems, and the increased reporting requirements under the AP. ISIS is a twenty-five-year-old system and was not designed for the modern safeguards regime. The USSP supported the IAEA's study of this problem by funding feasibility studies, a cost benefit analysis, and the development of a project plan. The USSP has also committed to provide a cost-free expert (CFE) who will be assigned to the Procurement Services Section to assist in the processing of IRP procurement documents. The IRP includes selection of a new hardware platform and redesign of the accompanying software at an estimated cost of $35 million. The United States has committed to providing up to 50 percent of the extra budgetary funding required for the project and is actively encouraging other member states to contribute to this important project.

b) Technical and Policy Experts. The USSP currently sponsors thirteen CFEs. U.S. CFEs work with the IAEA as regular staff members but their expenses are reimbursed by the USSP. CFEs have special work assignments for which the IAEA has no in-house expertise. Usually the assignments address a specific, non-recurring need that can be resolved within two to three years, at which time the CFE returns to employment in the United States. The CFE assignment often results in a new or improved capability for the IAEA, and many assignments over the past ten years have been related to strengthened and integrated safeguards. Two CFEs are currently assisting the IAEA's Section for Installed Equipment with the implementation of remote monitoring equipment. Two are working in the Section for Information Support Services on the collection and analysis of open source information. One expert has been instrumental in promoting the Department of Safeguards' Quality Management Initiative, which will lead to improved equipment, data, analysis, and conclusions.

The USSP is also providing the services of retired IAEA staff members who periodically conduct seminars on the evolution of strengthened safeguards and complementary access and assist with the development of approaches, guidelines, and criteria for implementing integrated safeguards approaches. These experts ensure continuity between traditional safeguards approaches and the developing IS regime.

Providing Training

Training is more important than ever to ensure that experienced inspectors learn new techniques and procedures and new inspectors quickly learn their roles. As the life cycle of today's electronics equipment continues to get shorter it becomes more important to be able to effectively train inspectors and technicians on the use and maintenance of the new equipment

a) Additional Protocol. The USSP is helping to train IAEA staff to carry out inspections under the Additional Protocol. In 2003, the USSP approved funding for the development of an AP workshop. Brookhaven National Laboratory (BNL) will develop a training exercise wherein IAEA inspectors will practice complementary access negotiations at a mock nuclear site. A similar exercise for entry-level inspectors was conducted in Finland in April 2004 under support of the Finnish Support Program. BNL and the IAEA are planning for the U.S. workshop, which will be targeted at experienced inspectors.

b) Safeguards Training Courses. The USSP supports a number of routine training courses to help IAEA staff members acquire or improve the skills they need to fulfill the IAEA's safeguards mission. For example, POTAS continues to support delivery twice per year of NDA training for new IAEA inspectors. POTAS also provides funding for training in enrichment technology, quality management and leadership, and advanced plutonium verification techniques. POTAS provides NDA experts to assist the IAEA in the delivery of the Introductory Course for Agency Safeguards.

Conclusion

In response to the extraordinary challenges now facing the NPT, the IAEA and its member states must redouble their efforts to strengthen the capability of the international safeguards system to verify compliance with nonproliferation commitments. At the core of strengthened safeguards is the AP, which gives the IAEA tools to provide increased assurance of undeclared activities—or to detect such activities should a state pursue them in violation of its NPT obligations. A key step that states can take to strengthen the safeguards system is to accept the AP.

As APs enter into force and as the IAEA gains experience in its implementation, the IAEA will continue to make progress in the transition to integrated safeguards. The United States believes that the IAEA and the international community can and must develop integrated safeguards that are effective, efficient, and flexible. In order to bring this new, strengthened safeguards system to fruition will require creativity, determination, and hard work. For its part, the United States is committed to providing the financial and technical support necessary to help the IAEA successfully develop and implement this more efficient and more effective approach to safeguards in the 21st century.

End Notes

1. 2002. The Conceptual Framework for Integrated Safeguards, *Report to the Board of Governors,* GOV/2002/8, February 8, 2002, page 13. IAEA, Vienna.
2. INFCIRC/153, paragraph 81, provides the criteria to be used for determining the actual number, intensity, duration, timing, and mode of routine inspections of any *facility,* e.g., the form of the nuclear material, the chemical composition, in the case of uranium, whether it is low or high enrichment, the number and type of nuclear fuel cycle facilities, etc.
3. 2002. "The Conceptual Framework for Integrated Safeguards," *Report to the Board of Governors,* GOV/2002/8, February 8, 2002, p. 13.
4. INFCIRC 153 paragraph 81 provides the criteria to be used for determining the actual number, intensity, duration, timing and mode of routine inspections of any facility, e.g., the form of the nuclear material, the chemical composition, in the case of uranium whether it is low or high enrichment, the number and type of nuclear fuel cycle facilities.

Integration: Transparency and Understanding as the Basis for Credible Judgment and Safeguards Conclusions

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Abstract

Basic ideas of consolidation and optimization go back to the consideration of measures to strengthen safeguards, which preceded Program 93+2 in the early 1990s—and, some would argue, well before that. Board approval of the model Addition Protocol and coining of the phrase integrated safeguards gave renewed focus and impetus to such consideration, and during the ensuing process it would seem the phrase integrated safeguards has come to mean a range of things to those involved. This article picks out some of the words and concepts that have recurred throughout the debate and development of integrated safeguards in attempting to examine key aspects and attitudes which, in our view, will help ensure that expectations of being able to use the Addition Protocol to open the road to integrated safeguards can be fully realized.

Integration

Dictionary definitions of integration are in terms of the combination of diverse elements into a unified whole—and it is this idea of a unified whole that has been the essence of work to integrate implementation of the safeguards measures that can be applied under INFCIRC/153 comprehensive safeguards agreements with those applicable under INFCIRC/540 Additional Protocols (AP). The primary aim of such a whole is that it is greater than the sum of its parts in providing the basis for confidence about both the absence of diversion of declared nuclear material and the absence of undeclared nuclear activities. Central to work on integration in the safeguards context has also been the idea that the process of combination or unification should not simply be additive but should also look for redundancies with a view to reducing or eliminating them. Optimization is therefore a key part of the International Atomic Energy Agency (IAEA) definition of integrated safeguards (IS) and has brought with it the clear and legitimate expectation of a reduction in INFCIRC/153-based activities—and associated expectations with respect to the agency's safeguards costs and resources. Perceptions of what integration will deliver differ—but that there must ultimately be a judgment of where the balance lies between sometimes conflicting expectations is another of the underlying features of the road to integrated safeguards.

Transparency

The essence of definitions of transparency relate to the quality of being viewed or seen through with clarity—linked to the idea that transparency equates to being obvious and easily detected. It would, in our view, be most unfortunate if the extent to which the term has come to feature in the modern safeguards vocabulary meant that perception of what transparency should encompass and can therefore contribute to integrated safeguards (IS) is diminished or devalued. Transparency in the safeguards context should, we believe, be seen first as a guiding principle in all states' dealings with the IAEA. For example:

- The Additional Protocol provides an agreed framework for a wide range of information to help the IAEA understand a state's nuclear activities and thus improve both the safeguards conclusions that can be drawn and then also the way safeguards are applied in the state. We believe that, for its part, the state should work on the basis that information relevant to this understanding should be made available unless there is good reason not to. This should include taking a proactive approach to consulting the IAEA about the kind of information that may be relevant rather than responding only to specific questions, seeking ways to make use of those protocol provisions that are not self-executing (e.g., its Article 2a(ii) concerning additional operational information and Article 8 on additional access) and, where appropriate, going beyond them (e.g., by looking to provide the kind of information that is shared in the context of export control regimes).
- The Additional Protocol (Article 14) also specifically addresses the "unattended transmission of information generated by Agency containment and/or surveillance measurement devices." Our view is that states should view the IAEA's use of remote monitoring to access containment and surveillance equipment in the same positive light as requests for other types of information (i.e., proactively, and with the presumption that such monitoring is to be encouraged unless there are good reasons not to). We would also suggest that the same presumption also extends to consideration of the continued use of existing surveillance equipment (i.e., if it is reliable and used in a way that has little or no impact on facility operations, can be accessed remotely, securely, and at reasonable cost, then why discard a source of information that has potential value both in terms of effectiveness and efficiency?).

- With respect to the activities of the State System of Accountancy and Control (SSAC, or corresponding regional organization), it might be argued that missions and objectives differ, but the underlying issues of materials accountancy are the same and so we believe that the relevant R/SSAC activities must be transparent to and, so far as possible, undertaken with a view to supporting those of the IAEA.
- The Additional Protocol (and of course the comprehensive safeguards agreement) also provides for potentially extensive access, and we would encourage adopting a similarly positive attitude to such access (e.g., looking for ways to support increased use by the IAEA of unannounced and unpredictable inspections, and for ways to limit the extent to which the inspection access involved needs to be managed).

Such *transparency* cannot just be in a single direction however— for it to flourish it will need to be reciprocated and so the IAEA's approach must continue to reflect and look to develop further a similarly accessible mindset. For example:

- In making sure that states and facility operators are aware of why particular information is sought and how it will be used
- In being able to explain the rationale for the use of new safeguards measures and approaches, their implications in terms of IAEA costs, and also how the IAEA has assessed their impact on states and operators. Debate on safeguards efficiencies must be based on better knowledge of the resources—IAEA, state, and operator—necessary to support a given safeguards activity or approach.
- In explaining the basis for its safeguards judgments and conclusions in respect of particular circumstances (e.g., why the approach adopted in one situation differs from that in another). The process whereby the IAEA assesses the safeguards measures it needs to apply in a given state ought, to the greatest extent possible, be transparent to the state, as should the results of the IAEA's evaluation of that application. Consolidating existing quality management-related initiatives for IAEA safeguards activities and formalizing them on the basis of recognized international standards would, in our view, also be an important contribution to this aspect of transparency—and offer a means of helping demonstrate clarity and consistency without compromising legitimate concerns regarding the sensitivity of the information involved.

It follows from this that we see the transparency aspect of the strengthened and integrated regime as closely linked to the question of *understanding.* Shortcomings in transparency will affect understanding—on the part of the IAEA, states, and others—and will in turn have implications for their views on the credibility of the overall system and its conclusions.

That said, however, there are of course good reasons why transparency cannot always be entirely unconstrained. For example, states may well have perfectly valid security or commercial grounds for wanting to control access to particularly sensitive information or locations. This too is recognized in the Additional Protocol, but the first consideration in such circumstances ought to be (and, ultimately, the requirement is) to explore how such concerns can be dealt with without diminishing the IAEA's understanding. By the same token, the degree of state access to the IAEA's evaluation process must not be to the detriment of that process (e.g., potentially constraining and/or perhaps compromising IAEA investigations, internal discussions, and some of the information that may be involved).

Transparency is of course also an issue with respect to the wider reporting of safeguards conclusions and the activities on which they are based (e.g., in the *Annual Safeguards Implementation Report)*—and we recognize that, for legitimate reasons of confidentiality, but also because of the practicalities involved, this cannot be total. Again though we believe transparency ought to be a guiding principle in describing, at least in broad terms, the approaches adopted for given states, the extent to which they were implemented successfully, and in particular the nature of any outstanding or unresolved issues.

We must acknowledge though that a great deal of what is described above is already promoted by the IAEA and increasingly accepted by many as standard practice. A key challenge for implementation of the Additional Protocol and the road to integrated safeguards is to have such attitudes become the instinctive norm.

Understanding

Dictionary definitions include the idea of having insight and good judgment—and also of being discerning or sympathetic (and intelligent). Again, it is to a great extent stating the obvious to say that comprehensive IAEA understanding of all of a state's nuclear activities is central to the effective and efficient safeguarding of those activities. The IAEA's state evaluation process is therefore crucial and should, as outlined above, be based on the fullest possible information. Clearly, information deficiencies can and will compromise IAEA understanding and everything that flows from it in terms of safeguards implementation and conclusions. Equally clearly, and as the IAEA has recognized, an evaluation process of this magnitude has very significant implications for the way the information concerned is handled, stored and processed. It is vital therefore that the IAEA's efforts to develop the means to do this are properly supported (e.g., the continued development of access to a wide range of information, including satellite imagery; projects to improve the necessary IT infrastructure, such as the IAEA Safeguards Information System, ISIS; and work to maintain the personnel, structures, and expertise necessary to help exploit all the available information). Again, shortcomings here can, and will, compromise both effectiveness and efficiency.

We believe it is now widely recognized and accepted that the process of determining the safeguards measures to be applied in a given state should be based on the IAEA's understanding as reflected in the state evaluation. The process must be top-down and encourage sufficient judgment to allow for activities that are tailored to the extent of the IAEA's understanding of all of the state's nuclear activities if the benefits of AP implementation and subsequent integration are to be fully realized. The state is after all the basic unit involved.

It is, we think, also now acknowledged that evaluating and resolving the discrepancies, anomalies, inconsistencies, and questions that the strengthened and integrated safeguards system is expected to detect should not be a matter of automatic preplanned reaction but instead call for judgment in the light of all the relevant information. It should, for example, take account of the degree to which resolution affects the overall evaluation for the state, and whether/how often similar issues have arisen before and/or in comparable situations elsewhere.

Understanding is, of course, also about learning—and so the top-down process must not be regarded as a one-off exercise that yields a fixed approach for the state concerned. The process must instead be such that results from regular updating of state evaluations (e.g., from anomaly follow-up) are fed back into regular reviews of the safeguards approach. Processes for safeguards implementation must be able to respond to sometimes rapidly changing circumstances.

Credible Judgment (and Safeguards Conclusions)

Combining various dictionary definitions yields the idea of comparing facts to arrive at a determination that is authoritative, reliable, and convincing. It is important to bear in mind that, authoritative, confident, and understanding as they are, safeguards judgments and conclusions cannot be absolute—and this must be taken account of in how they are used (whether in terms of determining a state-wide approach to integrated safeguards or otherwise). For example, we continue regard a conclusion of the absence of undeclared activities as a shorthand top-level expression of the increased confidence (i.e., improved transparency and understanding) the IAEA has from applying the range of safeguards measures available under comprehensive safeguards agreements and Additional Protocols to them.[1] It means that the IAEA has not detected indications of undeclared activity but it is not a guarantee that no such activities could exist—and integrated safeguards approaches must continue to reflect this, albeit reduced, possibility. It is also the case that because implementation of an AP is a prerequisite for drawing such a conclusion and such implementation is not yet as widespread as originally hoped, the IAEA's experience in applying the measures and then drawing and maintaining conclusions on the basis of this remains relatively untested.

Recognition that the kinds of judgments that are inherent in shaping integrated safeguards approaches are not absolute is, we believe, a key aspect of the credibility of the approaches. For example, integrated safeguards measures for timely detection of the diversion of material have generally been characterized in terms of the relaxation of timeliness goals commensurate with increased confidence in the absence of undeclared facilities for processing the material concerned. Our view remains that a key feature of any such relaxation is the retention of a reduced but still meaningful capability to detect diversion within the revised timeliness goal. This is in effect the case for the basic integrated approach for irradiated fuel and we believe that integrated safeguards offers the opportunity for more widespread use of this concept (i.e., for other less sensitive material types)—in what we have previously characterized[2] as more *sophisticated* approaches to timeliness that do not swap one rigidity for another but instead make use of unpredictability (probability) in better addressing the full spectrum of possible diversion and conversion scenarios. Experience in implementing approaches based on such concepts, and demonstrating credible conclusions as a result, might in turn provide a basis for applying the same kind of philosophy (i.e., moving from prescription and rigidity to a more randomized/more probabilistic approach) to other generic aspects of integrated safeguards implementation—for example, in making more use of information provided by a R/SSAC or maintaining adequate continuity-of-knowledge.

In addition, views on the credibility of new safeguards approaches and the conclusions derived from them will, we think, inevitably depend at least to some extent on comparisons with existing approaches. Put another way, claiming that new safeguards approaches which differ dramatically (e.g., in content, intensity, and even philosophy) from their predecessors can deliver a suitably confident conclusion on the nondiversion of material is one thing—demonstrating the credibility of such a claim is another. These same aspects of credibility are, we believe, also an important part of being able to show that, while differences can exist, basic safeguards objectives and frameworks remain transparently nondiscriminatory.

Conclusions

We must acknowledge that much of what is described above is already a feature of the development of integrated safeguards approaches. It is widely recognized that transparency and the resulting understanding can and do deliver significant safeguards benefits—and the Additional Protocol and then integrated safeguards provide a framework for maximizing these benefits. We hope and expect that the attitudes involved become the norm as experience grows with implementing such strengthened safeguards.

That said, we also recognize that calls for greater transparency and judgment are unlikely to make for an easier life. But that strengthened and integrated safeguards are not straightforward is, for us, one of the underlying (even positive) conclusions from the process of developing integrated safeguards. So far at least *silver bullets* (in the technical sense) that would suddenly and simply satisfy the many, and sometimes conflicting, wishes of those involved have not been identified. Credible judgment and safeguards conclusions—and the transparency and understanding on which they must be based—will ultimately rely on the continued accumulation of experience.

All of which brings us to one of the key words missing from this article until now. Cooperation between state and IAEA is of course a requirement of comprehensive safeguards agreements. Its extent can, as has been seen recently, vary substantially. But its importance to all the safeguards attitudes described above cannot be overstated—it is a most key determinant, and also measure, of effective and efficient safeguards.

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Multi- or Internationalization of the Nuclear Fuel Cycle: Revisiting the Issue

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Abstract

The multi- or internationalization of the nuclear fuel cycle was heavily discussed in the late 1970s and early 1980s, especially with regard to the nonproliferation of nuclear weapons. The discussions mainly took place in the framework of the International Nuclear Fuel Cycle Evaluation (INFCE) conference, which started in Washington, D.C., in October 1977. In the following two years, eight international working groups evaluated the advantages and challenges of various approaches for the nuclear fuel cycle to build on models of multi- or international cooperation. It was identified that given the appropriate administrative authority, both multi-nationalization and internationalization have a potential to significantly increase the proliferation resistance of the nuclear fuel cycle, thus contributing to the objectives of the Nonproliferation Treaty (NPT), especially the spirit of Article IV. However, implementing such cooperational models also would have disadvantages, especially in the areas of political independence, transfer of technologies, and planning security of national nuclear programs. To date, only a few examples of such multinational cooperation have been implemented. In view of recent changes in global politics, technology developments in the nuclear field, and the availability of state-of-the-art safeguards equipment and procedures, it is worth reconsidering the subject and examining whether the concerns and conclusions of the INFCE working groups are still valid. It should be further considered what type of multi- and internationalization would seem both feasible and appropriate to increase the proliferation resistance of the fuel cycle. First, this paper will recall the concept and conclusions of the INFCE investigations and describe existing forms of bi- or multilateral cooperation. Next, this paper will assess the advantages and drawbacks of internationalization in terms of economics and transparency. To conclude, this paper will judge the attractiveness of the different models with regard to administrative and economic feasibility in view of nonproliferation and enhancements in relation with the NPT and the Additional Protocol (INFCIRC /540).

Introduction

Political discussions on the nonproliferation of nuclear weapons do not arise as a matter of course so much as they are triggered by external occurrences. In the 1970s, the first Indian nuclear test explosion initiated the International Nuclear Fuel Cycle Evaluation (INFCE) Conference; in the early 1990s, the discovery of Iraq's clandestine nuclear weapons program gave rise to the International Atomic Energy Agency's (IAEA) new Integrated Safeguards System. In both of these situations, the resulting discussions confirmed that ensuring compliance with the Treaty on the Nonproliferation of Nuclear Weapons (NPT) was and still is the foundation for the prevention of nuclear weapons proliferation. Recently, three events have inspired renewed discussions on the effectiveness of the nonproliferation regime: the official announcement of the Democratic Peoples Republic of Korea (DPRK) to withdraw from the NPT, the status of the nuclear program in Iran, and the Libyan renouncement of its covert military program.

Once again, NPT stands in the center of the efforts of the international community to foster the peaceful use of nuclear energy. In this regard, its importance as a universal standard was confirmed at all NPT review conferences, culminating in the 1995 Review Conference when its validity was extended indefinitely. Subsequent national and multi-national obligations, agreements, and export control mechanisms have been realized to complement the NPT, thus forming a nonproliferation network.

In light of the overwhelming support, however, it has to be understood that the nonproliferation regime is a complex framework and system consisting of individual elements within a dynamic structure. For instance, the Nuclear Suppliers Group (NSG) guidelines (currently in its sixth edition) has been one element under periodic revision. Also, in response to significant events directly related to nonproliferation policy, the international community has adopted new texts and measures to adapt to the changing global political environment. The Additional Protocol INFCIRC/540 (corrected) is the latest example of such an adaptation process. It was designed in reaction to the discovery of a clandestine nuclear program in Iraq to allow the IAEA to inspect facilities and installations suspected to be, but not declared as, nuclear installations. This extended access, supported by additional information (e.g., open source), will prove to be a more and more efficient tool as it is ratified in an increasing number of signatory countries. Now, with the events in DPRK, Iran, and Libya, new ideas are emerging to strengthen the NPT regime in response to withdrawals and infringements of signatories. This development suggests that Article 4 of the NPT might have to be re-interpreted and adapted to new global nonproliferation requirements.

An important element of the NPT adaptation process has been the proposal to multi-nationalize or internationalize the nuclear fuel cycle, an idea that played a central role in the INFCE Conference. As such, this paper will begin by describing the starting position and the results of INFCE as regards the issue of multinationalization and internationalization of nuclear fuel cycle facilities. Next, an assessment of the different institutional models recommended by INFCE, especially in regards to nonproliferation and nuclear fuel supply assurance, will be discussed. Following, a revision of multi- or internationalization of the nuclear fuel cycle under contemporary economical and political structures will be presented. Recommendations for a possible reassessment of Article 4 of the NPT conclude the paper.

The International Nuclear Fuel Cycle Evaluation (INFCE)

In October 1977, INFCE started in Washington, D.C., to specifically investigate opportunities for the internationalization of the nuclear fuel cycle. U.S. President Carter's original INFCE objective was to concentrate exclusively on the issue of nonproliferation of nuclear weapons. However, while organizing the conference, participants instead agreed to address the broader notion of the utilization of nuclear energy without proliferation of nuclear weapons. Nevertheless, the nonproliferation aspect remained in the focus of the analyses performed by the eight INFCE working groups, yielding the conclusions:

> *...that nuclear energy is expected to increase its role in meeting the world's energy needs and can and should be widely available to that end; [...] and that effective measures can and should be taken to minimize the danger of the proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes.*

Additionally, to counter the danger of nuclear weapons proliferation in connection with the peaceful uses of nuclear energy, INFCE highlighted a number of universal measures: institutional measures, technical measures, and improvement and further development of IAEA safeguards. For the purpose of this analytical paper, only institutional measure will be investigated.

To understand the impact such measures have on nonproliferation, one has to realize that nuclear fuel supply assurance as well as waste management and storage solutions are essential to the economic feasibility and sustainability of a nuclear fuel cycle. Accordingly, an incentive for states to develop their own enrichment and reprocessing capabilities is the minimized dependence on international fuel supply; however, once a state has its own enrichment and reprocessing capabilities, it cannot be ruled out that these technologies will be used to create weapons-grade materials. This poses an exceptional proliferation risk considering that any signatory to the NPT has the right to withdraw from the treaty. Guaranteeing fuel supply and both waste management and storage services through institutional arrangements will reduce the incentive to develop national enrichment, reprocessing, and management capabilities, thus reducing the proliferation risk.

The term *institutional arrangements* was broadly interpreted in INFCE. It includes a variety of provisions that can be foreseen either by government agencies or by private entities. However, the effectiveness of any institutional arrangement applied to the nuclear fuel cycle has to be assessed in the light of both the nonproliferation of sensitive nuclear technologies and the assurance of supply. In detail, such institutional arrangements comprise commercial agreements, technical support programs, international studies, nonproliferation agreements, supply/delivery agreements, and international and multi-national institutions.

Institutional measures in the form of multi- or international cooperation prove to be attractive models. Within such cooperative relationships, trade arrangements and treaties can be viewed as tools of a nonproliferation policy. However, the successful implementation of such models is highly dependent on mechanisms to credibly guarantee an assured supply of nuclear fuel. For waste management and storage solutions, the proliferation risk is less imminent because there is less incentive for a country to develop its own capacities; furthermore, the development does not involve technologies essential to nuclear weapons development.

On the other hand, some states interested in utilizing nuclear energy in the future will not be prepared to address the full scope of requirements to sustain the infrastructure of a complete fuel cycle. This perceived technical inability might thus discourage them from exploring nuclear programs at all. Therefore, institutional mechanisms such as multi- or international cooperations that credibly provide front- and back-end solutions can help to foster the peaceful use of nuclear energy. The institutional models discussed by INFCE apply to the following front- and back-end services:

- Uranium enrichment
- Spent fuel reprocessing
- Plutonium storage
- Transport and storage of spent fuel

In the field of uranium enrichment, INFCE discussed institutional arrangements that foresee multi- or international control, with government participation, of the facility technologies and nuclear materials. It was stated that institutional measures such as classification and export controls of sensitive components and technologies were already practiced and that multi-national facilities already existed. In particular, such institutional arrangements are capable of preventing proliferation scenarios that are not covered by international safeguards agreements (e.g., in connection with the transfer of nuclear technologies).

In the field of spent fuel reprocessing, primary types of multi-national arrangements are reprocessing services guaranteed by countries with large reprocessing plants. For the more distant future, INFCE discussed the possibilities of multinational enterprises in the frame of regional fuel cycle centers. However, INFCE not only expected substantial obstacles in the areas of both plant operation and national legislation, but also practical difficulties in connection with the establishment of such institutions.

International plutonium storage facilities are recognized to have the potential to reduce proliferation risks by pooling sensitive materials in a limited number of storage facilities under safeguards. Thus, INFCE considered such an institutional measure an important tool to secure and safeguard excess plutonium and to strengthen the nonproliferation system.

In the field of transport and storage of spent fuel, INFCE suggested to further investigate the extent to which multi- or international cooperations could support economical and management infrastructures of spent fuel. Furthermore, it was stated that multi-national and international repositories for the final disposal of spent fuel can possibly be advantageous to nonproliferation and the economical feasibility of nuclear energy.

In their discussions, the eight INFCE working groups addressed different institutional models that could be the basis for an international cooperation in the nuclear fuel cycle, and, to their best knowledge, highlighted the advantages and disadvantages. Each working group's findings emphasized that multinationalization has the potential to limit the number of sensitive facilities. Such a limit would have a positive impact on both nonproliferation and economical operation of the plants. However, considerable drawbacks such as the risk of proliferation of sensitive know-how were highlighted. Important questions, especially those related to the host country of front- and back-end services, remained to be answered, such as:

What countries will host such facilities?

How will the responsibilities of the host country be defined in regards to safety, physical protection, and environmental protection while considering legitimate interests and influence of the foreign shareholders?

What solutions can be implemented to prevent the host country from jeopardizing the assurance of supply for foreign shareholders that invested into a facility located outside their national borders?

Assessment of Different Institutional Models

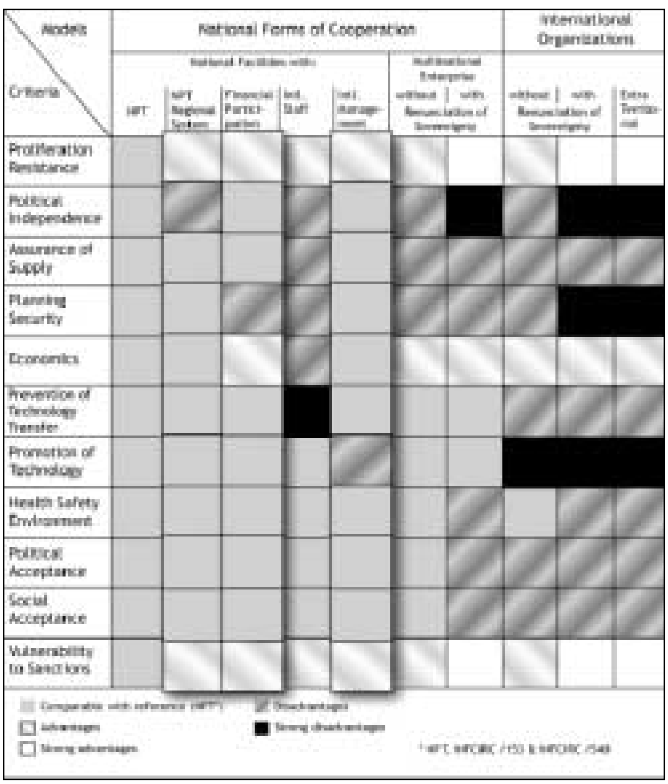
The INFCE investigations proved that there is a large variety of possibilities for cooperation in the nuclear area. The simplest form–a purely national enterprise–would involve a cooperation of all intra-national private entities as well as governmental bodies to comprehensively address a nation's nuclear energy needs. However, since this approach still holds the incentive to develop a country's own fuel services, it does not change the proliferation risk related to that country. To move from this purely national enterprise towards multi- or internationalization, a first step is to solicit the financial participation of other states in facilities not located within their own national borders. Further broadening the scope of cooperation models includes facilities operated by international staff or management, multi-national enterprises that renounce sovereign right to different extents, and, finally, international organizations on extraterritorial ground or regional fuel cycle centers.

Apart from supporting nonproliferation, such cooperative models have to be assessed in terms of their abilities to ensure assurance of nuclear fuel supply. However, when implementing multi-national facilities in practice, other criteria have to be taken into account, such as health, safety, environmental protection, and technology transfer, as well as social and political acceptance in the host state. These criteria might turn out to be negatively correlated to the increase in proliferation resistance, thus reducing the expected utility of implementing institutional models. Also, additional proliferation resistance is obtained by increasing dependencies under international law, especially when states participate in international forms of cooperation. While multilateral agreements on contractual basis can mitigate the complexity of such cooperations, international models have to credibly threaten sanctions to signatories that decide to break their commitments by denying fuel supply or waste management services to other participants.

In an international institutional scenario, host states face a higher proliferation threshold, as multi-nationalization limits the host government's legal possibilities to divert materials owned by multiple parties. Misuse could be detected sooner and more easily as the application of international safeguards would be more effective. It would also be possible for participating states or the international safeguards community to impose sanctions if international obligations were violated with facilities or materials being misused. On the other hand, it has to be taken into account that there may be problems arising from legal issues related to the integrity of the national sovereignty of the host country, which could detract from the advantages of such solutions.

Figure 1 analyzes how various aspects of institutional solutions bear upon the multi- or internationalization of the nuclear fuel cycle. From the assessment matrix, it may be concluded that when prioritizing the proliferation resistance criterion, a multinational enterprise with a certain degree of renunciation of sovereign rights on the part of the host state represents a favorable solution. The disadvantages are represented in reduced political independence as well as in reduced acceptance of the renunciation of sovereign rights in the host state. Also, safety, environmental considerations, and public and social acceptance considerations counterbalance the advantages in proliferation resistance. For these reasons, it might be very difficult to realize this institutional model. However, if the proliferation resistance criterion is not attributed the highest priority, the preferred models could be identified as a national facility located in a state that is party both to the NPT and to a treaty similar to the Euratom Treaty. In such balanced scenarios (highlighted columns in Figure 1), nonproliferation advantages are realized while detrimental factors only mildly influence the feasibility of the models.

Figure 1: Assessment Matrix for Institutional Models



Not all institutional measures for front- and back-end scenarios can be treated equally. In particular, international mechanisms are less appropriate to apply to production facilities for uranium enrichment, spent fuel reprocessing, or fuel fabrication, as such measures encounter a number of financial, technical, and R&D-political difficulties. In contrast, international organizations can be more easily realized in connection with storage facilities for fissionable materials and spent fuel; the storage of nuclear materials does not involve the application of sensitive technologies like fuel enrichment or reprocessing do.

Multi- or Internationalization Revisited

The INFCE results showed that, under certain conditions, multinational or international institutional models have a limited potential for application in the nuclear fuel cycle. However, the topic of assurance of supply, which dominated the INFCE discussions along with nonproliferation considerations, no longer holds the same relevance because enrichment services are now provided by a few suppliers, and there has been no shortage of capacities.

Today, as has been illustrated by the recent proliferation cases, the real proliferation concerns rest with the export of sensitive technology such as uranium enrichment using gas centrifuges. In addition, with the trend leaning toward privatization of previously nationally owned enterprises, profitability of electricity generation using nuclear energy has gained considerable importance. In this respect, private enterprises, dependent on both their shareholders' decisions and quotation agencies' reports, cannot afford to cover proliferation activities, especially while under constant media scrutiny.

To properly apply INFCE recommendations to foster the peaceful use of nuclear power while enhancing proliferation resistance and reducing the risk of illicit technology transfers, the economic dependability of nuclear energy in terms of assurance of supply and waste management needs to be highlighted. Having reliably available front- and back-end components (i.e., fuel enrichment, waste management, or final storage) is the only way to maintain a nuclear fuel cycle that can pose a valid, competitive alternative to other energy sources.

Also, it is important to understand how the global situation in regard to the use of nuclear energy has changed since the INFCE conference. In the timeframe of the 1970s and 1980s, energy markets were generally directed by governmental monopolies, and nuclear fuel programs were inspired by assumptions on national energy demands only. This situation implied each nation interested in using nuclear power had to develop its own solutions not only for the actual operation of reactors but also for sustaining the front- and back-end of the fuel cycle. This precisely reflects the spirit of Article 4 of the NPT that allows for signatory states to ask for assistance from the international community to develop such solutions in exchange for committing to safeguards.

In this respect, the INFCE recommendations were as revolutionary as they were anachronistic. Institutional mechanisms, such as multi- or international cooperations, were not backed by liberal energy markets driven by international companies with a global business approach. Thus, the implementation of such institutional measures could be prepared by international agreements, but not realized in a competitively functioning global marketplace.

Times, however, have changed. Today, energy markets are in the process of being privatized, and business players have started operating as global entities. Therefore, the following general trends can be identified as part of an international process that leads to more transparency and contributes to nonproliferation efforts:

Sustainable Development

With the depletion of fossil fuel resources (e.g., coal, gas, and oil), ongoing discussions on the general energy supply situation and calculations on meeting future energy demands address the peaceful use of nuclear energy more in economical, ecological, and socio-political terms than with nonproliferation considerations. Even if the nonproliferation of materials and technologies can be assured, nuclear power as a sustainable energy source can only be implemented if the expectations of the public regarding both safety and proliferation resistance can be sufficiently guaranteed.

Programs such as the U.S.-launched Generation IV International Forum (GIF) and the IAEA International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) take these considerations into account.

GIF, for instance, is designed to foster international cooperation in hopes of improving the attractiveness of future nuclear reactors, taking into account nuclear safety, economics, sustainable development aspects (e.g., minimization of waste, or a health issue), and nonproliferation issues. In the context of GIF, proliferation resistance is defined as a comprehensive approach involving technical (intrinsic) as well as institutional and political (extrinsic) measures. Six models have been selected for investigation. The Very High Temperature Reactor (VHTR) technology, for instance, should prove to be of interest from the proliferation resistance standpoint.

Liberalization of Energy Markets and Globalization in the Private Sector

Multi-nationalization is a trend that is nourished by the globalization of markets in general and the liberalization of the energy market in particular. In the field of nuclear energy, this trend is reflected in the establishment of AREVA, addressing the whole fuel cycle; British Nuclear Fuels (BNFL), addressing waste management and reprocessing services; as well as Urenco, addressing uranium enrichment services with plants located in three European countries.

Similar trends can be identified in the field of nuclear power plant design and construction where Framatome and Siemens entered into a partnership before joining AREVA. As the liberalization of markets progresses on a global scale, the competition among different primary energy carriers and energy technologies will lead to further merging of companies and will further enhance the process of multi-nationalization within the private sector.

Transfer of Sensitive Nuclear Technology

The most recent examples of undeclared activities in the field of uranium enrichment in Iran and Libya (although the gas centrifuge technologies that were used had been transferred from Pakistan) have demonstrated that the proliferation of sensitive technologies are difficult to inhibit, given the dissemination of knowledge and banalization of large parts of the technology. The improvement, standardization, and strict application of export controls, as well as the possibilities provided by international safeguards in combination with the Additional Protocol to detect undeclared nuclear activities will help prevent the construction of clandestine facilities. In addition, fostering the implementation of multi-national cooperation or multi-national applications will facilitate a worldwide reduction of commercial nuclear facilities in the sectors of uranium enrichment and spent fuel reprocessing; this, in turn, will help to reduce technology transfers that might be used for weapons programs, for instance, after a signatory withdraws from the NPT.

Multi-National Facilities and Effectiveness of Safeguards

As a complement to INFCIRC/153 (Corrected), the INFCIRC/540 does not represent a declared material-oriented and facility-related system but bases its safeguards implementation and evaluation on state-level information. The information sources employed are manifold and comprise, among others, safeguards inspections information on research and development, cooperative or export activities, as well as open source information. In the context of INFCIRC/540, the responsibility of a country using nuclear power for peaceful purposes to transparently share information with the safeguards community is of utmost importance.

The concept of multi-national facilities is able to support this transparency to a considerable degree and to further facilitate the verification of declared nuclear materials or activities. This is also important under the consideration of applying safeguards in efficient cost structures because fewer facilities have to be visited by international safeguards inspectors. Furthermore, the implementation of multi-national facilities will facilitate the swift investigation and resolution of possible inconsistencies or anomalies in a host country. Every shareholder country has an invested interest in preventing and uncovering possible diversion efforts because they might endanger their fuel cycle related services.

The migration of safeguards surveillance technologies from analog to digital systems, as well as the implementation of advanced encryption and authentication algorithms provides another tool that can support transparent monitoring of multi- or international facilities. Generated surveillance data can be shared by signatory states and individually reviewed for compliance verification purposes. Since this verification process is essential for the success of multi- or international models, the application of data-sharing safeguards equipment should be encouraged.

A state developing full nuclear fuel cycles that include fuel enrichment and reprocessing capabilities must commit to long-term research and development projects that require extensive planning and funding. If multi- or international front- and back-end cooperations can be successfully implemented (i.e., the availability of fuel supply and waste management services can be sufficiently guaranteed, and nonproliferation concerns can be transparently addressed), individual nuclear programs should no longer hold incentives. Should countries still pursue their own research, this pursuit could be considered an indicator that interests other than economic sustainability of nuclear energy are predominant drivers of such national programs.

A New Assessment of NPT Article 4

The central question is: What is the immediate result of the analyses of this paper in regards to the practical interpretation of Article 4 of the NPT?

Primarily, the basic right of states to utilize nuclear energy for peaceful purposes is not to be doubted. This basic right is an essential part of both the NPT and any well balanced system to foster the use of nuclear energy and safeguards, as well as to usher in the final nuclear disarmament of nuclear weapons states. This established norm of the NPT must not be jeopardized.

However, since the NPT was signed in 1968, the international community has experienced significant changes in the political and economical environment that are not accounted for in the spirit in which the NPT was written. The peaceful use of nuclear energy has to be evaluated not only with nonproliferation considerations but also in ecological, economical, and political terms. These evaluation patterns will be the basis of future innovative nuclear technologies that will be developed with the aim of ensuring proliferation resistance and reactor safety. Also, for these future concepts, economical requirements have to be met in order to ensure that nuclear energy is competitive with other energy sources.

For economic reasons and for reasons of competitiveness, the need for uranium enrichment and spent fuel reprocessing facilities is questionable in countries with small- or medium-sized nuclear programs if multi-national enterprises are able to reliably provide services on a global scale and to guarantee long-term services for international partners. This statement is valid not only in the nuclear energy sector but also in other areas involving sensitive technologies.

The INFCE discussions concluded that the institutional framework for multi- or international cooperations can generally be implemented. The globalization and liberalization of energy markets now provide an economic infrastructure that can partly respond to the need to internationalize the fuel cycle. Industry can consider strengthening the contractual basis for guaranteeing a supply of foreign customers, but this preferably will be done in the framework of long-term contracts and only within the limits of the state's guarantee to provide its authorization for export.

Negotiated contracts could include provisions that institutionalize the IAEA as the overseeing agency with the acknowledged duty of determining if a signatory country meets the safety requirements to receive fuel supplies. If the situation in a country is deemed unsatisfactory, the respective country's assured fuel supply could be suspended, and the provider of fuel could be compensated by the international community.

In the uranium enrichment or reprocessing sectors, financial participation in a multi-national private enterprise can represent a realistic solution that has in some instances already been implemented. In the waste management sector, different multi-national approaches under international safeguards are conceivable, but if an international depository is to be opened, it should be identified as such by the IAEA. The IAEA's identification should take into consideration its safety features, safeguards applicability, and its openness to quantities of waste coming from countries where no such disposal program is reasonably envisioned and regardless of the fabricated fuel's country of origin.

Recent cases or threats of proliferation have not stemmed from the diversion of civil trade that was placed under IAEA safeguards. Neither civil plutonium nor LEU that was under safeguards has been used or is thought to have been used (except for the specific case of DPRK). Instead, the main nonproliferation threats have originated from the use of sensitive technologies acquired by illicit or autarkical means. Thus, reinforcing the implementation of export control regulations worldwide and extending the commitment not to transfer these technologies can help address these types of threats.

The nuclear industry is willing to contribute to new ideas and to implement new contractual models that help avoid the dissemination of sensitive technologies in too many countries, thus supporting the task of the international safeguards community by concentrating their efforts in a few countries. For this purpose, Article 4 of the NPT indeed needs to be re-interpreted. Rather than fostering the transfer of sensitive technologies and materials, the international community should encourage shared comprehensive solutions that allow all signatories to the treaty to sustain reliable nuclear fuel cycles.

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IAEA to Participate in Summer Olympic Security

The International Atomic Energy Agency (IAEA) announced in May a joint action plan to help ensure a high-level of nuclear security at the 2004 Olympic Games.

The IAEA will cooperate with the Greek Atomic Energy Commission and the Greek Olympic Games Security Division to provide expert advice and technical.

The action plan is designed to protect facilities and materials, to detect illicit trafficking and malicious use of radioactive materials, and to ensure that emergency response forces are effective and efficient.

Much of the work in Greece has been undertaken in cooperation with some IAEA member states with substantial support provided by the United States and France in the fields of equipment, training, and technical advice.

The physical protection of the Demokritos nuclear research reactor, in a suburb of Athens, has been upgraded and the security of radioactive sources used at medical and industrial facilities in six Greek cities has been tightened.

Radiation detection equipment has been installed at borders and other entry points into Greece, and mobile detection equipment will be deployed elsewhere. Hand-held radiation monitors are being distributed to security personnel and customs officials involved in the security for the Olympics.

United States and Russia Cooperate on Return of Russian-Origin Research Reactor Fuel to Russia

In May, the United States and Russia governments signed a bilateral concerning the repatriation of Russian-origin high-enriched uranium (HEU) research reactor fuel to Russia. Under this agreement, more than a dozen countries are eligible to receive financial and technical assistance from the United States and others to ship their fresh and spent research reactor fuel to Russia for safe and secure management.

Beginning in December 1999, representatives from the United States and the Russian Federation, in cooperation with the International Atomic Energy Agency (IAEA), began developing a new program to support the return to the Soviet- or Russian-supplied fresh and irradiated HEU fuel, currently stored at foreign research reactors. Through these tripartite discussions, more than twenty research reactors in seventeen countries have been identified as having Russian/Soviet-supplied fuel. As an integral part of this Russian Research Reactor Fuel Return (RRRFR) program, participating countries agree to convert their research reactors from using HEU to low-enriched uranium (LEU) fuel upon availability, qualification, and licensing of suitable LEU fuel.

In September 2003, under the RRRFR program, Russia accepted approximately fourteen kilograms of fresh Russian-origin HEU from Romania. The HEU was airlifted from Bucharest, Romania, to Russia where it will be down-blended and used for nuclear power plant fuel fabrication. In December 2003, also under the RRRFR program, Russia accepted approximately seventeen kilograms of fresh Russian-origin HEU from Bulgaria. Most recently, in March 2004, under the RRRFR program, Russia accepted seventeen kilograms of fresh Russian-origin HEU from Libya. In addition, preparations are well advanced for the first shipment to Russia of irradiated fuel containing HEU from a research reactor in Tashkent, Uzbekistan.

DOE Releases Final Request for Proposals to Establish World-Class Nuclear Technology Lab in Idaho

In May, the U.S. Department of Energy (DOE) released a final request for proposals (RFP) inviting companies to submit proposals to establish the Idaho National Laboratory (INL) as the nation's premier laboratory for nuclear energy research, development, demonstration, and education within a decade. The Idaho National Laboratory combines the research and development components of the Idaho National Engineering and Environmental Laboratory and Argonne National Laboratory West. The new lab will begin operation on February 1, 2005.

INL will be a multi-program national laboratory that will conduct science and technology across a wide range of disciplines. Its mission include the development of advanced, next-generation nuclear energy technologies, promoting nuclear technology education, and applying its technical skills to enhance the U.S. security. The lab will continue to build on its role as the Office of Civilian Radioactive Waste Management's center for assuring the readiness of DOE spent fuel shipments to the nation's repository. It will also support a host of ongoing research and development activities for DOE and a diverse collection of programs for the U.S. Department of Defense, the U.S. Department of Homeland Security, and the U.S. National Aeronautics and Space Administration.

The new laboratory will lead the DOE's research and development efforts in developing a nuclear energy system that will produce both inexpensive electric power and large quantities of cost-effective hydrogen to support the development of a clean and efficient hydrogen economy in the United States.

A requirement for the INL contractor to maximize opportunities for small and regional businesses is included in the RFP. DOE will require and approve a small business plan under the contract that establishes specific goals for total planned subcontracting dollars to be awarded to small business concerns by the prime contractor.

The final INL RFP, No. DE-RP07-031D14517, may be found at the solicitation Web site, www.INL-RFP.gov. Additional information on the department's nuclear energy program, including its research programs and the Idaho site, may be found at www.nuclear.gov.

2004

September 20–24, 2004
PATRAM 2004: The 14th International Symposium on the Packaging and Transportation of Radioactive Materials
ESTREL Convention Center
Berlin, Germany
Sponsor:
Bundesanstalt für Materialforschung und prüfung (BAM) in cooperation with the IAEA and INMM
Contact:
Web Site:
http://www.patram2004.com

October 3–6, 2004
Americas Nuclear Energy Symposium (ANES 2004)
Deauville Beach Resort
Miami Beach, Florida, U.S.A.
Sponsor and Host:
U.S. Department of Energy and the American Nuclear Society
Contact:
Caroline Raffington
Phone: 305/348 5016
E-mail: anes@hcet.fiu.edu
Web Site: http://anes.fiu.edu

December 13–17, 2004
International Symposium on Disposal of Low Activity Radioactive Waste
Cordoba, Spain
Organizer:
International Atomic Energy Agency (IAEA)
Sponsors:
Agence nationale pour la gestion des déchets radioactifs (ANDRA) France, in cooperation with the OECD Nuclear Energy Agency (NEA)
Contact:
Web Site: http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=1242005

2005

January 26–28, 2005
Spent Fuel Management Seminar XXII
Loews L'Enfant Plaza Hotel
Washington, D.C., U.S.A
Sponsor:
Waste Management Technical Division of the Institute of Nuclear Materials Management
Contact:
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60 Revere Drive, Suite 500
Northbrook, Illinois 60062
Phone: 847-480-9573
Fax: 847-480-9282
E-mail: inmm@inmm.org
Web Site: http://www.inmm.org

April 17–21, 2005
Monte Carlo 2005: The Monte Carlo Method: Versatility Unbounded in a Dynamic Computing World
Chattanooga, Tennessee, U.S.A.
Sponsor:
American Nuclear Society
Web Site: http://meetingsandconferences.com/MonteCarlo

July 10–14, 2005
46th INMM Annual Meeting
JW Marriott Desert Ridge
Spa and Resort
Phoenix, Arizona, U.S.A.
Sponsor:
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