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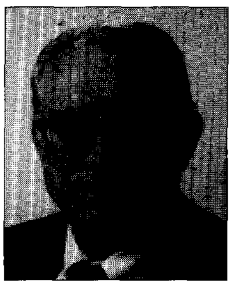

Many of you will have received this issue of JNMM at the 42nd INMM Annual Meeting in Indian Wells, California. I predict that this will be a record meeting with an outstanding program. The technical division meetings on Sunday afternoon are better organized and we have excellent speakers for both the opening and closing plenary sessions. If you were unable to attend this meeting, be sure to read the wrap up in the next issue of *JNMM* and on the INMM Web site at http://www.inmm.org.

I'd like to bring your attention to a number of interesting activities going on at INMM this year.

May 7-10, ESARDA held a very successful meeting in Bruges, Belgium. Several INMM members attended and were very positive about the content and operation of the meeting. As many of you know, INMM often cooperates with ESARDA on meetings of importance to both organizations. One of the last ones was the Third INMM/ESARDA Workshop on Science and Modern Technology for Safeguards, held last November in Japan. The Fourth Workshop will be held in Europe in 2002. Watch for more information on the INMM Web site and in the *Journal.*

The INMM's Nonproliferation and Arms Control Division held a one-day workshop—Russian Nuclear Security–Priorities and Alternatives—in Washington, D.C., on May 16, 2001. A report on this meeting will appear in an upcoming issue of *JNMM.*

I have mentioned in previous columns, that the PATRAM (Packaging and Transportation of Radioactive Materials) symposium will be held at the Hilton Chicago & Towers, September 3-7, 2001. INMM is hosting this year's meeting and we look forward to the next one in 2004. See page 4 for more information on this event and check out the PATRAM Web site at http://www.patram.org, for more information.

The Physical Protection Division plans to conduct a workshop in Cincinnati on September 18-20, 2001. More information will become available when plans are finalized.

The IAEA is sponsoring "Symposium on International Safeguards: Verification and Nuclear Material Security" in Vienna, Austria, October 29-November 1, 2001. INMM and ESARDA are assisting with that effort.

New for INMM this year is the joint sponsorship of the Eighth Nondestructive Assay Waste Characterization Conference in Denver, Colorado, December 11-13, 2001. This conference has been conducted for a number of years, but this is the first time that INMM will co-sponsor it. The conference is funded by DOE-ID through the Transuranic and Mixed Waste Focus Area (TMFA) at INEEL. Those of you who work in this area or who are interested in learning about this area should plan to attend.

Information on all of these activities and more is available on page 64 of the *Journal* or on the INMM Web site under the listing "Calendar." Our present and past INMM Communications Committee has been working with the INMM headquarters staff to update and improve our Web site. I think that it has been greatly improved and it should be fully functional when you receive this issue of the journal. Thanks to all who have worked on it. It is our expectation that everything you need to know about INMM and its activities can be found there. Please feel free to contact us with your comments on the site and its contents. Your suggestions are appreciated.

The 2001 INMM Membership Directory was mailed to members in April. This directory contains the names, address, and contact information for every INMM member. There are a few new members who have joined since the cutoff date and hopefully you can meet most of them at the Annual Meeting. In addition to the information about the members, the officers, committee chairs, division chairs, chapter presidents, and headquarters staff are listed. I continue to urge each one of you to identify one or more of the divisions in which to become active. A description of the focus of each division is given on the Web site and in the directory.

A copy of the INMM constitution and bylaws, information about awards, and various INMM forms are also included in the directory. A big thanks goes to the Membership Committee and the headquarters staff for their efforts in producing this fine directory.

The fall issue of *JNMM* is traditionally the Annual Meeting wrap-up issue. We include a transcript of the Roundtable Discussion with the opening plenary speaker, the text of the talks given by the closing plenary speakers, and include Charles Pietri's always lively article on the meeting and its highlights.

If you were unable to attend the Annual Meeting, the fall issue is a great way to learn what went on.

I hope to see you at PATRAM in September.

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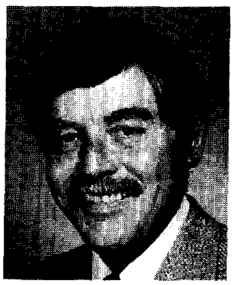
A Focus on Integrated Safeguards



We owe a sincere thanks to Jim Larrimore, chair of our International Safeguards Division, for the papers included in this issue of *JNMM*. As many of you know, Integrated Safeguards is a hot topic within the international safeguards community.

Last fall Jim asked me if a special edition of the *Journal* could be dedicated to the topic of Integrated Safeguards. He thought he could secure ten articles and an introduction by the International Atomic Energy Agency's Deputy Director General for Safeguards Pierre Goldschmidt. That's exactly what Jim accomplished. The contributions are from the IAEA, Argentina, Australia, Canada, Germany, Japan, Republic of Korea, Sweden, USA, the Brazilian Argentine Agency for Accounting and Control of Nuclear Material (ABACC), and Euratom.

I recall a similar effort that Cecil Sonnier arranged for the summer issue of the *Journal* in 1998. Those papers were the precursors of those in this issue. After the publication of the summer 1998 issue, I attended a meeting on Strengthened Safeguards arranged by Cecil. Interesting enough, almost all of the participants brought the issue with them. One even referred to his copy as the bible on Strengthened Safeguards. I believe this issue will serve the same purpose for Integrated Safeguards.

We likewise owe a special thanks to our managing editor, Patricia Sullivan, for her dutiful job of putting the finishing touches on the articles. She is certainly an asset to your *Journal*. Should you ever get the opportunity, please express your appreciation to Patricia.

The INMM lost a good friend when Paul Ek passed away. Our prayers go out for him and his family. We have included a short biography of Paul on page 5.

Membership Committee Chair Nancy Jo Nicholas is expanding the Members News reporting in this issue. She wants to make the report more newsworthy by including tidbits about our members, such as promotions, and awards received. Should you have any news about a member or even about yourself, please contact Nancy Jo.

We also include an article on the PATRAM Symposium hosted by the INMM this fall in Chicago. Please read about this important meeting and plan to attend.

Our upcoming fall issue will include a wrap up of the 42nd Annual Meeting. Charles Pietri will again recount the highlights of the meeting and the text of the opening and closing plenary speeches will be included. We'll also have a photo spread on the events at the meeting, and, of course, the transcript of the Roundtable Discussion with our opening plenary speaker John A. Gordon.

As always, if you have any questions, comments, or input to offer on the Journal, please contact me. We want the publication to serve your needs.

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PATRAM 2001 Draws 225 Abstracts on Packaging and Transportation Issues

More than 225 paper abstracts have been received for the 13th International Symposium on the Packaging and Transportation of Radioactive Material (PATRAM 2001), which will be held September 3-7, 2001, in Chicago, Illinois.

Topics to be discussed include:

- Packaging and components technology/engineering
- National and international regulations and their applications and implications
- Transport systems
- Transport operational experience
- Public perception of radioactive materials transportation
- Tracking of conveyances and emergency response
- Radiation exposure and environmental impact
- Transportation—integrator of the fuel cycle
- Onsite handling and transport requirements and practices
- National and international standards.

PATRAM 2001, sponsored by the U.S. Department of Energy in cooperation with the International Atomic Energy Agency, is held every three years and brings government and industry leaders together to share information on innovations, developments, and lessons learned about radioactive materials packaging and transportation.

The five-day symposium should be attended by everyone interested in the packaging and transportation of radioactive materials, including, packaging and transportation professionals, regulatory officials, government and public officials, government contractors, national laboratories, utilities, academic institutions, carriers, packaging industry officials, hazardous materials response units, and radioactive pharmaceutical personnel.

PATRAM 2001 is hosted by the Institute of Nuclear Materials Management at the landmark Hilton Chicago & Towers—in the heart of Chicago's Loop business district.

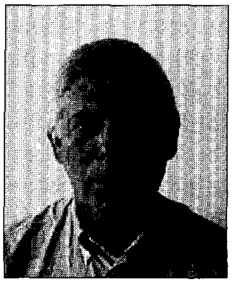
Hilton Chicago & Towers is located on Chicago's famous Michigan Avenue overlooking Grant Park and Lake Michigan. The Hilton offers guests a beautiful lakeside metropolitan setting located close to all the exciting museums, theaters, and nightlife Chicago has to offer.

The Hilton is one of Chicago's premier luxury hotels with 1,544 guest rooms, the Towers with 149 rooms and thirteen specialty suites, three restaurants including a signature steakhouse, an authentic Irish pub, an athletic club with indoor lap pool, sun deck, and state-of-the-art equipment, and a complete business center.

In order to secure your hotel reservations, call the Hilton Chicago & Towers reservation department at 312/922-4400 and identify yourself as an attendee of PATRAM 2001 to receive the special symposium rate of $116 single/$136 double plus tax. Reservations must be made at the Hilton Chicago & Towers before Friday, August 4. PATRAM cannot guarantee the availability of rooms after this date. Make your reservations early to assure your accommodations.

For more information, contact Julie Theander at the PATRAM 2001 headquarters at 847/480-6342.

In Memoriam
Paul Ek



Paul Ek, who was employed at the Swedish Nuclear Power Inspectorate, SKI, for many years, has died of cancer at the age of 63. He is survived by his wife, Ann-Marie, and their children, Thomas and Regina, and their families.

In 1963, Mr. Ek joined the relatively new Delegation of Atomic Energy Issues and was soon in charge of matters relating to the transport and control of nuclear materials. Mr. Ek immediately perceived the potential of this somewhat neglected area and developed the Swedish State System for Accountancy and Control of Nuclear Materials. He became the director of the Office of Nuclear Materials Control, now called the Office of Nuclear Non-Proliferation or M-Office. The Office has remained more or less unchanged through a number of reorganizations of SKI, and its activities carry Mr. Ek's distinctive mark.

Mr. Ek was the type of person who rapidly identified areas where work was needed. He was in the vanguard of work within physical protection and safeguards and, thereby, established a strong position for himself and for his colleagues. He was a key figure on the international scene and was a driving force in the negotiations concerning the Non-Proliferation Treaty, the Convention on Physical Protection, and other important instruments.

His strong position on the international front led to his appointment by IAEA Director General Hans Blix to the task of rationalizing the IAEA's inspection activities. Mr. Ek was employed at the IAEA from 1983 to 1985. Shortly afterwards, he assumed the position of chairman of the Standing Advisory Group on Safeguards Implementation (SAGSI) to the director general of IAEA, and revived the group, turning it into what is now a driving force in the area of international safeguards. Mr. Ek's main contribution was probably that of laying the foundation for the reinforcement of IAEA's safeguards after Iraq's nuclear arms program was exposed. As chairman of SAGSI, Paul formulated the "93+2" program, currently included in the additional protocol to the IAEA's safeguards agreement which is about to enter into force.

In early 1990, Mr. Ek assisted Cecil Sonnier in the formation of the INMM's International Safeguards Subcommittee, a part of the then Safeguards Committee. He served as vice chair of this subcommittee, the subsequent International Safeguards and Nonproliferation Division, and then the current International Safeguards Technical Division. He served in this capacity until the end of 1996.

Mr. Ek left the position of head of the M-Office in 1996 to, directly under the leadership of SKI's director general, work on support to Central and Eastern Europe. This was an area where Mr. Ek, in his typical way, was one of the first to identify the need for reinforcement. He was in the midst of this significant work when he passed away.

During his long career at SKI, Mr. Ek made his mark within safeguards, on the national and international front.

Through his enthusiasm, initiative, and commitment, Paul Ek made significant achievements, at the same time that he was controversial. Those of us who worked with him know that he was an excellent leader, always paving the way, while supporting and encouraging his colleagues.

IAEA Releases Nuclear Power Statistics for 2000

A total of 438 nuclear power plants were operating around the world at the end of 2000, according to data reported to the IAEA's Power Reactor Information System. The plants had a total net installed capacity of 351 GW(e). Also during 2000, six nuclear-power plants representing 3,056 MW(e) net electric capacity were connected to the grid, one in Brazil, one in the Czech Republic, three in India, and one in Pakistan.

Construction of three new nuclear reactors began in 2000—one in China and two in Japan, bringing the total number of nuclear reactors reported as being under construction to thirty-one.

Nuclear power provides about 16 percent of global electricity, with about 83 percent of nuclear capacity concentrated in industrialized countries.

The ten countries with the highest reliance on nuclear power in 2000 were: France, 76.4 percent; Lithuania, 73.7 percent; Belgium, 56.8 percent; Slovak Republic, 53.4 percent; Ukraine, 47.3 percent; Bulgaria, 45 percent; Hungary, 42.2 percent; Republic of Korea, 40.7 percent; Sweden, 39 percent, and Switzerland, 38.2 percent.

In total, seventeen countries relied upon nuclear power plants to supply at least a quarter of their total electricity needs.

In North America, where 118 reactors supply about 20 percent of electricity in the United States and 12 percent in Canada, the number of operating reactors has declined slightly. In Western Europe, with 150 reactors, overall capacity is likely to remain at or near existing levels in the coming years. In Central/Eastern Europe and the Newly Independent States, with sixty-eight reactors, a few partially built plants are likely to be completed, while aging units are being shut down. Only in the Middle East, Far East and South Asia, with a total of ninety-four reactors at present, are there clear plans for expanding nuclear power, particularly in China, India, the Republic of Korea, and Japan.

Worldwide in 2000, total nuclear-generated electricity increased to 2,447.53 terawatt-hours. Cumulative worldwide operating experience from civil nuclear-power reactors at the end of 2000 exceeded 9,800 reactor-years.

Key Convention on Safe Management of Spent Fuel and Waste Enters into Force

At a ceremony at IAEA Headquarters in March, Ireland deposited its instrument of ratification to a convention on the safe management of spent fuel and radioactive waste, thereby ensuring its entry into force. The Convention will be the first international instrument to address the safety of management and storage of radioactive wastes and spent fuel in countries with and without nuclear programs.

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was adopted and opened for signature in September 1997. The convention applies to the safety of spent fuel management, defined as "all activities that are related to the handling or storage of spent fuel, excluding off-site transportation." It also applies to the safety of radioactive management, defined as "all activities, including decommissioning activities that are related to the handling, pretreatment, treatment, conditioning, storage, or disposal of radioactive waste."

Beyond this, the Convention covers the safety of management of spent fuel or radioactive waste resulting from military or defense programs if and when such materials are transferred permanently to and managed within exclusively civilian programs, or when declared as spent fuel or radioactive waste for the purpose of the Convention.

"One of the main objectives of this Convention," IAEA Director General Mohamed ElBaradei said, "is to ensure that during all stages of spent fuel and radioactive waste management there are effective defenses against potential hazards so that individuals, society and the environment are protected from harmful effects of ionizing radiation, now and in the future".

The Convention establishes a binding reporting system for contracting parties to address all measures taken by each state to implement the stated obligations. This would include reporting on national inventories of radioactive wastes and spent fuel.

The Joint Convention enters into force ninety days after twenty-five states, including fifteen that have operational nuclear power plants, have deposited their instruments of ratification, acceptance, or approval with the IAEA. The Convention entered into force in June 2001.

The twenty-five states that are parties to the Convention are: Argentina, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Morocco, Netherlands, Norway, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and the United Kingdom.

The text of the Convention is available on the IAEA website at: http://www.iaea.org/worldatom/Documents/Legal/jointconv

U.S. DOE Fines BNFL Inc. for Nuclear Safety Violations

The U.S. Department of Energy, through its Office of Price-Anderson Enforcement, in March issued a $41,250 civil penalty to BNFL Inc., a contractor conducting decontamination and decommissioning activities at the department's East Tennessee Technology Park (ETTP) in Oak Ridge, Tennessee.

The penalty is associated with a metal fire that occurred in the ETTP K-33 Building on April 4, 2000, during decontamination and decommissioning activities. The fire was contained in a bundle of metal tubes housed in the assembly being decontaminated. The investigation found that BNFL failed to follow established procedures and implement an effective quality-improvement process to identify and correct problems. As a result, safety and worker hazards were not fully identified or analyzed. Although there were no worker exposures or release of uranium into the environment, the fire caused the release of uranium from the metal tubes into the building while the workers were fighting the fire. Additionally, the fire department did not receive the information it needed about potential hazards when fighting the fire.

The K-33 Building at the former Gaseous Diffusion Plant was placed into operation in 1954 to produce highly enriched uranium. The building was permanently shutdown in 1987 and decontamination and decommissioning activities began in 1998.

BNFL Inc. has proposed and implemented corrective actions, including an improved work plan that addresses potential safety hazards and development of a detailed fire protection plan, to help ensure that an incident of this nature will not reoccur.

The Preliminary Notice of Violation (PNOV) was issued on March 19 and becomes final within 30 days unless challenged by BNFL Inc. The firm is required to respond to the Preliminary Notice with a schedule for completing all corrective actions. The Energy Department will review BNFL Inc.'s response to the PNOV and determine whether further enforcement action is necessary.

The Price-Anderson Amendments Act of 1988 requires the Energy Department to undertake regulatory enforcement actions against contractors for violations of its nuclear-safety requirements. The program is implemented by the Office of Enforcement and Investigations. This action was taken with the support and participation of the department's Oak Ridge Operations Office, which will ensure that the corrective actions are fully implemented.

Additional details can be found on the Internet at http://www.eh.doe.gov/enforce.

Yucca Mountain Reports and Estimates Issued by U.S. DOE

The U.S. Department of Energy in May released four documents related to its ongoing work and study of Yucca Mountain, Nevada, as a possible site for a long-term nuclear waste and materials repository.

Documents released include:

- The Yucca Mountain Science and Engineering Report, which provides a summary of scientific and other technical information developed by the DOE over the last twenty years in its study of Yucca Mountain, Nevada. The department is accepting public comments on this material.
- Supplement to the Draft Environmental Impact Statement (EIS) for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada. This supplement provides the most recent information on the repository design evolution and the potential environmental impacts associated with this updated design information. The original draft EIS was issued in August of 1999 followed by 21 public hearings and a 199-day comment period. DOE held three public hearings on the supplement document in Nevada during the forty-five-day comment period.
- The 2000 Total Systems Life-Cycle Cost Report of the Civilian Radioactive Waste Program, which estimates the total amount of dollars required for project completion.
- The 2000 Fee Adequacy Report Assessment, which determines whether the fee charged to ratepayers is sufficient to cover the total life-cycle cost of the project and is intended to inform Congress as to the sufficiency of the fee.

All the reports can be used by the public as reference materials in providing comments on the technical information and data underlying the consideration of a possible recommendation of the Yucca Mountain site as a long-term nuclear repository.

Copies of the documents are available by contacting DOE Public Affairs Specialist Gayle Fisher at 702/794-1322, or through the Web site at http://www.ymp.gov.

Progress Toward the Integration of INFCIRC/153 and INFCIRC/540: Foreword

■

Pierre Goldschmidt
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■

As foreseen in this *Journal* in the summer of 1998, the integration of the traditional safeguards measures with the strengthening measures developed in recent years is the beginning of a new era for safeguards. The goal that we are now actively working toward is a new and exciting challenge both for inspectors in the field and for analysts at headquarters. It will involve new techniques and new mindsets. We now have available a wide range of strengthening measures, such as broader information evaluation at the state level, satellite imagery, environmental sampling and, especially, the measures contained in Additional Protocols. The term "integrated safeguards" refers to 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 exercising the Agency's right and fulfilling its obligation in paragraph 2 of INFCIRC/153 (Corrected).

The development of integrated safeguards is a high-priority task and is being undertaken within the Secretariat together with the assistance of a group of experts, the technical advice of the Standing Advisory Group on Safeguards Implementation (SAGSI), and the involvement of a number of member state support programs for safeguards. Contributing authors from every paper on integrated safeguards included in this issue are directly involved in this development work through their participation in one or more of these groups.

Objective and Basic Principles of Integrated Safeguards

The objective of implementing the measures provided for in a state's comprehensive safeguards agreement together with an Additional Protocol is to enable the Agency to draw the necessary safeguards conclusions and thereby provide credible assurance of both the nondiversion of nuclear material from declared activities and of the absence of undeclared nuclear material and activities in the state as a whole. A conclusion by the Agency of the absence of undeclared nuclear material and activities in a state as a whole, particularly activities related to enrichment and reprocessing, would permit a redefinition of current safeguards implementation parameters (e.g. timeliness, detection probabilities) for less-sensitive nuclear material (e.g. depleted, natural and low-enriched uranium and irradiated fuel), with corresponding reductions in the current level of safeguards verification effort on such declared nuclear material. Such reductions would occur largely in states with significant nuclear programs and would allow a reallocation of resources to information evaluation tasks at headquarters and to complementary access activities in the field. However, in countries with small or no nuclear programs, integrated safeguards will increase, not decrease, Agency costs.

The basic principles that govern the development of integrated safeguards are that:

(a) They should be non-discriminatory, i.e., the same technical objectives should be pursued in all states with comparable safeguards obligations although the measures actually used in individual states may differ;

(b) They should be based on statewide considerations, i.e.,
   (i) Comprehensive evaluation of information for the state as a whole should play a key role in planning the activities implemented in that state, and
   (ii) Integrated safeguards approaches should be designed to provide coverage of all plausible acquisition paths by which a state might seek to acquire nuclear material for a nuclear explosive device; and
(c) Nuclear-material accountancy should remain a safeguards measure of fundamental importance.

The main focus of the work on integrated safeguards is the detailed development of guidelines, safeguards approaches, and implementation criteria. This work includes:

(a) Specifying in detail the process by which a conclusion of the absence of undeclared nuclear material and activities in a state can be drawn and maintained; and
(b) Having drawn this conclusion, considering what measures would subsequently be appropriate to apply to declared nuclear material in specific types of facility in order to continue to provide a conclusion of its nondiversion.

Conditions for the Implementation of Integrated Safeguards

It is important to note that the entry-into-force of an Additional Protocol is not in itself a sufficient basis for the Agency to modify safeguards measures currently implemented in a particular state with a comprehensive safeguards agreement. To reduce certain traditional verification measures on declared nuclear material, conclusions of the nondiversion of such material, and of the absence of undeclared nuclear material and activities in the state as a whole are required.

The conditions for such conclusions, after entry-into-force of an Additional Protocol, include the following:

(a) The state has complied in a timely manner with the requirements of its Safeguards Agreement and Additional Protocol;
(b) The Agency has implemented the necessary measures for verifying declared nuclear material and has drawn a conclusion of nondiversion of such material; and
(c) The Agency has:
   (i) Conducted a comprehensive state evaluation based on all information available, including the declarations submitted by the state under Article 2 of the Additional Protocol, and satisfactorily resolved any inconsistencies and questions; and
   (ii) Implemented complementary access, as necessary, in accordance with the Additional Protocol.

Once conclusions of the nondiversion of declared nuclear material and the absence of undeclared nuclear material and activities can be drawn for a state as a whole, the implementation of integrated safeguards can proceed. However, the ability of the Agency to continue to draw such conclusions must be maintained under integrated safeguards by continuing to implement measures to verify the nondiversion of declared nuclear material, by continuously reviewing and evaluating information, by continuing to take all actions necessary to resolve questions and inconsistencies and by conducting complementary access as necessary. If, during the implementation of integrated safeguards in a given state, the Agency were not able to reaffirm the conclusion of nondiversion of declared nuclear material or of the absence of undeclared nuclear material and activities for a state as a whole, corrective actions would have to be taken which, depending on the circumstances, could include restoring traditional safeguards activities in the state, while continuing to implement the measures of the Additional Protocol.

Current Status and Work Plan

The Secretariat is currently executing a detailed work plan related to the development of integrated safeguards. Specification of the process for drawing and maintaining a conclusion of the absence of undeclared nuclear material and activities in a state has been largely completed. Guidelines that identify the conditions to be met by a state and activities to be performed by the Agency that are considered adequate for drawing and maintaining this conclusion have been prepared and are in provisional use. Generic safeguards approaches for implementation under integrated safeguards are currently being developed for specific facility types which will result in less inspection effort on declared nuclear material than there is with current approaches at such facilities. To date integrated safeguard approaches have been prepared for light-water reactors (LWRs) without mixed-oxide (MOX) fuel, research reactors, and spent-fuel storage facilities. Work is currently under way on approaches for on-load refuelled reactors, LWRs with MOX, and LEU fuel-fabrication plants. Implementation-related aspects of integrated safeguards being further elaborated include safeguards criteria for facility-type approaches, the conditions for conducting effective unannounced inspections, and procedures for random selection of facilities for inspection.

Work is also being conducted on specific state-level approaches involving the combination of integrated safeguards approaches for the specific facility types present in a state and the implementation of measures of the Additional Protocol (specifically complementary access), taking into account the state's nuclear-fuel cycle, the interaction between facilities, and other state-specific features (for example, the Agency's ability to successfully carry out unannounced inspections in the state and the technical effectiveness of the state or regional system of accounting and control). This combination will be made in an optimal way to achieve maximum effectiveness and efficiency within available resources. A state-level integrated safeguards approach has been prepared for one state, Australia, and is now being implemented.

It is expected that the conceptual framework for integrated safeguards in all types of nuclear-fuel cycles, including generic facility-type approaches, will be largely completed by the end of 2001. Work will proceed on the implementation of integrated safeguards in specific states when the necessary conclusions have been drawn and the relevant facility-type approaches have been developed. As more Additional Protocols enter into force, and subsequently more states meet the conditions for the implementation of integrated safeguards, the focus of the work after 2001 will move towards implementation support. As experience is gained with the implementation of integrated safeguards, adjustments to the system will be made, as appropriate, in an evolutionary manner.

Achieving overall cost neutrality when integrated safeguards is implemented on a sufficiently broad scale remains a goal. Cost neutrality in this context has as a reference point the actual level of expenditure on safeguards activities in 1997 (around $95 million, consisting of $82 million from the regular budget and $13 million from extra-budgetary contributions) i.e., before any Additional Protocol measures were implemented. There will, however, be an increase in costs related to the implementation of safeguards in any state during the period immediately following entry-into-force of the Additional Protocol and pending a conclusion of the absence of undeclared nuclear material and activities. During this period, both traditional safeguards and Additional Protocol measures will be implemented, imposing a severe strain on manpower and resources, before the reduction in inspection effort for less sensitive nuclear material reduces the burden.

Integrated Safeguards: Conceptual Framework and Scheme of a State-level Approach*

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Abstract

IAEA safeguards are very important instruments of the international nuclear nonproliferation regime. Argentina considers it important to improve international safeguards, and thus, it has been actively involved from the beginning of this process in contributing to its development.

In May 1997, the IAEA Board of Governors approved the Model Additional Protocol[1] aimed at strengthening the effectiveness and improving the efficiency of safeguards. For states with comprehensive safeguards agreements, the measures adopted provide credible assurance on the absence of undeclared nuclear materials and activities. This increased assurance allows reducing current verification efforts while strengthening the international safeguards system.

At five years after the approval of the Model Additional Protocol, substantive work has been done and progress achieved for its implementation and its integration with current international safeguards. However, there is still much to be done, especially in the area of integrated safeguards (IS).

The objective of this paper is twofold. It reflects some considerations related to the IS conceptual basis and provides a preliminary view on a possible state-level approach to Argentina's nuclear fuel cycle activities.

Introduction

The international community engaged in the area of nonproliferation is mindful that the development of IS, in particular the challenging and difficult task of setting up its conceptual framework and principles, will guide international safeguards for the next decades. Therefore, it has been intensely involved in this process.

The International Atomic Energy Agency, with the collaboration of its member states has made commendable and substantive progress in the analysis of the integration of safeguards and has assigned high priority to its development for states with comprehensive safeguards agreements and the protocol. It is about to complete the development of the IS conceptual framework and has established the basis and general principles for its implementation in those states for which all conditions have been met.

The outcome of this process should be a new strengthened and more efficient safeguards system consistent with the IS definition. Such system should fully reflect the synergies between protocol and traditional safeguards measures, specifically with respect to declared nuclear material and activities.

General Considerations Concerning the Integration of Safeguards

Integrated Safeguards means establishing a new international safeguards system

The Agency is about to finalize the conceptual framework on which IS will be based. Its clear description and scope is of utmost importance for the development of IS as the new international safeguards system. In this regard, it is essential that the framework fully takes into account the meaning of IS.

IS has been defined as 'the optimum combination of all safeguards measures available to the Agency, including those from the Additional Protocol (INFCIRC/540), which achieves the maximum effectiveness and efficiency within the available resources in fulfilling the Agency's right and obligation in Article 2 of INFCIRC/153.'[2]

The expression "system"[3] is a key concept on which the integration of safeguards has to be built. Once the new system is designed, it becomes a unique body that adequately satisfies its objective. Consequently, the integration of safeguards should not be seen as a mere aggregation of two different sets of independent measures serving different objectives but as the new safeguards system that allows the Agency to fulfill its rights and obligations under Article 2 of INFCIRC/153.

** This paper represents only the views of the author.*

For comprehensive safeguards agreements, IS means designing a new safeguards system aimed at providing credible assurances on the completeness and correctness of states' nuclear materials declarations and at improving safeguards efficiency.

'Reversibility' to current safeguards against IS definition

Given that IS means the optimum combination of safeguards measures that achieves the maximum effectiveness and efficiency within available resources in fulfilling the Agency's right and obligation in Article 2 of INFCIRC/153, the rationale on which traditional measures or criteria (that are left aside or changed due to the confidence on the absence of undeclared nuclear material and activities) would be restored is not clear. In other words, if IS does serve its objective, there is not an evident reason to set conditions or principles such as reversibility.

Therefore, IS has to be *designed* bearing in mind its objective. Further thought should be given to the benefit of setting up principles that may be perceived as questioning the effectiveness of IS.

This does not rule out the possibility of *implementing* IS with a cautious approach and by that, considering its implementation provisional. Under provisional implementation of IS in a state, reversibility and other conditions could be maintained, but not as IS principles and only on an ad hoc basis until the Agency gains experience. In such case, it is quite important to clearly reflect this decision as well as the estimated timeframe foreseen until routine IS implementation.

An example that may help to understand this approach can be found in current safeguards agreements. When a state adheres to a comprehensive safeguards agreement, safeguards is applied on an ad hoc basis until the Agency has verified the initial nuclear material inventory in the country. During this time, the Agency has flexibility in exercising its verification activities.

On the other hand, the design of IS in compliance with its definition and in light of the assurances provided by the strengthening measures does not contradict the Agency's right to apply any of the measures available to it (including special inspections) in case of serious discrepancy.

The benefits in following this approach are, among others, that IS would be designed and perceived as the set of measures (system) required to adequately fulfill its objective and it would avoid keeping some measures at declared facilities needed to satisfy the reversibility condition which would demand more resources. One example could be the need to keep costly containment and surveillance measures (C/S) in certain IS approaches for generic facility types.

Summing up, continuing efforts should be maintained to design IS in conformity with its definition. Should an anomaly occur, it has to be resolved as today using expert judgment and the best available safeguards measures. If the rationale behind establishing certain conditions is the need to gain experience with the IS system, in particular, Additional Protocol measures, it would be better to apply IS on a provisional basis than to set up conditions or principles that might be perceived as having a negative connotation on IS effectiveness and may be difficult to change in the future.

Designing IS at State-level

The strengthened safeguards measures provide the required level of assurance regarding the absence of undeclared nuclear material and activities for the state as a whole (credible assurance). Therefore, the first step in designing the IS *as a system* is to review and modify current safeguards parameters, criteria and approaches in the light of this fact. It is well known that current verification effort has been built based on certain conservative assumptions. Now with the implementation of the Additional Protocol, these assumptions should be revised and modified.

A second phase refers to the implementation of the new safeguards system (IS) in a particular state. In doing so, the characteristics of the nuclear fuel cycle and other technical features of the state will be taken into account to apply the optimal combination of measures that allow the Agency to fulfill the safeguards objective in the most efficient way (e.g., remote monitoring, increased cooperation with the single state and regional SSACs, environmental sampling, unannounced inspections, or satellite imagery).

In designing IS, the Agency has decided to follow a bottom-up approach, so after setting IS general conditions and principles, it has started to develop generic IS approaches for facility types. Notwithstanding the advantages and disadvantages of this approach, it is important to set up procedures that allow IS to be achieved at state-level. These procedures should include a review mechanism for further revisions of IS approaches for facility types to take into account possible iterations between safeguards measures at each facility and to include specific state factors.

The selection of possible IS approaches constituting optimal combinations of available measures for a particular state requires an evaluation and a well documented decision-making process. Besides the information about the effectiveness of selected measures, associated cost data is also a very important component that should be available and considered at the evaluation stage.

Argentine IS State-level Preliminary Approach

The second part of the paper provides a preliminary view on a possible state-level approach to Argentina's nuclear fuel-cycle activities. In doing so, a description of the Argentine nonproliferation commitments and of its nuclear-regulatory infrastructure is given first, followed by a brief explanation of the basis for a possible IS approach at state-level, including a description of IS by facility type. The paper concludes with some remarks on IS concepts. A general description of Argentine fuel-cycle activities is included as Appendix I.

Argentine Nuclear Nonproliferation Framework

Argentina is firmly committed to nuclear nonproliferation. In this regard, in the implementation of Argentina's nuclear policy, Article 1° of Law N° 24804 , (in force as of April 25, 1997,) orders that "the obligations assumed by the Argentine Republic must be strictly obeyed in virtue of the Latin America and Caribbean Treaty for the Proscription of Nuclear Weapons (Tlatelolco Treaty); the Nonproliferation Treaty of Nuclear Weapons (NPT); the Agreement Between the Argentine Republic, the Federative Republic of Brazil, the Brazilian-Argentine Agency for the Accounting and Control of Nuclear Materials, and the International Atomic Energy Agency for the Application of Safeguards, as well as the commitments assumed as member of the Nuclear Suppliers Groups and the National Regime on Control of Sensitive Exports."

This law, known as the Nuclear Activity National Act, established a nuclear regulatory authority (ARN) as an autarchic entity to succeed the Nuclear Regulatory Board. The ARN reports to the Argentine presidency and is empowered to regulate and control all nuclear activities concerning radiological and nuclear safety, physical protection, and nuclear nonproliferation aspects. It is also empowered to apply sanctions and has an advisory role to the executive on issues under its scope. Regarding safeguards, the goal of this regulatory system is to ensure that nuclear materials are not diverted for unauthorized purposes and nuclear activities are performed in accordance with international agreements to which the state is a signatory.

The existence of a competent SSAC is another element to be considered at the time of designing IS for a state. The ARN has established an SSAC that applies a set of requirements and procedures applicable to all nuclear materials and other materials, equipment, and information of nuclear interest. The SSAC is aimed at ensuring, with a reasonable degree of certainty, that such elements are not intended for an unauthorized use, and that the international agreements signed in this matter are fully respected.

In the international arena, by virtue of the Agreement between the Argentine Republic and the Federative Republic of Brazil for the Exclusively Peaceful Use of Nuclear Energy signed in Guadalajara in 1991, the System for Accountancy and Control of Nuclear Materials' (SCCC) and the Brazilian-Argentine Agency for Nuclear Material Accountancy and Control (ABACC) were established to ensure that all nuclear materials in all peaceful nuclear activities are not diverted for the manufacturing of nuclear weapons or of any nuclear explosive devices.

Immediately after the Bilateral Agreement came into force, a comprehensive safeguards agreement was concluded between Argentina, Brazil, ABACC, and the International Atomic Energy Agency for the application of safeguards (referred to as Quadripartite Agreement).[4]

Regarding the status of the Additional Protocol to the Quadripartite Safeguards Agreement, consultations are being held between Argentina, Brazil, and ABACC. Drafts of the Additional Protocol have been exchanged with the Agency. Substantive progress has been achieved regarding the text of the Additional Protocol to consider the role of ABACC. It is expected that consultations with the Agency on implementation aspects of the Additional Protocol will commence in the near future.

Application of the State-level Integration Concept to Argentine Fuel Cycle

This preliminary proposal deals only with the fuel cycle aimed at electrical power production and is broken down by facility type to simplify the analysis. Nevertheless, it is important to keep in mind that the IS should be designed at state-level.

The proposal presents a series of alternatives (menu of options) for further consideration. Some of these alternatives require a more detailed analysis to define if the set of proposed measures is the optimal one.

In the particular case of Argentina, a regional safeguards regime (SCCC) applied by an independent international organization (ABACC) is an important contribution to the transparency of the nuclear activities of this country in the design of the IS proposal.

Other factors to be considered are the existence of a nuclear-weapon free zone in Latin America and the existence of a competent national authority (SSAC) to facilitate safeguards implementation.

As said, the application of the protocol will offer credible assurance on the absence of undeclared nuclear materials and activities, in particular enrichment and reprocessing. It will also provide a clear picture of the nuclear activities of the country and on the flow of nuclear material in the fuel cycle. In this context, the present verification effort dedicated to less-sensitive nuclear materials can be diminished while improving the global effectiveness of the safeguards system. Although the view of maintaining the current level of verification effort for direct use material sounds reasonable, the analyst must also consider the possibility of its modification and replacement by other measures of more qualitative nature (e.g., protocol measures) that might contribute in a more effective and efficient way to the control of the acquisition paths related to this material.

One of the pillars of IS continues to be the system of accountancy of declared nuclear material because it constitutes the essential base for its verification. The system of accounting and operational records and reports will be maintained in all cases. Its audit can be optimized by means of the implementation of diverse systems that will be the object of later analysis.

In the proposal of IS for the state-level approach to the Argentine fuel cycle, and in addition to what is suggested below, it is advisable to further analyze the convenience of implementing a random unannounced inspection scheme and the extent this alternative could introduce further efficiencies in the field while maintaining safeguards effectiveness. This scheme might be developed to randomly select fuel cycle related facilities (e.g. by sectors of the fuel cycle).

The proposal also considers the entrustment by the Agency of some of the current verification activities to the SSAC (single or regional), auditing its performance on a random basis.

IS at Argentine Fuel-cycle Facilities
Conversion and Fuel-cycle Facilities

The analysis of quantities of nuclear material and the magnitude of the MUF of the natural uranium and LEU cycle in Argentina indicate that a potential diversion of significant quantities of nuclear material within MUF would take some years.

Taking into account assurances provided by the implementation of the Additional Protocol on the absence of undeclared enrichment and reprocessing activities, an annual PIV is considered enough. In this context, interim inspections to verify the flow of nuclear material seem to be unnecessary. The possibility of performing simultaneous physical inventory verification (SIM-PIVs) needs further analysis.

Nuclear Power Plants

In view of the IAEA's increasing confidence on the absence of clandestine reprocessing facilities, in the case of spent fuel the proposal is to extend the timeliness goal to twelve months. In this framework, an annual PIV would be sufficient (verification activities to fulfill timeliness goals are performed at the PIV). The application of C/S systems adapted to remote transmission of relevant data in near real time is under consideration. Other alternatives like the use of unannounced inspections are also under consideration.

In the proposed integration scheme, it is considered appropriate to review the present role of the C/S systems in the safeguards approaches. For instance, should the C/S systems for the nuclear power plants continue to be applied and their results be positive, PIV or timeliness activities on spent fuel could also be reduced.

If additional inspections are required for the servicing of C/S systems, it is proposed to increase the cooperation with ABACC and the SSAC. For instance, the IAEA could assign certain activities to SSACs under appropriate arrangements.

The verification of spent fuel transfer to dry storage could be covered in a more efficient way by either applying the remote monitoring system under development or by an unannounced inspection regime applied on a random basis.

Finally, for the verification of movements of large containers (i.e., Co 60 containers), the use of optical surveillance schemes (underwater cameras) or the use of short-random inspection schemes is proposed.

Uranium Enrichment Plant

Remote data transmission in near real time of agreed parameters used to confirm the nonoperative condition of the plant, might lead to reduce current verification effort applied to this facility, thus eliminating the need for interim inspections in the field. An annual PIV that includes strengthening measures such as environmental sampling and DIV activities would be sufficient.

Conclusions

- IS has to be designed at state-level and avoid conditions that might imply that IS is not as effective and efficient as expected from its definition. Further consideration needs to be given to the rationale for including certain conditions or principles.
- The implementation of the Additional Protocol for a state with a comprehensive safeguards agreement provides 'credible assurance on the absence of undeclared nuclear material and activities' for the state as a whole. This has to be considered in redefining certain current hypotheses and the relative weight of diversion scenarios.
- There is a synergy between traditional safeguards measures and the strengthening ones that should be fully considered at the time of the integration of available measures. Therefore, some of the current criteria and parameters could be eliminated or relaxed while increasing the overall confidence about the correctness and completeness of states' declarations.
- The use of new techniques and procedures (e.g. unattended systems, remote monitoring, unannounced inspection) as well as an enhanced role of C/S will also contribute to strengthening the effectiveness and improving the efficiency of the new safeguards system.
- The potential benefits of increasing cooperation with the SSACs (regional or single) should also be fully considered. Under the Argentine IS preliminary approach, an important role of ABACC and the SSAC is proposed.

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Since 1996, Moreno has been head of Institutional Affairs and Non-Proliferation of the Nuclear Regulatory Authority being responsible for the coordination and follow up of bilateral and multilateral cooperation, safeguards, and physical protection. She has been involved in the development of the Common System of Accounting and Control of

Nuclear Materials applied by ABACC and in the Argentinean delegation for the negotiation of the Agreement between Brazil and Argentina for the Exclusively Peaceful Use of Nuclear Energy and the Quadripartite Safeguards Agreement. She has also actively participated in the work of Committee 24 of the IAEA Board of Governors that prepared the Model Protocol Additional to Safeguards Agreements.

She is also part of the Argentinean delegation to the IAEA Board of Governors and the General Conference. She performs the follow-up of the Argentine Support Program to IAEA Safeguards and the cooperation with ABACC. She is a member of the Ad Hoc Expert Group that advises the Commission of ABACC and since 1992 is member of the Standing Advisory Group in Safeguards Implementation.

Notes

1. Published as INFCIRC /540, corrected.
2. IAEA SAR-28 Experts Group Meeting on Integrated Safeguards Working Paper, Vienna, September 1998.
3. A set of elements or coordinated parts that appropriately grouped between them contributes to a defined objective or function/A set of definitions and operative rules that are used to fulfill a defined goal or objective.
4. INFCIRC/435, based on INFCIRC/153 and the Bilateral Agreement.

Appendix I

Argentine Nuclear Fuel Cycle General Description

The natural uranium fuel cycle in the Argentine Republic comprises mining and milling, uranium concentration (yellow cake), and UO_2 powder production, nuclear fuel fabrication and their use at the Embalse reactor (600 Mwe Candu). Yellow cake is also imported. The second power reactor in operation (Atucha I) uses slightly enriched uranium as fuel (0.85 percent in U235). Currently, low-enriched uranium (less than 5 percent in U235) is imported and is blended with natural uranium to obtain 0.85 percent slightly enriched uranium. The process takes place at the same facilities used for the conversion and fabrication of natural uranium fuels.

Natural uranium purification and UO_2 conversion are carried out in a facility about 700 km away from the fabrication plant; its nominal production capacity is around 180 tons of U per year. The natural uranium and LEU fuel-fabrication plant is also licensed to import and isotopically dilute low enriched uranium and to import Candu type fuel elements. The fuel fabrication plant nominal production capacity is about 120 tons of natural uranium and 95 tons of LEU per year.

Embalse spent-fuel bundles are temporarily stored in decay ponds for about five to seven years and then they are transferred to dry storage at the same installation for an extended period of time. Atucha I spent fuel is stored in decay ponds.

There are, in addition, a third power reactor under construction (Atucha II), a heavy water production plant, and a special alloy plant that supplies zircaloy claddings and other fuel element structural components. A gaseous diffusion enrichment uranium plant and a UF6 production plant (both being refurbished at present and nonoperative) are located in the south of the country.

The nuclear activities in Argentina also include critical facilities, research reactors, research and development laboratories, small conversion, fabrication and scrap recovery plants, laboratories for chemical analysis, and materials storage handling direct and indirect nuclear materials.

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Integrated Safeguards: Australia's Views and Experience

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Abstract

Australia is the first state in which integrated safeguards are being applied. As such, Australia's experience will be of interest to other states as they consult with the IAEA on the modalities for the introduction of integrated safeguards in their jurisdictions. In January 2001, the IAEA approved an integrated safeguards approach for Australia on a state-as-a-whole level. This approach relies *inter alia* on unannounced inspections, and on complementary access to provide the necessary level of assurance as to the absence of undeclared activities. The purpose of this paper is to outline Australia's experience with strengthened safeguards and Australia's views on the implementation of integrated safeguards. Other matters discussed include the logistics of complementary access and unannounced inspections.

Introduction

Australia's Role in the Development of Integrated Safeguards

Australia has had a pioneering role in assisting the IAEA to develop the procedures and methods for strengthened safeguards, both before and after the conclusion of Australia's additional protocol. Australia played a key role in the negotiation of the model Additional Protocol, and made ratification a high priority in order to encourage early ratification by other states. Australia was the first state to ratify an additional protocol, on December 10, 1997, and was the first state in which the IAEA exercised complementary access, managed access under the Additional Protocol, and complementary access to a uranium mine. Consequently, Australia has undergone three full cycles of evaluation under strengthened safeguards measures, enabling the Agency to conclude it was appropriate to commence implementation of integrated safeguards.

From Strengthened Safeguards to Integrated Safeguards

From the early 1990s, the IAEA, with the assistance of member states, has been engaged in a major undertaking to strengthen and streamline its safeguards system. The principal directions of the strengthened safeguards system currently under development are to:

- shift the focus of verification activities from declared inventories and flows of nuclear material at individual facilities toward safeguards approaches based on evaluation of the state as a whole;
- provide credible assurance of the absence of undeclared nuclear material and activities in the state concerned; and
- diversify the methods of verification and detection, introducing methods based upon quite different principles (such as environmental sampling and satellite imagery), resulting in a more robust safeguards system.

From the outset, it was recognized that under a strengthened-safeguards system the IAEA would need greater rights of access at declared sites and elsewhere, greater capabilities to acquire and analyze information, and the deployment of new technologies, particularly environmental sampling (which had proven to be highly effective in Iraq). Many of these elements required additional legal authority for the IAEA, and this has been given expression through the model Additional Protocol (INFCIRC/540), agreed in the Board of Governors in May 1997, which serves as the model for each state to conclude with the IAEA an individual protocol additional to its safeguards agreement (which for states under comprehensive safeguards is based on INFCIRC/153).

Substantial work has been undertaken, and is ongoing, developing the safeguards approaches, procedures, technologies, quality-assurance systems, evaluation methodologies, and reporting modalities required to ensure that the strengthened safeguards system will be effective in practice. At the same time as this work proceeds, attention is also being given to the next major stage in the evolution of IAEA safeguards, *integrated safeguards*. Integrated safeguards refers to the optimum combination of all safeguards measures available to the IAEA under comprehensive safeguards agreements and additional protocols which achieves the maximum effectiveness and efficiency within available resources.

Under classical safeguards, the level of verification effort takes into account the possibility that undeclared nuclear activities may exist undetected. Thus, for example, the timeliness goal for detection of diversion of spent fuel incorporates the assumption that an undeclared reprocessing plant may exist ready to use in processing diverted material immediately after diversion. The basis of integrated safeguards is that classical and strengthened safeguards are self-reinforcing and to some extent redundant—as strengthened safeguards establish credible assurance of the absence of undeclared nuclear activities, particularly enrichment and reprocessing, a corresponding reduction should be possible in the intensity of classical safeguards effort.

The IAEA has determined that the introduction of integrated safeguards can be considered if there are positive results from the implementation of both classical and strengthened safeguards activities. For each state, therefore, progress to integrated safeguards is a *two-stage process*, the first stage of which is to meet the requirements of strengthened safeguards.

Implementation of Strengthened Safeguards

State Evaluation

Central to the strengthened safeguards concept is the state evaluation, a comprehensive analysis by the IAEA of all the information available to it regarding the nuclear program of each state. A substantially increased amount of information is available to the IAEA as a result of safeguards strengthening measures, including:

- information supplied by the state itself, under its safeguards agreement, under its additional protocol, and voluntarily;
- information from the IAEA's verification activities, including inspections and complementary access;
- open source and related information; and
- information provided by third parties, such as export data.

Through the state evaluation process the IAEA seeks to establish a thorough understanding of the state's nuclear and nuclear-related activities, including the consistency of declared activities with the nuclear program as a whole, and identifying questions and inconsistencies requiring further explanation. An important aspect is the identification of possible indicators of undeclared nuclear activities and how to acquire and recognise such indicators. All of these matters are taken into account in reaching a conclusion about the absence of undeclared nuclear material and activities in the state.

While the undertaking of a state evaluation is not dependent on the conclusion of an additional protocol, without a protocol it would be of limited value. Obviously a wider range of information becomes available to the IAEA once a protocol is in place—and the evaluation is more meaningful as it can be used more efficiently in the planning of the IAEA's verification activities, such as the resolution of any questions or inconsistencies.

The state evaluation is the subject of ongoing review—the initial analysis is used to identify areas requiring further clarification, including through the conduct of safeguards activities such as complementary access and environmental sampling, and the results of these activities are fed back into the evaluation process.

Expanded Declaration

A major step in the state evaluation process is submission by the state concerned of initial declarations in accordance with its protocol provisions, including a full and comprehensive declaration of all safeguards relevant activities that have been conducted in the state.

This process was simpler for Australia than might be the case for many other states, as Australia had already spent a number of years clarifying and extending its knowledge of its nuclear history in preparation for the additional protocol, and had already submitted a trial expanded declaration to the IAEA. Even so, this was not a straightforward exercise as Australia's nuclear research site, Lucas Heights, has been involved in nuclear activities since the 1950s, and much of the early history has been lost. It was necessary to go through an iterative process in which Australia supplied all of the available information and the IAEA investigated and sought clarifications and expansion. This provided the IAEA with useful experience of some of the practical difficulties involved in reconstructing the history of a nuclear site and early programs.

As regards provision of the wider range of information required under the Additional Protocol, Australia was well placed because the Safeguards Act—the relevant legislation—had been drafted more widely than required solely to implement the basic safeguards agreement. The Act covers not only nuclear material, but also nuclear-related materials, equipment and technology, to give the fullest effect to NPT commitments and to reflect commitments under various bilateral agreements. Thus legal and administrative frameworks were already in place for collecting most of the additional information required under the protocol.

Complementary Access

Complementary access is an essential part of strengthened safeguards, involving extensive access at nuclear sites and locations with nuclear-related activities to establish the absence of undeclared activities, and access elsewhere in the state where there are questions or inconsistencies to resolve. As Lucas Heights is a government site, providing the IAEA with complementary access presents no difficulty. However, the government could not guarantee access at privately owned locations, and a key step in ratifying the Additional Protocol was to amend the Safeguards Act to ensure the IAEA could be given access for protocol purposes at any location in Australia.

Prior to conclusion of the Additional Protocol, Australia had cooperated with the IAEA in the trial of protocol measures, including access along complementary access lines. Since Australia's protocol entered into force, as at the time of writing this paper, April 20, 2001, the Agency has exercised complementary access on eleven occasions, nine times at Lucas Heights and twice elsewhere in Australia. One of the complementary accesses at Lucas Heights was on a managed-access basis.

All but one of the complementary accesses was requested during a routine safeguards inspection. For seven of the complementary accesses at Lucas Heights, inspectors gave two hours notice, and were given access within this period. For the managed access, the IAEA had foreshadowed its request well in advance to allow sufficient time for appropriate arrangements to be established.

One of the cases of complementary access away from Lucas Heights involved a location in South Australia, some 1,100 km distant. Notice was given during a routine inspection at Lucas Heights, for access twenty-four hours later. The other complementary access was to the Ranger uranium mine in the Northern Territory, a remote location difficult to reach particularly by public transport. Notice was given during a routine inspection at Lucas Heights, for access five days later. Even with five days' notice there were difficulties arranging transport.

Conditions for the Introduction of Integrated Safeguards

As noted above, progress to integrated safeguards is a two-stage process, the first stage of which is to meet the requirements of strengthened safeguards.

A positive result—an initial IAEA conclusion of the absence of undeclared nuclear material and activities in a state—would be based on the following conditions:

- the state has concluded an Additional Protocol;
- the state has complied in a timely manner with all the requirements of its safeguards agreement and the Additional Protocol;
- the IAEA has conducted a comprehensive state evaluation;
- the IAEA has drawn a conclusion of nondiversion of declared nuclear material in the state;
- the IAEA has implemented complementary access as necessary, to resolve questions and inconsistencies identified during the information review process, and to assure the absence of undeclared nuclear material at sites and other locations specified in the protocol, and has found no indications of undeclared nuclear material or activities in the state.

This conclusion would be maintained, and should be enhanced, by ongoing implementation of the Additional Protocol and continued satisfactory resolution of any further questions and inconsistencies.

In Australia's case, the series of complementary accesses, combined with the results of environmental sampling and information analysis, assisted the IAEA in concluding there is no indication of undeclared nuclear material or activities in Australia and that the expanded declaration was correct and, most importantly, complete. Once the IAEA had arrived at a credible level of assurance that there are no undeclared nuclear activities in Australia, it became possible for the IAEA to make a statement to that effect in its Safeguards Implementation Report (SIR).[1]

Whole-of-State Approach

The evaluation of the state as a whole has a central place in developing integrated safeguards approaches. The classical safeguards system has been characterised by a uniform approach to safeguards implementation, exacerbated by the facility-by-facility approach. This has had unfortunate consequences for inspection resources, with effort being expended in a mechanistic way based on the category and amount of nuclear material in each facility. Although INFCIRC/153 safeguards agreements provide for flexibility, taking account of factors such as the characteristics of the state's nuclear fuel cycle, its international interdependence, and the effectiveness of the national safeguards system, in practice opportunities for flexibility have not been used to advantage.

Integrated safeguards however provide the opportunity for greater cost-efficiency, to take account of state-specific circumstances. Rather than treat each facility type identically regardless of the state in which it is located, the facility can be considered in its broader context. For example, the proliferation potential of an inventory of high-enriched uranium (HEU) at a research reactor will depend on factors such as: whether that is the only HEU in the state concerned; whether further processing would be required to upgrade the HEU for weapons use; if so, whether the state is known to have the necessary processing capability; and so on. It might be judged that a lesser safeguards intensity is appropriate in a state where there is just one holding of such material than in a state with a number of such holdings. In the latter case, the safeguards approach might be determined by considering all relevant facilities collectively rather that just repeating the same safeguards measures at each facility. It is likely no two states will have identical circumstances, and therefore the implementation of safeguards will vary from one state to another. This will have to be done, however, in a transparent way, using objective criteria, to avoid any suggestion of discrimination. The methodologies for this are being developed by the IAEA in consultation with member states.

The Integrated Safeguards Regime for Australia

Australia has five material balance areas (MBAs), the principal one covering the 10 MWt research reactor at Lucas Heights and the associated inventory of fresh and irradiated

HEU fuel. Under classical safeguards, generally Australia was subject to annual physical inventory verifications (PIVs) for the four MBAs at Lucas Heights, plus quarterly interim inspections, making a total of four inspections a year (PIVs for the different MBAs were conducted concurrently with each other or with interim inspections in other MBAs), although there was a period when the fresh fuel inventory exceeded 1 SQ (significant quantity)[2], requiring monthly inspections.

Under strengthened safeguards, this pattern of four inspections a year was maintained, with the addition of complementary accesses, which in most cases have been undertaken at the Lucas Heights site.

Under the integrated safeguards regime now being applied, the timeliness period for irradiated fuel has been changed from three months to twelve months, eliminating the quarterly interim inspections. The four inspections each year have been replaced by one PIV (including comprehensive Design Information Verification activities), and an average of one unannounced inspection. The objectives of the unannounced inspection include, to verify the fresh and spent-fuel inventory and if possible the core fuel, and to confirm facility design information, the declared operation of the reactor, and the absence of undeclared activities. The term "average" is important—to maintain deterrence, once the unannounced inspection has taken place, there will always be the possibility of a further unannounced inspection in the same year. Where possible, fuel transfers will be verified during the PIV or unannounced inspection(s), but the IAEA has indicated that, if necessary, additional inspections may be undertaken for this purpose.

In addition to the inspections outlined above, there will be five or six complementary accesses each year, mainly at the Lucas Heights site, but also encompassing uranium mines and LOFs (locations other than facilities). In most circumstances it is expected that complementary accesses would be carried out when inspectors are in Australia for routine inspections.

In future the inventory of unirradiated HEU is not expected to exceed 1 SQ. If this does occur, the Agency has foreshadowed a return to monthly inspections, or the use of remote monitoring in conjunction with further unannounced inspections. This is a case where the state-as-a-whole approach is important; a substantial increase in safeguards effort might not be warranted if (as in Australia's case) this was the only HEU inventory in the state and the excess over 1 SQ was small.

The overall savings in inspection effort are expected to be about 45 percent (a reduction from 18 to 10 person days of inspection or PDI) a year. However, this depends on whether additional inspections are required to verify fuel transfers—this is an area where Australia considers remote monitoring could be very useful, as discussed below.

Some Implementation Issues

Participation of National Inspectors in Inspections and Complementary Access

Under Australian law, IAEA inspectors have no authority to enter property unless they have the permission of the occupier or they are accompanied by a national (ASNO) inspector. A national inspector can, if necessary, obtain a warrant from a magistrate to enter property, and can call on police assistance. Although difficulties are unlikely to arise, it is Australian policy that IAEA inspectors should be accompanied by national inspectors, to ensure full cooperation is extended to the IAEA, and to ensure that the government is immediately aware if there are any difficulties.

Australia has a large land mass, and the logistical challenge of arranging a complementary access to a distant part of Australia on short notice can be difficult to meet. As noted above, arranging transport to a uranium mine proved difficult even with five days' notice. Australia anticipates that requests for complementary access to remote locations should be infrequent—otherwise this could cause practical difficulties.

Unannounced Inspections

These are not unique to either strengthened or integrated safeguards—the standard safeguards agreement (INFCIRC/153) provides for a proportion of routine inspections to be unannounced. However, the value of unannounced inspections—i.e. inspections whose timing is unpredictable to the state or the facility operator—has been particularly recognized in the context of integrated safeguards.

It should be appreciated that unannounced inspections do not necessarily—or usually—mean *immediate* access. A distinction is made between the initiation of the inspection—arrival of inspectors at the facility—and the time in which the inspectors require access to the area to be inspected.

In determining the required access time, the IAEA should take account of practical matters—availability of operators' personnel essential to the conduct of the inspection, any requirement for national inspectors to be present (as discussed above), and so on. There needs to be a careful balance between the objectives of the inspection and these practical considerations. If the scenario the inspection is intended to address would remain detectable over a period—e.g., modifications to plant that would take days to reverse, environmental traces that could be detected weeks or even months after the event—this can be factored into the required access period. Indeed, in many situations it may be possible to provide some advance notice of the inspection. To the extent consistent with the requirement for detection capability, the principal aim should be *unpredictability* rather than surprise.

In Australia's case, the IAEA has agreed to provide three hours' notice of required access pursuant to an unannounced inspection. Notice would normally be given at 7 a.m. of an inspection to commence at 10 a.m. that day. This is consistent with the travelling time required for national inspectors to reach Lucas Heights from ASNO's office in Canberra (a distance of 275 km), and reflects the Agency's judgment that any undeclared activity at the Lucas Heights site could not be concealed within that time. If for any reason national inspectors are delayed in reaching the site, the inspection can commence in any event after three hours.

Remote Monitoring

After some initial enthusiasm, the IAEA now seems cautious about using remote monitoring because of problems related to reliability and cost. Remote monitoring has not been included in the integrated safeguards approach for Lucas Heights, though the Agency recognizes that remote monitoring could be a useful enhancement to routine inspections.

Australia considers that problems with remote monitoring can be overcome by well-designed systems, and is proposing a remote monitoring installation to address the verification of fuel transfers at Lucas Heights—the loading of spent fuel shipping containers, and the receipt of fresh fuel. If the Agency needs to undertake additional inspections for these purposes, this would negate the savings in inspection effort introduced by integrated safeguards. Australia's remote monitoring proposal is under discussion with the Agency.

Verification Measures for Uranium Mines

Under classical safeguards, uranium production was considered to be "before the starting point of safeguards." Verifying production at a uranium mine on any rigorous basis would require continuous inspector presence. Since any diverted ore or source material would have to pass through many downstream processes, each of which offers some opportunity for detection, before attaining a form suitable for nuclear explosive use, it was not considered cost-effective to extend safeguards to uranium mines.

During the development of strengthened safeguards, it was considered that the possibility of verification of uranium production was worthwhile as a complement to conventional safeguards, and the additional protocol provides for broad reporting requirements and complementary access at mines. Although accountancy-type measures are not practicable, appropriate verification measures could identify questions or inconsistencies indicating the need for wider investigation in the state concerned. At one extreme is the discovery of totally undeclared production, i.e., an undeclared mine, or a mine incorrectly declared to be closed down. Perhaps a more plausible scenario is the understating of production. Australia is assisting the Agency in developing verification approaches and techniques that could identify such a situation, including use of satellite imagery and environmental sampling to date production.

Failure to Maintain the Conditions for the Implementation of Integrated Safeguards

One issue being addressed is what would be the consequences if the IAEA is unable to resolve significant questions and inconsistencies in a state in which integrated safeguards are being applied. Leaving aside evidence of non-compliance—which would be reported in due course to the IAEA's Board of Governors and, if necessary, the Security Council—if the situation is merely one of suspicion or uncertainty, should the IAEA revert to the full range of classical safeguards measures, as well as continuing to apply strengthened safeguards measures? The IAEA has concluded that in these circumstances it must have the ability to increase the intensity of routine safeguards measures. Exactly what the Agency does, however, should be decided on a case-by-case basis—in many cases a blanket return to routine safeguards might make no sense. Of course, any such action by the Agency could be contentious, as the state concerned would resent apparently accusatory action. This is an argument for flexibility in safeguards, moving away from the rigid parameters of the classical system, so the Agency can fine tune its handling of each particular situation without necessarily appearing to cast aspersions on the standing of the state concerned.

Conclusions

The classical safeguards system provides a high degree of assurance that there is no diversion of nuclear material from declared activities. The objective of complementing classical safeguards with strengthened safeguards measures is to provide the IAEA with credible assurance of both the nondiversion of nuclear material from declared activities and the absence of undeclared nuclear material and activities. Since assurance of the absence of undeclared nuclear material and activities can never be absolute—it will never be possible to definitively prove a negative—it is recognized that the degree to which strengthened safeguards measures provide such credible assurance will not lend itself to quantitative assessment. The IAEA will be required to use its judgment, which should be as objective, reliable and definitive as possible.

For the safeguards system to provide the necessary degree of assurance to the international community, it is essential that there is a clear understanding on the part of states of the IAEA's new approaches and methodologies, and the way it makes evaluations and reaches conclusions. In addition to the development of new verification techniques, substantial effort is being devoted to the development of quality assurance systems, and appropriate ways of reporting the IAEA's conclusions to member states.

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

Major issues being addressed include how to ensure the verification activities undertaken by the IAEA are sufficient to support a credible conclusion of the absence of undeclared nuclear activities. This involves both establishing the appropriate methodology and ensuring the methodology is implemented at an appropriate quality standard. As one subset of this point, there is the question of how to select locations for complementary access, especially how to ensure this is not done in a mechanistic or systematic way. An important group of issues concerns how to implement integrated safeguards in a flexible manner, based on state-specific factors, incorporating the expert judgment of the Agency, in a way that avoids accusations of discrimination and delivers the required credibility.

Clearly the effective implementation of integrated safeguards presents a series of challenging tasks both for states and the Agency. The importance of doing this successfully cannot be overstated: the general application of strengthened safeguards measures is essential to providing the international community with assurance that NPT commitments are being met—and integrated safeguards are essential to achieving this in a cost-efficient manner. It is very much in the interest of all states to participate constructively with the Agency in this effort.

Notes

1. The 1999 SIR—the most recent available at the time of writing this paper—included the following statement: *"For two states, each of which has a comprehensive safeguards agreement and an additional protocol in force, the Agency was able to draw a further conclusion relating to the absence of undeclared nuclear material and activities in the State as a whole."* Australia was one of these states. The other was the Holy See.

2. For HEU a Significant Quantity is uranium containing 25 kg of U-235.

Integrated Safeguards: A State-level Approach for Canada

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Abstract

With the introduction of the Additional Protocol to comprehensive safeguards agreements, the IAEA has new measures that strengthen its safeguards regime. The introduction of these new measures enables the IAEA to obtain increased assurances of the absence of undeclared nuclear activities and nuclear material in a state. Having implemented these new measures, having obtained credible assurance of the absence of undeclared nuclear material and activities, and having concluded there was no diversion of declared nuclear material, the application of traditional safeguards measures with those of the Additional Protocol can be optimized resulting in an effective and efficient safeguards system. Such a system, centered on openness and transparency, is proposed for the Canadian nuclear-fuel cycle. The foundation of the approach is extensive declarations of activities related to the nuclear-fuel cycle, near-real-time reporting of nuclear material movements, and enhanced access to nuclear-fuel cycle locations, including the use of remote monitoring and satellite imagery. The approach is designed to give the IAEA comprehensive information of nuclear activities and material in the state which will be analysed extensively to determine what follow-up activities need be undertaken, including inspections and complementary access that should be targeted to specific locations. The approach becomes information driven at the state level rather than a facility by facility approach as is currently undertaken.

Introduction

The IAEA, on a high priority basis, has been working toward an optimization of INFCIRC/153 and 540 measures into an efficient and effective verification regime, known as Integrated Safeguards that would allow the Agency to fulfill its right and obligation under paragraph 2 of INFCIRC/153. Integrated safeguards is the optimum combination of all safeguards measures available to the Agency, including those from the Additional Protocol (INFCIRC/540), which achieves the maximum effectiveness and efficiency within the available resources in fulfilling the Agency's right and obligation in Article 2 of INFCIRC/153.

The state-level approach conceptualized in this paper describes possibilities of how the IAEA can realize a more efficient and effective safeguards system while, at the same time, achieving an increased level of assurance that the state is complying with its NPT obligations not to use nuclear material for weapons purposes. It is recognized that any increase in efficiency attained by a reduction of effort must, however, ensure that the implementation does not result in a decrease in Agency confidence.

Canada's Nuclear-fuel Cycle

The uranium mining/milling industry is currently only operational in the province of Saskatchewan. The active licensed mines are Cluff Lake, Key Lake, Rabbit Lake with McArthur River, and McClean Lake under construction. The refining of uranium concentrate to UO_3 occurs in Blind River (CAMECO) and uranium conversion in Port Hope (CAMECO). Large-scale fuel fabricators are located in Port Hope (Zircatec) and Toronto/Peterborough (General Electric).

Canada currently has twenty-two licensed commercial nuclear-power reactors for the generation of electricity. The breakdown of ownership and location is as follows. Ontario Power Generation Nuclear (OPGN) operates twelve reactors including Bruce A, a multi-unit facility containing four reactors and presently de-fuelled in lay up state; Bruce B, which is the same configuration and currently in operation; Pickering, which is a multiunit facility containing eight reactors, (Pickering A with four reactors in lay up state and Pickering B with four operating reactors); and Darlington, also a multi-unit four reactor facility and presently is in operation. Hydro Quebec operates a CANDU 600 unit at Gentilly and New Brunswick Power operates a CANDU 600 unit at Point Lepreau.

Operational dry spent-fuel intermediate-storage facilities are located at Pickering NGS, Gentilly NGS, Point Lepreau Power NGS, and the Atomic Energy of Canada Ltd. (AECL) Chalk River Laboratories (CRL). A dry-storage facility is also planned to service the Bruce A and B NGS. Dry storage of spent fuel is being considered for Darlington NGS.

There are five shut down nuclear reactors in Canada.

These include power reactors (NPD-NGS at Rolphton, Douglas Point NGS at Tiverton, Gentilly-1 NGS at Gentilly) and large research reactors (WR-1 at Whiteshell and NRX at the AECL CRL site).

Static stores of nuclear materials now under safeguards are located at the Gentilly-1 site, Douglas Point NGS site, and the AECL CRL and WL sites.

There are also research reactors and subcritical assemblies located at various universities for research and teaching purposes, namely six SLOWPOKEs, one pool-type reactor, and one subcritical assembly. The SLOWPOKE is a low power, 20-kW unit with a core containing less than 1 kg of HEU.

Research related to the nuclear-fuel cycle continues extensively in Canada. AECL maintains Canada's main research site located at Chalk River, Ontario. AECL also runs an auxiliary R&D site, Whiteshell Laboratories in Manitoba (AECL-WL), and a LOF (AECL-CANDU Operations Division) in Mississauga, Ontario. The two R&D sites contain large research reactors (both operating and shut down), fuel fabrication, direct use materials, and the infrastructure for all aspects of nuclear cycle related R&D. In addition the WL site will be closed down in the next few years.

The present active LOFs in Canada are the TRIUMF cyclotron facility in Vancouver, Stern Laboratories in Hamilton, OPGN Research Division in Toronto, and MDS Nordion in Ottawa.

Canada also has had facilities for manufacturing heavy water. Presently, there are only operational facilities for upgrading and storage of heavy water. The Canadian nuclear-fuel cycle industry also has manufacturers of zircalloy tubing and other technical components.

A schematic of the fuel cycle is provided in Figure 1.

Use of the Zone Approach

In Canada, the IAEA has been applying simultaneous physical-inventory verification (SIM-PIV) in a zone approach. There are, in effect, two zone approaches applied in Canada, namely the CRL Zone and the Natural Uranium Zone. The application of SIM-PIV to a natural uranium zone approach is an effective and efficient methodology, reducing requirements for flow verification and thereby resulting in substantial savings in IAEA resources.

Preconditions for the Implementation of an IS State-level Approach

In order to move towards an IS state-level approach it is assumed that:

- The Agency has drawn positive conclusions from the mature and well-developed nuclear material accountancy-based verification regime of traditional safe-

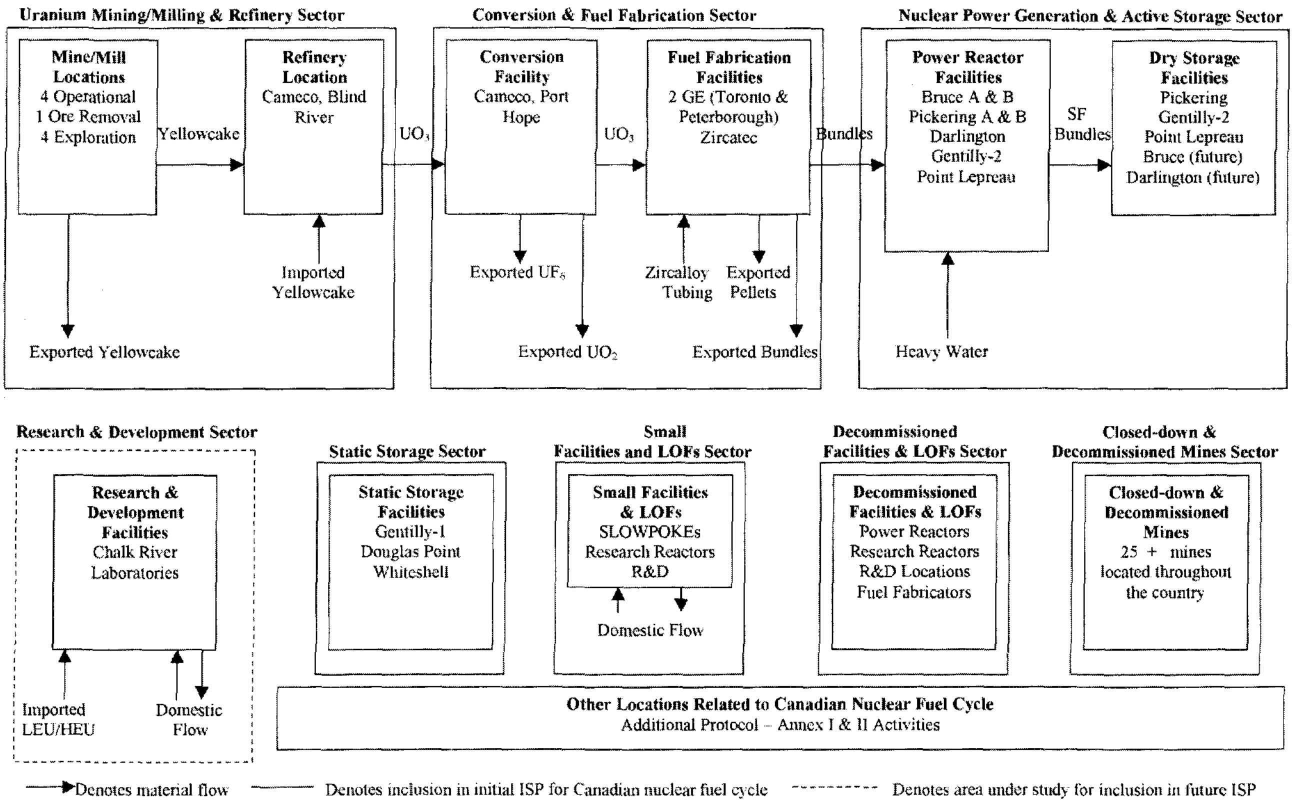

Figure 1. Canada Nuclear Fuel Cycle

guards, thus achieving a certain level of confidence relative to the declared nuclear program in the state.

- The Agency has received from the state information required to fulfill the obligations of the Additional Protocol.
- The Agency has, using a clearly established methodology, analyzed the Additional Protocol information, information available through its ongoing implementation of INFCIRC/153 and information from open sources.
- The Agency has used the information analysis process and all tools available to it to analyse and evaluate the state's declarations concerning the entirety of its past, present and future nuclear programs.
- The analysis process has been ongoing and the Agency has exercised its rights of access under the Additional Protocol and satisfactorily resolved questions or inconsistencies.
- The Agency's analysis has also included information received regarding imports/exports under both the Voluntary Reporting Scheme and the Additional Protocol.

The Agency, after implementing the safeguards measures of INFIRC/153 and 540 and assessing the state's nuclear program as an interrelated set of nuclear operations, should then be able to conclude both the absence of diversion of the declared nuclear program as well as the absence of clandestine activities and undeclared nuclear material, specifically the absence of enrichment and reprocessing.

The Outline of the State-level Approach for Canada

After reaching a positive conclusion for the Canadian fuel cycle, as described in the preceding section, the IAEA would be in a position to implement an integrated safeguards. A state-level approach for Canada is discussed in the following four sections: Enhanced Information, Enhanced Access, Safeguards Activities, and Other Aspects.

The first pillar of this approach is the provision of enhanced information to the IAEA in the form of near-real-time (NRT) data on the dynamic nuclear material flow in Canada, remote transmission of safeguards data from installed equipment at safeguarded facilities, and the use of satellite surveillance for remote or static locations. It also includes the timely updating of all information in Canada's Protocol declaration.

The second pillar is the enhanced access achieved through unencumbered access to facilities and locations in the state in order to implement activities under the safeguards agreement and the Additional Protocol, including unannounced inspections or complementary access. The identification of locations and sites will be based on both random selection and extensive IAEA analysis, thus directed with specific purpose and activities.

These pillars would be merged with the efficient application of traditional measures on declared nuclear material. This can be achieved through the application of technological advances and the randomization of traditional verification activities. In parallel, the IAEA would maintain information gathering and analysis activities for the state-as-a-whole, followed by investigation and resolution of questions and inconsistencies, where required.

To date the development of the IS proposal for Canada has not included the AECL CRL site which will be incorporated in the near future. It is expected that, as with the natural uranium fuel cycle, there are efficiencies to be gained in the application of unannounced and random inspection concepts to the CRL site.

Enhanced Information

As part of this conceptual approach to IS, Canada, under Article 2 a. (ii) of the Protocol, will provide the IAEA, through its SSAC, NRT access to reports on all nuclear material transfers occurring in the state, including import and export of nuclear materials. The Canadian fuel cycle starts with the mines and the present domestic end point is waste or spent fuel in dry storage. The Canadian Nuclear Material Accounting System (NMAS) is presently being upgraded to accommodate the data handling requirements of the Additional Protocol and to make use of modernised technologies in data handling and transmission. Although the IAEA will be accessing dynamic nuclear material flow data for locations and activities that are pre-safeguards, the Protocol states that the Agency shall not mechanistically or systematically seek to verify the information referred to in Article 2. The provision of this information should be used in analyzing the overall consistency of the declared nuclear program. The IAEA would use this data to perform a nuclear material balance for the state's nuclear-fuel cycle, to follow the flow of nuclear material from the mines through the fuel cycle to the storage of spent fuel in bays or dry storage taking account of imports and exports, and to perform random verification of flows if required. The flows of nuclear material are represented in Figure 1. The information provided goes beyond the requirements of INFIRC/153 and 540. It enhances the information available to the IAEA and is an example of increased cooperation with the SSAC.

Another aspect of enhanced information will be the use of a mailbox approach in the provision of a declaration of transfers of nuclear material to dry storage. The mailbox for information on the transfer of spent fuel to dry storage is envisioned as being done in two stages. The first stage to be done by the SSAC would contain advance notification of the operator's intention to transfer nuclear material. The second stage would be the confirmation by the facilities prior to the actual transfers taking place.

In addition to information of the flow of nuclear material between facilities, detailed information on the flow of nuclear material in power reactor facilities will be obtained using a combination of access to operator information and remote transmission of data from installed safeguards equipment. The state would provide the Agency with read-only access to operator databases which outline nuclear material receipt and inventory in the fresh fuel storage area, fueling records showing the flow of material into and out of the reactor core(s) into the spent fuel bays, and the flow of spent fuel in both inter-bay and dry storage transfers concluding with the inventory spent fuel in dry storage. Through the use of remote transmission from installed safeguards equipment, the Agency could have real-time confirmation of spent fuel flow in the facilities from core discharge monitors (CDM), bundle counters (BC), and surveillance cameras.

Having established the dynamic flow of nuclear material, the Agency should easily be able to determine the operational status of the locations/facilities/sites declared by the state. Agency activities will include verifying that these remain in the operational status as declared by the state. To optimize the Agency activities in this endeavour, it is proposed that the Agency make use of satellite imagery. This tool lends itself to the observation of locations such as mines, closed facilities and the construction of new facilities or operations at existing facilities.

Enhanced Access

Under this conceptual approach, the Agency will have access to all safeguarded facilities and sites. This access would be used primarily to verify Canada's declarations, including, where applicable, the dynamic nuclear material flow information and the performance of Protocol activities required to maintain the conclusion regarding the absence of undeclared material or activities. The performance of present criteria-based verification activities are envisioned as part of the approach to maintain assurances regarding both the absence of diversion and undeclared use of the nuclear program.

An important element of openness and transparency in Canada is the IAEA Toronto Regional Office. The location allows for access within a two-hour time frame to most Canadian nuclear facilities. In addition, the TRO provides the Agency with access to information from within the state. It is expected that the TRO will be the recipient of all data transmissions from safeguarded facilities in Canada thus providing the Agency with quick response capabilities for both verification of the dynamic nuclear material flow and safeguards equipment malfunction or failure indications indicated through the transmission of state-of-health data. This capability puts the TRO on the front line for the verification aspects of a state-level IS regime.

Safeguards Activities

This conceptual state-level approach and any other approach should make optimal use of all verification techniques available under INFCIRC/153 and 540 and advances in safeguards methodology and technology.

The IAEA will, under the Additional Protocol, use visual observation, collection of samples including environmental sampling, utilization of radiation detection devices, application of seals, other tamper indicating devices and other activities such as item counting of nuclear material, nondestructive measurements, and sampling as well as examination of records including, where applicable, relevant production and shipping records.

Under this conceptual approach, the Agency will continue to perform measurement and verification activities as provided by 153. For materials of less strategic importance, a more randomized approach than the current safeguards criteria would be applied to all facilities in the state. Agency resource savings from traditional safeguards obtained through the optimisation of IS could be redirected to the performance of Protocol measures throughout Canada or in the application of safeguards in other states.

Interim Inventory Verification (IIV): The traditional IIV verification to satisfy the current criteria at safeguarded facilities involving less strategic nuclear material are not necessary under this IS approach. This approach suggests that, for less strategic material, periodic (initially quarterly) nuclear material accountancy book audits would be done remotely for all facilities. The reasons for this proposal are twofold. First it would increase transparency. Second it would give early indication of accounting errors. The IAEA could target a particular facility for the application of specific safeguards measures based on the results of this remote audit.

Physical Inventory Verification: Initially it is not foreseen that PIV frequency be changed from once per year. However, implementation of a modified SIM-PIV concept is proposed. All fuel-cycle facilities would conduct a physical inventory taking (PIT), prepare a list of inventory items, close their books, have all records and reports available, and have resources in place for a PIV. The Agency would randomly select or target specific facilities for verification purposes. It is proposed that the IAEA would select 50 percent (random medium) of the facilities and perform the same level of verification as is performed by the current safeguards criteria. In addition, Protocol measures could also be performed. Should there be a need to restore traditional safeguards at any facility or all of them, the IAEA would have complete accountancy information of all nuclear material at each facility, particularly when combined with the near-real-time reporting of all nuclear transfers within the state. This approach would maintain the advantages of the zone approach, while significantly reducing the peak demand for inspectors, from about twenty-four to about twelve.

Other options had been considered, such as performing all PIVs but at reduced coverage such as reducing the detection probability and detection level or verifying only selected strata at each facility to the traditional detection values. However, these would only achieve similar effectiveness as the random SIM-PIV but with reduced efficiency.

It is proposed to achieve further efficiencies through the introduction of unannounced inspections (UAI) that would be performed on a random basis. Such inspections are viewed as an effective measure to increase the levels of confidence and deterrence. By implementing a number of such inspections to verify the flow of nuclear material or to detect clandestine nuclear material or activities, one could reduce the coverage of the SIM-PIV from random medium to random low or 20 percent. The number of these inspections could be small and targeted more to the larger facilities rather than locations other than facility (LOFs). The UAI could average one for each of the larger facilities. This would maintain the effectiveness of the approach while reducing the peak load on inspectors by spreading some of the effort throughout the year.

Regarding transfers of spent fuel to dry storage, this approach suggests verification would be done on an unannounced randomized basis. The Agency would have the declarations supplied by the SSAC and confirmed by the operator twenty-four hours before the transfer through the mail box approach and could chose to verify only a portion of the transfers. The loading and shipment of the spent fuel from the spent fuel bays is covered by IAEA surveillance that can be monitored remotely. The portion of the transfer process not under direct surveillance, presently covered by inspector presence, would be covered by a combination of time analysis and unannounced inspection. The level of verification activities required also needs to be established. For the calculation of inspector effort presented later a value of 20 percent is used. As stated previously, this area offers the greatest optimization of IAEA resources in Canada since the zone approach for the natural uranium portion of the fuel cycle already provides considerable efficiencies.

Complementary access (CA) and UAI: The selection of where and what activities to undertake is decided using Agency analysis methodology assisted by the use of the physical model and other available tools. In the absence of any IAEA developed guidelines, an attempt is made to make a reasonable estimate of the effort the IAEA might require. In order to have a basis for making random selection this proposal divides the fuel cycle into a number of sectors. Each of the sectors is evaluated in terms of the strategic significance of the nuclear material and activities to determine the level of effort that the IAEA should deploy in implementing its safeguards measures. The amount of CA could vary from 50 percent of facilities that are further along the fuel cycle, such as fuel fabrication plants or reactors, to 20 percent for mines or 5 percent for inactive or decommissioned mines. In the latter case CA could be replaced or reduced through the application of satellite imagery. In addition, the IAEA would use the results from its information analysis to target certain facilities or locations. The activities to be undertaken at each location or site would be drawn from the measures provided under INFCIRC/153 and 540 and tailored to meet the specific demands identified by the information analysis. Although certain locations or activities of more strategic value are more likely to be selected for access and application of safeguards measures, this approach would also ensure that locations or activities of lower strategic value could also be chosen.

The application of randomization suggests that the level of confidence attained with this state-level approach would be greater than an inflexible or predictable model. The introduction of a random, particularly unannounced, inspection regime has been suggested as a practical method to make better use of inspection resources and includes a deterrence factor.

It may happen that the application of random unannounced inspections is problematic, for example, inspection costs may be high due to the requirement for air travel to one site. Therefore other approaches are being investigated involving the installation of additional equipment with remote monitoring, possible involvement of the SSAC to perform some activities on behalf of the IAEA which would randomly audit the process, and the use of radiation signatures to confirm that the contents of the spent fuel transfer/storage containers have not changed.

Other Aspects

Coverage of acquisition paths: It should be noted that the proposed IS approach for Canada maintains coverage of all credible diversion paths covered by traditional safeguards. The paths are now covered by a combination of traditional measures, some at reduced levels, and new measures such that there should be no reduction in effectiveness. Reductions in coverage by the traditional measures have been compensated by the new measures, the deterrent value of unannounced inspections and the overall state analysis performed by the IAEA based on all the information available to it. In addition, the IAEA has increased safeguards effectiveness for the state as a whole as the new measures provide an assurance of the absence of undeclared nuclear activities and material that was not previously achievable.

CANDU safeguards: The proposed IS approach makes use of the installed instrumentation (core discharge monitors, bundle counters, and surveillance) at the CANDU reactors since much of the capital investment is relatively recent. The equipment will have a useful life for many years and the addition of remote monitoring capabilities adds to the enhanced information available to the IAEA. In the future, consideration will be given to alternative approaches as the equipment reaches the end of its operational lifetime and as more experience is gained in the implementation of integrated safeguards. Another result of the continued use of this instrumentation is a change to the traditional PIV activities related to the spent-fuel inventories. The CDM and BC confirm, on a real-time basis, absence of unreported irradiation and diversion between the cores and the spent fuel bays. The BCs perform 100 percent item count and method H on the spent fuel entering the spent-fuel bays, and surveillance maintains continuity of knowledge of the spent fuel in the bays. It is proposed, therefore, that the annual PIV of the spent-fuel bays would not be required.

Requirements for reverification of inventory following IAEA equipment failure: This approach considers that, with the level of confidence regarding the absence of clandestine activity attained with the implementation of the Protocol, there should not be an automatic requirement for reverification of inventory should safeguards equipment fail. Rather the IAEA should examine all the information at its disposal in making a decision to reverify the nuclear material. This approach proposes that no reverification is required for failure of remotely monitored equipment where the IAEA would immediately know of the failure through transmission of status-of-health messages and alarms. This capability enables the IAEA to immediately address the problem.

Optimal use of installation and maintenance visits: Since the proposed state-level approach makes use of IAEA instrumentation, the Agency should consider making full use of access for installation or maintenance purposes. Presently, IAEA technical staff are accompanied by inspector(s) during access to safeguards equipment that is being maintained or installed. This announced inspector presence at the facility could be more fully utilised by having the inspector perform unannounced safeguards activities. The Agency may also want to consider giving special inspector designation to the technical staff so that inspector resources would not be required for simple activities such as unsealing and resealing a cabinet.

Indication of Inspector Effort for an Integrated Safeguards Approach for Canada

Using the foregoing concepts for an Integrated Safeguards approach, an effort is made to indicate the inspection effort and compare it to the effort under traditional safeguards. The results are provided in Table 1. The IAEA 153 effort is based on person-days of inspection (PDI) for a point in the future when all six reactor stations would be conducting transfers to dry storage. At present this occurs at only one of the four multiunit stations and both of the single unit stations. In the case of IS, the data is estimated as inspector effort for CA, UAI, design-information verification (DIV), PIV, and transfer-verification inspections for spent fuel (TVI). It should be noted that increased CA would likely occur in the first years of implementing the Protocol leading up to implementation of IS. In addition, the estimates are only approximate. The CA effort would be determined once the IAEA has refined its methodology and only includes CA performed on a selective basis, not that required to resolve questions and inconsistencies. The CA activities actually performed would be taken from those identified under Article 6 of the Protocol.

The information in Table 1 is for the case where 20 percent of the facilities are inspected in the SIM-PIV. If SIM-PIV was implemented at the 50 percent level there would be no need for the UAI and the effort for the PIV would increase by about thirty PDI with a net gain in effort of about twelve PDI.

Satellite imagery could be utilized by the IAEA, particularly with respect to the mining sector and for closed down or decommissioned facilities. Static storage facilities would use remotely monitored surveillance or seals.

Table 1. Estimated Safeguards Effort

Sector	Average of 153 Effort	Integrated Safeguards					
		CA	UAI	DIV	PIV	TVI	Total
1. Mines, Mills, Refineries	0	3	0	0	0	0	3
2. Conversion, Fuel Fabrication	42	2	4	3	16	0	25
3. Nuclear Power Generation Action Storage	272 PDI 880 TVI	3	6	6	16	0 175	27 175 TVI
4. Static Storage	15	1	0	1	2	0	4
5. Small Facilities & LOFs	9	2	2	1	2	0	7
6. Decommissioned/Closed-down	0	1	0	0	0	0	1
7. Nuclear Research Site	258	12	6	10	242	incl.	258+ 12CA
8. NM not subject to Safeguards	0	2	0	0	0	0	2
9. Annex I, II Non-NM R & D	0	0	0	0	0	0	0
10. Other Locations	0	0	0	0	0	0	0
Total/Type of Effort	1,476	26	18	21	280	175	520

Conclusions

The presentation of the conceptual approach for an IS state-level approach for Canada is seen as a step along the path to developing the actual IS. The foundation of the approach presented, in addition to traditional nuclear material accountancy-based safeguards, is the provision of near-real-time information on nuclear material flows in the state and the application of a randomized verification regime. While maintaining the traditional levels of safeguards at major research facilities, sensitive nuclear materials and associated activities, this conceptual state-level approach offers a reduction of effort on less sensitive nuclear materials. As shown in this paper, the Agency's saving of resources would be the greatest in Canada by reducing the activities related to transfers of spent fuel to dry storage. This proposed concept is put forward as one of the first steps in an evolutionary process towards IS and is seen as an example to advance the debate and analysis of state-level approaches.

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Beyond Nuclear Material and Equipment: What Else is Relevant for Comprehensive Information Analysis in Integrated Safeguards?

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Abstract

As a part of its efforts to strengthen international safeguards, the IAEA is making use of increased amounts and types of information on states' nuclear and nuclear-related activities. The Agency now has the tools to gather and consider information generated by independent sources to check against a state's declaration. Besides the results of its own verification activities, e.g. complementary access, environmental sampling, cross-checks of declarations under the reporting scheme, evaluation of satellite images, the quality and independence of the SSAC, the characteristics of the national fuel cycle, the political and social infrastructure, and information from open sources can considerably endorse the credibility of the state's declaration.

As a systematic means of categorizing and recording relevant information from the various sources, a "Physical Model" was developed by the IAEA describing the steps that would be involved in the nuclear-fuel cycle from source material acquisition to the production of weapons useable material. As implied by its name, this model concentrates on the physical aspects of a proliferation, i.e. nuclear material and equipment, and neglects the necessary remaining environment to conduct the diversion.

Besides the nuclear material and the necessary equipment, the strategy for a proliferation attempt would have to make available additional resources, such as appropriate funding, human resources including the appropriate scientific infrastructure, special R&D activities, logistics and training, procurement, and decision-making bodies and procedures. The degree to which all this could be performed in a completely secret way, and thereby the extent of the risk of early detection, is strongly influenced by the state's political and social infrastructure. Even if the absence of any indicator for those activities in the open-source information of an open society cannot definitely prove the absence of such activities, it can clearly endorse the credibility of the state's declaration.

Introduction

Triggered by the events in Iraq and North Korea and the uncovering of South Africa's clandestine nuclear-weapon program, the IAEA embarked in the 1990s on major undertakings to strengthen and streamline the international-safeguards system. The results of this effort became known as the Strengthened Safeguards System (SSS) and culminated in the adoption of the Additional Protocol in May 1997 by the IAEA Board of Governors.

The focus of the Model Additional Protocol is to strengthen the Agency's capability to detect undeclared nuclear material and activities, in order to provide credible assurance of their absence. To this end, the new strengthened-safeguards measures provided for in the Additional Protocol endow the Agency with extensive access rights to information, facilities, and locations, and equip it with new technical means such as the use of modern communication systems and environmental sampling. These measures can provide a new quality of safeguards.

Information Analysis

A cornerstone in this new quality safeguards is information analysis. With the implementation of the Additional Protocol, the IAEA will have greater access to information from a variety of sources:

- States' declaration covering the complete fuel cycle with nuclear facilities, R&D-activities, export of sensitive goods, etc.
- Information gathered through its own inspection activities, including environmental sampling and complementary access

- Information collected from the Agency's internal databases and from open source information
- Other external sources like satellite imagery and information provided by third parties

The determinant of the contribution information analysis can make to a new safeguards scheme is how this information is analyzed, assessed, evaluated, and used to draw conclusions.

The most important tool to help in the technical assessment is the Physical Model of nuclear activities. The Physical Model describes all known processes to convert source material to weapons-grade nuclear material. For each process, the required nuclear and nonnuclear material and equipment are described. In reverse, a piece of equipment or material can indicate a nuclear activity. The analyst assesses the indicator in the context of other information available. All questions or inconsistencies revealed in this process must be followed up.

To evaluate the information for a specific state, besides assessing the consistency of the state's declaration with other information available and the relevance of indicators found, the concept of acquisition paths is used. Acquisition path are combinations of possible actions by which a state might seek to acquire nuclear material for a nuclear explosive device.

Possible Acquisition Paths for HEU in Germany

According to the structure of the acquisition path concept, there exist two principle ways to produce highly enriched uranium:

- Misuse of an existing enrichment plant or
- Construction and use of a clandestine enrichment plant

In Germany, there exists one centrifuge enrichment plant at Gronau which produces low-enriched uranium (less than 5 percent enrichment) for LWR fuel. The facility is owned and run by URENCO, a trinational consortium with British, Dutch, and German participation. Besides the Gronau plant, URENCO is running other enrichment plants in Capenhurst (Great Britain) and Almelo (Netherlands).

Misuse of an Existing Enrichment Plant

A misuse of the Gronau enrichment plant to produce high-enriched uranium, which may in principle be technically feasible, would require major and time-consuming reconstruction of the cascades arrangement. To switch to high enrichment would also require major changes in the handling procedures, e. g. for safety or criticality reasons. Since the plant is subjected to IAEA safeguards, such a change in design and product would inevitably be detected by the safeguards measures applied. This purely technical view is the only way considered in the acquisition path analysis.

But there exist additional proliferation barriers which might be much stronger than the IAEA's technical safeguards measures against a potential misuse of the plant. How could a state, here Germany, obtain complete control over the plant which would be a prerequisite to use it for proliferation purposes?

The technical and the managerial staff consists of members of all three nations owning the plant. As Gronau is just one of the three similar plants run by the same company, a regular exchange of staff and material between the plants takes place. Staff members of the sister plants would immediately recognize any changes in the cascade arrangements or handling procedures.

The same holds for the commercial procedures. The plants have long-term contracts and commitments to deliver product to their clients. How could this be handled without most of the commercial staff knowing or without raising massive mistrust? How could a misuse of one facility be managed and kept secret without involving the management and the technical personnel of the complete trinational enterprise? The plants are also subjected to close supervision by the respective national boards of control of the three countries. How could a misuse be disguised from them? In consequence, a proliferation would require collusion among the three states, one of which is a nuclear-weapon state.

Considering this specific situation, it can obviously be stated that a misuse of the existing enrichment plant for proliferation purposes would be impossible even when no IAEA safeguards measures where carried out.

These nontechnical aspects resulting from the multinational ownership of the plant are completely ignored by the current acquisition-paths model. The principle deficiency of this type of evaluation is to only look for indicators or possibilities of noncompliance with the safeguards obligation and to completely neglect indicators or arguments that support compliance. Besides the fact that this way of evaluation deprives compliant parties of the opportunity to convincingly demonstrate their compliance with the nonproliferation goal, the Agency will miss the identification of opportunities to increase efficiency without compromising effectiveness in the situation of short resources.

Construction of a Clandestine Enrichment Plant

The second possibility to acquire high-enriched uranium would be the construction of a clandestine enrichment plant. One scenario could be to mirror the existing plant in a clandestine facility and thus reduce R&D and engineering work to a minimum.

If such an undertaking is conducted in the form of a private enterprise, the erection and operation of the plant has to follow the usual procedures and regulations to avoid attracting unnecessary attention. First of all, the facility needs a credible cover story to disguise its real purpose. Depending on the type of story chosen and due to the federal structure of the German political system, several different and independent levels of government and supervisory authorities have to be involved over the lifetime of the plant, e.g. to get the licenses to construct and run the facility, to pass the environmental impact assessment, to show compliance with the occupational health and safety regulations, to show compliance with imposed environmental obligations, with handling and transport obligations for dangerous goods, etc. The observance of most of these regulations is monitored on a regular or random basis. Especially in the case of any type of accident, detailed investigations will be carried out at the plant. The operation of the plant will thus not be possible without initiating at least some of the authorities on the real purpose of the facility.

If the story involves the handling of nuclear material, the number of authorities to be involved will increase considerably. This includes EURATOM with regular inspections and verification activities. In this case, the facility will also face great public interest and strong opposition from civic groups. If the story does not involve nuclear material, it is very difficult to explain the necessary precautions for handling and transport of the high-enriched product.

The next hurdle is the acquisition of the necessary equipment and personnel. The centrifuges are composed of many different parts delivered by different manufactures from different countries and assembled in the enrichment facility. Each centrifuge assembled in one of the URENCO enrichment facilities leaves a characteristic sequence of records in the, at present still voluntary, reporting scheme of the IAEA for special equipment and dual use goods which will become mandatory with the entry into force of the Additional Protocol. An in-country production of all necessary components would require building additional clandestine manufacturing capabilities with lots of additional imponderables.

The circumstances described here are only a small part of the necessary actions to be planned and carried out clandestinely, e.g. the issues of acquisition of uranium feed material, of financing, logistics, and communication, and decision-making bodies are still neglected. But even in this simple scenario, many people have to be involved, have to be constantly motivated to perform deliberately illegal actions, and to maintain strict secrecy over years.

An alternative could be to locate the clandestine enrichment facility within a military environment and thus avoid or facilitate the necessary interactions with some of the civil supervisory authorities. But this would only make sense if the state really has full and exclusive sovereignty over this military sector and military sites. In the case of Germany, with its close relationship with the North Atlantic Treaty Organization (NATO), and the presence of military reconnaissance planes and stations and other military facilities of allied forces within Germany, such a procedure wouldn't be able to remain undetected. It is not imaginable to perform construction and operation of such a plant together with the associated logistics and communication activities directly under the eyes and ears and in physical presence of foreign military forces in the immediate area without being detected.

Above all, the state must be aware of the fact that within its boundaries is URENCO, a competent and independent observer which closely watches the market and will recognize immediately an increased demand for the expertise, personnel, or raw materials needed for the manufacture of the gas centrifuges, such as special steel alloys and other components.

This example shows how much the feasibility and success of such a proliferation attempt depends on the specific situation in the state concerned and its political and social culture and infrastructure. These are parameters which could be influenced by the behavior of the state. If a state sets the boundary conditions in such a way to willingly increase its risk of early detection in the case of a proliferation attempt, this too is an active demonstration of compliance with its nonproliferation commitment and should increase the credibility assigned to this commitment by the IAEA.

Possible Acquisition Paths for Plutonium

The second acquisition route to obtain weapon usable material is the Plutonium path. The acquisition-path approach considers the following three generic paths to acquire material:

- Diversion of existing plutonium
- Misuse of an existing plant to separate PU, or
- Construction of a clandestine plant to separate PU

Until 1994, the fuel-cycle policy in Germany was based on reprocessing spent fuel. The reprocessing of nuclear fuel from Germany is exclusively done in France and the United Kingdom, as there are no more industrial or research reprocessing activities in Germany. A project for a reprocessing plant at Wackersdorf was abandoned in 1988. The former pilot reprocessing plant WAK at Karlsruhe was shutdown in 1990, and all components necessary for reprocessing (dissolver, mixer-settler batteries etc.) have been dismantled.

The existing plutonium stockpile resulting from the reprocessed fuel is subjected to IAEA safeguards. Since no reprocessing facilities exist in Germany, the misuse of an existing facility can be excluded. The only remaining path would be the construction of a clandestine plant. Here in principle the same considerations apply as do for a clandestine enrichment plant. However, due to the complexity of a reprocessing facility, there is an even higher risk of early detection, in particular since it can be practically excluded that advantage can be taken of a military installation as a shelter to protect the secrecy.

Additional Indicators

But the acquisition of direct-use nuclear material is just one step in the complete chain of proliferation. In addition to the acquisition of ready-to-use nuclear material, a proliferator needs to develop ignition technology for nuclear weapons. The production of an ignition system will require considerable R&D activities and the procurement of special equipment. The indicators associated with those activities could be detected.

Depending on the specific state, there may exist a range of other indicators that could set off an alarm in the case of an attempted proliferation, but could on the other hand support the credibility of compliance if they were not triggered. A survey of those indicators together with a detailed description of how they could be used to identify clandestine, undeclared nuclear (weapons) programs in a timely manner is given in Reference 1. The following list of characteristics that could serve as a sensor to set off an alarm in the course of an attempted proliferation is extracted from this paper:

- parliamentary control of the military and secret services with the participation of the opposition
- audit offices (GAO) with comprehensive opportunities of access (not necessarily associated with sanction power) for all relevant offices
- cooperation with international safeguards authorities (IAEA)
- constitutional state/prosecution of infringements of the law
- openness of government decisions
- independent licensing and supervisory authorities
- open research community in the nuclear research sector
- investigative, professional journalism
- independent worker/employee associations in the respective sectors
- effective foreign trade statistics (without any gaps) publicly accessible
- open company reports/statements (no sectors with exceptions)

As an example, one of the listed indicators is the existence of parliamentary control of the military and secret services with the participation of the opposition. The idea is that the government is not able to conceal large projects from an opposition invested with control responsibilities if this opposition pursues their task seriously and competently. It is assumed here that the parliamentary opposition would make public illegal activities by the government or any other government authority or would make this the subject of fact-finding committees.

Those characteristics or indicators could increase the risk of early detection or, if not triggered, support the credibility of compliance. A broad-based information analysis should involve and evaluate also those indicators and use them in both ways—to check for indications of noncompliance as well as to recognize them as a support for the credibility of compliance if they are not triggered.

Conclusions

In the expectation of most of the member states that negotiated the Protocol in Committee 24, the Additional Protocol and the SSS are, despite their names, not simple add-ons to traditional safeguards. The intention rather was to establish the basis allowing for a fundamental shift in the way NPT safeguards are implemented and to focus verification activities more effectively on areas of real concern.

To meet these expectations, the Agency, in implementing the SSS, must fundamentally revise the way it verifies compliance of member states with their NPT obligations. It must shift away from the current formal and mechanistic rules to a flexible and qualitative verification policy. This will affect the way the Agency collects and analyses information, and draws conclusions about states' compliance. A really broad-based information analysis can in many cases give a sound basis to judge a state's compliance or noncompliance with its nonproliferation commitment.

As shown in the example given, the degree to which all actions necessary to conduct proliferation could be performed in a completely secret way is strongly influenced by the characteristics of the national fuel cycle and the state's political and social infrastructure. As a principle, a broad-based information analysis should not only look for indicators or possibilities of noncompliance with the safeguards obligation but also for indicators or arguments that support a state's compliance. While it is true that the absence of any indicator for proliferation activities in an open society cannot definitely prove the absence of such activities, it can clearly endorse the credibility of the state's declaration.

If all available information fits together into a consistent and transparent picture and the Agency is able to draw a credible conclusion of the absence of undeclared nuclear material and activities in the state, this will allow the concentration of Agency inspection activities on proliferation sensitive key technologies like enrichment and reprocessing. The Agency then should concentrate on what is truly essential and not divert attention and resources away from its priority objectives. Reinforced Agency inspection activities would be triggered by an inconsistency detected in the information analysis or by the need to better understand an element of the country's fuel cycle.

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Progress Toward the Establishment of Integrated Safeguards in Japan

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Abstract

Japan considers the strengthening of international and regional/national safeguards vital for improving the global nonproliferation regime. Japan has been actively involved in promoting the program for strengthening and streamlining IAEA safeguards both within the framework of INFCIRC/153 and through measures under the Additional Protocol (AP). Being one of the first countries with an extensive peaceful nuclear fuel-cycle program, Japan ratified the AP between Japan and the Agency on December 16, 1999, which is also the date of the AP's entry into force (EIF). The initial declaration required under its Article 2 was made in June 2000, providing the Agency with a vast amount of information including those related to 4,885 buildings on 151 sites.

For the sake of early realization of integrated safeguards (IS), the Japanese government has established an expert study group to develop IS. It is actively reviewing such topics as the development of new safeguards theory and technologies, the role of SSACs under IS and re-examination of safeguards criteria. Concrete measures for strengthening and streamlining safeguards are being reviewed and proposed, including the application of SNRI to the entire LEU fuel cycle in Japan. It is recognized that, in the review of streamlining IAEA safeguards, a priority should be given to those related to nuclear materials of lower nuclear-proliferation risk, such as low-enriched uranium and irradiated direct-use material. The outcome of the study group's deliberations is being presented at such international forums as the IAEA's Technical Coordination Meeting for IS.

Japan continues to make every effort to contribute toward the establishment of IS. This paper summarizes Japan's effort as well as the lessons learned so far.

Introduction: Japanese Initiative

Japan considers the strengthening of international and regional/national safeguards vital for improving the global nonproliferation regime. Japan has been actively involved in promoting the program for strengthening and streamlining IAEA safeguards both within the framework of INFCIRC/153 and through measures under the Additional Protocol (AP). [1,2]

Japan played a key role in developing and negotiating the Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards (INFCIRC/540) through active participation in the special committee deliberations under the IAEA Board of Governors. From the very beginning, Japan has advocated universal adherence to the AP, both by the nuclear weapon states (NWSs) and the nonnuclear weapon states (NNWSs). Japan is the first to ratify the AP among those countries with a fully developed fuel cycle. Japan has also promoted the idea of streamlining safeguards activities under INFCIRC/153 with the implementation of those measures under INFCIRC/540 to provide an increased level of assurance with regard to the absence of undeclared nuclear materials/activities. Accordingly, Japan has initiated a range of actions to assist the Agency and accelerate the development of integrated safeguards, namely the optimal combination of all safeguards measures available to the IAEA under comprehensive safeguards agreements and APs that achieve the maximum effectiveness and efficiency within available resources. These actions include:

(1) A series of AP implementation trials carried out at two representative Japanese nuclear research centers, i.e. Tokai Research Establishment of Japan Atomic Energy Research Institute (JAERI) and Oarai Engineering Center of Japan Nuclear Fuel Cycle Development Institute (JNC).

These trials were conducted in cooperation with the IAEA Secretariat before the EIF of the AP between Japan and the Agency on December 16, 1999, (for details, see Section 3 (2) below); [3]

(2) In anticipation of closer cooperation between Japan's SSAC and the IAEA, Japan strengthened its SSAC by designating the Nuclear Material Control Center (NMCC) as the official entity to perform national safeguards inspections on behalf of the Japanese government. This provides an organizational basis for maintaining a cadre of experienced inspectors;

(3) Japanese safeguards experts have been actively involved in making positive contributions to the IAEA Secretariat's efforts in developing IS proposals, for example, through their participation in the meetings of the Group of Experts on IS and the Standing Advisory Group on Safeguards Implementation (SAGSI). Also Japan's Support Program for Agency Safeguards (JASPAS) has several ongoing tasks dealing with IS concepts; and

(4) The Japanese government has established a technical committee to advise the government on safeguards issues, including the establishment of IS. The experts of the committee and its working groups are specifically addressing the following points:

- Review of new concepts, theories and advanced technologies for IS;
- Review of the role of SSACs under IS; and
- Review of safeguards criteria under IS.

Underlying Principles for Developing Integrated Safeguards

Among the NNWSs in the world, Japan has one of the most advanced nuclear-fuel cycles and is the only state proceeding with a program of plutonium recycling. Japan is fully aware of the safeguards requirements for commercial-size enrichment and reprocessing facilities and those associated with the manufacture and utilization of MOX fuels. Under the current INFCIRC/153 regime, the total Agency inspection efforts in Japan amounted to some 2,000 person-days for 1999. It is expected that once IS is established and implemented, current safeguards efforts would be rationalized. It is extremely important, therefore, for Japan to develop its own practical ideas of IS in order to optimize the safeguards implementation and make practical proposals to the Agency. This work is currently proceeding on the basis of the following underlying principles:

- INFCIRC/153 and INFCIRC/540 are to be treated not as a set of separate documents but in their totality. Safeguards measures provided in respective documents should not be simply superimposed but streamlined to constitute a single unified safeguards system;
- Once the conclusions of the nondiversion of declared nuclear material and of the absence of undeclared nuclear material and activities can be drawn, the implementation of IS can proceed;
- When a conclusion is drawn by the Agency on the absence of undeclared nuclear material/activities in a state, particularly for activities related to enrichment and reprocessing, it would allow the reduction of current safeguards implementation parameters (e.g. timeliness, detection probabilities) as appropriate, with corresponding reductions from the current level of safeguards verification efforts on such declared nuclear materials;
- When the Agency is not able to maintain the level of assurance on the absence of undeclared nuclear materials/activities for the state, corrective actions, including the restoration of traditional safeguards activities, may have to be taken while continuing to implement the measures of the AP; and
- Increased cooperation between the IAEA and SSACs has long been recognized as a step toward more effective and efficient safeguards on declared nuclear material. The advent of IS provides an opportunity to address the issue of increased cooperation between the IAEA and SSACs from new perspectives with a different distribution of respective responsibilities.

Activities for the Implementation of the Additional Protocol

Ratification and successful implementation of an AP is one of the prerequisites for a state to enjoy the benefits of IS. Japan has been taking necessary steps to meet this requirement. The relevant law and regulations have been revised to accommodate the requirements of the AP, *inter alia* to collect and provide necessary information to the Agency on Annex I activities that is required under Article 2.a. (iv) of the AP as well as to facilitate complementary access by the Agency to relevant places or locations as proscribed in Article 2 of the AP.

1. Initial Declaration Based on the Additional Protocol

Immediately after the EIF of the AP between Japan and the Agency, the Japanese government organized two sessions of detailed briefings to nuclear-facility operators and other related organizations in Japan, such as manufacturers of nuclear equipment/components. They comprise a part of the infrastructure of Japan's nuclear industry and information on their activities is to be declared to the Agency under Article 2 of the AP.

These briefings were essential for the initial expanded declaration to be submitted to the Agency within the time limit set out in the AP, i.e. 180 days after its EIF. Most of the required information was collected by the beginning of March 2000. The information, originally submitted in Japanese to the government, had to be translated into English. Japan's initial declaration report, including expanded information on 151 nuclear sites containing 4,885 buildings, was made to the Agency, on time, in June 2000.

This provided the Agency with the complete picture of nuclear activities that have taken place in Japan.

The following points were noted with regard to this experience of Japan's initial declaration:

- The names of facilities and buildings are originally in Japanese and normally they do not have equivalent English names. As various organizational units are involved in the preparation of the initial declaration of a site, it is often difficult to keep consistency in the English translation of the name of a particular facility. This led to the need for further clarification and inquiry by the Agency. Things are more complicated owing to the large volume of information involved with the Japanese declaration.
- The Agency seems to fully utilize its own information obtained from open sources in order to check the completeness and correctness of the initial declaration, for example, referring to some activities of which even the Japanese authorities have no knowledge. Further, satellite imagery was effectively used by the Agency to confirm the initial declaration with regard to the buildings on a site.
- In August 1997, the Agency prepared guidelines and format for the preparation and submission of the expanded declaration. In anticipation of the preparation for Japan's declaration, the Japanese authorities and facility operators reviewed these guidelines and format. The review revealed the need for further elaboration to increase their clarity and usefulness. Accordingly, substantive comments were made to the Agency. It is hoped that they will be revised in a timely manner to reflect these practical comments.

Japan's initial declaration is currently being evaluated by the IAEA. It is the strong wish of the Japanese government that the Agency will complete its evaluation of the initial declaration and make the State Evaluation of Japan based on their activities under the AP at an early date.

2. Implementation Trials

It was recognized that implementation of the AP involved brand new activities to be carried out by states and the IAEA that require new procedures, guidelines, and training. At the IAEA Board of Governors meeting in December 1997, the Japanese representatives announced their intention to propose to the IAEA an implementation trial of AP-related activities at a nuclear site in Japan.

In March 1998, preliminary discussions were held between the Japanese authorities and the IAEA on the AP and related subsidiary arrangements. During those discussions, it was noted by the government of Japan that there were several aspects of implementation of the AP for which there was no experience, making it difficult to prepare for implementation. It was therefore suggested that the IAEA and the Japanese government jointly conduct implementation trials of some of the measures contained in the Model AP. This included 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.

Two large nuclear R&D sites were selected by Japanese authorities and proposed to the IAEA for the trials to be conducted: JAERI Tokai Research Establishment and JNC Oarai Engineering Center. These sites were selected in view of their respective uniqueness. The Tokai Research Establishment has the following characteristics:

- A wide range of basic research related to the nuclear

Table 1. Complementary Access Conducted under Additional Protocol (as of mid-March 2001)

Date	Site	Location	Advance Notice
Nov. 29, 2000	Ningyo-toge Environmental Engineering Center	Uranium recovery system building	2 hours notice
Nov. 30, 2000	Toakai Works	Storehouse of shipping casks	24 hours notice
Dec. 13, 2000	Tokyo Electric Power Co. Fukushima #1 NPS	Waste treatment building for unit	22 hours notice
March 1, 2001	Japan Atomic Power Co, Tokai NPS	Several buildings.	24 hours notice
March 2, 2001	Tokyo Electric Power Co. Fukushima #1 NPS	Site Banker	24 hours notice
March 12, 2001	Japan Atomic Energy Research Institute	JRR-3 Mockup	2 hours notice

fuel cycle is conducted there;

- It has a research history of more than forty years, with some research having been terminated;
- Most of its research involves nuclear materials;
- More than 300 buildings are located in a vast site.

The JNC Oarai Engineering Center has the following characteristics:

- It is engaged in research related to FBRs;
- In many buildings there, the research does not use nuclear materials, only sodium;
- The site boundary needs careful attention because it borders another nuclear research center, JAERI Oarai Research Establishment.

It was recognized that such experience could contribute to the development of infrastructures within Japan and within the IAEA necessary for successful implementation of the AP, particularly in a state with a large nuclear program.

The trials were intended to provide valuable experience:

- To facility operators in assembling the information required for Article 2 declarations, developing logistics and procedures for CA on sites, and identifying the need for, and making arrangements for, MA;
- To state authorities in compiling Article 2 declarations, implementation of CA, and identifying the need for, and making arrangements for, MA; and
- To the IAEA in reviewing declarations, preparing for and conducting CA, including making arrangements for and conducting MA, and the documentation and follow-up of CA activities.

Through the trials, the following lessons were learned:

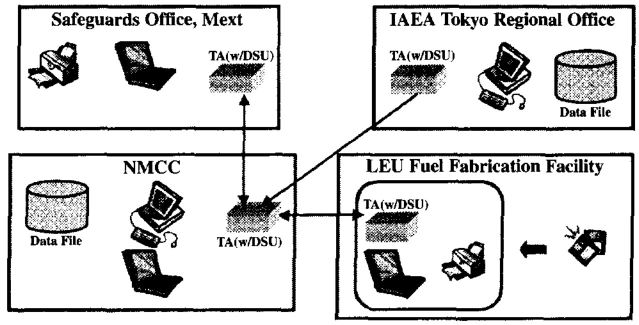
- In order to conduct MA smoothly, it was necessary to clarify in advance the objectives and the procedures involved among the parties concerned, i.e. the government, the Agency, and the operator.
- In some cases in the future, the operator of the facility where CA is to be conducted might not be familiar with the IAEA verification activities because the operator's activities do not involve nuclear materials and thus they are not under the INFCIRC/153 safeguards regime. It is strongly recommended that the government inform such an operator of the expected activities of the Agency in detail for them to understand fully and be well prepared.

3. Implementation of Complementary Access

By the middle of March 2001, six cases of CA were implemented by the Agency since its receipt of Japan's Article 2 declaration, as outlined in Table 1. Each complementary access was implemented to confirm the absence of undeclared nuclear material and activities by means of visual observation, NDA measurements and the collection of environmental samples. So far, no MA has been conducted in conjunction with these cases.

When a CA was conducted independently from a routine inspection of a site, a twenty-four hour advance notice was given, while a two-hour advance notice was given in the case of CAs in conjunction with a routine inspection of a site. The former caused some administrative problems because the national requirement for a state representative to accompany such CAs. It was felt extremely difficult to meet this requirement especially when a remote site was selected.

Figure 1. Outline of the Remote Data Transmission System



TA (w/DSU): Terminal Adapter with Data Storage Unit

Candidate Approaches of Integrated Safeguards

The deliberations of the technical committee and its working groups mentioned above, as a matter of priority, focus on the development of optimized safeguards approaches for less sensitive materials. The approaches considered also include Part 1 measures for strengthened and more efficient safeguards.

The followings are some examples of candidate approaches contemplated for LEU fuel-cycle facilities in Japan under an IS regime, intended to meet overall cost performance requirements while maintaining safeguards effectiveness. [4]

1. Unannounced Inspection

Implementation of unannounced or short-notice random inspections (SNRI) for LEU fuel-fabrication facilities and light-water reactors (LWRs) without MOX are considered in connection with a remote data transmission capability. A key element is that the IAEA have near-real-time information on nuclear material transfer and facility operation with the use of the remote data transmission system as shown in Figure 1.

At present, SNRIs are carried out at all Japanese LEU fuel-fabrication facilities using a mailbox system. However, the Inspectorate is able to access the total population of nuclear materials of the strata concerned that is required for verification only when inspectors visit a facility and open the mailbox. On the other hand, with a remote data transmission capability, a mailbox is located at the Inspectorate. This allows the timely provision of information on the total population of nuclear materials accessible for verification and can result in increased verification coverage with fewer total inspections in the field.

2. LWRs without MOX
Based on the Agency's proposal of the IS approach for LWRs without MOX, the proposed verification activities including unannounced inspections are being studied by the Japanese government in consultation with the Federation of Electric Power Companies. It is hoped that by mid-2001, acceptable conditions will be delineated that will accommodate the domestic legal requirement that SSAC personnel should accompany IAEA inspectors during the conduct of inspection activities.

3. LEU Fuel Fabrication Facility
A data transmission test using a remote data transmission system for the SNRI mailbox is being carried out. Plans are for the remote data transmission system to be installed and to be fully utilized at all LEU fuel-fabrication facilities by the end of 2001.

Application of the mailbox scheme to LWRs is also under consideration. The resulting fuel-assembly transfer tracking system will improve the transparency of LEU fuel-cycle activities. Further, currently under consideration is the possibility of eliminating borrowing inspections at LEU fuel-fabrication facilities by means of additional mailbox declarations of intermediate products (fuel pellet production) in a manner so that all the material concerned for borrowing scenarios is subject to verification during an SNRI.

4. Near-real-time Fuel Assembly Tracking System
The timely identification of the location of a fresh fuel assembly by its unique batch identification number (fuel assembly ID) provides a link to discrete accountancy data that was verified at the fuel-fabrication facility and will improve transparency of the entire LEU fuel-cycle process. The fuel assembly tracking system can be created through the adoption of the above mentioned remote data transmission system.

5. LEU Fuel-Cycle Oriented Approach
It is clear that a zone approach can contribute to a significant reduction of inspection activities for facilities within the zone by eliminating the requirement of verifying material transfers within the zone. However, the requirement for simultaneous PIVs to confirm that there has been no borrowing to conceal diversion is not practically feasible in Japan, as the zone would contain more than forty facilities. However the need to carry out simultaneous PIVs to detect borrowing might be met through unannounced inspections covering all facilities in the zone.

Therefore, a new concept of a zone or fuel-cycle-oriented approach covering the the entire LEU-fuel cycle is promising. A further optimization of the LEU fuel-cycle safeguards approach involving random selection of a facility (or facilities) for inspection rather than selection of individual material strata within the facility is also possible when all LEU-cycle facilities come under an unannounced inspection regime.

6. Maintaining a Quality-assurance System of SSACs
The effectiveness and competence of an SSAC primarily determines if the Agency can delegate some activities to the SSAC under an IS regime. In order to assure an effective and competent SSAC, a quality assurance program for both the SSAC and facility operator's material control and accountancy is needed. In particular, an internal audit (or self diagnostic) function is essential for attaining the continuous assurance of the technical performance of the SSAC. This quality assurance system will improve the function and the credibility of nuclear material control and accounting systems at the facility level. It will also improve the quality of the independent conclusions required of the SSAC.

Tasks Ahead
With regard to the development and the implementation of IS, some issues remain to be addressed:

- *Universal Application:* From the very beginning, Japan has advocated universal adherence to the AP, both by the NWSs and the NNWSs. As of March 8, 2001, fifty-four states have signed the AP and, among them, eighteen states have their respective APs in force. However, all of them are NNWSs and most of them do not have a substantial nuclear program. Although all the NWSs have signed the AP, none have ratified their AP. There is a need to accelerate the early ratification of the AP by all the states, especially those with a large nuclear program.
- *Burden to Facility Operators:* IS is intended to streamline the Agency's verification activities and reduce its resource requirement, but not necessarily the activities and resources of the state authority and the facility operators. The proposed IS approach for the LEU fuel-fabrication facilities in Japan is deemed to increase the financial and administrative burden of the operators due to the extra work associated with timely updating of the necessary operation data through a remote data transmission system. The question remains who pays the cost of installing and maintaining such a system.
- *Disincentives to States:* The IS approach for LWRs without MOX fuels has been proposed by the Agency and is currently under review by the Agency and Japanese authorities. One of the possible alternatives to the Agency's Base Proposal is to install permanently an optical surveillance system operating in overwriting regime at a LWR site. The question is again who pays the cost of installing and maintaining such a system. One argument is that if the state opts for the deviation from the Agency's Base Proposal,

then the associated costs should be borne by the state. If this is the case, this increases the financial burden of the state and serves as a disincentive for a state to conclude the AP.

- *Expanded Use of Remote Data Transmission:* In devising a candidate IS approach for sensitive nuclear materials such as unirradiated direct-use materials, consideration could be made on the possibility of enhanced use of a remote data transmission system to cover not only optical surveillance data, as in the case of remote monitoring at present, but also additional data such as those from process flow monitors or NDA equipment in order to constitute an unattended verification system. It goes without saying that the decision on whether or not to adopt such an approach should be made based on the overall evaluation of cost-benefit analysis of such a system.

Summary

Since the start of the discussion of Program 93+2, Japan has made a significant contribution to strengthening and improving the efficiency of IAEA safeguards. This includes the implementation of Part 1 measures, such as early provision of design information and facilitating environmental sampling for obtaining baseline data, closer cooperation with IAEA to gain practical experience in the implementation of AP measures prior to its entry-into-force, and extensive efforts by the Japanese government to bring Japan's AP into force at the earliest date despite its enormous number of nuclear activities involved.[2]

Japan has also been strengthening its SSAC capabilities, including the designation of NMCC as the official entity to perform national safeguards inspections on behalf of the Japanese government. The enhancement of the function of the Safeguard Analytical Laboratory operated by NMCC in Tokai, and acquiring its own environmental sampling capability through the construction and the operation of a clean laboratory at JAERI Tokai are other ways that Japan is strengthening its SSAC capabilities.

While many missions remain to be completed, Japan is committed to cooperate with the Agency and other member states for the earlier establishment and implementation of IS.

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A Step-by-step Approach to Nuclear Confidence-building Measures in the East Asian Region with Integrated Safeguards

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Abstract

This paper describes a step-by-step institutional arrangement in nuclear confidence building coincident with the onset of the IAEA's integrated safeguards. Specific relevance is given to the East Asian region where the promotion of peaceful uses of nuclear energy is most active in the form of nuclear electricity and radioisotope applications. It is prudent to recognize country-specific fuel-cycle-related proliferation issues which may be of concern to the neighboring states, e.g. verification of DPRK activities, Pu recycling in Japan, and rad-waste disposal in the ROK. These issues provide motivation for seeking enhanced cooperation in nuclear transparency through verification among the regional states entering into integrated safeguards with IAEA. Inherent to the concept of integrated safeguards is the enhanced cooperation with SSACs or RSACs as applicable.

One example is an enhanced cooperation with IAEA on LWRs without MOX in ROK before the Additional Protocol went into force. Increased cooperation in bilateral or multilateral schemes in the region in the area of nuclear control and verification could be implemented with increasing significance as mutual confidence is gained. Joint safeguards training courses, seminars and joint research projects could be formulated. Between Japan and ROK, these types of exercises are already taking place. A loose form of Association of Asian Safeguards Agencies (AASA) could be envisioned to promote such activities among states with good Integrated Safeguards standing with IAEA. This could lead to a more permanent institutional setup, such as a regional nonproliferation research center, as mutual confidence is increased further. Valuable lessons learned from EURATOM and ABACC experiences can enhance a long-term prospect for developing an Asian RSAC. Nuclear confidence building among neighboring states can only be achieved gradually and with perseverance. A longer-term scenario is presented based on what is being implemented in the region today, with strong motivation to adapt to the changing environment.

Introduction

Unlike Europe, there is no nonproliferation verification regime in Asia. This is partly due to the cultural and political diversity of the region and partly due to relatively late utilization of nuclear energy compared to Europe. For the last several decades, however, some countries in this region (Japan, Korea, and Taiwan, China) have taken advantage of nuclear energy for peaceful purposes, while others have not. Nowadays, these countries are showing interest in the peaceful use of nuclear energy as a substitute source for fossil energy. China, DPRK, and some southeastern countries are examples. As a consequence, Asia has become the region where nuclear activity is growing and thus the proliferation concerns increase. In 1993, proliferation concerns escalated until the Agreed Framework was signed by the United States and DPRK. There remained a regional concern about DPRK's commitment to the Agreed Framework and about the completion of the nuclear fuel-cycle technology in countries such as Japan.

IAEA spends one-third of its inspection efforts in this region every year. To maintain the effectiveness and efficiency of safeguards after the implementation of the Additional Protocol, IAEA might need to utilize individual SSACs since there is no regional system in East Asia. It is necessary to review the current situation in East Asia and other nonproliferation verification regimes in order to construct a confidence-building regime in a changing environment of the IAEA safeguards system due to the introduction of integrated safeguards.

Country-specific Issues in East Asia

In developing nuclear energy in this region, each nation has country-specific issues that could act as an obstacle to the full utilization of nuclear energy. Most of the arguments are not directly related to the power generation itself, but to the uncertainties in the back-end of the fuel cycle. Country-specific issues in this region would be:

- Japan has fifty power reactors in operation today supplying about one-third of its electricity. In addition, Japan has entire nuclear fuel-cycle facilities, including reprocessing plants for the separation of plutonium. Japanese policy on the utilization of plutonium either for fast-breeder reactor fuel or for MOX fuel in light-water reactors may draw concern from neighboring countries about excess stockpiling of separated plutonium in Japan.
- DPRK should meet the IAEA safeguards full compliance conditions before the delivery of the first key nuclear components to the LWR site under the Supply Agreement with KEDO (Korean Peninsula Energy Development Organization). IAEA announced that it needs at least two years to inspect nuclear facilities and materials in DPRK fully, which is a necessary condition for the full compliance with IAEA safeguards.
- China is one of the nuclear-weapon states in the NPT regime. However, China's ambitious nuclear-power development program is bound to bring its peaceful nuclear activities into more transparency.
- Taiwan operates six LWR-power reactors which deliver nearly 30 percent of its electricity. In order to resolve the rad-waste disposal issue, Taiwan attempted to transport its low-level rad-waste to the DPRK in 1997.
- Australia and Indonesia have concentrated on medical and industrial applications of nuclear energy. A 30 MW research reactor in Indonesia has been in operation since 1987. BAPETEN (Nuclear Energy Control Board of Indonesia), established in 1998, is a nondepartmental government agency controlling the operation of nuclear energy in Indonesia. The Australian Nuclear Science and Technology Organization (ANSTO) in Australia recently initiated construction of a 30 MW new research reactor to replace the HIFAR reactor. ANSTO maintains active participation in SSAC efforts as well as in global nonproliferation concerns.

Safeguards Program and Issues in ROK

ROK developed its power reactor strategy with a combination of PWR-type LWRs and CANDU-type OLRs during the past thirty years. Repeat construction of 1,000 Mwe PWRs known as KSNP (Korean standard nuclear-power plants) has proven successful with commercial operation of four KSNP units at Yonggwang and Ulchin. Additional construction of eight more KSNP units will be continued. Today, Korea has accumulated more than 4,500 tons of spent fuel from more than 100 reactor-years of sixteen nuclear-power plants in operation. New nuclear power plants will aggravate the situation. In addition, ROK is developing proliferation-resistant fuel-cycle (PRFC) technologies such as DUPIC (Direct Use of PWR spent fuel in CANDU) to reduce the burden from the accumulated spent fuels. The Declaration for Denuclearization in the Korean Peninsula (1992) specifically waives reprocessing and enrichment facilities. ROK's current policy on spent-fuel management is wait and see, perhaps until the declaration is revised between the two Koreas. The Technology Center for Nuclear Control (TCNC) under MOST provides the full range of technical support in conducting national safeguards inspections in parallel with IAEA (about 350 PDIs/year). ROK signed the Additional Protocol in 1998 and now is preparing domestic procedures for the entry into force of the Protocol. The Atomic Energy Act was already amended to accommodate this protocol and regulations will be amended as required by the middle of July 2001. The Additional Protocol is expected to enter into force in early 2002, after the ratification process by the National Assembly at the end of 2001.

1. Enhanced Cooperation for LWRs

During the Eighth IAEA-ROK Joint Review Meeting on Safeguards Implementation in 1999, IAEA and ROK agreed to seek a new scheme applicable to the LWRs taking advantage of local SSAC expertise as well as ongoing digital surveillance camera upgrades. This is known as Enhanced Cooperation between IAEA and Korean SSAC or a single state, before the implementation of the Additional Protocol in Korea. The main objective of the Enhanced Cooperation is to save IAEA resources without sacrificing the effectiveness of the safeguards system. Both sides are developing the enhanced-cooperation scheme with C/S working in remote data transfer, and utilization of the SSAC for interim inspections.

Enhanced cooperation does not mean simply application of the new technology and sharing inspection effort in the facility, but it also includes the sharing of data and instruments necessary for the implementation of IAEA safeguards.

Currently, all of the C/S equipment at LWRs in Korea is being upgraded to digital by 2001 and a central hub station was established at the TCNC/KAERI site. Along with the hardware setup for the enhanced cooperation, software-oriented rehearsal for the enhanced-cooperation campaign has been performed since November 2000, which includes training for inspectors and operators. Enhanced cooperation is expected to enter into force after the signature of a Memorandum of Understanding between IAEA and ROK in the second half of 2001.

2. Issues Associated with KEDO LWR Construction

After experiencing many years of delays since the creation of KEDO in 1995, the construction project finally started to move in 2000 with all supply contracts entering into force. While the design, engineering, and manufacturing activities are in full gear at various Korean nuclear industries at present, the site construction is expected to reach a highly visible milestone with the excavation work on the reactor building beginning by the end of this year. The safety-review process is underway in order to meet the target of issuance of the construction permit. Barring any unforeseen circumstances, the first key component (which is interpreted as the reactor vessel for unit 1) is scheduled for site installation by the end of 2004. In order for this to happen, however, the Agreed Framework has stipulated that IAEA must complete its verification activities to show the correctness and completeness of DPRK's initial declarations.

Integrated Safeguards in East Asia

The role of IAEA is expected to change fundamentally with the new roles derived from the Additional Protocol (INFCIRC/540) in addition to the existing comprehensive-safeguards agreements (INFCIRC/153). Achieving long-term cost-neutrality through efficiency gains of the integrated safeguards is the overriding concern.

1. Conventional Safeguards Agreements

The IAEA full-scope safeguards system is already applied to all nuclear facilities in the region while DPRK is in a status of noncompliance with its IAEA safeguards agreement since the failure of ad hoc inspection at Yongbyun in 1993. China, as one of the weapon states, is voluntarily accepting facility-based safeguards.

2. Additional Protocol

Since 1997, five countries in this region have signed the Additional Protocol with the IAEA. Among them, Australia, Japan, Indonesia, and Taiwan, China have had the Additional Protocol enter into force. It is expected that Korea will ratify the Additional Protocol at the end of 2001. China has signed the Additional Protocol, while the DPRK remains uncertain on the Additional Protocol yet. This status is summarized in Table 1.

3. Application of Integrated Safeguards

The main purpose of integrated safeguards is to implement the IAEA safeguards system required by the conventional safeguards agreement and the Additional Protocol in optimal combination, in a manner which will promote confidence among nations in the region. IAEA is in the process of finalizing the integrated safeguards approaches for various facility types, starting with LWRs without MOX. Other facility types; I.e. research reactor and critical assemblies (RRCA), spent fuel storage facilities (SFSF), LEU fuel-fabrication facilities and onload reactors (OLR), are being investigated to define suitable integrated safeguards approaches by the end of 2001. Remaining bulk-type direct-use material facilities; i.e. reprocessing, enrichment, and MOX fabrication facilities, will remain with the traditional safeguards approaches.

4. Cost Neutrality

It is clear that additional resources are necessary for the implementation of the Additional Protocol to maintain the effectiveness and efficiency of IAEA safeguards in the integrated safeguards system. IAEA is giving consideration to the reduction of conventional safeguards efforts by extending the deadlines for less-sensitive facilities so that the resources saved could be used for implementation of the Additional Protocol. In this case, the role of the SSAC becomes crucial to maintain the current level of effectiveness of the conventional safeguards measures.

5. Role of SSAC(RSAC) in Integrated Safeguards

In order to maximize efficiency without losing effectiveness, a key element of implementing the Additional Protocol is making greater use of the SSAC (or RSAC) for integrated safeguards at facilities in a state (or group of states). The one-man, one-job concept in the new partnership approach (NPA) with EURATOM is a good example. Since there is no existing RSAC in Asia, enhanced SSAC cooperation may be applied in this region.

Towards a New Regional System

1. History

There have been a couple of significant proposals in the past for the confidence-building process among nuclear nations in this region, namely ASIATOM and PACATOM . The concept of ASIATOM was introduced by Atsuyuki Suzuki of the University of Tokyo in the early 1970s as an Asian equivalent of EURATOM, while PACATOM was later suggested by Robert Manning of the United States. However, because of geopolitical concerns they could not materialize without impending common bonds or compelling reasons.

The introduction of integrated safeguards at IAEA is creating new opportunities for the East Asian region as a number of countries are having their Additional Protocols enter into force; i.e. Australia, Japan, Indonesia, Taiwan, and ROK soon to follow. Upon the conclusion by IAEA that a state with INFCIRC/153 and540 has satisfied all prerequisite conditions (absence ofundeclared nuclear material and activities in a state) for integrated safeguards to be implemented, then the so-called angel state may be in a privileged position.

2. Japan/ROK Bilateral Safeguards Cooperation

Japan and Korea have instituted a national inspection regime in addition to their comprehensive safeguards agreements with IAEA. In 1995, NMCC (Nuclear Material Control Center) of Japan and TCNC (Technology Center for Nuclear Control) of Korea signed a cooperation agreement. As an outgrowth of this cooperation scheme, NMCC and TCNC have initiated an advanced inspector's training course with the help of IAEA. This is to raise both countries' safeguards inspectors to the level of IAEA inspectors by giving the courses in English to experienced national inspectors. By sharing the same inspection technologies, it may become useful to have closer collaboration, and possibly cross inspection activities on similar facilities in the future.

3. AASA (Asian Association of Safeguards Agencies)

After the Third INMM/ESARDA Workshop in Tokyo in November 2000, the experts from four countries (Australia, Indonesia, Japan, and Korea) in this region met and discussed a measure to enhance transparency and build confidence in states in this region.

The objectives of the AASA are to promote cooperation on safeguards, to enhance public understanding of nuclear nonproliferation, to assist IAEA activities and to seek common approach to safeguards issues.

The activities of the Association include meetings, discussions, exchanges of views, and seminars on matters of common interest. As opportunities arise, assisting member Agencies in facilitating staff *augmentation* and exchanges, participation in safeguards inspections and related activities, and training courses may take place.

AASA can be characterized as a loosely connected technical association among safeguards-related authorities in states in this region, specifically aimrd at confidence building in the field of utilization of nuclear energy in the East Asia.

4. Asian Nonproliferation Research Center (ANREC)

Asian Nonproliferation Research Center, or ANREC, was first proposed by the Study Group on Peaceful Uses of Nuclear Energy and Nonproliferation Action Plan towards 21st Century in Japan. ANREC is aiming at a nongovernmental, independent, international organization for research related to nonproliferation and transparency of a state in East Asia. The main function of this organization is to provide information and to analyze policy on nonproliferation issues.

5. Proposal for a New Regional System

In formulating a new confidence-building regional system through promoting nuclear transparency in the East Asian region, the following concepts need to be properly addressed:

- It is advisable that the new system is focused on the nonproliferation aspects of nuclear energy only in its beginning stage.

Table 1: Status of Additional Protocol in the Region (as of April, 2001)

Country	Board Approval	Signed	In Force
Japan	98-11-25	98-12-04	99-12-16
ROK	99-03-24	99-06-21	-
DPRK	-	-	-
China	98-11-25	98-12-31	-
Taiwan*			(98-08-10)
Indonesia	99-09-20	99-09-20	99-09-20
Australia	97-09-23	97-09-23	97-12-12

Taiwan, China*

- It is advisable that the main function of the new system is to complement the IAEA integrated-safeguards implementation.
- Establishing a strong SSAC in technology, manpower, and infrastructure is a prerequisite to any meaningful job-sharing with IAEA.
- For the establishment of the system for confidence building, a step-by-step approach may be helpful in the long run. While the system makes an effort to build confidence multilaterally, it is necessary to encourage the building of confidence between two nations and to take advantage of the result.

Conclusion

The Far East Asian region contains the highest density of nuclear power reactors and potential for future growth. IAEA safeguards efforts in the region is more than one-third of the world's total which is commensurate with the scale of nuclear energy utilization. The East Asian region is leading the world in bringing the Additional Protocol into force (Australia and Japan) as IAEA is undergoing fundamental changes with integrated safeguards.

Integrated safeguards on facility types is being formulated by IAEA starting with less-sensitive facilities; LWRs without MOX, research reactors, spent-fuel storage, LEU fabrication plants and OLRs. The recent approach to enhanced cooperation for LWRs in the ROK will offer efficiency gains in both IAEA and SSAC activities. The Asian Association of Safeguards Agencies and Asian Nonproliferation Research Center initiated by Japan could offer a starting point in regional confidence building. A step-by-step gradual approach to a RSAC in the East Asian region can be envisaged starting with common interests such as training, seminars, workshops, information exchange, and joint research projects.

As more SSACs in the East Asian region enter into state-specific integrated-safeguards approaches with IAEA, opportunities may arise for linking similar facility-type approaches in multiple states in the region, which could naturally evolve into a viable RSAC.

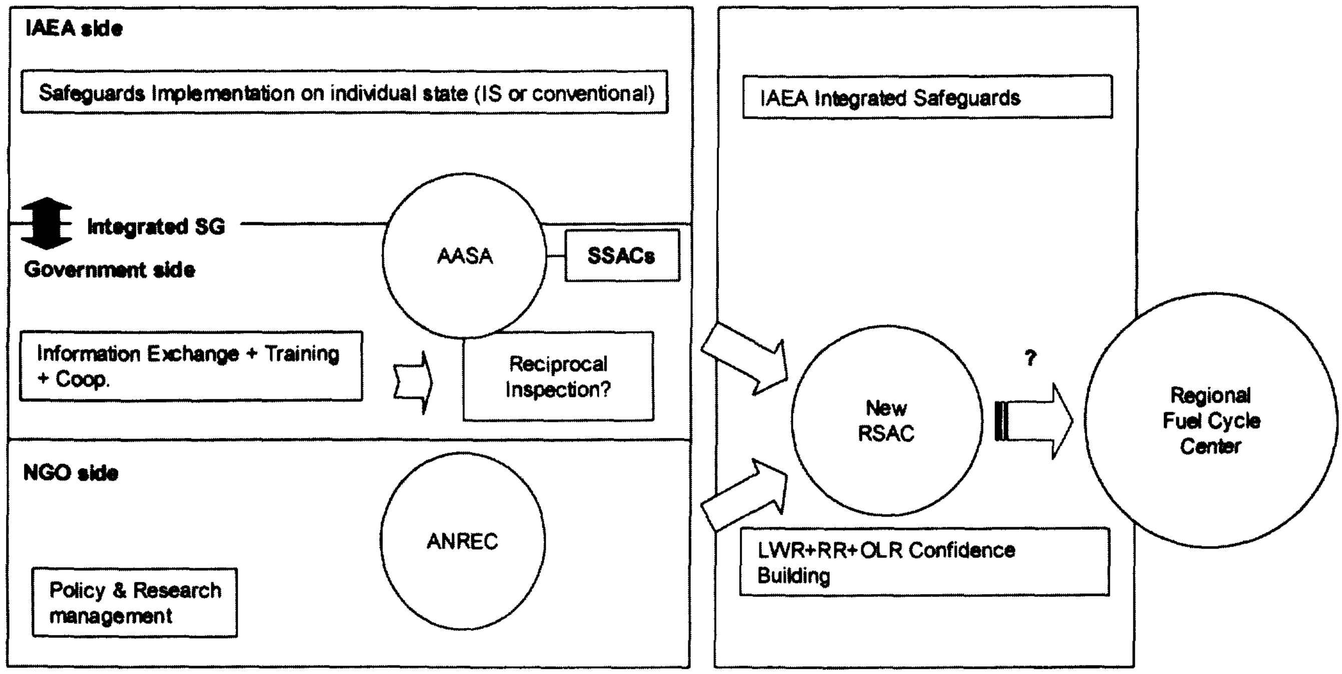

Figure 1. Schematic drawing for step-by-step approach for the regional system in the East Asia.

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Safeguards in Sweden: Challenges and Prospects

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Abstract

Sweden, together with the other European Union member states, signed the Additional Protocol on September 22, 1998. After that, each state started the process of adapting to the situation expected after ratification. Sweden had been intensely involved in many activities that were of major importance for the development of the Strengthened Safeguards System (SSS) and the Additional Protocol (AP).

This paper describes in short the nuclear history of Sweden and the development of the Swedish SSAC from its start in 1970 to the changes that are being finalized. During the early 1990s, Sweden took part in several tasks related to the 93+2 Program at the Agency. These tasks were mostly focused on testing different elements and activities to strengthen international safeguards. The result of these and other tasks performed by other member states of the Agency resulted in the SSS and the AP.

Sweden has an interesting nuclear history as it, from the start, had a two line nuclear program, civil and military. During the early 1960s, Sweden was very active in promoting nonproliferation work. The idea was that if there were an international agreement against nuclear proliferation, then Sweden would leave the option to develop nuclear weapons. After signing the NPT, Sweden has joined most international nonproliferation agreements and treaties. Since 1995, Sweden, as a new member of the EU, is part of a regional safeguards control system, Euratom, which also affects the safeguards activities in Sweden.

Swedish activities since signing the AP and ideas on how international and national safeguards can be carried out in Sweden in the future will be discussed in this paper.

1. Introduction

When discussions began within the IAEA in the early 1990s on strengthening the safeguards system, Sweden decided at an early stage to contribute by taking active part in different strengthening activities under the so-called Programme 93+2. This paper will describe the different tasks and activities that Sweden performed during this period. The activities in preparing for implementation of the Additional Protocol as well as ideas and expectations for future safeguards in Sweden will also be presented.

2. Background

Sweden developed its safeguards system around 1970 by setting the regulations and requirements for nuclear facilities and nuclear activities. That system was in principle working with only minor changes until 1995 when Sweden joined the European Union and thus also became part of the Euratom safeguards system. The IAEA has been performing inspection activities in Sweden since 1972, first on a trilateral basis covering only U.S.-obligated material. But since 1975, there has been full-scope safeguards on all nuclear material under Swedish jurisdiction.

As most of the Swedish facilities came into operation after 1970, they have been subject to the Swedish SSAC and IAEA safeguards from the beginning and thus safeguards has become an integrated part in the facility control system. The Swedish operators have also shown a great interest in safeguards and that is clearly shown by their willingness to participate in different tasks to further develop safeguards. That has been one of the key elements that has made the Swedish Support Program to IAEA Safeguards the success it has so far been by making it possible to use facilities under operation for training and testing purposes. Sweden has also been very active in international safeguards development through Swedish participation in various advisory and consultants meetings, working groups, etc. There have also been Swedish director generals for the IAEA and Swedish chairpersons for SAGSI for a number of years.

3. Program 93+2 and the Strengthened Safeguard System

When the IAEA initiated the program in the beginning of the 1990s, after the Iraq events, Sweden took an active part in initiating and participating in and carrying out a number of different tasks to test elements of a strengthened safeguards system. The main areas where Sweden was involved were tests of unannounced inspections, collecting and submitting information, development of IAEA use of elements of SSAC, and environmental monitoring for safeguards. To be able to do these activities, the long-time safeguards experience of both the state authority and the operators was of great importance, and led to a very positive result.

One could divide the activities performed by Sweden into eight different categories, which will be described in more detail below.

1. Declaration
2. Use of SSAC
3. Information/reporting system
4. Remote transmission
5. Environmental sampling
6. Unannounced inspections
7. Satellite imagery
8. Open source information

Declaration

As a first step Sweden agreed to submit an expanded declaration to the IAEA on nuclear activities in Sweden. The expanded declaration gave information on the present situation (1994) of the nuclear-fuel cycle, describing the active operators and authorities, research activities and also shut down facilities. A detailed description of the Swedish SSAC with the legislative and regulatory basis was provided. This also described the safeguards activities performed by the responsible authority, the SKI.

Use of SSAC

With the above-mentioned information and other information available to the IAEA, the Agency and SKI agreed on an inspection and reporting scheme where the SSAC should perform parts of the Agency activities in the state. The main activities were that the SKI would perform the routine interim inspections alone by auditing the operator's safeguards accountancy and by servicing the containment and surveillance systems (MIVS and VACOSS seals). The SKI would inform the Agency before the inspection, giving the Agency the opportunity to show up during inspections. After an inspection period, the Agency sent an inspector to the SKI office where the Agency inspector together with the SKI inspector checked the results of the inspections and reviewed the surveillance tapes jointly.

Information/reporting

To allow the Agency to have near-real-time information on the status of all Swedish facilities, the Agency and SKI set up a communication link between the two headquarters. This link was used to submit weekly information on the next week's planned operation of the LEU fuel-fabrication plant and also for weekly submission of ICRs. The Swedish SSAC required and still requires the facilities to report their inventory changes within a week to the SKI. Therefore the submissions of weekly ICRs were easy to fulfill, while procedures had to be established with the fuel fabrication plant to acquire information on the operation of the plant and ways to transfer that information to the SKI.

Remote Transmission

Together with the U.S. Department of Energy and Sandia National Laboratories, the SKI initiated a field trial at the Barsebaeck NPP to monitor spent-fuel transfers at the facility by using several detectors and a digital video system. The data were then transferred to Sandia and SKI via an ordinary telephone line. Through this project, experience was gained on the functioning of the technical equipment and the operator's acceptance of remote surveillance. In parallel with this system, the ordinary MIVS system in operation gave the opportunity to verify that all events were covered during the trial.

As a follow up on this project, another project was initiated under the Swedish Support Program in which a digital surveillance system equipped with a DCM-14 video camera and VACOSS seals linked to a server was installed in the reactor hall of Barsebaeck 2. That system has now been running for more than four years without any disturbance or need for service. Data have been transferred every night to IAEA and SKI and also to Euratom in Luxembourg via a telephone line.

Environmental Sampling

In 1993, a support program task on environmental monitoring was accepted jointly by the U.S. and Swedish support programs. This project focused on the vicinity around (up to 25 km) three nuclear power sites, a fuel-fabrication plant, and a research reactor/facility in Sweden. It was based on sampling of water, sediments, and biota and analyzing their content of radionuclides and stable elements by gamma-spectroscopy measurements and other analytical methods. Results from these tests showed that nuclear operation in coastal areas could be detected up to 20 km from the facility depending on releases and local transport conditions. Nuclear reactor operations can be detected by the presence of activation products in water and sediment samples. Other experiences from this test were the evaluation of methods and organization of sampling procedures.

Unannounced Inspections

During 1995, procedures for testing no-notice inspections, as they were then called, were set up by the Agency and SKI. There were a number of Agency inspectors designated for this activity. For each of these inspectors, ground passes valid for one year were prepared at each nuclear facility. The inspectors had to have passed the Swedish radiation training course (valid for three years) and must bring their health/radiation certificate issued by the Agency. Upon arrival at the facility, the inspector would contact the main entrance and phone one SKI inspector from a given list, who then would try to get to the facility within two hours. In any case the inspector would get access to the facility after two hours to start the inspection. The activities performed during these inspections were design information verification and confirmation that the operation of the plant was in accordance with the weekly submitted information. A number of no-notice inspections (fewer than ten) were carried out at reactor facilities, the fuel-fabrication plant and the research facility.

Satellite Imagery and Open Source Information

To assist the IAEA in acquiring experience in new technologies to strengthen safeguards, the Swedish Support Program has made a cost-benefit analysis to set up a unit for satellite imagery capable of performing advanced image processing as a tool for various safeguards tasks at the Agency. The Swedish Support Program has also offered training in using satellite imagery and open-source information.

All these activities and some not mentioned here have involved a lot of personnel of different categories from operators, authorities, and other contractors in Sweden. By working in this way in testing and preparing for different activities that might be used in a new safeguards scheme, a very good understanding and acceptance has been gained within Sweden. That will, of course, facilitate implementation of the Additional Protocol and other safeguards-strengthening efforts in Sweden.

4. Integrated Safeguards Proposal for Sweden

A proposal for how integrated safeguards could be performed in Sweden has been worked out by SKI within the IAEA Member State Support Program (MSSP) under the title "The Application of State-Level Integration of Safeguards in Sweden." The proposal was presented at the 41st INMM Annual Meeting in 2000.

Background—Implementation of Current Safeguards in Sweden

The safeguards activities in Sweden today are based on Swedish legislation, the Euratom Treaty, and the Agreement with IAEA. This means that nuclear facilities in Sweden are subject to safeguards control by three different organizations, each with its own inspectors and different objectives. The Swedish state inspections are carried out by the Swedish Nuclear Power Inspectorate (SKI). Before Sweden joined the EU, the SKI took part in all Agency inspections but now SKI normally only participates at the physical-inventory verifications (PIV). Apart from the PIVs, SKI performs national inspections at the nuclear facilities. IAEA and Euratom cooperate under the New Partnership Approach (NPA) with the result that Euratom sometimes performs inspections without the presence of an Agency inspector.

Normally Euratom/IAEA inspections at the Swedish facilities are conducted every three months. At the fuel-fabrication plant, inspections take place roughly every month.

Seals at the reactor core at the BWRs and at the transport channel at the PWRs are used as are cameras for remote monitoring.

Proposal for Integrated Safeguards in Sweden

The proposal is intended to provide a pragmatic basis for consideration by addressing, in general terms, the following issues:

- Circumstances and conditions that make it possible for IAEA to proceed successfully with the implementation of integrated safeguards in Sweden;
- Existing measures or activities that can be left "unapplied" or undone by IAEA at declared facilities (aimed at detecting diversion or unreported production), new measures and use of advanced technology (e.g. satellite imagery, open sources etc.), and use of increased and enhanced cooperation arrangements;
- Possibilities to facilitate cost-effective and efficient implementation by redefining the roles and functional responsibilities of the different parties (operators, SKI, Euratom and IAEA) for the purpose of implementation of integrated safeguards in Sweden and to develop a QA/QC approach for the parties;
- Consequences in respect to meeting the objectives of integrated safeguards in Sweden.

The proposal is based on the assumption that circumstances supporting the implementation of integrated safeguards in Sweden are fulfilled. In particular, that the IAEA has concluded that "there is credible assurance of the absence of undeclared nuclear materials and activities" in Sweden, both in declared locations and elsewhere in Sweden. And, that IAEA has decided to proceed with the implementation of integrated safeguards in Sweden.

Such credible assurance, as it relates to absence of enrichment and reprocessing, appears to permit reductions in the traditional safeguards-verification effort, particularly when the object is less-sensitive nuclear material and does not contain significant quantities of unirradiated direct-use material (HEU or Pu).

It is understood that routine interim inspections for timeliness purposes and for confirmation of absence of unreported production can be addressed appropriately by greater use of unannounced inspections, complementary accesses, and by measures implemented to assure the absence of undeclared nuclear materials and activities.

As a precaution, it should be possible to maintain conditions that would facilitate a return to traditional safeguards implementation, if IAEA one day is unable to draw the conclusion of the absence of undeclared nuclear materials and activities in Sweden.

For the purpose of further discussion, it appears reasonable to make the following proposals for integrated safeguards measures applicable for implementation at declared facilities and LOFs in Sweden and aimed at detecting the diversion of declared nuclear material:

- One PIV annually at each material-balance area (MBA)
- No interim routine inspections will be carried out by the IAEA

- One or two unannounced inspections
- Neither seals nor surveillance cameras used
- Advanced technology, C/S, and NDA instruments, with or without remote monitoring capability, may be used in any special safeguards situations

Current inspection activities and the Swedish proposal for future inspection activities are summarized in Table 1.

Safeguards for new facilities, for the conditioning facility and for the final storage of spent fuel is under development both within the IAEA and under the joint Support Program Task Experts Group on Safeguards for Final Disposal and in the ESARDA working group on the Backend of the Fuel Cycle.

In Table 1, one must take into account that the Agency has made use of the NPA with Euratom and that the figures for the inspections for IAEA in fact should have been somewhat higher.

The measures of the AP should be better understood in respect to how those measures could detect clandestine nuclear activities and undeclared nuclear material and thus contribute to the reduction of traditional safeguards measures. If it is concluded that there is no reprocessing facility in the country, then a timeliness criteria of twelve months is adequate. The confidence in the ability of the IAEA to draw conclusions on the absence of undeclared nuclear materials and activities in a state is expected to increase as experience is gained.

The roles and functional responsibilities of the four parties; operator, SSAC/SKI, Euratom, and IAEA shall be reviewed and modified as appropriate to ensure optimal resource utilization for the implementation of integrated safeguards. The infrastructures of the SSAC/SKI and the RSAC/Euratom and their current implementation practices shall also be reviewed and improved or modified as necessary to ensure adequate response to the new requirements.

Future–Challenges and Prospects

Sweden has finalized the legislative basis for the implementation of the AP in Sweden by creating a new law on inspections to make it possible for access to all locations and areas where the Agency finds it necessary to have access. There were also changes made in the law on nuclear activities to cover research and manufacture of products defined in the AP. At the moment, new regulations are under development to modernize and update the exiting regulations.

As Sweden had both a civil and military nuclear program in the past, a great effort is put in reviewing that history. Historical research projects have been performed to look into the archives and to interview people who were active in those days when the Swedish nuclear industry was developed. By doing this historical investigation and including the result in the declaration, Sweden will show that the military part of the nuclear fuel cycle is terminated. It will also show where these activities were carried out and which facilities were used. The Swedish Support Program has a task in which the procedure to do this kind of investigation will be described. We hope to make a presentation on this at the IAEA Safeguards Symposium in October 2001.

All major Swedish licensee holders have been visited by SKI and the requirements of the AP have been discussed in view of the facility specific conditions. The operators have indicated that they will start the work with the initial declaration this autumn. Their goal is to have their initial declaration

Table 1. Number of Safeguards Inspections and the Swedish Proposal

	SKI 1999	Euratom 1999	IAEA 1999	Proposal for IAEA inspections
LEU fuel fabrication plant	1	16	6	1
Research reactor	5	5	4	1
LWR's (12)	20	71	45	12
AFR storage	5	5	4	1
Ranstad uranium recovery	1	1	1	1
LOF's (24)	0	0	0	1
Unannounced inspections	-	-	-	2
Complementary access	-	-	-	3
Conditioning facility (planned)	-	-	-	Approach to be developed
Spent fuel final storage (planned)	-	-	-	Approach to be developed
Sum of inpections and complementary/managed access	32	98	60	22

NB: Most of the inspections have been done simultaneously by the different agencies

finished during spring 2002, which seems to be sufficient. The protocol will enter into force in all the fifteen EU member states at the same time and then the initial declaration should be sent to the Agency within 180 days. Most of the operators think the work with the initial declaration will be without problems, but of course it will take time.

The Swedish authority is responsible for the activities that are defined in the AP. Articles that cover nuclear material fall under the responsibilities of the Euratom Safeguard Office. There are also some articles where the responsibility is shared. How this is going to be handled must be clarified between Euratom and SKI.

In Sweden there are also approximately twenty-five LOFs and a few companies producing nuclear-related material according to the definition of Annex I of the AP. SKI has to inform and educate those companies about the meaning and purpose of the AP. The LOFs are already involved in the safeguard system but for some, which have very few changes of the inventory, the understanding of the AP has to be pedagogically presented. As Sweden already in 1993 agreed to the INFCIRC/415 reporting regime, companies subject to Annex I and the SKI have already have gained a good background for understanding the necessary activities that have to take place due to the AP.

SKI will make arrangements to educate responsible people so they have the full understanding of the meaning of nuclear transparency. It is important to have a network of people who have competence in this field, and this will improve the efficiency of nonproliferation. For the same reason, efficiency of nonproliferation, SKI thinks it is important to agree on what the organizations, RSAC/SSAC/IAEA should be responsible for. The IAEA has to draw their independent conclusions about safeguards but can get the information in different ways. A system where the four parties, RSAC, SSAC, IAEA, and operator, are included in a QA/QC system could make the nonproliferation work more efficient if it is developed in a way where all parties are involved in a proper manner. We believe that the best way to an efficient nonproliferation control regime is to have a close dialogue with the different actors in a confidence-building way. Progress in confidence building is as important as progress in mechanistic technique.

6. Conclusion

As has been described in this paper, Sweden has much experience in safeguards and has been involved in many activities in preparation for a new strengthened-safeguards system. This has involved actors from many different areas within Sweden who will be subject, more or less, to the new safeguards. By working in this way, we expect that the safeguards measures that will be applied in Sweden by the Agency will be accepted and easily applied from all involved. The voluntary description of the historical part of the fuel cycle and a complete description of the present and future fuel cycle and nuclear activities will contribute, we hope, to a smooth transition to a new safeguards approach for Sweden as a whole. We believe that it will be a more effective and a less intrusive system than today's.

Göran Dahlin has been working with safeguards at the Swedish Nuclear Power Inspectorate since 1980. His work has focused on inspections, information treatment, and regulatory issues. Mr. Dahlin is the coordinator for the Swedish Support Program to IAEA Safeguards. Dahlin is also a member of the ESARDA Steering Committee and the Scientific Council and Coordination Board of ESARDA. In 2001, he is the convenor of the ESARDA Working Group on the Back-end of the Fuel Cycle.

Mats Larsson has been working with safeguards at the Swedish Nuclear Power Inspectorate since 1998. His work focuses on inspections and regulatory issues. He is the Swedish task officer for the Support Program task "Application of State-level Integration Concept on Fuel Cycles under Safeguard." In 2001, Larsson is the secretary of the ESARDA Working Group on Integrated Safeguards. His earlier work involved QA in the mining industry.

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United States' Views on Integrated Safeguards

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Abstract

The United States supports the IAEA's effort to integrate INFCIRC/540 and INFCIRC/153 measures as a means of strengthening the effectiveness of safeguards and improving their efficiency. The United States will continue to provide support to the IAEA in areas related to integrated safeguards to promote progress in this area. This paper provides our current thinking on the development and implementation of integrated safeguards. These views may change as the integrated safeguards matures and as more information on resource requirements and effectiveness of proposed systems becomes available.

The IAEA's General Approach to Integrated Safeguards

At the December Board meeting, the U.S. provided a detailed paper outlining our preliminary views on recent progress in integrated safeguards by the IAEA, as described in GOV/INF/2000/26. The United States supports the general approach taken to integrated safeguards described in that document. We believe the basic principles identified in paragraph 6 of that document for the development of integrated safeguards are sound: (a) the system should not discriminate between states; (b) it should utilize comprehensive information evaluation for the state as a whole; (c) it should be designed to provide coverage of all plausible acquisition paths; and (d) it should retain nuclear-material accountancy as a safeguards measure of fundamental importance.

We also believe that the general approach taken by the Agency to the questions of information analysis and complementary access is sound, and that the process by which the Agency proposes to come to a conclusion regarding the absence of undeclared activities in a state is appropriate. The initial conclusion on the absence of undeclared nuclear activities in a state should be especially careful and based on all available information relevant to the state, and take into account existing IAEA experience in a state. If these approaches are pursued, the new measures can provide a meaningful increase in the ability of the IAEA to detect undeclared nuclear material and activities. As a result, we believe this "would permit," as set forth in GOV/INF/2000/26 "a redefinition of current safeguards implementation parameters, particularly for less sensitive nuclear material, with corresponding reductions in the current level of safeguards verification effort on such declared nuclear material."

Developing Integrated Safeguards Approaches

The challenge that currently faces the Agency is turning these general principles into specific safeguards procedures; and the Agency is under considerable pressure to proceed expeditiously toward the introduction of integrated safeguards. We believe careful analysis of the proposed procedures is needed to avoid jeopardizing the strengths of the current system. The end of 2001 is a reasonable goal for the completion of the conceptual development of integrated safeguards, but re-creating the technical basis of safeguards is a very large task; evaluation of all aspects of integrated safeguards must be thorough, and artificial deadlines should be avoided.

The result of this development process must be an integrated-safeguards system designed with a sound and credible basis. Before committing to specific approaches to integrated safeguards, the Agency should have an understanding of the effort that will be needed and the effectiveness of the proposed systems. The resources that will be required for information analysis and complementary access must be understood as accurately as possible; otherwise, it is difficult to assess the level of reductions in inspection effort at declared facilities. The United States has therefore joined other states in asking the Agency for estimates of the resource requirements it believes will be required.

The United States also believes that SAGSI's advice on the development of integrated safeguards for LWRs is generally applicable to other types of declared facilities. The Agency should document its analysis of alternative safeguards approaches, including (1) the capabilities for detection of diversion or facility misuse, (2) identification of scenarios in which the assumption of the absence of undeclared activity is particularly important, and (3) estimates of resource implications. The resulting system should adhere to the following guidelines.

Guidelines for Integrated Safeguards Approaches

Material accounting should remain a fundamental element of integrated safeguards. Regardless of the assurances provided by the new measures, the Agency should periodically confirm the material balance at declared facilities.

Reduced detection capabilities and inspection effort at declared facilities appear appropriate in many certain cases in the context of integrated safeguards. Because virtually all paths for the acquisition of weapons-usable material involve clandestine activities, the ability of the new measures to detect such activities would justify a reduction in effort and detection capability at declared facilities. Because the Agency will focus on detecting clandestine reprocessing and enrichment, it is appropriate that initial reductions in inspection effort be focused on declared facilities with indirect use or irradiated direct-use material. We therefore support the reduced numbers of interim inspections and reduced detection probabilities proposed by the IAEA at LWRs without MOX. We are also analyzing the potential impact of reduced detection probabilities for other types of material, so that, for example, reducing the frequency of inspection at LWRs with MOX could be considered.

Safeguards at declared facilities should remain credible. We do not believe it is prudent to rely entirely on an assumption of the absence of undeclared activities. Even when a conclusion of the absence of undeclared activities is drawn, their presence remains a possibility. As noted in paragraph 9 of GOV/INF/2000/26, the "confidence in such conclusions is related to the availability, quantity and quality of the information reviewed." This confidence level is a matter of judgment and may vary widely for different acquisition paths. For example, the information available may differ, perhaps substantially, by type, scale and status of undeclared activity. Therefore, while detection capabilities at declared facilities can be reduced in the context of integrated safeguards, all credible diversion or misuse scenarios at declared facilities should be addressed by meaningful detection capabilities of safeguards measures at those facilities.

The Agency should retain the ability to draw independent conclusions based on its own observations. The United States supports technical improvements in SSACs and RSACs that can reduce the cost or burden of IAEA safeguards or increase their effectiveness. Examples of such improvements are providing real-time or mailbox declarations, or meeting the preconditions for valid unannounced inspections. However, the IAEA's utilization of SSAC support must not sacrifice the IAEA's ability to draw independent conclusions. While development work to further reduce IAEA resource requirements by using the SSAC should be supported, the confidence level for IAEA conclusions is dictated by the IAEA's own independent observations.

Implementation of integrated safeguards should be nondiscriminatory, but implementation should be flexible, and the means of application and intensity may vary from one state to another. Member states are developing a number of approaches to integrated safeguards, adapted to the specific safeguards-related conditions in their state; these might make use of, for example, the SSAC characteristics mentioned in the paragraph above. Although integrated safeguards should be nondiscriminatory in the sense that the goals for all states should be the same, enough flexibility should be allowed to take advantage of such state-specific conditions leading to greater efficiency or effectiveness. In addition, decisions on the implementation of integrated safeguards should not be based on rigid rules, but should take into account all available relevant information. We therefore support SAGSI's efforts to consider less-prescriptive approaches to criteria for integrated safeguards.

Unannounced or random inspections should be used only where preconditions for their effectiveness are met. A number of the new proposals for integrated safeguards rely heavily on such inspections, and we believe that such inspection strategies can play an important role. However, the Agency has had relatively little experience with such inspections, so the Secretariat should identify and document the conditions under which unannounced or randomized inspections would be unpredictable, not amenable to circumvention, and otherwise valid. This would involve identifying how the inspection times would be scheduled, what observables could be identified during the inspection, and how short the effective notification period would have to be in order to detect those observables. Such inspections will not provide deterrence unless there is a significant likelihood of detection. State-specific conditions relating to inspection implementation (such as requirements that state representative accompany inspectors) may determine what type of inspection scheme is workable.

Complementary access should be viewed as a routine element of integrated safeguards. All elements of safeguards agreements and the Protocol need to be implemented effectively and on an on-going basis, including the conduct of complementary access at sites. This access must be a normal, not a rare, part of integrated safeguards. This is essential for the Agency to pursue its continuous evaluation of the state's nuclear program and to reaffirm annually its conclusion of the absence of undeclared nuclear material and activities. Moreover, the focus of complementary access not associated with specific questions or inconsistencies should be locations with the potential for reprocessing or enrichment.

Integrated Safeguards at LWRs

The Agency has proposed a twelve-month timeliness goal for spent fuel under integrated safeguards. We believe a prudent approach is to retain a capability to detect diversion of spent fuel within three months, while agreeing that the detection probability can be less than 100 percent. We agree that the number of interim inspections for purposes of timely detection should be reduced, and agree that this can be achieved by replacing inspections at fixed three-month intervals by a smaller number of inspections scheduled at random times. The reduced probability of achieving this goal is justified by the increased probability of detecting undeclared activities. With respect to the timeliness goal, the following factors are relevant: (a) integrated safeguards should detect efforts to acquire nuclear material for weapons before it can be turned into a nuclear weapon; (b) for acquisition paths involving diversion from declared activities, detection should not rely entirely on detecting undeclared activities; (c) the time to convert diverted nuclear material to weapon components is based on technical parameters for processing that are independent of safeguards strengthening measures; and (d) the existence of undetected clandestine facilities, including operable ones, remains a possibility that cannot be discounted.

As a consequence, if the integrated safeguards system does not detect the undeclared facility and detection of diversion occurs after twelve months, detection will occur well after weapons are created. We do not think the integrated-safeguards system should be designed on that basis. We note also that a diversion of nuclear material from declared activities would most likely take place only when undeclared facilities are ready to utilize the diverted material. Thus, a diversion indicates that measures to detect undeclared activities would have failed.

The fundamental Agency approach to safeguards for LWRs without MOX involving a reduction in the number of interim inspections is appropriate. The Secretariat's base integrated safeguards approach described in GOV/INF/2000/26 uses random inspections and, thus, it retains a capability for timely detection using the current timeliness goal, consistent with the concept just described. The average number of inspections can be reduced at least from three to one; further changes, whether increases or decreases, would occur only when information available to the IAEA warrants it. The Agency proposal called for a one-level reduction in detection probabilities, not to be less than "low." As a generalization, this approach is reasonable.

To reduce costs, the Agency's base safeguards approach for LWRs without MOX also eliminates permanently installed surveillance, retaining temporary surveillance only during the refueling period. The elimination of permanent surveillance means that the detection of certain credible diversion scenarios would depend upon a relatively small number of unannounced inspections intended to detect events that may be brief. Even if the conditions to conduct unannounced inspections are met, the likelihood of detection may not be large enough to be meaningful.

There are other significant advantages to retaining permanent surveillance whose use is suitably adapted to a longer inspection interval. When conclusive, it provides meaningful assurance of the absence of diversion. Permanent surveillance can act a backup to the core seal and to other C/S measures during the refueling period. Permanent surveillance does not add to the number of interim inspections, although review of surveillance records and maintenance does add to inspection effort.

We are aware of the problems that historically and currently attend surveillance. It should be noted that the Agency will have to continue to rely on surveillance in many circumstances, including during refueling at LWRs, so that problems with reliability and inconclusive results must be addressed in any event. Some of these problems can and should be solved by implementation of more reliable surveillance systems, which the United States will support. However, some of the problems associated with the current utilization of surveillance would be substantially mitigated under an approach in which the surveillance data were treated in a more flexible manner, consistent with our views of how integrated safeguards should be implemented. In particular, we believe that the information provided by surveillance systems should be analyzed *in the context of all of the information available to Agency under the strengthened safeguards system*. The results of this assessment would be used to determine follow-up activities. Thus, inconclusive results would not necessarily lead to further Agency action.

Integrated Safeguards: A Pragmatic Balance

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Abstract

Regarding integrated safeguards, the current state of the art seems to allow as the only available alternative for conceiving a system the use of a sound logic and professional judgments. In developing such a system, fundamental aspects, like the conceptual differences between old and new safeguards and the basic conditions that should be fulfilled for starting and maintaining the application of integrated safeguards, should be considered. In addition, the limit conditions in between which any conceivable integrated safeguards system should be accommodated should be clearly understood. This paper describes these aspects and lists some essential additional elements that should be considered for developing an integrated safeguards system. Finally, a brief description of the essential contribution that a credible regional system can provide to a sound integrated safeguards system is provided.

1. Introduction, or Why a Pragmatic Balance?

The term integrated safeguards means the optimum combination of all safeguards measures available to the Agency under comprehensive safeguards agreements and additional protocols. Such an optimum combination should achieve the maximum effectiveness and efficiency within available resources (i.e. with a cost constraint).[1]

The definition seems to be quite good, and due to the nice wording, it appears to permit a precise formalization of the "optimum combination." However, for those who should attempt to develop an integrated safeguards system, the definition alone does not help because it is subjective enough as to allow almost infinite combinations that may qualify as optimum as a function of the criteria adopted.

Therefore, it must be recognized that at present there are no conditions to precisely define any "optimum combination" because of the lack of agreed criteria for optimizing combinations of safeguard measures. Furthermore, there is also no agreement on values of effectiveness to be assigned either to a single safeguards measure or to any combination of them.

The context described above clearly indicates the impossibility of any sound attempt to quantify alternatives and find out the precise combination of safeguards measures that constitute the optimum. In addition, a cost constraint is a condition that technically speaking means that instead of looking for the optimum combination, the best cost-effective combination of safeguards' measures shall be found. Evidently, in the context described it is also impossible to determine the cost-effectiveness of combinations of safeguards measures.

Therefore, at present and for several years, the only possibility is to conceive an integrated safeguards system based on professional judgments. The challenge of this task is to make a pragmatic balance between traditional safeguards activities and the new ones that arise from the Additional Protocol. In doing that, using a sound logic, the potential efficacy of measures of the Additional Protocol should be evaluated, and traditional safeguard activities should be critically reviewed.

Perhaps after accumulating some substantial experience it would be possible to attempt to define agreed optimizing criteria, to assign values of cost and efficacy to single safeguards measures and combination of them. This is essential for attempting to develop a credible model for optimizing safeguards measures. It will not be an easy task and should involve the expertise of the entire safeguards community.

2. Old and New Safeguards Concepts

Integrated safeguards and traditional ones have several significant conceptual differences, and probably the main ones are on verification activities and on the conclusions that may be obtained from such activities.

The basic element in traditional safeguards is the independent verification of the state/operators' declaration for confirming its correctness. The conclusion in traditional safeguards is based on a quantitative assessment, where detection probabilities, statistical tests, and measurement quality and intensity play the central role. Essentially, a positive conclusion in traditional safeguards is an independent confirmation of the correctness of the inventory of nuclear material, facilities, and LOFs declared by a state.

In integrated safeguards, it is essential to conclude the absence of undeclared nuclear materials or activities. Such a conclusion can only be inferred from the lack of evidence to the contrary. In this case, the activities performed should be aimed at finding out if something that was not declared and, in general, it would be worthless to spend time and money on the independent verification of the state's declaration. Furthermore, in this case, the conclusion must be based on qualitative judgments driven mainly by information evaluation.

Each state declaration would be examined, analyzed, and scrutinized as well as compared to similar information obtained by other means, but this would not be done for confirming the declaration. Everything will be done looking for something that should be in the declaration and was intentionally omitted. In this context, a positive conclusion is an independent confirmation of the completeness of the state declaration based on the absence of incriminating evidence.

It is stressed that there is the need to consider these conceptual differences when building the integrated safeguards system, and therefore this should be part of the logic scheme. These facts have significant implications on the conception and implementation of integrated safeguards.

3. The Basic Conditions

It is stressed that the entry into force of the Additional Protocol in a given country is a condition necessary but not sufficient for starting the application of integrated safeguards. The starting condition should be the confirmation obtained by the IAEA of the absence of undeclared nuclear materials and activities. This means that there will be a transitory situation, e.g. a couple of years, that usually will end with an IAEA statement that implicitly confirms the satisfactory clarification of all questions and inconsistencies.

Furthermore, the system implemented should allow the periodic reconfirmation of the initial credit given to the state for maintaining the regular application of the integrated safeguards regime in such state. This second basic condition, or continuity condition, is as fundamental as the starting one. If at any time, the IAEA is not able to conclude on the absence of undeclared nuclear materials or activities, the application of regular integrated safeguards should be interrupted. In such an exceptional case, the IAEA should plan and execute a set of measures tailored to the specific case, it being absurd to think about the reapplication of current traditional safeguards to declared materials and facilities as appropriate countermeasures. By adhering to the Additional Protocol, a state has accepted an utterly new safeguards regime and it is unthinkable that an IAEA statement would indicate that a given state satisfies INFCIRC/153 but does not satisfy INFCIRC/540.

4. The Limit Positions

As indicated above, a pragmatic balance based on professional judgments seems to be the only available alternative for a first systematization of integrated safeguards. Such being the case, it seems useful to indicate the extreme positions between which any conceivable integrated safeguard system should be accommodated.

4.1 Position A

One extreme position is to assume that the information provided by the state, third parties, and open sources could be analyzed and treated so as to provide in time and with high confidence indicators of undeclared nuclear materials or activities. This assumption being valid, it would be almost unnecessary to carry out traditional safeguard activities and it could even be considered not essential to implement some of the new safeguard measures (like complementary access) on a random basis. In this approach, the verification of the declared nuclear material should be limited to the minimum compatible with the requirements of INFCIRC/153. Moreover, with this assumption any complementary access would be triggered by the results of the information analysis and would be aimed at confirming an already credible evidence of undeclared activities obtained from information analysis alone.

In other words, information analysis is considered such a powerful tool that it will allow the identification of any type of clandestine activities, as well as the location where they are taking place and even the people involved. Then, using the tools provided by the Additional Protocol, a precise set of activities might be planned and executed by the IAEA to prove the violation of the safeguards agreements and non-proliferation treaties.

The main criticisms of this extreme position may be summarized as follows:

i) It is hard to believe that such a quality of detection through information alone would be possible. In principle, it seems logical that information analysis should be able to detect the routine operation of clandestine pilot reprocessing or enrichment plants, as well as reactors, and even be capable of detecting the construction of such plants. However, previous stages would be more difficult to detect. In general terms, it seems logical to consider that the power of information analysis as a detection tool will be lower for initial clandestine research activities and laboratory scale production of undeclared nuclear materials, special components or equipment.

ii) Another source of doubt is the fact that the essential element in the power of the analysis would be the quality of information provided by third parties. Such quality, neither influenced nor controlled by the IAEA, would be difficult to evaluate.

iii) Finally, some persons consider that the cost of having such an efficient system for collection and treatment of information will significantly exceed the present IAEA safeguard budget. Not to say that it would also require a substantial modification of the IAEA structure as well as the need to incorporate a great number of specialized personnel with the appropriate skills and training.

4.2 Position B

The other extreme position is to assume that no significant credit could be given to information collection and treatment regarding detection of undeclared nuclear materials and activities. Therefore, all the measures foreseen in the Additional Protocol should be implemented but nothing should be simplified or modified in traditional safeguards. Moreover, new techniques or technologies should be added to the existing ones aimed at strengthening the control on declared nuclear materials and declared facilities (e.g., remote monitoring).

The main criticisms of this extreme position may be summarized as follows:

i) The new safeguards measures of the Additional Protocol are powerful tools that were unthinkable years ago. One can ask whether the new obligations assumed by the states regarding provision of information and so on, as well as the additional IAEA rights, are worthless. In this context, the position B could be understood as a proposal to re-discuss the Model Additional Protocol or, perhaps, to reconsider if the IAEA is the proper organization for its application.

ii) It does not seem logical to consider that by strengthening the control on declared nuclear materials and activities the ability for detecting undeclared nuclear materials or activities would be improved (see point 2 above).

iii) Even not being perfect, the information collection and treatment analysis should increase the IAEA level of confidence on the absence of undeclared nuclear materials and activities. This fact should allow a simplified methodology for controlling declared nuclear materials and facilities.

5. Making a Pragmatic Balance

As indicated, the only realistic alternative for developing an integrated safeguards system seems to be the use of a sound logic and professional judgments. Such a development should consider the changes in safeguards concepts (point 2 above) and the basic conditions already described (see point 3). In addition, as the proposed integrated safeguards system will fall somewhere in between the extreme positions described in point 4, the developers should also consider such limit positions as well as their criticisms (see point 4).

In the authors' opinion, some additional essential elements that are listed below should also be taking into account and properly considered when developing the integrated safeguards system.

- Continuity: Measures aimed at keeping the initial level of confidence on the absence of undeclared nuclear materials/activities should be included (see 3 above).
- Deterrence: Deterrence measures should be included for helping to keep stable through the years the initial positive conclusion.
- Exceptions: Dubious states should not be considered when developing integrated safeguards. Dubious states will never fulfill the basic starting condition for the application of integrated safeguards (see point 3 above).
- Safeguards conclusions: Under the new regime, the conclusion obtained applies to the whole state and not to any one facility or nuclear material in particular. The traditional safeguards measure incorporated into the integrated safeguards system would be only aimed at providing additional confirmations on declared nuclear materials and activities and would play a complementary role.

  (It is interesting to note that diversion of declared nuclear material as well as misuse of facilities seem to be the only cases that can be detected either with the Additional Protocol safeguards measures or the traditional ones.)
- Review of current safeguards measures: When integrating current safeguards measures into the integrated safeguards regime, aspects that deserve consideration seem to be:
  a) The traditional basic parameters are not necessarily valid. In particular the timeliness concept has no meaning in integrated safeguards and detection probabilities and other parameters may be significantly modified.
  b) The intensity of traditional safeguards measures should be linked to the type of facility. Probably in the first attempt, current safeguards approaches for direct use material storage and most enrichment and reprocessing plants would not be modified. For the remaining types of facilities, it seems logical to decrease the intensity of traditional safeguards measures as one moves from nuclear power plant to fuel fabrication plant to conversion plants. This implies giving more credit to information treatment as an effective tool as the number of steps for obtaining direct use material increases.
  c) The activities of credible regional safeguards systems should be properly incorporated (see below) and in some conditions the activities carried out by state safeguards systems may be incorporated.

6. Role of Regional Systems

A credible regional system provides solely by its existence additional guarantees regarding the absence of undeclared nuclear materials and activities. In addition, a regional system carries out a systematic verification of declared nuclear materials and facilities. A pragmatic incorporation of these elements into the integrated safeguards system will improve the efficacy and efficiency of international safeguards. Several papers have been presented in the past that describe in detail possible ways of incorporating a regional system into integrated safeguards.[2-6] The proper incorporation of the regional system's contribution is a challenge that the IAEA should face.

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Euratom Safeguards Office Views on Integrated Safeguards in the European Union

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1. Abstract
The three Additional Protocols of the European Union were signed on September 22, 1998, and will enter into force when all signatories have ratified it. Experience has shown that the collection of information and the preparation of the initial declaration require a significant amount of work for the different operators and member states. But, more importantly, in order to guarantee successful implementation of the Additional Protocol, the IAEA will have to invest the necessary resources in evaluating all the information it receives and in performing complementary access where necessary. Only then can credible assurance be obtained that no clandestine activities are taking place in a state. We hope that in the European Union the IAEA will soon be able to draw conclusions regarding the absence of clandestine activities and that integrated safeguards can be implemented in the not too distant future.

The different parties that form the safeguards community in the European Union, i.e. the IAEA, the Euratom Safeguards Office, the state authorities, and the operators, all have their own visions and expectations of what integrated safeguards should bring. The most important outcome of the whole exercise should be a strengthened IAEA safeguards system, which has the necessary resources available to focus on areas where a real proliferation risk exists. European operators are ready to invest resources in complying with all the measures of the Additional Protocol, knowing that the proliferation risk in the European Union is minimal, but they are prepared to do so as an example to states with higher risks. They, however, expect that with integrated safeguards the IAEA will reduce significantly the classical inspection effort in the European installations and make it commensurate with the very low proliferation risk that exists in this area of the world.

The Euratom Safeguards Office believes that integrated safeguards could be the basis for the IAEA to make enhanced use of Euratom's Regional Safeguards System. The IAEA should fully exploit the activities performed and the results provided by the Euratom Safeguards Office thereby freeing the resources needed by the IAEA for focusing its activities on areas of real concern and for the implementation of the measures of the Additional Protocol. The Euratom Safeguards Office itself will also have to re-assess its role and scope in this new safeguards environment.

2. The Euratom Safeguards Office: Its Legal Basis, Goals, and Objectives
The Euratom Safeguards Office provides assurance that nuclear material is not diverted from its intended use on the territory of the fifteen member states of the European Union. This responsibility has its legal basis in the Treaty establishing the European Atomic Energy Community, concluded in 1957. Euratom Safeguards started soon after the conclusion of this Treaty, so that it can now look back on more than forty years of experience.

The implementation of safeguards under the Non-Proliferation Treaty of Nuclear Weapons in the European Union member states is governed by three tripartite safeguards agreements between the member states, Euratom, and the IAEA. One agreement, the Verification Agreement, covers the thirteen nonnuclear member states of the European Union, one covers the United Kingdom, and the third one France. The International Atomic Energy Agency and the Euratom Safeguards Office carry out together the safeguards activities under this Agreement. Joint IAEA/Euratom safeguards activities under the Agreement started in 1978.

All Safeguards Agreements indicate that the IAEA shall make full use of the Euratom Safeguards System. It specifies that cooperation in the application of safeguards in the European Union shall avoid unnecessary duplication of Euratom safeguards activities. In determining the actual number, intensity, duration, timing, and mode of the IAEA inspections, account has to be taken of the inspection effort carried out by Euratom in the framework of its Regional Safeguards System. The working arrangements between the IAEA and Euratom have evolved over the years. They were further improved in 1992 into what is now known as the New Partnership Approach (NPA).

The last revision of the Euratom Safeguards Office goals and objectives took place in the early 1980s to ensure that all obligations of the Euratom Treaty can be met, including those arising from the cooperation with the IAEA under the Verification Agreement.

Since that time the safeguards environment has changed significantly, including the possible role of Regional Safeguards Systems. The European Commission has decided to review the role of the Euratom Safeguards Office. This review would cover the political objectives, working methods and possible synergies with other organisations and authorities that are active in the field of safeguards. As part of this process, the Euratom Safeguards Office is at present evaluating whether there is room for an alignment of its present goals and objectives to the new safeguards system. Any proposal for a modification in its own activities would be formulated in such a way that the ESO would continue to be able to meet its obligations under the Euratom Treaty, including the obligations coming from the three Safeguards Agreements, which are governed by Article 77b of the same Treaty.

This evaluation process is only starting now. The ideas expressed in this paper are not a prejudgment of the outcome of this evaluation process and do not commit the European Commission to any of the activities presented, including those related to the implementation of the Additional Protocol. They only represent the present thinking of the authors of this paper.

3. Implementation of the Additional Protocol in the European Union

The three Euratom Additional Protocols, one for each safeguards agreement, were signed in Vienna on September 22, 1998, during the IAEA General Conference. They will enter into force once all member states concerned have finalized their domestic ratification procedure and have notified the European Commission that they have become applicable in accordance with their respective national laws. Although there is no requirement for all three Additional Protocols to enter into force on the same day, there is a political will to do so. To date, six member states have ratified: Spain, the Netherlands, Germany, Greece, Sweden, and Finland. The UK legislation has received Royal Assent and will be brought into force when necessary.

The three Euratom Additional Protocols foresee that for measures that involve declared nuclear material, the IAEA and the Euratom Safeguards Office shall cooperate to facilitate their implementation and shall avoid unnecessary duplication of activities. The Euratom Safeguards Office shall provide the IAEA with the information specified in Article 2 of the Additional Protocol, as far as it relates to nuclear material, for all member states of the European Union, and as far as it relates to sites, for all thirteen non-nuclear weapon states (NNWS).

The role of the Euratom Safeguards Office in the provision of Article 2 information that does not relate to nuclear material or a nuclear site would vary from member state to member state. In the NNWS protocol, there is a provision for states to entrust to the European Commission the implementation of the provisions in the Protocol which are their responsibility, e.g., provision of information that does not relate to nuclear material or to nuclear sites. Member states that decide to do this can do so by informing the other parties to the Protocol through a "Side Letter." A number of member states have already decided to entrust these measures to the Euratom Safeguards Office; other member states have decided not to do so. With regard to the Community's Joint Research Center, the Community shall also implement the measures, which the Protocol sets out for states, as appropriate in close collaboration with the state on whose territory an establishment of the Center is located.

Whereas until now, all IAEA safeguards measures in the European Union were implemented through the Euratom Safeguards Office, this situation will change significantly once the Additional Protocol enters into force. The implementation of the Additional Protocol in the European Union would not be identical for all member states of the European Union. The way it is implemented would largely depend on the decision of the member state to entrust, or not, to the Commission the measures which do not relate to nuclear material. This would therefore have its implications regarding other activities of the Additional Protocol such as requests for amplifications and clarifications, follow up of questions and inconsistencies, complementary access and managed access. The precise arrangements are being discussed and agreed upon member state by member state with the Euratom Safeguards Office.

Thus far, Belgium, Germany, Greece, Luxembourg, Portugal, Spain, and the Netherlands have confirmed in writing that they would want to use the services of the Commission for the implementation of the measures of the Additional Protocol that do not relate to nuclear material. Italy also indicated its intention to transfer. Austria, Finland, and Sweden have indicated that they are not planning to use the Commission services for the implementation of the measures not relating to nuclear material. Formal replies from Denmark and Ireland are outstanding but during initial informal contacts, these two states indicated that they were not considering making use of the Commission services for these tasks. The Side Letter was never an option in the French and UK Additional Protocols. These two member states plan to implement themselves the measures of their (limited in scope) Additional Protocol that do not relate to nuclear material.

It is not the intention of the Euratom Safeguards Office to draw conclusions regarding the absence of undeclared nuclear material and activities in the European Union. It will not install a parallel Additional Protocol implementation and evaluation scheme in the European Union. The Euratom Safeguards Office would ensure, as far as possible, that information transmitted to the IAEA is complete, consistent, in the correct format and free of obvious errors in order to facilitate the IAEA's evaluation process.

The Euratom Safeguards Office would in any case provide to the IAEA the information requested in the Additional Protocol relating to nuclear material for all fifteen member states of the European Union and for the Joint Research Centre and the information related to sites for the thirteen NNWS.

If the necessary resources are available, the Euratom Safeguards Office will also provide all other Additional Protocol information for those member states that have entrusted to the European Commission the implementation of provisions, which are their responsibility. The Euratom Safeguards Office would serve for these states as the focal point for communication exchange with the IAEA. It would collect the information from the states and check for completeness and obvious inconsistencies. It would format the data where necessary and forward it to the IAEA. The Euratom Safeguards Office would also coordinate IAEA requests for amplifications, questions, and inconsistencies, and complementary access and would support its member states.

The Euratom Safeguards Office would accompany IAEA inspectors during complementary-access activities on sites or to places where nuclear material is present in all fifteen member states and to all other places where complementary access is executed for those member states that entrust to Commission the implementation of the other Additional Protocol provisions. For these latter member states, a uniform system towards the IAEA would exist, which would facilitate largely the IAEA's work.

The role of the Euratom Safeguards Office for the implementation of these measures in the different member states could be very different from state to state. Some states have indicated that they would pass national legislation in such a way that the Euratom Safeguards Office would be responsible for the implementation of (almost) all measures in their country, having direct contact to all persons and undertakings referred to in the Additional Protocol. Other member states have indicated that they see the role of the Euratom Safeguards Office more as a mailbox to transmit information to the IAEA and to coordinate practical arrangements for access. Bilateral discussions have started with the member states interested to define the Euratom Safeguards Office's role on their territory.

4. The Role of the Euratom Safeguards Office Under Integrated Safeguards

The different parties that form the safeguards community in the European Union, i.e. IAEA, the Euratom Safeguards Office, the state authorities, and the operators have their own visions and expectations on what integrated safeguards should bring. The most important outcome of the whole exercise should be a strengthened IAEA safeguards system, which has the necessary resources and legal authority to focus on areas where a real proliferation risk exists. European operators are ready to invest resources in order to comply with all the measures of the Additional Protocol, knowing that the proliferation risk in the European Union is minimal, but they are prepared to serve as models for states with higher risks. They, however, expect that with integrated safeguards the IAEA will reduce significantly its classical inspection effort in the European installations and make it commensurate with the very low proliferation risk that exists in this area of the world.

The rationale of integrated safeguards is that a strengthened and more efficient IAEA system would result from redistributing some of those resources currently committed to nuclear material accountancy related activities to a new set of activities, based on the new legal authority given by the Additional Protocol. Integration of the old and the new safeguards measures should also enable the IAEA to focus its activities on those states that pose a real proliferation risk so that the overall IAEA safeguards effectiveness is increased. It enables the IAEA to *differentiate* between states without *discriminating*, distributing the verification burden over the states based upon objective (information-driven) rules.

The Euratom Safeguards Office believes that integrated safeguards could be the basis for the IAEA to make enhanced use of its Regional Safeguards System. The IAEA should fully exploit the activities performed and the results provided by the Euratom Safeguards Office thereby freeing the resources needed by the IAEA for the implementation of the measures of the Additional Protocol and for focusing its activities on areas of real concern. The Euratom Safeguards Office itself would also have to re-assess its role and scope in this new safeguards environment.

With the implementation of the new state level approach through the Additional Protocol, the IAEA would gain a comprehensive picture of the European Union states' nuclear activities and technical capacities for proliferation. It would get credible assurance of the absence of undeclared nuclear material and activities in the European Union non-nuclear weapon states. In the light of this assurance, traditional safeguards activities related to nuclear material accountancy could be significantly reduced. Once this reduced set of activities has been defined, one can ask the question whether these remaining activities all have to be performed by the IAEA, or whether the IAEA could make use of the results of the Euratom safeguards activities. It is clear that the results of the well-established regional Euratom Safeguards System should have great value to the IAEA.

Attempts have been made to define the conditions under which the IAEA could use the results of verification activities by regional and state systems of accountancy and control to draw its own independent conclusions. Once these conditions are met, the IAEA should not need to verify the declared nuclear material to the same level as in states or regions where such a system does not exist. These conditions are:

1. The reporting requirements for independent verification are fully met. This means that all safeguards relevant events, data and results are irrevocably reported to the IAEA in a time frame that realistically makes them subject to verification (quality control measures on the data provided);

2. The data produced by the regional or state system of accountancy and control are technically valid. The IAEA would therefore have the possibility to audit the technical effectiveness and capabilities of the regional or state system of accountancy and control (quality-assurance measures on the regional or state system of accountancy and control system);

3. The data produced by the regional or state system of accountancy and control are politically valid. This requirement appears to be met in the framework of integrated safeguards where a conclusion of the absence of undeclared material and activities is drawn;

4. The conditions for unannounced inspections by the IAEA will be fully met. This requirement is linked to condition 1 as unannounced inspections may prove to be the only way for the IAEA to conclude that the regional or state system of accountancy and control inspection results provided earlier are correct. This will require appropriate arrangements to be agreed upon with the Euratom Safeguards Office.

Once integrated safeguards has been implemented in the European Union, the IAEA activities could therefore shift from performing detailed verification of nuclear material to auditing the Euratom Safeguards System supplemented by a number of quality control measures on inspection results provided by the Euratom Safeguards Office. It should be noted that this approach does not delegate the responsibility for drawing conclusions from the IAEA to the Euratom Safeguards Office. These quality-assurance/quality-control activities would allow the IAEA to draw its own independent conclusions about the integrity of results and thus the absence of diversion. The Euratom Safeguards Office would perform the detailed verification of the declared nuclear material in the different facilities to at least the level identified in the IAEA integrated safeguards criteria. We are convinced that this combination of Euratom verification activities, IAEA quality assurance/quality control activities and the activities under the Additional Protocol would lead to effective safeguards in the European Union and would liberate IAEA resources that can be used in areas of proliferation concern.

Integrated safeguards would not change the role of the Euratom Safeguards Office in implementing the existing Safeguards Agreement. The Euratom Safeguards Office would continue to be responsible for the reporting to the IAEA of nuclear-material inventories and transfers. It would implement the necessary classical safeguards measures in the European Union under the NPA arrangements and would assist the IAEA in all its Additional Protocol activities that are carried out during planned routine inspections.

The Euratom Safeguards Office would continue to ensure that operators meet all requirements of Chapter VII of the Treaty and in consequence of the Safeguards Agreement. It would ensure that operators establish and maintain high quality measurement and adequate accounting and control systems. It would promulgate and enforce relevant standards and procedures and monitor the performance of the operator systems to ensure that the standards are met and that measurement biases are controlled and corrected. The Euratom Safeguards Office would ensure that facility records are complete, internally consistent, free of clerical errors and, where appropriate, accessible electronically in order that the IAEA's quality control examination can be done with maximum efficiency. It would iron out, in advance of IAEA inspections any problems that could delay or otherwise interfere with the inspection.

The Euratom Safeguards Office would inform the IAEA in advance about its activities under the Agreement. As required by the Safeguards Agreement including the Additional Protocol, it would also provide the IAEA with facility based operating reports, which might describe advance information about the operational programme, including a description of major inventory changes expected, major maintenance activities and changes in operational conditions. This additional information is intended to enhance the effectiveness of IAEA inspections and to make it possible to perform simultaneous inspections at short notice or unannounced inspections.

The Euratom Safeguards Office would verify inventories and flows of nuclear material to a level equal to, or higher than, the IAEA integrated safeguards requirements. The Euratom Safeguards Office would continue to transmit to the IAEA the full report of all activities performed. The data provided to the IAEA would include all discrepancies and anomalies detected by the Euratom Safeguards Office and the actions taken to resolve them.

The Euratom Safeguards Office would continue to use with the IAEA commonly agreed measurement instruments and containment and surveillance systems, in line with the NPA procedures that are in place. The IAEA would have every opportunity to participate in the calibration of the instruments used by the Euratom Safeguards Office, and would be given the detailed verification results of all activities performed by the Euratom Safeguards Office.

The IAEA would have the opportunity to perform repeat measurements for quality control purposes, at a subsequent unannounced inspection, up to 20 percent of the level it would have to perform in the absence of the Euratom Safeguards Office. Factors that can affect the level of these quality-control measures could be, amongst others: type of facility, grade of the material being safeguarded, extent of Euratom's activities, and the level of authentication in place.

The IAEA would base its conclusions on the information provided by the Euratom Safeguards Office and the IAEA's quality-control/quality-assurance measures.

5. Would Reduced IS Verification Levels Also Apply to Euratom?

The reduction of classical safeguards measures under integrated safeguards is often seen by the states as a trade off for accepting the measures of the Additional Protocol. The question whether the regional or state system of accountancy and control would also reduce its own activities once the conditions for integrated safeguards are met has therefore to be addressed.

As indicated above, the Euratom Safeguards Office is at present evaluating whether there is room for an alignment of its present goals and objectives to the new safeguards system. Although it would not be appropriate to try to prejudge the eventual outcome, thinking within the office runs along these lines. The role of the Euratom Safeguards Office under the Euratom Treaty to ensure that all persons and undertakings holding nuclear material have an up-to-date material accountancy and control system in place should remain. The Euratom Safeguards Office capability for this purpose, including the conduction of inspections, would therefore have to be maintained. This includes independent verification of inventories and flows of nuclear material using high quality NDA- and DA-measurement techniques.

The Euratom Safeguards Office would continue to use automated, unattended and remotely monitored measurement and containment and surveillance systems in order to save human resources. These systems are and would continue to be installed in situations where they can replace human presence in a cost-effective way. Places with high radiation levels are also candidates for the installation of such systems. A decision to install such devices would be made based on a cost benefit analysis, case by case.

Safeguards implementation criteria that derive purely from an NPT perspective (production of nuclear weapons) might be relaxed, taking into account however the Euratom Safeguards Office's obligations towards the IAEA under the Safeguards Agreement including the arrangements of the new partnership approach. Examples are timeliness goals that are linked to the conversion time for the production of direct-use material.

An important reduction of the Euratom Safeguards Office effort can be expected for activities that up to now were only implemented to satisfy mechanistic IAEA criteria and that were imposed upon the community for reasons beyond their control. Typical examples are the requirements for re-verification after a C/S failure that was due to a failure of the inspectors' equipment. It is clear that in an integrated safeguards situation where the state has shown transparency and the IAEA has drawn conclusions about the absence of undeclared nuclear material and activities, such inspector-triggered anomalies should not cause additional burdens on the operator.

An analysis would therefore have to be made on a case-by-case basis, facility type by facility type. Looking at the proposals for the integrated safeguards approaches that are on the table right now, we believe that the Euratom Safeguards Office could also adjust its own activities to the reduced levels as proposed by the IAEA for Integrated Safeguards.

6. Conclusions

Integrated safeguards provides an opportunity for the IAEA to enhance its cooperation with the Euratom Regional Safeguards System. By using a system based on QA/QC measures on the Euratom Safeguards Office and the verification data it provides to the IAEA, the IAEA can save resources that can be used for the measures of the Additional Protocol or implemented in areas of higher proliferation concern, thereby strengthening the worldwide IAEA safeguards system.

The revision of the Euratom safeguards objectives might result in a consolidation of its activities. The Euratom Safeguards Office could consider under these circumstances to adjust its own activities to the levels as proposed in the integrated safeguards approaches that are on the table right now.

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Avens to Lead LANL Nonproliferation Program Office

Dr. Larry R. Avens has been selected to lead Los Alamos National Laboratory's Nonproliferation Program Office. The office manages the program execution and development in the domestic and international safeguards, export control and nonproliferation policy, waste assay research, HEU transparency, and DoD-related arms-control technical support programs for Los Alamos.

Avens has many years of experience as an accomplished manager in the Nuclear Material Technology Division at Los Alamos. He managed the group that designed, fabricated, and commissioned the ARIES pit disassembly and conversion prototype system at Los Alamos' Plutonium Facility. At Los Alamos Avens also led the development and implementation of the R&D plan for plutonium stabilization in response to DNFSB recommendation 94-1.

Previous Nonproliferation Program Office managers include fellow INMM members James W. Tape and Sara C. Scott.

The membership committee of the INMM welcomes your contributions to the Member News section of JNMM. Please keep us up to date on your promotions, awards, retirements, and other career news.

Send your news and photos to Managing Editor Patricia Sullivan at INMM Headquarters, 60 Revere Drive, Suite 500, Northbrook, IL 60062 U.S.A., or by e-mail at psullivan@inmm.org, or by fax to 847/480-9282. Be sure to include a daytime phone number and e-mail address.

Author Submission Guidelines

The *Journal of Nuclear Materials Management* is the official journal of the Institute of Nuclear Materials Management. It is a peer-reviewed, multidisciplinary journal that publishes articles on new developments, innovations, and trends in safeguards and management of nuclear materials. Specific areas of interest include physical protection, material control and accounting, waste management, transportation, nuclear nonproliferation/international safeguards, and arms control and verification. *JNMM* also publishes book reviews, letters to the editor, and editorials.

Submission of Manuscripts: *JNMM* reviews papers for publication with the understanding that the work was not previously published and is not being reviewed for publication elsewhere. Papers may be of any length.

Papers should be submitted in *triplicate*, **including a copy on computer diskette**. Files should be sent as Word or ASCII text files only. Graphic elements must be sent in TIFF format in separate electronic files. Submissions should be directed to:

Dennis Mangan
Technical Editor
Journal of Nuclear Materials Management
60 Revere Drive, Suite 500
Northbrook, IL 60062 USA

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    1. F.T. Jones and L.K. Chang. "Article Title," *Journal* 47(No. 2):112–118 (1980).
    2. F.T. Jones, *Title of Book*, New York: McMillan Publishing, 1976, pp. 112–118.
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Peer Review: Each paper is reviewed by two or more associate editors. Papers are evaluated according to their relevance and significance to nuclear materials safeguards, degree to which they advance knowledge, quality of presentation, soundness of methodology, and appropriateness of conclusions.

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Calendar

July 15-19
42nd INMM Annual Meeting, Renaissance Esmeralda Resort, Indian Wells, Calif., U.S.A. Sponsor: Institute of Nuclear Materials Management. Contact: INMM; phone, 847/480-9573; fax, 847/480-9282; E-mail, inmm@inmm.org; Web site, http://www.inmm.org.

September 3-7
PATRAM 2001, Chicago, Ill., U.S.A. Sponsors: U.S. Department of Energy, in cooperation with the International Atomic Energy Agency. Hosted by the Institute for Nuclear Materials Management. Chicago Hilton and Towers. Contact: INMM, phone, 847/480-6342; Web site, http://www.patram.org.

September 9-13
International Meeting on the Back End of the Fuel Cycle: From Research to Solutions (GLOBAL 2001), Paris, France. Sponsor: American Nuclear Society. Contact: American Nuclear Society Meetings Department, 555 North Kensington Avenue, LaGrange Park, IL 60526, U.S.A.; phone, 708/352-6611; fax,708/352-6464; E-mail, meetings@ans.org; Web site, http://www.ans.org/meetings.

September 17-21
45th General Conference of the International Atomic Energy Agency, Vienna, Austria. Sponsor: International Atomic Energy Agency. Contact: Conference Service Section, IAEA, P.O. Box 100, A-1400 Vienna, Austria; phone, 43 1 2600 21310; fax, 43 1 26007; E-mail, Official.Mail@iaea.org; Web site, http://www.iaea.org/worldatom/.

September 18-20
INMM Physical Protection Workshop, Cincinnati, Ohio U.S.A. Sponsor: Institute of Nuclear Materials Management. Contact: INMM; phone, 847/480-9573; fax, 847/480-9282; Web site, http://www.inmm.org.

September 30-October 3
NRI International Uranium Fuel Seminar, South Seas Plantation, Captiva Island, Fla., U.S.A. Sponsor: Nuclear Energy Institute. Contact: Nuclear Energy Institute, 1776 I St., NW, Suite 400, Washington, D.C. 20006-3708.

October 17-18
Nuclear Decommissioning (DECOM 2001) International Conference, London, England. Organized by British Nuclear Energy Society/ImechE. Contact: Maureen Carter, conference office, Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1P 3JJ; phone, 44 (0) 20 7222 7899; fax, 44 (0) 20 7222 4557; E-mail, m_carter@imeche.org.uk; Web site, http://www.imeche.org.uk.

October 29-November 1
Symposium on International Safeguards: Verification and Nuclear Material Security, Vienna, Austria. Sponsor: International Atomic Energy Agency in cooperation with ESARDA and INMM. Contact: Regina Perricos, Conference Service Section, Division of Conference and Document Services, IAEA; phone, 42 1 26000, Ext. 21315 or 21311; E-mail, R.Perricos@iaea.org; Web site, http://www.iaea.org/worldatom/Meetings/Planned/2001.

December 5-6
6th BNES/BNIF Nuclear Congress Conference and Exhibition, London, England. Organized by British Nuclear Energy Society/ BNIF. Contact: Andrew Tillbrook, Secretary, BNES, 1 Great George St., London, SW1P 3AA; phone, 44 (0) 20 7665 2241; fax, 44 (0) 20 7799 1325; E-Mail, andrew.tillbrook@ice.org.uk.

December 11-13
8th Annual Environment Management Nondestructive Assay (NDA) Characterization Conference, Adams Mark Hotel, Denver, Colo., U.S.A. Co-sponsored by the TRU and Mixed Waste Focus Area, the Department of Energy Idaho Operations Office, and the Institute of Nuclear Materials Management. Contact: Technical Chairman Greg Becker; phone, 208/526-9033; E-mail, gkb1@inel.gov; Web site, http//:badlands.inel.gov/tmfa/nda/overview.htm.

January 9-11, 2002
Spent Fuel Management Seminar XIX, Loews L'Enfant Plaza Hotel, Washington, D.C. U.S.A. Sponsor: Institute of Nuclear Materials Management. Contact: INMM; phone, 847/480-9573; fax, 847/480-9282; Web site, http://www.inmm.org.