# JNMM

## Journal of Nuclear Materials Management






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INMM
INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT

# The INMM Plays a Significant Role in Supporting Nuclear Nonproliferation

This year, the INMM Japan Chapter is celebrating the 20th anniversary of its founding. It was the first INMM chapter and remains one of the most active. I was honored to be invited to make a few brief welcoming remarks at the 16th Annual Meeting of the chapter in Tokyo in early December. While thinking about what to say beyond the obvious congratulations to the founding members, as well as to the current members and leaders, I reflected on the role of the INMM in supporting the international nuclear nonproliferation regime.

The control of nuclear materials is one of the few remaining barriers to the proliferation of nuclear weapons. Although technologies for producing nuclear materials are still limited and, therefore, the control of these technologies is still a worthwhile proliferation control measure, it is unrealistic to place too much faith on the barriers provided by export controls. Similarly, information regarding the design of nuclear explosives is also limited; however, the basic information is generally available and cannot be assumed to be sufficiently unavailable to prevent proliferation. Thus, as is well-recognized in the nonproliferation community, protection and control of nuclear materials is an essential element of the nonproliferation regime.

Safeguards on nuclear materials at the national and international level provide for the protection, control and accounting of these sensitive materials and assure the international community of States' commitments to nonproliferation. Institutional measures are also essential to the nonproliferation regime and work in concert with technology. Continued improvements in safeguards technology and institutional measures are key to the nuclear future. I feel it is important to emphasize a point about safeguards and the growth of declared nuclear activities such as those associated with generation of electricity: Technical and institutional measures for safeguarding declared facilities in stable regions of the world have been equal to the task of providing domestic and international safeguards as fuel cycle facilities and nuclear materials inventories have grown. (For further discussions on this point, I recommend obtaining a copy of the American Nuclear Society's Special Panel Report "Protection and Management of Plutonium.")

The dismantlement of nuclear weapons and the ultimate disposition of weapons nuclear materials also requires the responsible management of nuclear materials. The purposes here are to ensure irreversible arms reductions — to cap and reverse the nuclear arms race between the superpowers that characterized the Cold War.

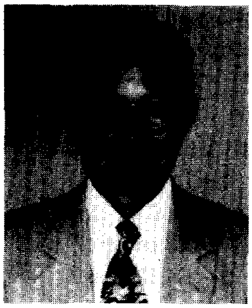
Although not directly an element of the nonproliferation regime, the responsible management of nuclear wastes and the safe packaging of nuclear materials are also important to the national and international nuclear communities and the public. Technology development and implementation play key roles here as in safeguards; however, the primary problems seem to be nontechnical in nature and suggest the need for improved education of political bodies and the public.

The management of nuclear materials in support of nonproliferation, nuclear arms control, waste management, and packaging and transportation of nuclear materials must take into account a complex mix of institutional, political and technical considerations.

The INMM was founded to promote research and development in new concepts, approaches, techniques and equipment in the field of nuclear materials management. We are a nonprofit, international, technical, professional society that is independent of governments. The institute provides a forum to openly discuss effective and efficient technical and institutional solutions to nuclear materials management issues on an international basis, and plays a role in developing a common approach to nuclear materials management around the world. The INMM's Annual Meeting in the United States (to be held next July 28–31, 1996, at the Registry Hotel in Naples, Fla.) has become an important gathering place

*Continued on page 9*

# International Safeguards Concerns Haven't Changed Much Over the Years



In this season of looking ahead to anticipated activities of the new year and reflecting back to accomplishments of the past year, I thought it might be interesting to look much further back to see what was on the minds of the people active in safeguards more than 20 years ago. William Higinbotham, who served as technical editor of the *Journal of Nuclear Materials Management* (*JNMM*) for more than a quarter century, often reviewed current concerns in his editor's column. In a column titled "Concerns Do Change" in the Fall 1974 issue, he wrote, in part:

"The prime topic of discussion this year at Atlanta was safeguarding the Egyptian reactor against diversion and sabotage, which illustrates how times have changed. Years ago the INMM constitution stated its goal as the management of nuclear material because of its high monetary value. Those who framed that constitution were, of course, concerned about diversion, too. But today, you would put diversion and terrorism away ahead of the dollar value.

"In 1969, there was a lot of talk about better measurements, new developments for nondestructive assay and about fully measured material balances. People still spoke of normal operation loss as something distinguishable from MUF. The only mention of physical security was Sam Edlow's scathing critique of transportation. Safeguards today starts with physical protection.

"This is 1974. The public is worried about nuclear safety, nuclear diversion and nuclear sabotage. The [U.S.] Congress is worried. The Atomic Energy Commission (AEC) feels the pressure and responds by issuing licensing amendments and writing guides. That puts the monkey on the back of the industry.

"The fact is that neither the AEC nor the nuclear industry has knocked itself out to prove reactor safety or to provide highly reliable protection of nuclear materials. That there have been no serious incidents so far does not satisfy the intervenors, who point out that an incident could be a whopper. To make things worse, the public associates nuclear materials with Hiroshima and with insidious, invisible radiation.

"INMM has been and is fulfilling a useful role, especially via the annual meeting. Its members work diligently and effectively on ANSI standards. And there is this journal, about which I have mixed feelings. But one might hope to encourage more dialogue between the members on the government side and those on the industry side, perhaps moderated by other members not so committed. We have some tough jobs to do together."

Sound familiar? After more than 20 years? Perhaps concerns don't change that much after all.

Thanks to the INMM International Safeguards Division, this issue features a quartet of related papers on remote monitoring. They represent not only the dialogue that Higinbotham was seeking, but a real joint effort among government officials, industry, national laboratories and an international organization — the International Atomic Energy Agency.

This issue also features the text of the plenary speech from the INMM 36th Annual Meeting last summer. The speech was presented by Kenneth Luongo, director of the Office of Arms Control and Nonproliferation at the U.S. Department of Energy, on behalf of Secretary of Energy Hazel O'Leary.

*Darryl Smith*
*Los Alamos, New Mexico, U.S.A.*

## Start Preparing Your Paper for the INMM 37th Annual Meeting

A new year has begun, and so has the planning for the INMM 37th Annual Meeting, July 28–31 at the Registry Resort, Naples, Fla. A call for papers is in progress.

The INMM Annual Meeting provides a forum for the exchange of the newest technical information in all aspects of nuclear materials management. Papers fall into one of six categories that are directly correlated to the six INMM Technical Divisions. The categories (and some possible topics) are:

- International safeguards, including advanced safeguards concepts, policy and analysis, and containment and surveillance;
- Materials control and accountability, including measurement and instrumentation, information systems, and insider protection technology and concepts;
- Nonproliferation and arms control, including transparency and verification technology, export controls, and nuclear materials management collaborations with the former Soviet Union republics;
- Packaging and transportation, including risk assessment, rules and regulations, and public concerns;
- Physical protection, including intrusion detection and assessment, entry control systems and computer security; and
- Waste management, including spent fuel storage, processing and disposing of mixed wastes, and hazardous waste management.

**Guidelines**

The INMM established guidelines for submitting abstracts, oral presentations and biographies. These guidelines must be followed in order for a paper to be considered for the Annual Meeting and are explained further in the INMM call for papers brochure. If you did not receive one, call INMM headquarters at (847) 480-9573.

**Deadlines**

- By Feb. 1, submit on disk a 200-word abstract and a short biographical sketch. Include your telephone and fax numbers. Submit to Technical Program Chair Charles Pietri, c/o INMM headquarters, 60 Revere Dr., Suite 500, Northbrook, IL 60062 U.S.A.
- By approximately March 30, the INMM will notify selected authors.
- By July 28, submit full papers to be published in the Annual Meeting Proceedings.

Questions regarding preparation of abstracts, papers and oral presentations should be directed to Pietri, (847) 252-2449; telex, 687-1701 DOE ANL; fax, (847) 252-7947; e-mail, Charles.Pietri@ch.doe.gov.

## INMM Russian Federation Chapter Cosponsors Safeguards Conference in Moscow

The INMM Russian Federation Chapter, along with the Nuclear Society of Russia and the Russian Research Center Kurchatov Institute, is sponsoring an international conference on nonproliferation and safeguards of nuclear materials in Russia, May 14–17 in Moscow.

The conference will provide a forum to exchange the newest information on political, legal, regulatory and technical aspects of nonproliferation and nuclear materials safeguards in Russia, and assess the present situation and future perspectives. Conference language will be English and Russian, and simultaneous translation will be provided for all conference events.

A call for papers is in progress. Papers are solicited on such topics as:

- Status of nuclear facilities and materials in Russia;
- Technical developments in nuclear materials safeguards, physical protection, control and accounting;
- Bilateral, regional and international cooperation in nonproliferation, nuclear materials management and safeguards;
- Nuclear export control and prevention of illegal traffic of nuclear materials;
- Role of nongovernmental organizations and mass media in nuclear nonproliferation;
- Problems and prospects of nuclear nonproliferation and safeguards after the extension of the Nuclear Nonproliferation Treaty; and
- Legislative, organizational and regulatory bases for nuclear materials management in Russia;
- Ex-military nuclear materials management and safeguards problems.

Abstracts must contain no more than 300 words and are due Feb. 1. They should be submitted to Sergei Kushnarev, RRC Kurchatov Institute, Kurchatov Square, Moscow 123182, Russia; 095-196-7300; fax, 095-196-2073. For more information, the U.S. contact is Dr. Walter Kato, Brookhaven National Laboratory, Upton, NY; 516/282-2444; fax, 516/282-5266; e-mail, kato@bnl.gov.

## INMM Cosponsors a Low-Level Radioactive Waste Technical Seminar in France

The INMM and ANDRA, the national radioactive waste management agency in France, are cosponsoring a low-level radioactive waste (LLW) technical seminar, April 23–25, at the Troyes Holiday Inn, Troyes, France.

Centered on technical issues, the seminar will provide open debate on the development and operation of new disposal capacities, facilitate exchange of views on waste conditioning methods of disposal, address all aspects of safety assessments for LLW disposal and provide the latest information on regulatory initiatives dealing with low-specific-activity wastes.

Just a few miles from the seminar site is the Centre de l'Aube (CSA) disposal facility. Managed by ANDRA, the CSA is the most modern LLW disposal facility in the world and has a nominal capacity of 1 million cubic meters. Opened in 1992, its enhanced environmental safety attributes address such distinct needs as the ability to provide long-term durability, monitoring capability and superior containment technology through the utilization of specific materials of construction, waste monitoring systems, waste handling systems, engineered modules, overpacks and an earthen cap. Seminar participants will have a tour of the facility on April 25.

This seminar will appeal to a broad range of professionals, including:

- Staff members of radioactive waste management agencies;
- Staff members of engineering firms interested in the design and construction of low-level radioactive waste disposal facilities;
- Staff members of regulatory organizations with responsibilities relating to low-level, BRC (very-low-level) and greater-than-Class-C waste management;
- Utility company personnel involved in low-level radioactive waste management activities;
- Public policy makers;
- Consultants with interest in low-level and BRC waste management activities; and
- Manufacturers of containers, high-integrity containers and overpacks.

Special seminar rates are being arranged and will include room, breakfast, lunch and gourmet dinner. The Troyes Holiday Inn is 192 km east of Paris and located in the Forêt d'Orient Natural Park in the heart of the Champagne region. The resort amenities include a championship golf course, tennis, swimming, horseback riding, archery and nature trails.

For registration information, contact INMM headquarters, 60 Revere Dr., Suite 500, Northbrook, IL 60062 U.S.A.; (847) 480-9573; fax, (847) 480-9282.

### Tentative Schedule for Low-Level Radioactive Waste Technical Seminar

**Tuesday, April 23**

Registration 7:30 a.m.–9 a.m.

**Session I: Status of Low-Level Radioactive Waste Management Programs and Policies** 9 a.m.–Noon

*Discussion of low-level and very-low-level waste from an historical perspective, definitions and charter comparisons. Current status of programs and policies from North American, South American, European, Eastern European and Pacific Rim countries.*

**Session II:**
**Low-Level Radioactive Waste Practices** 2 p.m.–5p.m.

*Brief presentations on waste classification, characterization, segregation, acceptance criteria, treatment and conditioning for disposals and packaging specifications, followed by panel discussions with representatives from Western and Eastern Europe, the United States and Pacific Rim.*

Reception 6 p.m.

**Wednesday, April 24**

**Session III:**
**Low-Level Waste Management Practices** 9 a.m.–Noon

*Brief presentations on disposal facility siting, design, safety assessment, operational aspects, closure, postclosure, monitoring and long-term surveillance, and economics of national programs. Panel discussions will follow.*

**Session IV:**
**Low-Level Waste Management Practices** 2 p.m.–5 p.m.

*National and international regulatory aspects of low-level waste management, safety principles and guidelines in the IAEA RADWASS program, review of modeling methods for near field assessment and evaluation of long-term safety, contribution of engineered barriers to long-term safety.*

**Thursday, April 25**

**Session V: Special Considerations Related to Very-Low-Level Waste/ Low-Specific Activity Waste Management** 9 a.m.–Noon

*Development of exemption principles, application of exemption principles to low-level waste disposal and recycle of waste from nuclear installations, radiological protection criteria for recycling, review of measurement technologies for controlling very-low-level radioactivity. Improvements to source codes, development of EPA radiation site cleanup and waste management regulations, regulatory impacts.*

**Session IV: Technical Visit of the Centre de l'Aube Low-Level Waste Disposal Facility** 1 p.m.–4:30 p.m.

## Divisions: MC&A

The As an experiment in electronic distribution methods for the archival copies of the INMM Annual Meeting Proceedings, the entire 1994 issue is on-line on the World Wide Web at http://www.c3.lanal.gov/inmm. [See *JNMM*, Fall 1995, pages 9-10, for more information.] At the July 1995 Annual Meeting, the INMM Executive Committee authorized this experiment in on-line access for a period of one year.

Statistics on access and usage of the INMM proceedings home page were initiated in August. The number of unique hosts accessing the home page increased from 1,000 per month in August to more than 2,000 per month in October. Hosts accessing the page are from universities, national laboratories and commercial sites worldwide. The IAEA established a pointer to the INMM proceedings on its World Wide Web page and the INMM can expect increased usage as additional organizations include the INMM Proceedings in their lists of related information sources.

*Rich Strittmatter, Chair*
*INMM Materials Control and Accountability Division*
*Los Alamos National Laboratory*
*Los Alamos, New Mexico, U.S.A.*

## Waste Management

The INMM Waste Management Division has been working on finalizing the program for the INMM Spent Fuel Management Seminar XIII, Jan. 24–26, at Loew's L'Enfant Plaza Hotel in Washington, D.C. Five sessions are planned:

- Overview of Spent Fuel Management Programs and Policies,
- Spent Fuel Storage Technology,
- Multipurpose Canister Technology,
- Spent Fuel Transportation Issues, and
- Special Considerations Related to Spent Fuel Management.

The division prepared and mailed to interested parties a preliminary announcement and call for papers for the low-level radioactive waste (LLW) technical seminar, scheduled for April 23–25 in Troyes, France. It is being cosponsored by ANDRA, the national radioactive waste management agency in France. This seminar is modeled after the Spent Fuel Seminar, and several topics will be covered:

- Status of low-level radioactive waste management programs and policies,
- Low-level radioactive waste practices,
- Low-level waste management practices,
- National and international regulatory aspects, and
- Special considerations related to very-low-level waste/low-specific-activity waste management.

See page 7 for more information.

*E.R. Johnson, Chair*
*INMM Waste Management Division*
*E.R. Johnson Associates Inc.*
*Fairfax, Virginia, U.S.A.*

## Chapters: Pacific Northwest

A half-day technical paper seminar was held Oct. 26, 1995, at the Federal Building in Richland, Wash. The seminar was designed for staff at the Westinghouse Hanford Co. who were unable to attend the INMM Annual Meeting to hear technical papers given by other Hanford people. Some of papers presented were:

- "Comparison of NDA and DA Measurement Techniques for Excess Plutonium Powders at the Hanford Site: Operator and IAEA Experience," Cal Delegard;
- "Testing Results of Phase I Vendor Glasses During Evaluation of Melter System Technologies for Vitrification of Hanford Low-Level Radioactive Wastes," X. Feng;
- "Chemical Durability of Low-Level Simulated Nuclear Waste Glasses Containing High Concentrations of Minor Components," Hong Li; and
- "Project Planning at the Hanford Site for International Atomic Energy Agency Safeguards of Excess Fissile Material," Larry McRae and Brian Smith;

An evening banquet was held at the West Richland Golf Course following the seminar. Results of the recent Pacific Northwest Chapter elections were announced:

- Chair: Scott Gority,
- Vice Chair: Don Six,
- Secretary/Treasurer: Gary Fetterolf, and
- Executive Committee: Jim Andre, Cindy Parnell, Dan Noss and Dean Scott (past chair).

*Scott Gority, Chair*
*INMM Pacific Northwest Chapter*
*Pacific Northwest National Laboratory*
*Richland, Washington, U.S.A.*

## Chair's Message

*continued from page 4*

for the international nuclear materials management community. In addition, the INMM sponsors periodic workshops, publishes the *Journal of Nuclear Materials Management* (*JNMM*), and is developing an INMM home page on the Internet.

With the management and control of nuclear materials a central element of the nonproliferation regime, and the *raison d'être* of the INMM, I feel the INMM does and will continue to play a significant role in supporting nuclear nonproliferation.

**INMM News**

The INMM Executive Committee held its fall meeting at the Registry Hotel on Nov. 7 and 8. As is normal for this meeting, we discussed and approved a budget for the INMM's fiscal year 1996, which began in October. We approved a balanced budget that includes plans for a number of workshops in addition to the 37th Annual Meeting.

In recognition of the fact that much of the support for INMM activities derives ultimately from U.S. government funding sources and the ongoing struggles in Washington, D.C., to reduce government spending and balance the federal budget, the INMM budget is (we hope) conservative. We feel strongly that INMM activities are essential to the national and international nuclear materials management community and that the Institute and its members make unique, cost-effective contributions to the protection, management and control of nuclear materials in support of long-standing U.S. and international policy commitments. Therefore, we continued to budget for those essential activities of the INMM, such as the *JNMM*, which are necessary for professional development and communications.

Overall, the Executive Committee is committed to managing the institute in a responsible fashion, with a balanced budget that supports professional, technical activities in nuclear materials management.

Finally, let me remind you who is on the Executive Committee for fiscal year 1996. Obie Amacker is vice chair, Vince DeVito is secretary and Bob Curl is treasurer. Members at large are Jill Cooley, David Crawford, Scott Straight and Marcia Lucas. Dennis Mangan is past chair. Do not hesitate to contact any one of us concerning INMM activities. (See end of column for phone numbers and e-mail addresses.)

I hope to see you at INMM workshops and the Annual Meeting.

*James W. Tape*
*Los Alamos National Laboratory*
*Los Alamos, New Mexico, U.S.A.*

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# Fissile Materials and International Security in the Post–Cold War World

■

*The prepared remarks of Hazel O'Leary*
*Secretary of Energy*
*U.S. Department of Energy*
*Washington, D.C., U.S.A.*

*INMM Annual Meeting Plenary Session*
*July 10, 1995*
*Palm Desert, Calif., U.S.A.*

*Delivered by Kenneth Luongo*
*Director, Office of Arms Control and Nonproliferation*
*U.S. Department of Energy*
*Washington, D.C., U.S.A.*

■

## Introduction

Thank you for the invitation to address the 36th Annual Meeting of the Institute of Nuclear Materials Management [INMM]. This organization provides a vital forum for discussion of the international effort to control the illicit use of weapons-usable nuclear materials and ensure the peaceful uses of nuclear energy.

It is essential that members of industry, government and international organizations be able to come together to discuss the latest developments in this vital field at events such as this.

Given the number of years this organization has devoted to the issue, the INMM must find it interesting that the control of fissile materials has become such a high-profile issue in the policy and political communities. But, this evolution in policy is a natural outgrowth of the changing world situation. While just 10 years ago the United States and Soviet Union were churning out the fissile materials needed for weapons, today these former rivals are working together, hand in hand, to corral the danger posed by these materials.

And, while it is clear that the world no longer lives on the edge of nuclear war, the nuclear danger still exists, though in a less obvious and perhaps more insidious form. It is a great challenge in this post–Cold War world to contain this nuclear threat.

It is prudent and necessary for the United States to be in the forefront of efforts to address and tame this problem. The fundamental threat posed by the proliferation of nuclear weapons and materials is a direct challenge to U.S. and world security.

President Clinton has clearly recognized the changed nature of the nuclear danger. To meet this challenge, he has labored to put in place a comprehensive and integrated plan for addressing this threat. The U.S. Department of Energy has a unique role in this effort because, as an institution with many decades of experience in fissile material matters, it is able to provide expertise and technical analyses that are essential in defining and implementing policy prescriptions.

## Nuclear Nonproliferation Policy Prescriptions

The president's comprehensive plan to prevent nuclear proliferation and reduce the danger posed by weapons-usable nuclear materials has four essential elements:

- Secure existing nuclear material stockpiles,
- Limit fissile material production and use,
- Eliminate warheads, and
- Strengthen the nonproliferation regime.

### *Secure Existing Nuclear Material Stockpiles*

The period of U.S.–Soviet military competition produced fissile material stockpiles of enormous proportions. The United States has reported it produced 994 metric tons of highly enriched uranium and 91 metric tons of weapons-grade plutonium. The Soviet Union produced on the order of 1,200 metric tons of highly enriched uranium and 150 metric tons to 200 metric tons of plutonium. In the case of the United States, some of this material was produced with such an intense focus on its end use that not all of it was accurately accounted for within the system, especially in the early days. The Department of Energy has publicly acknowledged this fact. Yet, the production of such vast amounts of weapons-usable nuclear materials brings with it a special and weighty responsibility to ensure its security. To this end, before the Cold War thaw, the United States undertook a comprehensive assessment of the means by which it protected and accounted for this material. The results were instructive and pushed our nation to strengthen the methods for addressing the vulnerabilities that were identified by this review. With the end of the Cold War, the opportunity presented itself to the United States, Russia and the other nations of the former Soviet Union, which together had created the vast majority of the world's nuclear weapons and fissile materials, to work jointly to further their mutual desire to ensure that this legacy was subject to the strictest control and accounting.

This common purpose led the United States and the former Soviet Union nations to begin work on a joint program to strengthen nuclear materials protection, control and accounting. The results have been substantial and encouraging, especially over the past 12 months.

The U.S.–former Soviet Union program to secure nuclear material stockpiles is implemented under two mutually complementary efforts. The original effort, formalized under government-to-government agreements, is an outgrowth of the U.S. Nunn-Lugar Cooperative Threat Reduction Program. Under this program, the United States cooperates with Russia, Ukraine, Kazakhstan and, beginning just recently, Belarus.

The second effort is a U.S.-Russia laboratory-to-laboratory initiative. This program, just over a year old, brings together U.S. and Russian technical experts and scientists to solve the problems associated with securing nuclear materials.

The progress made in both of these programs over the past year has been impressive. The laboratory-to-laboratory program was quick to move out of the starting gate and has resulted in the completion of a series of pilot programs and the establishment of multilaboratory teams in the United States and Russia. These teams will soon complete an integrated action plan that will define their joint work for the coming years.

The successes of this program are well-known to U.S. and Russian experts, but perhaps not to the wider community of experts. They include:

- The joint development of a materials protection, control and accounting technology system at the Russian nuclear weapons laboratory, Arzamas-16;
- The installation of materials protection, control and accounting upgrades at the Kurchatov Institute in Moscow;
- The deployment of portal monitors at high-throughput installations like Tomsk-7 and Chelyabinsk-70; and
- The nearly completed upgrades of the Fast Physics Assembly at the Institute of Physics and Power Engineering at Obninsk.

These advancements are tangible and welcome. In fact, during the May 1995 meeting of the Gore-Chernomyrdin Commission in Moscow, we toured the Arzamas demonstration, which was located in the room right next to Russian Atomic Energy Minister Mikhailov's office. It was very impressive. This joint work represents a great step forward; we thank Arzamas for its leadership in this area. We also visited the Kurchatov Institute to review the excellent work that has been accomplished at this facility. The leadership at Kurchatov deserves credit for the great vision it has shown in furthering our cooperative work. In both of these visits, I, as head of the Gore-Chernomyrdin Energy Policy Committee, represented Vice President Gore, who was unable to make the visits but aware and supportive of these examples of progress.

The progress at the Gore-Chernomyrdin Commission meeting did not end with the laboratory-to-laboratory effort. Much was also accomplished under the government-to-government framework. The United States and Russia agreed to work jointly on safeguards enhancements at five key civilian facilities possessing weapons-usable nuclear materials. The first steps will get under way next month. We also agreed to demonstrate a wide range of U.S.-supplied safeguards equipment at the Mayak reactor-grade plutonium storage facility under operational conditions.

The U.S.-Russia collaboration also expanded at the Gore-Chernomyrdin Commission meeting when the U.S. Department of Energy signed an agreement to cooperate with Gosatomnadzor, the Russian nuclear regulatory agency, on the improvement of a national-level system of materials protection, control and accounting. The department is anxious to get this collaboration underway.

Russia is not the only country where collaboration on nuclear materials security is making headway. The most publicized event in the non-Russia former Soviet Union was Project Sapphire. This international success story involved transporting 600 kg of weapons-grade uranium from Kazakhstan to the U.S. Department of Energy's Oak Ridge facility in Tennessee in November 1994. We anticipate that this highly enriched uranium removed from Kazakhstan will soon be subject to International Atomic Energy Agency (IAEA) safeguards. The United States, Kazakhstan, Russia and IAEA all collaborated to make this project a great success.

But the U.S.-Kazakhstan collaboration did not end with Project Sapphire. Work is currently focused on upgrading the Ulba fuel fabrication facility, and we hope to soon expand our work to three additional facilities at Aqtau, Semipalatinsk and Almaty.

The United States also initiated collaborative efforts with Ukraine and Belarus under the Nunn-Lugar Program. In fact, the United States recently signed an implementing agreement with Belarus to allow us to work together on nuclear materials security. There are roughly five facilities we would like to work with in these two nations.

While the Nunn-Lugar Program limits our cooperation to Kazakhstan, Ukraine and Belarus, the Department of Energy desires to broaden its work to other former Soviet Union nations. U.S. experts visited Latvia, Uzbekistan and Lithuania to discuss nuclear materials security and survey facilities for future work, and we would like to expand this effort one step further to the republic of Georgia.

As you can determine from the demonstrated results, the U.S.–former Soviet Union collaboration on securing existing stockpiles of weapons-usable materials is moving forward at a rapid pace, and the promise of future progress is bright.

*Limit Fissile Material Production and Use*

Another increasingly bright spot in the U.S. fissile materials control agenda is in the area of limiting fissile materials production and use.

The possession of weapons-usable fissile materials is the essential ingredient in the ability to manufacture a nuclear weapon. Ending the production and limiting the stockpiling and use of these materials, both military-grade and civilian, decreases the chances and opportunities for these materials to be diverted to weapons use.

Many of the initiatives in this area of limiting fissile materials are international in nature and some are controversial. One effort that has full international support is the U.S.-Russian agreement to end the production of weapons-grade plutonium and shut down all remaining plutonium production reactors by the year 2000.

This agreement was signed by Gore and Prime Minister Chernomyrdin in early 1994. In the intervening period, the Russian Federation declared that it is no longer producing plutonium for military uses. This is great news.

The agreement, however, still requires considerable attention on both sides. A key issue is how to replace the civilian energy output from the three remaining reactors once they are shut down. The United States and Russia have been working steadily on this issue for more than a year.

At the recent meeting of the Gore-Chernomyrdin Commission in Moscow, both sides agreed to implement a comprehensive approach to identifying the replacement sources of energy. The approach includes the study of the feasibility of fossil power replacements, the assessment of the feasibility of nuclear power replacements, and a first-phase study at the conceptual-design level of converting the core of the reactors so they will no longer produce weapons-grade plutonium.

The United States believes that, by studying all the options, we provide ourselves with the best opportunity to solve this difficult issue and achieve our high-priority nonproliferation objectives.

Many have considered the U.S.-Russia agreement to end plutonium production for weapons as a first step in the international negotiation to end the production of fissile material for nuclear weapons purposes. This bilateral agreement certainly does lend momentum to further progress on the international ban, and results are beginning to show. Efforts to achieve a negotiating mandate for this agreement have paid off, and we expect a chair for an ad hoc committee at the Conference on Disarmament to be named soon. However, there are clearly many political and technical questions to answer. But, our goal is clearly in sight, and we can achieve it if we remain focused.

Of course, the international fissile materials cutoff convention is not aimed at materials produced for peaceful nuclear purposes. The United States recognizes and respects the nuclear power choices that are made by individual nations. These sovereign decisions are made for sound reasons. However, there is no denying that the United States views the nuclear fuel cycle differently from other nations. The most notable examples of U.S. policy in this area are our decisions not to encourage the use of plutonium for civil purposes and our efforts to eliminate the use of highly enriched uranium in research and test reactors.

The United States has taken steps to give meaning to these policies. For example, we took the responsible action of seeking to have returned to the United States the spent fuel from reactors converted under the Reduced Enrichment for Research and Test Reactors (RERTR) Program. This has not been politically popular in the United States nor easy to accomplish. However, it is the correct policy, from a nonproliferation standpoint, and we are making progress. Additionally, we moved beyond the past scope of RERTR and expanded the program to include collaboration with Russia and China. Based on our work and conversations to date, the United States has enthusiastic partners in this effort in both countries, and we look forward to quick progress.

The U.S. policy on plutonium use has been more contentious than our policy on highly enriched uranium use. The United States took steps at home to demonstrate that, as a domestic matter, we will not use plutonium for civilian power production. The most visible example is the United States' decision to terminate the integral fast reactor program. This also was a difficult decision that was made to underscore U.S. nonproliferation objectives. Ultimately, the U.S. Congress agreed with this approach, but, again, it was a tough political fight.

However, while the United States does not encourage civil plutonium use, it has taken no steps to impose its decision on plutonium use on other nations. Still, the United States has welcomed the opportunity to exchange views with other nations on civil plutonium issues in the context of the international plutonium management discussions in Vienna. This has provided our government with insight and information on the views and motivations of other nations and, we hope, has provided other nations with an understanding of U.S. policy and objectives.

*Eliminate Warheads*

Much of the Clinton administration agenda that has been outlined so far focuses on preventing the use of fissile materials in weapons. There is another component of the agenda that addresses the flip side of the issue: dismantling existing nuclear warheads and controlling and disposing of the materials that are removed from these weapons.

Many of these activities are being undertaken jointly by the United States and Russia.

One new initiative in this area was codified at the May 1995 summit between Presidents Clinton and Yeltsin. In Washington, D.C., the two presidents issued a joint statement endorsing the transparency and irreversibility of the process of reducing nuclear weapons. This is a far-reaching initiative that will move the U.S.-Russian nuclear arms control process beyond the process of reducing nuclear warheads and into an era of warhead elimination. As a first step, the presidents agreed that fissile materials removed from excess nuclear warheads and newly produced fissile materials, including that from civil nuclear programs, will not be used to manufacture nuclear weapons. Additionally, the presidents agreed to negotiate new agreements that will allow for the exchange of information on warhead and fissile material stockpiles, reciprocal monitoring of fissile materials removed from warheads, and establishment of other cooperative measures necessary to enhance confidence of warhead dismantlement and elimination.

This new initiative is outstanding as an example of how far the United States and Russia have come in their cooperative relationship on reducing the danger posed by nuclear weapons.

Another exceptional example of U.S.-Russian cooperation is the agreement to purchase 500 metric tons of highly enriched uranium from Russian nuclear weapons. This agreement has dual nonproliferation benefit. First, the agreement assists Ukraine in becoming a non–Nuclear Weapon State and a party to the Nuclear Nonproliferation Treaty (NPT). It also allows for the conversion of a large amount of weapons-grade uranium to peaceful purposes.

Much has been written in the press about this agreement, and many of these press reports predicted a dismal future for the agreement. These reports have not accounted for the strength of the commitment to the agreement by the U.S. and Russian governments.

One underreported fact is that the agreement is on track. Two shipments of blended-down uranium arrived in the United States and 1.4 metric tons of highly enriched uranium from dismantled warheads (about 50 weapons) already are converted to low-enriched uranium for use as nuclear reactor fuel.

Gore, during his visit with Chernomyrdin, made great progress advancing this agreement. He was assisted by key members of the U.S. delegation. The agreements reached in Moscow will allow Russia to receive prompt payment for the full value of its shipments, including the value of the natural uranium. Additionally, the U.S. Enrichment Corp. will advance $100 million to Russia as a loan against future deliveries under the agreement. In return, the United States will be provided additional access to key facilities and copies of records to supplement its confidence that the blended-down highly enriched uranium is derived from dismantled warheads.

We believe this vital agreement is now on a firm footing for the future.

Not all of the U.S. efforts on warhead elimination are conducted in collaboration with Russia. The United States has also undertaken a unilateral initiative that calls for the international safeguarding of fissile material declared excess to U.S. national security needs.

Clinton announced in March 1995 that 200 tons of U.S. fissile materials were no longer needed for U.S. national security purposes. This was an historic event that signaled to the world the seriousness with which the United States views its arms control and nonproliferation commitments.

Even before his announcement, Clinton put in place a policy whereby excess fissile material was to be placed under international safeguards. Since the initiation of this policy, more than 10 tons of excess highly enriched uranium and plutonium have been placed under IAEA safeguards. At one U.S. facility in Oak Ridge, IAEA inspectors have been safeguarding excess highly enriched uranium since September 1994. At the U.S. Westinghouse Hanford facility in Washington, international inspectors have made regular visits to safeguard excess U.S. plutonium, and more plutonium will be added this summer. Additional material at EG&G Rocky Flats in Colorado will soon be added to the IAEA list. With the president's announcement, this initiative and inspection regime will grow. The U.S. Department of Energy, in collaboration with others, is examining all relevant issues and working toward an implementation plan.

Another initiative the United States has undertaken is to determine the best method of ultimately eliminating its excess fissile materials. Methods of disposing of surplus highly enriched uranium are fairly well-known. The material can be blended down to a low-enriched form that is not weapons-usable. This can be used as commercial nuclear reactor fuel.

Disposing of surplus plutonium, however, poses a greater challenge. The United States has carefully reviewed 37 different options for plutonium disposition. After a significant effort, 11 technically viable and available alternatives were identified for further study. All of these options would convert the plutonium into a form that is at least as proliferation-resistant as spent fuel (the spent fuel standard). The Department of Energy plans to have a record of decision on plutonium disposition by the end of 1996. The ultimate decision will reside with the president.

*Strengthen the Nonproliferation Regime*

All the elements of the U.S. fissile materials control agenda have been placed on a firmer foundation through the indefinite extension of the NPT. This remarkable accomplishment is a testament to the international consensus against the further spread of nuclear weapons.

The indefinite extension of the NPT also provides the United States and the world with the opportunity to take additional steps to further strengthen the international nonproliferation regime. Many of these steps are contained in the document on principles and objectives for nuclear nonproliferation and disarmament that was worked out during the course of the Review and Extension Conference of Parties to the Treaty on the Nonproliferation of Nuclear Weapons in May 1995.

The United States takes its commitments under this document very seriously and is diligently working toward key goals, such as completion of a comprehensive nuclear test ban and an international ban on the production of fissile materials for weapons.

The United States is also working to fully support the IAEA. The need to support the operations of the IAEA — financially, technically and politically — is essential if the world is to reinforce the now-permanent norm against the proliferation of nuclear weapons.

To this end, the United States has worked closely with the IAEA on efforts to strengthen safeguards through [the IAEA's] Program 93+2. The IAEA board of governors recently agreed to implement a number of important recommendations for substantially enhancing IAEA capabilities to detect undeclared nuclear activities. A second set of proposals, many of which would further expand the IAEA's ability to detect undeclared facilities and materials, are still under review. The United States warmly welcomes the decision of the board and will assist the IAEA in implementing the recent decisions. Further, we will urge Member States to support the additional measures when they are considered by the board in December. But, even with this significant progress, the safeguards community must not stop in its search for creative solutions to assist the IAEA in strengthening safeguards.

In addition to supporting the IAEA, the United States is also working closely with the IAEA on the important matter of the Democratic People's Republic of Korea [DPRK] nuclear program. The Department of Energy accepted responsibility under the U.S.-DPRK agreed framework to treat the pool in which the DPRK's spent fuel is stored and also to place this fuel in sealed cans. Preliminary activities in this effort were recently completed in the DPRK, and we expect the full-scale effort to get under way in the near future.

## Conclusion

The Clinton administration agenda for fissile materials control is clearly broad in scope, comprehensive in its objectives and ambitious when measured against past policies in this important area. It must be all these things to be effective and responsive to the dramatic changes thrust upon us by the end of the Cold War. While this agenda may not be universally accepted, and well-reasoned and significant disagreements with it have surfaced, there can be no disagreement that preventing further proliferation of nuclear weapons is something we can all endorse wholeheartedly.

It is on this unifying goal that we all must focus. We in the U.S. government cannot make this goal a reality without the dedication and assistance of the international community of experts in nuclear materials control. We need to work together to accomplish our common objective and find solutions on issues on which we may not agree.

I have been honored to be invited to present my views on this vital issue to your institute this morning. I hope our dialogue will help to advance our common objective of enhancing international security in the post–Cold War world through more effective fissile material controls.

# Remote Monitoring Safeguards for the 21st Century

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## Introduction

The 39th regular session of the International Atomic Energy Agency (IAEA) General Conference took place in Vienna, Austria, during the week of Sept. 18, 1995. U.S. Secretary of Energy Hazel O'Leary addressed the IAEA and its Member States by acknowledging the historical accomplishments that have been made over the past year to combat the proliferation of nuclear weapons and promote the peaceful uses of nuclear energy. Speaking for President Clinton, O'Leary urged the Member States to seek continued improvement in the IAEA's ability to detect undeclared nuclear activities and strengthen safeguards on all nuclear material. She called on the IAEA and its Member States to seek "bold strategies for the 21st century."

O'Leary stated that the United States stands firmly behind these goals of strengthened safeguards and nonproliferation controls and is demonstrating its commitment in many ways. She elaborated on the United States' demonstrated commitments:

- Clinton's decision to pursue a zero-yield comprehensive nuclear test ban treaty;
- Withdrawal of 200 tons of fissile materials from the defense stockpile, never again to be used for nuclear explosives;
- Bilateral cooperation, aimed at securing nuclear materials, with the states of the former Soviet Union; and
- The United States' contributions to improving IAEA nuclear safeguards.

A highlight of the conference was O'Leary's demonstration of technology that the U.S. Department of Energy (DOE) and its global commercial and governmental partners have been developing and demonstrating aimed at meeting the new challenges associated with nuclear materials security. The technology allows inspectors to transmit data remotely from unattended sensors and cameras


*U.S. Secretary of Energy Hazel O'Leary demonstrates a prototype remote monitoring system to the participants at the 1995 International Atomic Energy Agency General Conference.*

installed in nuclear facilities worldwide to their personal computers for verification of safeguards obligations. The advantages of this technology include lower cost through fewer on-site inspections, reduced worker radiation exposure, and reduced intrusion to facility operations. O'Leary presented a demonstration of the remote monitoring system to IAEA Director General Hans Blix and the heads of delegations.

## Background

The DOE and its international partners have been investigating and promoting remote monitoring's application to safeguards and transparency since 1993. The DOE helped install remote monitoring systems and initiate field trials in Argentina, Australia, Japan, Russia, Sweden, and the European Commission Joint Research Center in Ispra, Italy. Global interest in remote monitoring has been exceptional, and discussions have been ongoing with additional countries and international organizations. In the near future, additional installations and field trials will be initiated with Brazil, Finland, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials, and the IAEA. The DOE is planning a remote monitoring field trial on U.S. excess defense material at the Oak Ridge, Tenn., Y-12 site. Discussions with South Korea are positive and present a potential future DOE cooperation partner.

In March 1995, the first remote exchange of data and images from U.S. and Russian weapons-usable nuclear material storage vaults occurred. This historical achievement was presented to O'Leary, the Russian ambassador to the United States, and the press. During an interview on the Cable News Network, O'Leary stated that remote monitoring represented "the future" in nonproliferation verification and that "if it's cheaper, more reliable and less intrusive, it makes good common sense."

O'Leary met with Blix during his April 1995 visit to the United States. During their meeting, she briefed Blix on the bilateral project between the DOE and the Russian Kurchatov Institute. He was interested in the technology and invited O'Leary to demonstrate the remote monitoring system at the IAEA General Conference in Vienna.

## The Secretary's General Conference Address

During her Sept. 18, 1995, address to the IAEA General Conference, O'Leary stated:

"New strategies for nuclear security have never been more important than now. This historic year allows us to fully eclipse the shadow of the Cold War and its legacy of nuclear weapons development and production. Today, we have entered an era that is dominated by nuclear weapons dismantlement and fissile material control. ... However, while the world no longer lives on the edge of nuclear war, the danger still exists. ... Success will require a comprehensive agenda of disarmament progress, fissile material control and safeguards improvements."


*Kenneth Baker, acting director, U.S. Department of Energy Office of Nonproliferation and National Security, presents a remote monitoring overview to Hans Blix, International Atomic Energy Agency director general, (front row, center) and others.*

During her dynamic speech, O'Leary emphasized points of "disarmament progress, fissile material control and safeguards improvements" with the help of a number of interactive visual aids. These aids included U.S. news clips concerning Project Sapphire and its removal of 600 kg of highly enriched uranium from the Kazakhstan fuel fabrication facility in Ulba, and the demonstration of a tabletop remote monitoring system.

O'Leary demonstrated that the remote monitoring system would operate in an unattended mode and could, among other things, monitor the personnel entry to a nuclear material area, movement of the nuclear material, and access to the nuclear material. Using a mock nuclear material canister and a tabletop remote monitoring system that consisted of an infrared break beam sensor, load cell, and fiber-optic seal that reported via radio frequency, O'Leary proceeded to break the infrared beam, simulating personnel access. An audio annunciator connected to the system announced, "Access detected!" She then removed the material canister from the load cell. The system announced, "Material removed!" She then cut the fiber-optic seal. After a climactic pause, the system announced, "Seal open!"

That afternoon, a more comprehensive demonstration was provided to Blix, IAEA Deputy Director General for Safeguards Bruno Pellaud, and heads of delegations. This demonstration involved three elements: an overview of what remote monitoring is, a demonstration of the on-site system utilizing a mock facility, and the transfer of data from facilities around the world.

## What Is Remote Monitoring?

Remote monitoring is the transmission, via telephone, Internet, satellite, or other communication link, of information from unattended sensors and cameras installed in nuclear facilities worldwide directly to an inspector's personal computer for verifying safeguards obligations. The advantages of this technology include lower cost through fewer on-site inspections, reduced worker radiation exposure, and reduced intrusion to facility operations.

## Austria Center Nuclear Facility

A mock nuclear facility, complete with a remote monitoring system, was assembled in the Austria Center in Vienna to demonstrate the operation of the on-site sensors. The facility was designed to simulate a material storage area, in-plant material transportation system, and processing area. This design permitted demonstration of various sensors to give the audience a sense of the wide capabilities of remote monitoring. Sensors included infrared break beam, item motion sensors, microwave motion detectors, magnetic switches, load cells, temperature sensors, and electromagnetic and vibration sensors. Specific sensor alarms were used to trigger camera snapshots, which help the inspector assess the situation.


*Bruno Pellaud, International Atomic Energy Agency deputy director general for safeguards, (center of photo) is monitored by the demonstration remote monitoring system.*

## Y-12 Demonstration System

The presentation included the remote transfer of safeguards data from sensors installed in facilities in Argentina, Australia, Russia, Sweden, and the United States. To further demonstrate the system's potential, a remote monitoring system was installed at the Oak Ridge Y-12 vault, which contains excess U.S. defense nuclear material under IAEA inspections. The remote monitoring system at Y-12 included an item motion sensor, fiber optic loop seal, and camera. The transmission of data from the Y-12 sensors to the IAEA was accomplished via a VSAT satellite terminal. Images were remotely transmitted, and the audience was able to view various activities, including IAEA inspectors conducting their inspections at the Y-12 vault the week before the IAEA General Conference. During the demonstration, a satellite link was used to acquire nonvideo sensor information in real time.

*U.S. Secretary of Energy Hazel O'Leary (right) was one of the key figures at the 1995 International Atomic Energy Agency (IAEA) General Conference. She is shown here with IAEA Director General Hans Blix.*

## Conclusion

The remote monitoring activities mentioned in this paper are expanded in three other papers in this issue of the *Journal of Nuclear Materials Management*:

- "Remotely Monitoring in International Safeguards," page 19;
- "IAEA Field Trials of the Remote Monitoring System for Safeguards Applications at the Oak Ridge Y-12 Facility," page 31; and
- "Bilateral U.S. and Russian Remote Monitoring System for Special Nuclear Materials," page 36.

Quite clearly, remote monitoring will become a fundamental element of international safeguards of the future. These demonstrations and field trials will provide a very strong basis for pursuit of this objective.

*Remote monitoring technology was a highlight of the 1995 International Atomic Energy Agency (IAEA) General Conference. Among those in attendance at the conference were (from left to right) Kenneth Sheely, U.S. Department of Energy remote monitoring manager; David Waller, IAEA deputy director general for administration; U.S. Secretary of Energy Hazel O'Leary; and IAEA Director General Hans Blix.*

# Remote Monitoring in International Safeguards

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## Abstract

*In recent years, technology that permits the integration of monitoring sensors and instruments into a coherent network has become available. Such integrated monitoring systems provide a means for the automatic collection and assessment of sensor signals and instrument readings and for processing such signals and readings in near real time. This results in a significant reduction in the amount of monitoring information collected, compared with traditional monitoring systems, without loss of effectiveness. This reduction in the volume of data can, in turn, significantly reduce the effort required for review and evaluation by monitoring agencies.*

*To gain experience with the new monitoring system technology, the U.S. Department of Energy, through bilateral agreements with its international partners, has initiated a project to emplace demonstration systems in various nuclear facilities and conduct field trials of the technology. This effort is the International Remote Monitoring Project. Under this project, remote monitoring systems are being deployed around the world in an incremental manner. Each deployment is different and each offers lessons for improving the performance and flexibility of the technology.*

*Few problems were encountered with the operation of the installations to date, and much has been learned about the operation and use of the new technology. In the future, we believe systems for safeguards applications should be capable of being monitored remotely, emphasize the use of sensors, and utilize selective triggering for recording of images.*

*Remote monitoring across national borders can occur only in the context of a cooperative, nonadversarial implementation regime. However, significant technical and policy work remains to be done before widespread safeguards implementation of remote monitoring should be considered. This paper shows that an abundance of technology supports the implementation of integrated and remote monitoring systems. Current field trials of remote monitoring systems are providing practical data and operational experience to aid in the design of tomorrow's systems.*

## 1. Introduction

The continuing spread of nuclear knowledge and nuclear technology, along with continuing tensions and conflicts in certain regions of the world, has led to efforts to strengthen various international agreements and inspection regimes that support nuclear nonproliferation. One area of considerable importance to nonproliferation, and one that has been the focus of many of these efforts, is international safeguards. The need to improve the efficiency and effectiveness of international safeguards and expand the role of international monitoring and inspections in related nonproliferation activities has led to an increase in the responsibilities and obligations of the International Atomic Energy Agency (IAEA). To meet this expanded role within the practical limitations of budget and staffing, it is essential for the agency to incorporate new policies and technology in performing its duties related to nonproliferation.

In the past, agency monitoring of safeguarded nuclear activities has been based primarily on quantitative data obtained from such sources as inventories, assays, and audits. Technology has played a vital role in this monitoring and the techniques that have been used have long demonstrated their value. However, significant increases in the efficiency and effectiveness of these methods through improvements in technology, inspector training, and other methods appear unlikely. Instead, in this post-Iraq era, it appears likely that meaningful gains in the efficacy of future IAEA safeguards activities will require the introduction not only of new technology but also of new approaches for the application and use of that technology. We believe that one of the new directions that will be required in order to achieve these meaningful gains is to include as part of the agency repertory a cooperative monitoring option that offers both comprehensive scope and unlimited site access through technical means. Such a regime will not depend exclusively on quantitative measurements but will incorporate a qualitative aspect that will include confidence-building through frequent, random interrogation of the monitoring instrumentation. The activities at the monitored site would become open and transparent to all parties, leading to mutual understanding and full confidence that the declared functions of the site are correct.

## 2. Integrated Monitoring Systems

In recent years, technology that permits the integration of a variety of sensors and instruments into a coherent and organized monitoring system has become available. This technology is an extension of the computer networks and communications systems that have made such a significant impact on modern industry. The term *integrated monitoring system* (IMS) has been used to describe the employment of this network technology in on-site monitoring applications.[1] Network technology provides a means for interconnecting all elements of a monitoring system in a flexible and efficient manner.

Integrated monitoring systems provide a means for the automatic collection and assessment of sensor signals and instrument readings and for processing such signals and readings in near real time. Thus, actions such as the collection of video imagery or radiation spectra can be initiated as required to ensure a flexible and coherent response to site activities. The IMS also provides for coordinated, uniform, single-point storage of video surveillance imagery and monitoring sensor data. This offers the possibility of speeding and simplifying the retrieval of data that are recorded on-site.

By incorporating an automatic assessment capability, an IMS can reduce the collection of data and imagery related to those activities not associated with safeguarded operations. This reduction is possible while ensuring the unimpairedcollection of data required for monitoring such activities. The result is generally a significant reduction in the amount of monitoring information collected, compared with traditional monitoring systems, without loss of effectiveness. This reduction in the volume of data can, in turn, significantly reduce the effort required for review and evaluation by the monitoring agency.

The IMS consists of a system control computer; a set of nodes, each containing a sensor or other instrument; usually one or more video cameras; and communication links connecting these elements together. The communication link connecting the sensor or instrumentation nodes with the control computer is a local network. The interface of each node with the network is through a NEURON communications chip. Information is transmitted on the network using the proprietary LONWorks system of addressing and protocol. Both of these are products of the Echelon Corp. of Palo Alto, Calif.

Each node in the network contains a microprocessor that allows node-specific programming and control. All data collected by the instrumentation nodes are transmitted to the control computer, where they are stored and assessed. Video data are not transmitted over the network. Instead, as presently configured, the video cameras are linked to the control computer through independent links. The IMS control computer records only digital imagery. Upon command, video frames from the cameras are acquired, digitized, compressed, and stored by the computer.

## 3. Remote Monitoring and the International Remote Monitoring Project

Although, compared with past monitoring systems, an IMS offers a much-improved capability for on-site, unattended monitoring, it still requires on-site visits in order to retrieve the data collected by the system, verify the correct operation of the system elements, and modify the software or adjust the configuration of the system components. This requirement is not inherent, however, for the IMS provides an opportunity to remove this limitation. The IMS network provides a ready interface for transmitting system data to off-site locations and for receiving instructions for modifying system operation and configuration. Such off-site data collection and system control is termed *remote monitoring*.

Remote monitoring is not a new concept. One needs only to recall the images presented daily on the television networks to observe its practical use. Other more or less mundane examples of remote monitoring include security sensors used to monitor homes and businesses, data from remote seismic stations transmitted to various collection points around the world, and messages transmitted via satellite communication systems between dispatch stations and various vehicles. Application of this communications technology to safeguards monitoring using IMS offers the opportunity for data to be collected from any site at any time. The status of individual sensors can be polled, sensors can be turned on or off, and images can be collected from any camera at the site.

Adoption of IMS and remote monitoring by international agencies charged with the responsibility of monitoring sites for nonproliferation purposes will not occur automatically. A process of demonstration and assessment must be conducted in order to confirm the operation of such systems, verify their security and reliability, and determine the savings that actually can be obtained from their use. Experience with these systems is essential before the stakeholders in international safeguards — the State regulatory organizations, international monitoring organizations, inspectors, facility operators, and developers of the technology — can provide the technical data and policy guidance necessary for its routine acceptance. In order to gain this experience, the U.S. Department of Energy (DOE), through bilateral agreements with its international partners, has initiated a project to emplace demonstration systems in various nuclear facilities and conduct field trials of the technology. This effort is the International Remote Monitoring Project (IRMP).[2]

The IRMP involves the participation of Sandia National Laboratories (SNL) in New Mexico, Lawrence Livermore National Laboratory in California, and Oak Ridge National Laboratory in Tennessee. In addition, the project includes participation by the IAEA, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC), European Commission Joint Research Center in Ispra, Italy (JRC-Ispra), and organizations in Argentina, Australia, Germany, Japan, and Sweden. The project is expected to expand to include other IAEA Member States, other DOE laboratories, and commercial firms.

The IRMP is an important element of the DOE's International Safeguards Program. A principal goal of the project is to enhance the verification techniques available to international, regional, and bilateral organizations that support nonproliferation objectives. The project promotes the exchange of monitoring, data handling, and communication technology; the installation and testing of such technology in various types of nuclear facilities; and the collection and assessment of data obtained from the fielded systems. The project is expected to demonstrate that significant improvements in the effectiveness and efficiency of domestic, regional, and international safeguards are possible and to promote international acceptance of these new techniques.

The formally stated objectives of the IRMP[2] are to:

- examine and, through field trials, define the technical parameters related to communications protocol, digital standards, sensor and subsystem interfaces, data display and management, system and component reliability, authentication and confidentiality of transmitted data, and other areas as necessary;
- demonstrate the technical feasibility and political acceptability of remote monitoring in today's safeguards environment;
- gain international acceptance of the remote monitoring concept; and
- consider legal and institutional constraints in the universal implementation of remote monitoring.

Under the IRMP, remote monitoring systems are being deployed in an incremental manner. Each deployment is different and each offers lessons for improving the performance and flexibility of the technology. The first field trial began in Australia in February 1994. This was followed with installations in Sweden (August 1994), the United States (November 1994), Japan (December 1994), Argentina (March 1995), and JRC-Ispra (September 1995). The results of these field trials to date have been encouraging. A detailed program analysis is under way.

IRMP installations in Germany and Finland are planned in early 1996, and other installations are under consideration. In addition, a fully operational IMS has been installed at SNL. To the extent practical, the U.S. systems will contain examples of all of the detectors and video systems used in the various installations of the IRMP. Both are remote monitoring systems and used as test beds for detectors provided by the project participants.

It should be noted that significant technical and policy work remains before widespread safeguards implementation of remote monitoring should be considered. Technical work is underway in a number of areas. A large amount of information has been collected from the systems that are currently operating, and analysis of these data is under way. The results of this analysis will provide a sound basis for addressing the benefits and deficiencies of the system as currently configured and for determining the steps necessary for its full implementation by the international safeguards community.

## 4. Field Trial in Australia

In February 1994, a remote monitoring system (RMS) was installed at the dry spent fuel storage facility of the High Flux Australian Reactor, located in Lucas Heights, Australia.[3] The facility is operated by the Australian Nuclear Science and Technology Organization, and the remote monitoring activity is sponsored through a bilateral agreement between the Australian Safeguards Office and the DOE. Before inception of this project, the Australian Safeguards Office had been working with a remote video transmission system at this facility. This work was sponsored by the Australian Support Program Project for the IAEA. The new system was a logical extension of their past work.

At the Lucas Heights facility, 49 spent fuel storage tubes are kept under IAEA seals for safeguards monitoring. Agency inspectors must travel to the facility to verify that the spent fuel has not been removed from the tubes. An RMS has been installed to monitor these spent fuel storage tubes independently and without interfering with the agency monitoring. The objective of the system is to demonstrate that the spent fuel can be monitored remotely with the same level of confidence achieved by the current monitoring system but without requiring the same frequency of on-site inspection.

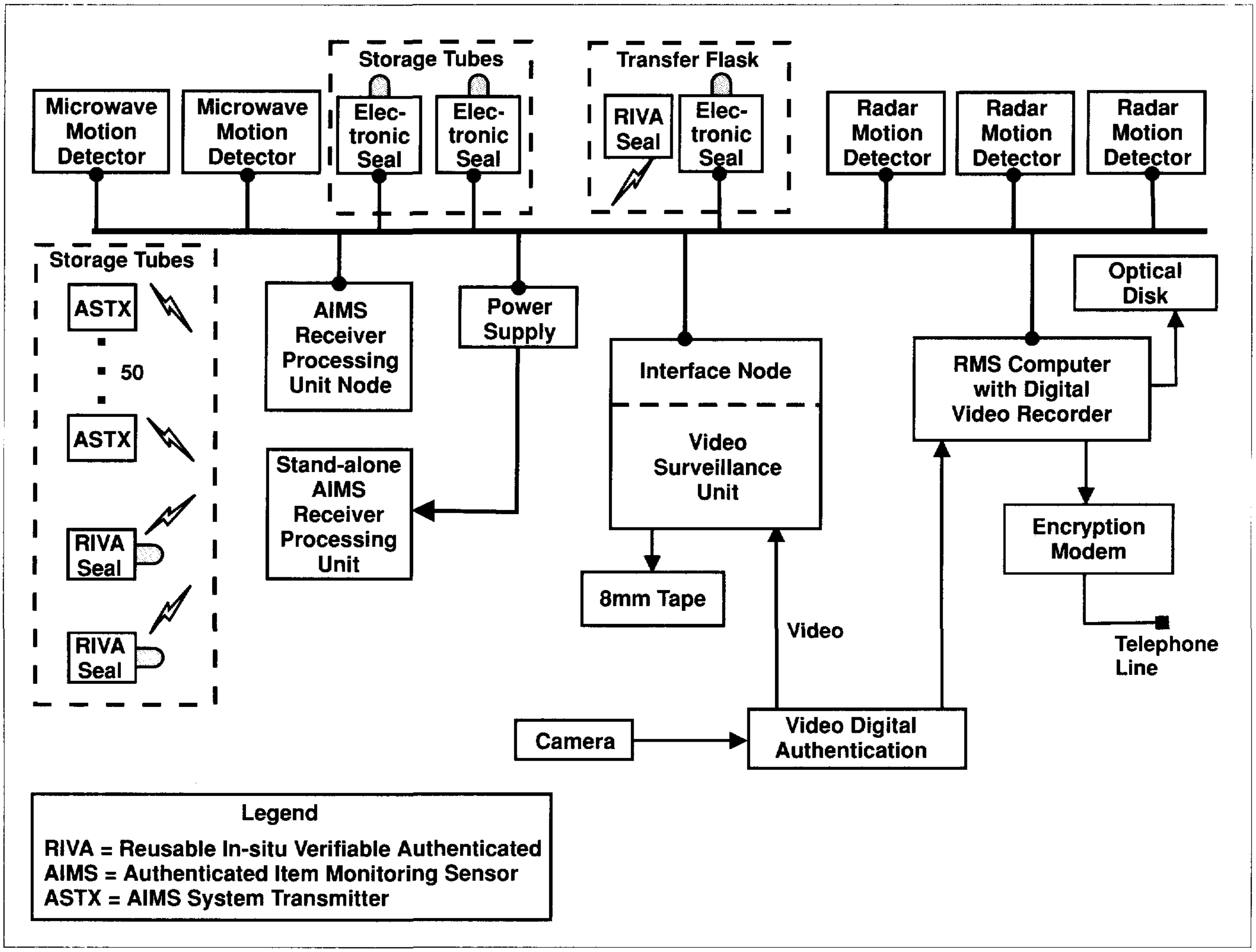
Figure 1 (page 22) shows a block diagram of the remote monitoring system installed in Australia. The IMS system includes microwave and radar motion detectors, door switch sensors, electronic seals, and item monitoring sensors. Video imagery is collected whenever any of the sensors indicate activity in the facility. To prevent collection of excessive images, a lockout period of two minutes is imposed after the collection of each image; i.e., when an image is recorded, another will not be recorded until the lockout interval has passed, even if the sensors continue to indicate activity in the facility. This ensures that the storage memory will not be filled with extraneous images.

Using a commercial telephone link, researchers at remote monitoring stations in Canberra, Australia, and Albuquerque, N.M., can retrieve data and images on demand from the RMS in Lucas Heights. For security, the data and images are encrypted before transmission. Access to the RMS computer and the transmitted data cannot be obtained without the correct encryption keys and passwords.

The RMS in Australia has been operational for almost two years. During this period, the system has been interrogated regularly from both of the remote monitoring stations. The authenticated item monitoring sensor (AIMS) motion sensors have been found to be excessively sensitive; e.g., they routinely produce triggers when site personnel walk through the storage room. This has resulted in a significant number of nuisance alarms. In the next system upgrade, the sensitivity of these sensors will be reduced. Otherwise, the system sensors have performed as designed, and, except for a brief period of power loss that exceeded the system backup power time limit, the images triggered by the sensors and retrieved over the telephone connection have recorded all activities that have occurred in the facility since system installation.

The system was upgraded in the spring of 1995. In this upgrade, the encryption modem that was included in the original installation was replaced with a standard modem and encryption software was installed. An improved version of the system operational software also was installed. In addition, difficulties with lost images, experienced during the early part of 1995 and believed to be caused by a bad cable, were corrected. Since this upgrade, intermittent communication difficulties have been encountered and are being investigated. They are believed to be caused

**Figure 1: Block diagram of the remote monitoring system in Australia**



by a modem mismatch. A detailed report on these field trials is in preparation.

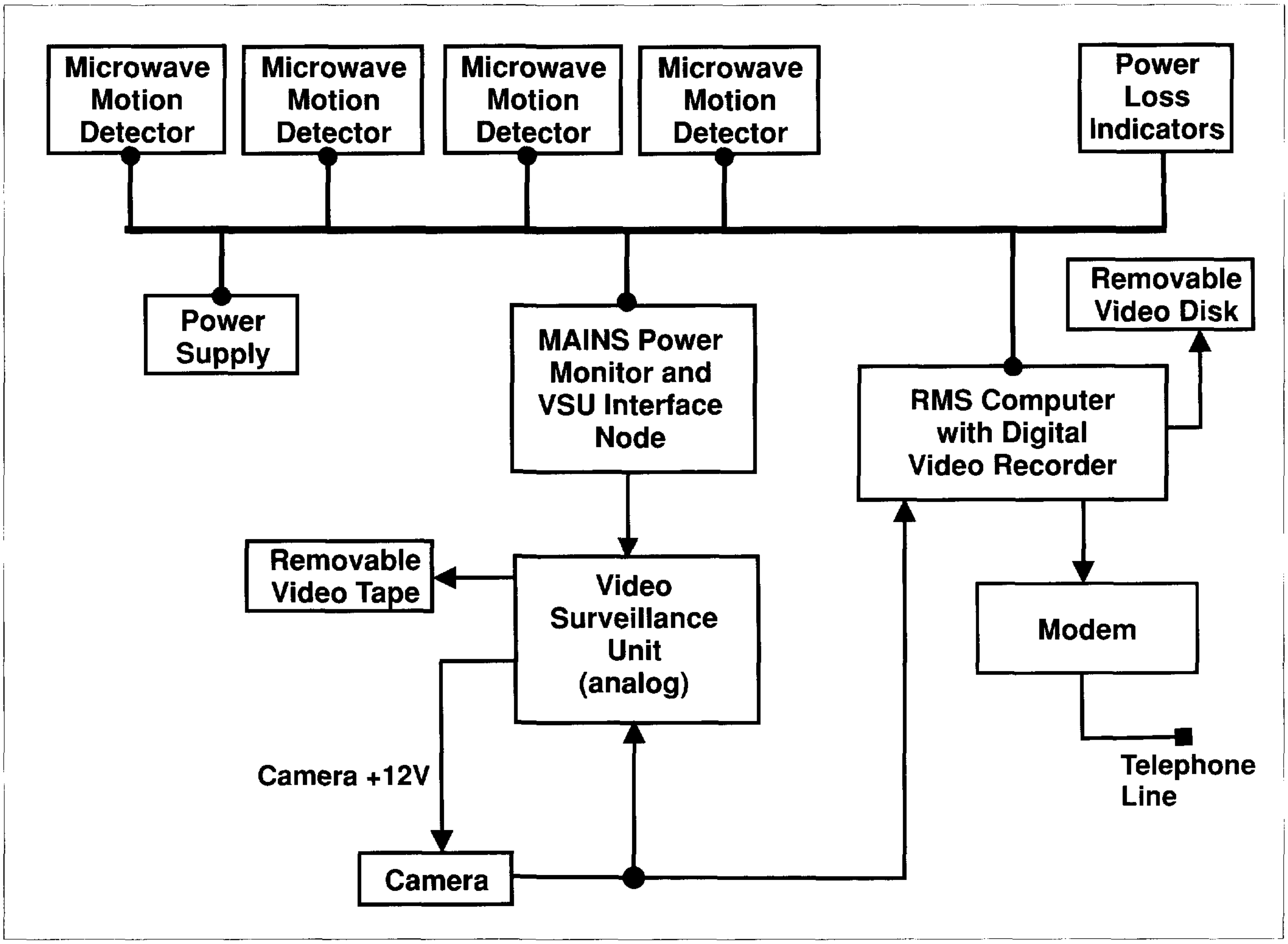
The Australian Safeguards Office has prepared a draft upgrade plan for the RMS and discussed the plan with the IAEA. This upgrade is expected to extend the scope of the field trial to include IAEA participation and is aimed toward ultimate acceptance of the system by the agency for safeguards use. The next upgrade activities are expected to commence in the spring of 1996.

## 5. Field Trial in Sweden

In August 1994, an RMS was installed for field trials at the Barsebaeck light water reactor facility in Sweden.[4] This RMS was designed to test a number of concepts expected to be useful for unattended remote monitoring activities at power reactor stations. The purpose of the Barsebaeck installation was to monitor spent fuel handling activities in the reactor hall. To accomplish this, a set of microwave motion sensors was installed to monitor activities in the reactor high bay and to monitor the use of the overhead crane by which the transfer flask is moved for spent fuel handling operations. In addition, a video camera was installed to observe the spent fuel handling operations, and a power monitor was added to detect loss of site power. Figure 2 (below) shows a block diagram of the RMS installed in Sweden.

The motion detectors trigger the recording of digitized, compressed video images by the system control computer. The mains power monitor uses the network communication link to send data to an alarm box to report loss of site power. As a means of comparison with the triggered image record, a video surveillance unit — an analog, time-lapse video recorder system — has been installed to provide a record of all activities in the reactor hall. Images are recorded by this unit at six-minute intervals, whether or not activity is detected in the reactor hall. In addition to transmitting signals from the microwave motion sensors to the system control computer, the network sends the trigger signals to the analog recorder, and a special image recording is made by this unit when motion is detected. Thus, triggered images are available from both the analog and the digital recorders. The analog recordings are made

**Figure 2: Block diagram of the remote monitoring system installed in Sweden**



on 8-mm videotape using the same data format as that used by the modular integrated video system, a standard surveillance unit fielded by the IAEA. These analog recordings can be reviewed in the same manner as other IAEA video surveillance tapes. This provides a particularly useful comparison between the data review requirements of these monitoring systems.

Data and images from the area under surveillance can be retrieved on demand via commercial telephone lines from the Swedish Nuclear Power Inspectorate headquarters in Stockholm, Sweden, and SNL. As with the Australian system, all data communications on site are authenticated and all off-site communications are encrypted. Access to the system through the off-site link requires a password and decryption key.

All spent fuel movements at Barsebaeck have been successfully imaged by the RMS since its installation. The sensor network and digital recording system have effectively screened out thousands of images that the time-lapse system recorded. Reducing the number of images recorded reduces the amount of time that is required to transmit and review the data and images. An example of the data reduction that has occurred can be illustrated by the fact that only 47 images were captured by the RMS during its first month of operation at Barsebaeck. In the same time period, the time-lapse recorder collected approximately 14,400 images on two recorders. The number of images to be reviewed was reduced by a factor of more than 150 (or 300, if both analog tapes had to be reviewed). During this period, no spent fuel activities occurred in the facility.

Spent fuel was moved out of the Barsebaeck reactor during October 1994. The movement of one spent fuel transfer flask into and out of the reactor hall took approximately 49 hours. During this 49-hour time period, the analog recorder collected about 1,000 images. In the same period, the RMS received 272 triggers from the four microwave sensors and, in response to these triggers, 141 images were recorded. There were 86 images associated with triggers of flask loading and crane movement activities. This left only 55 images to be reviewed to determine the times of flask entry and exit from the reactor hall.

The RMS in Sweden has been operating successfully for 16 months. It was upgraded in the spring of 1995 with the installation of a standard modem and encryption software, as well as a new version of the system software. Further upgrades to this system are planned during 1996.

## 6. Field Trial in the United States

A remote monitoring test bed has been established at the Idaho National Engineering Laboratory, Idaho, under the sponsorship of the DOE. The project work is being performed as part of the Modular Integrated Monitoring System (MIMS) Program. Under this program, sensors and instrumentation are to be provided for test and evaluation by DOE laboratories, cooperating international partners, and private industry. The test bed uses the Echelon-based IMS network as its basic monitoring architecture and provides remote monitoring access through a commercial telephone link.

An initial experiment using the test bed was performed in November 1994. The experiment involved a variety of sensors provided by different DOE laboratories. These included indoor and outdoor cameras, nuclear sensors, vehicle monitors, door monitoring sensors, intrusion detectors, stack effluent emission and meteorological sensors, motion sensors, and other instruments. A block diagram of the initial test system is shown in Figure 3 (opposite page).

For the purposes of the experiment, remote monitoring stations were established at a remote location on the Idaho laboratory site and at SNL. Some limited data fusion was performed in which data from several sensors were combined logically to provide robust data analysis, and the ability to have the site initiate contact with the remote sites upon receipt of certain alarms was added. In the initial tests, data from all sensors were correctly transmitted and recorded. Video images and auto-dialer alarms were properly transmitted, received and displayed. The test successfully demonstrated the use of a variety of sensors and camera placements, triggering of video image collection, on-site data recording and display, and remote retrieval of data and images.

This initial test was the first of many anticipated under the MIMS Program. As this system matures, it will continue to provide modular interface capability to incorporate new types of sensors, increased data fusion, and improved sensor and system output display. Improved data authentication and data encryption will also be tested using this installation.

## 7. Field Trial in Japan

In December 1994, under the cooperative agreement between the DOE and the Japan Atomic Energy Research Institute (JAERI), an RMS designed for purposes of test and evaluation of hardware and systems operation was installed at the JAERI Safeguards Technology Laboratory in Tokai-Mura, Japan. This system consists of a data acquisition system with digital video storage, a network of sensors, video camera, and data and image review station. The review station was installed in a laboratory adjacent to the system hardware. A simulated remote link was established with this monitoring station at JAERI and a link was established with SNL. Both links use commercial telephone lines. This configuration allows both JAERI and SNL to access and evaluate the system data. A block diagram of the system is shown in Figure 4 (page 26).

The Japan field trial will include JAERI evaluation of the RMS sensor interfaces, digital standards, system reliability, and user interface. JAERI plans to add sensors to the network and also will investigate the possible installation of the RMS equipment in an operational nuclear facility in Japan. The latter will provide an opportunity to evaluate the system under realistic operational conditions.

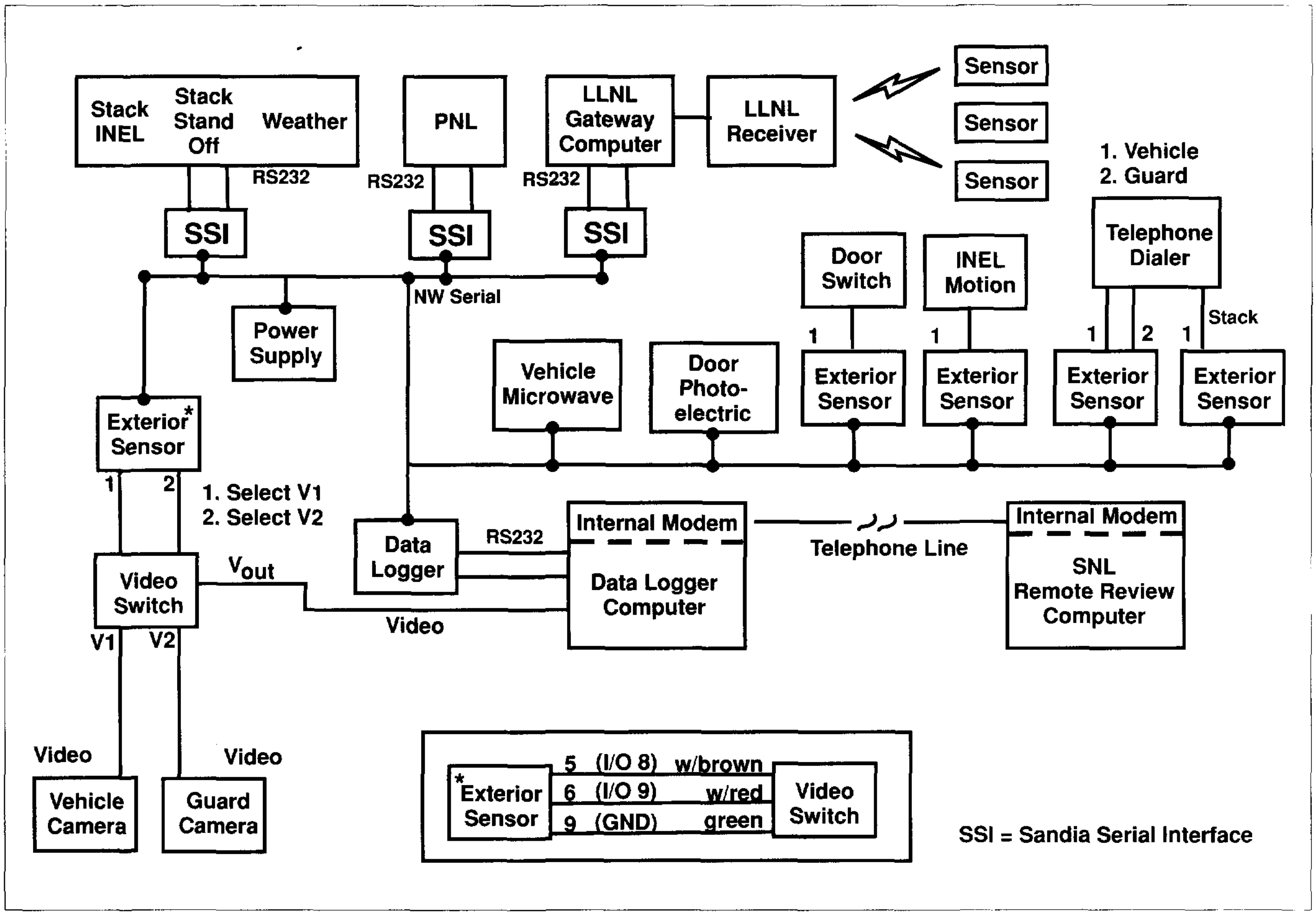
## 8. Field Trial in Argentina

In March 1995, under the cooperative agreement between the DOE and the Argentine Comission Nacional de Energia Atomica, an RMS was installed at the Embalse Nuclear Power Station located in Cordoba Province, Argentina.[5] The system monitors the safeguards conditions of four typical CANDU spent fuel silos located in a storage area at the reactor site. The silos are under the safeguards control of both the IAEA and ABACC and the regulatory control of the Ente Nacional Regulador Nuclear (ENREN). The RMS has been emplaced with the approval and cooperation of each of these organizations, as well as the facility operator, and personnel at all of these organizations are closely following the progress of the field trial.

The monitoring equipment for each silo consists of an AIMS motion sensor, analog temperature and gamma radiation sensor, and active fiber optic seal. The motion sensors and active seals will detect whenever the seal plug for the silo instrumentation tube is removed. The radiation sensors measure the radiation environment in the instrumentation tube to verify the presence of the spent fuel in the silo, and the temperature sensor provides data to support the field evaluation. Because of temperature effects on the radiation detector electronics, the temperature data also are used to correct the radiation data. The AIMS unit provides periodic state-of-health reports to the system control computer. All silo instrumentation is battery operated. A block diagram of the system is shown in Figure 5 (page 27).

All sensor data are transmitted from the silos to two AIMS receiver processing units mounted on the roof of the adjacent reactor service building. The transmissions use the AIMS authenticated radio-frequency (RF) link. One receiver unit transmits the data to an on-site recording system for use by the IAEA. The other receiver provides the data to a system control computer, which provides both data storage and access to an off-site communication link. Because there is in effect only a single node in the system, no computer network is required. Remote access to the data is available through a commercial telephone link with the system control computer. At present the data are being accessed by the ENREN offices in

**Figure 3: Block diagram of the U.S. remote monitoring system**



Buenos Aires, Argentina, the ABACC offices in Rio de Janeiro, Brazil, and SNL.

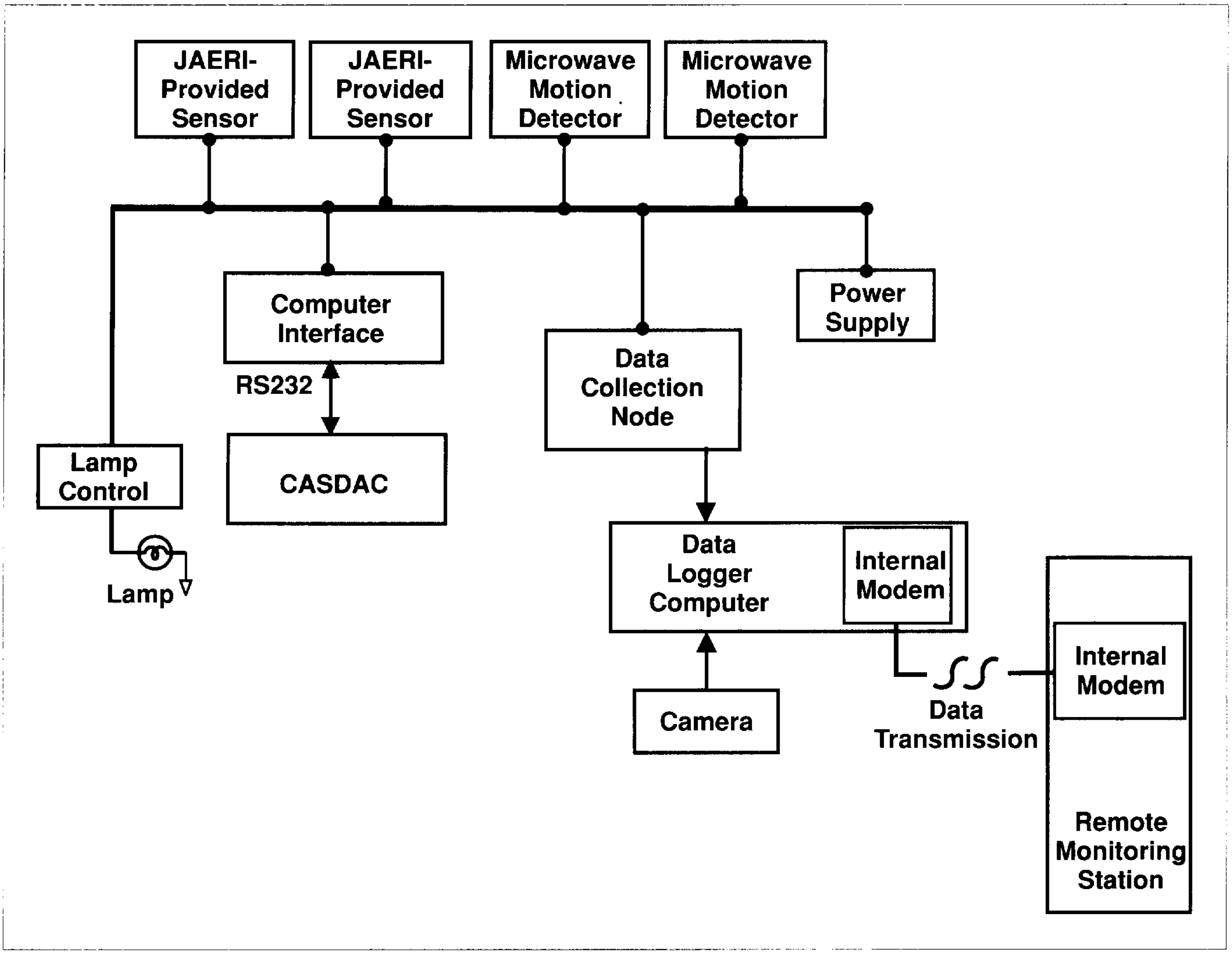
The data are currently being evaluated by the IAEA and ABACC to address a long-standing safeguards objective of being able to verify the spent fuel containment without requiring physical access to the seals located on top of the silos. Following the RMS installation, all system features performed as expected. Two different radiation sensors are in place, one of which is solid state. As expected, the solid-state detector has suffered a steady decline in efficiency because of cumulative radiation damage to the sensor.

Since the installation, communication difficulties have been encountered periodically. At the present time, these difficulties appear to be caused by a mismatch between the modems used for the communication link. A system upgrade is anticipated sometime in 1996, during which the modems will be changed, and the communication problems are expected to be resolved. Further, the system will be expanded to include monitoring the transfer of spent fuel from the facility storage pond to the outdoor silo storage area.

## 9. Field Trial at JRC-Ispra

In September 1995, under the cooperative agreement between DOE and the European Union, an RMS was installed at the JRC-Ispra Laboratory for Surveillance and Containment. The principal objective of this cooperative effort is an exchange of technology related to integrated monitoring systems and remote monitoring. RMS software was installed on two JRC-supplied computers. One computer serves as a system data acquisition system, while the second serves as a data and image review station. SNL-supplied microwave, photoelectric, and vibration sensor nodes that were set up and interfaced to a JRC-supplied computer through an RS232 interface. A block diagram of

**Figure 4: Block diagram of the Japan remote monitoring system**



the JRC system is shown in Figure 6 (page 28).

During the installation, a problem was encountered with the JRC internal telephone system. Internal back-to-back testing of the system could not be accomplished. External calls also were blocked because the modem did not recognize the password. The problem was caused by the characteristics of the JRC internal telephone system, which uses a three-beep dial tone that the modems would not recognize. The communications problems were resolved, and field testing is now underway.

## 10. Installation of Monitoring Stations at the IAEA

The IAEA has been kept informed of all IRMP plans and installations. With approval of the participating partners, analyzed data have been and will continue to be supplied to the agency. Thus, agency personnel are aware of the project and its objectives and will soon be able to gain practical experience in the use of the RMS.

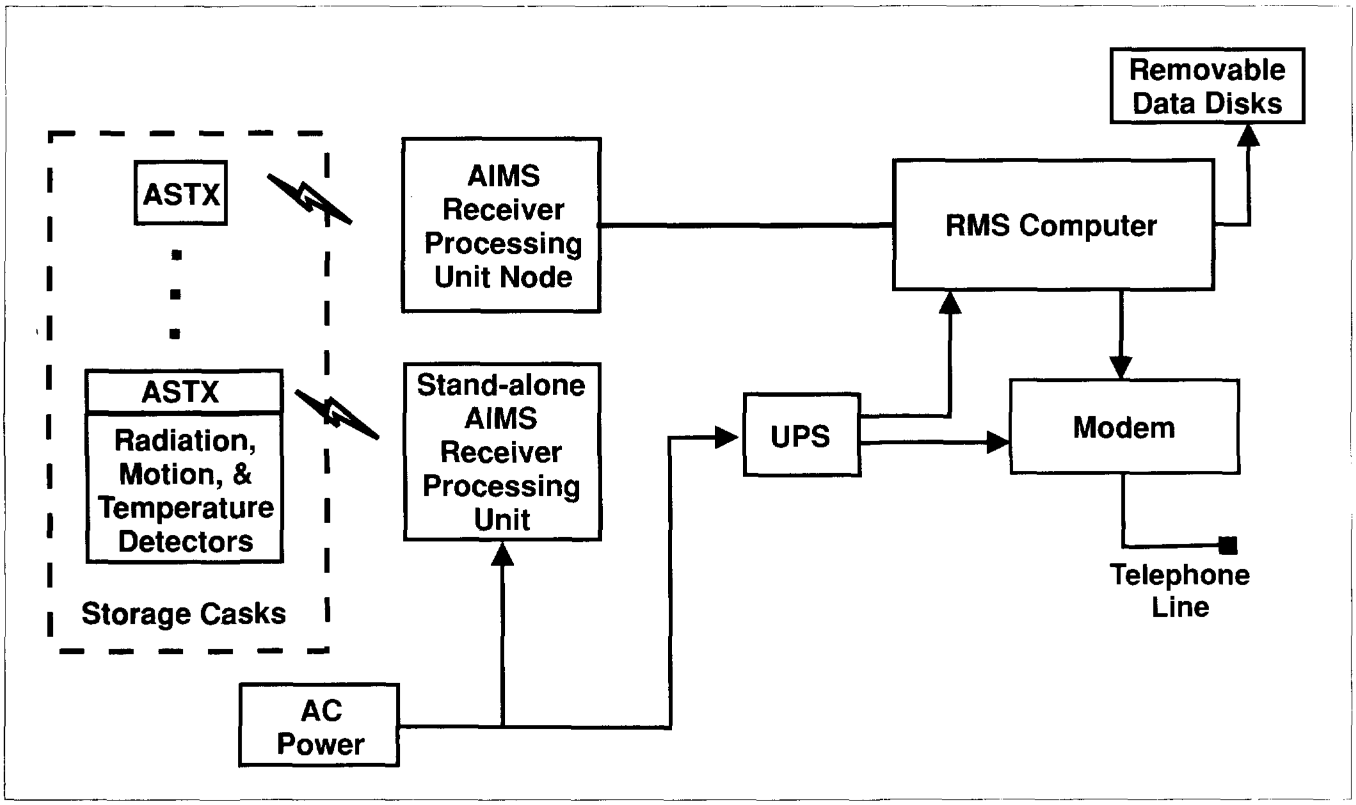
As part of the incremental process planned for the IRMP, several data and imagery review stations are scheduled to be installed at IAEA headquarters in Vienna, Austria, in early 1996. With these stations, agency personnel will be able to commence direct retrieval and evaluation of data from those IRMP field trial sites that the participating partner has approved for agency access to the site data. It is anticipated that this access will lead to queries and constructive comments or recommendations from all participating partners that will help make the systems more practical and safeguards-relevant.

## 11. Future Safeguard Systems

Although very few problems have been encountered with the operation of the IRMP installations to date, much has been learned about the operation and use of the IMS and of remote monitoring. As indicated previously, software upgrades have been installed at several sites. Other needed improvements have been identified and efforts are under way to address them. The RMS field trials can provide valuable information on how to design tomorrow's safeguards systems. Of course, while the technology for remote monitoring exists today, it may be some time before the numerous policy constraints on remote monitoring can be resolved to make such monitoring possible on a worldwide basis.

A number of development programs that address future technology needs for RMS systems are planned or are under way at present. These needs include analysis and development work related to system and component vulnerability assessment, equipment reliability, improved interactive display equipment, authentication and encryption key management, technical comparisons among alternate communications modes, information management, data format standards, information screening for decision

**Figure 5: Block diagram of the Argentina remote monitoring system**



making, advanced data and sensor integration, advanced communications methods, and increased network architecture flexibility.

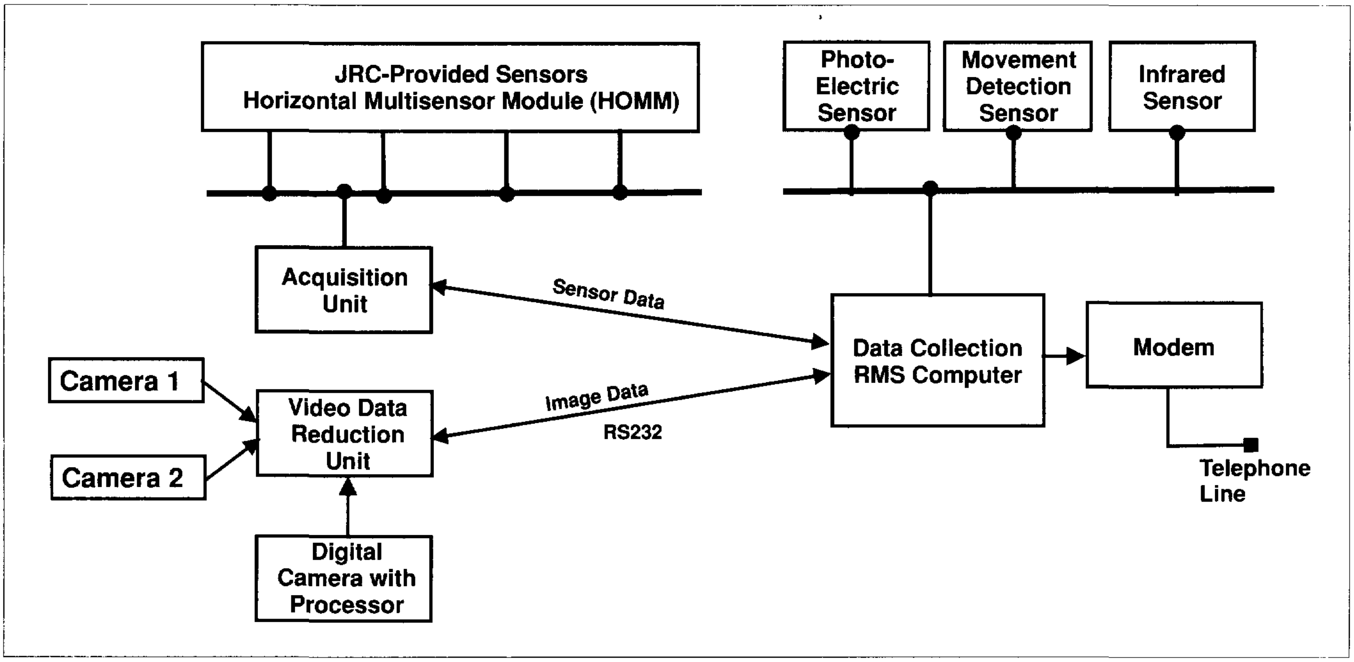
Data management, including presentation of data and imagery for analysis and reporting, will present a significant technical challenge when a large number of facilities are monitored. In the data-rich environment that will exist from the extensive use of IMS systems, inspector analysis of the data must be based on sophisticated screening and effective presentation of the data. Methods for converting the monitoring data into knowledge for making decisions and reaching conclusions exists only in rudimentary form at present but will become essential in the future.

Authentication of data and images in safeguards systems has always been of concern, but new technology is now available to help address this concern. The LONWORKS network includes an authentication feature for all information transmitted on the network, and other network authentication schemes are either available or under development. The video data that are not transmitted over the network require independent consideration. New technology will provide the ability to digitize images in the camera housing, apply an authentication algorithm to the resulting image file, and transmit the authenticated image file on a serial digital link to the system computer.

The block diagram in Figure 7 (opposite page) shows some of the key features that should be part of a complete approach to remote monitoring.[6] However, the block diagram does not show some of the important software programs and related data formats necessary for total system integration. Some of these key features are:

- Front-end detection: A network of sensors provides the capability of collecting trigger signals from a number of different types of sensors. Since the network can contain microprocessors at every node, distributed processing of sensor signals before they are transmitted to an acquisition and storage module is possible. If the proper sensor suite is installed to trigger the capture of video images, then the number of images to be stored will decrease significantly.
- Image compression and authentication module: Camera images must be authenticated to ensure that substitution has not occurred. The function of a data compression and authentication module is to capture and digitize a video image, compress the resulting file, and authenticate the file before sending it over a serial link to the acquisition and storage module.
- Removable information module: This module should provide a means for on-site data and image removal. Optical disks provide compact, high density, removable media and have many advantages over the various tape formats. It is also possible to use removable hard disks but, at the present time, cost seems to be against their use.
- Acquisition and storage module: The data and images are collected and stored by this module. An embedded computer in the module would perform authentication and encryption on all the collected data and images. Thus, standard modems could be used to communicate over various links, such as telephone, satellites, or the Internet.
- Data review: An information collection station could

**Figure 6: Block diagram of the JRC-Ispra remote monitoring system**



be part of a remote monitoring review center. Trained operators could call and collect remote information in encrypted files and send the files to a network server for storage. Inspectors could then access the stored files by obtaining the encryption keys from a key management unit and going to a data and image review station to review the data.

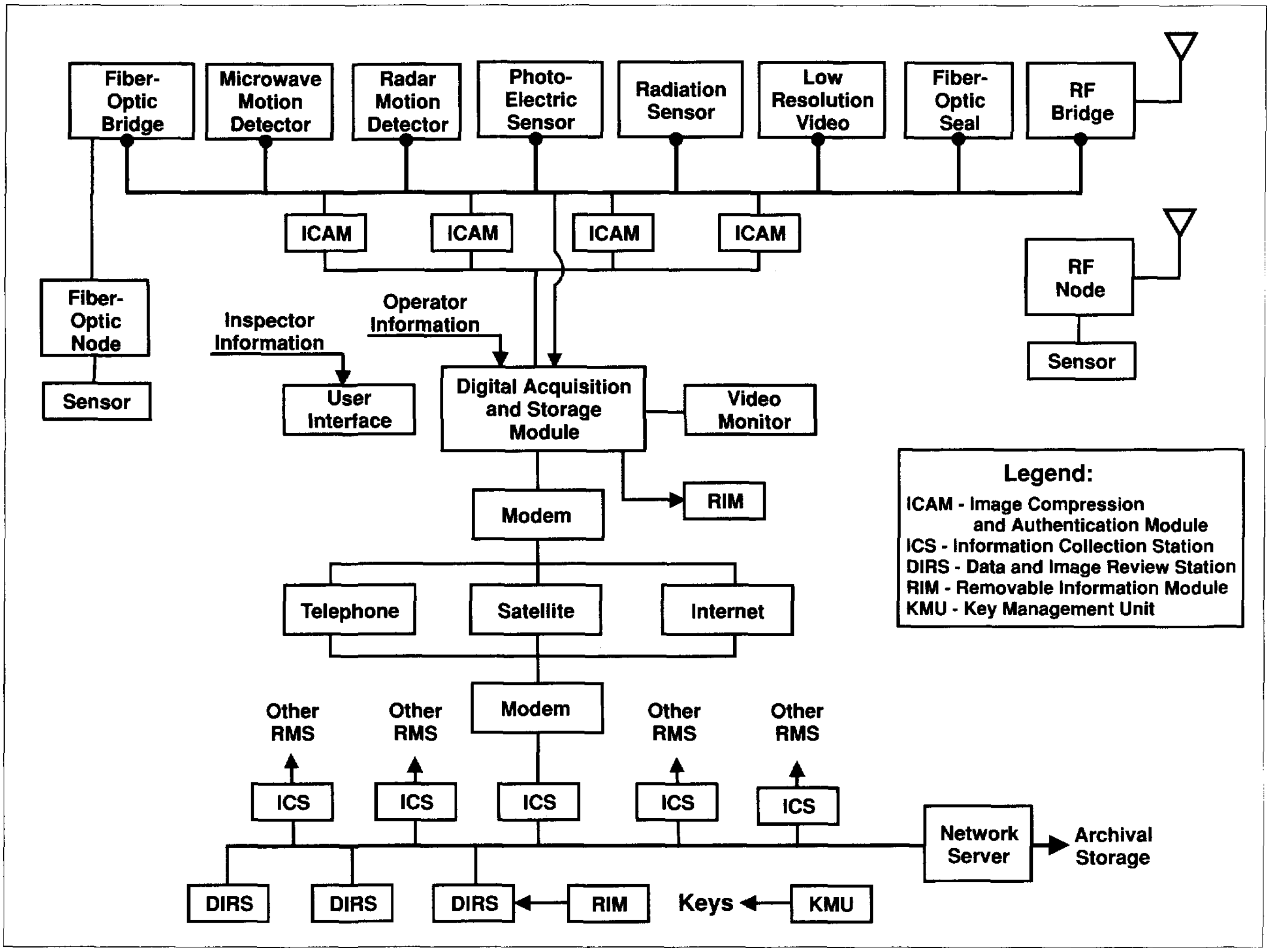
Much work remains to be done before the level of technical sophistication in remote monitoring envisioned here is achieved. However, building on the experience gained with the IRMP, the United States and its partners are pursuing various technology development programs. Regular meetings of the IRMP participants are held in order to compare experiences, to assist in data analysis, promote discussions of future requirements, and draw conclusions and recommendations about the further course of the project.

## 12. Implications of Remote Monitoring

One of the most important aspects of remote monitoring is the potential constraints related to the transmission of data out of a facility or beyond national borders. This has been a long-standing issue directly related to the rules and rights of worker associations and national sovereignty. Approval of remote monitoring at safeguarded sites cannot be imposed upon the host. Thus, it is quite clear that, in a practical sense, remote monitoring across national borders will occur only in the context of a cooperative, nonadversarial implementation regime.

If remote monitoring is used for safeguards purposes, it is generally assumed that the transmitted data must be encrypted. It then becomes important to consider the form and process of such encryption. The entire subject of encryption for IAEA application, and the use of keys and data security procedures, requires careful examination. Another issue related to data transmission is that of facility or State access to the information transmitted. In most cases, current IAEA practice denies access to safeguards data by the facility or State in which the safeguard activities are performed. Transmission of safeguards data

**Figure 7: Future remote monitoring system features**



introduces new concerns regarding the facility or State access to the data acquired by the IAEA. This problem is related to the degree of openness that will be required in the remote monitoring regime.

The overall cost effectiveness of remote monitoring must be evaluated in order to determine its merits in relation to current safeguards techniques. This will require an assessment of the extent to which on-site inspections, materials inventories, and other traditional labor-intensive safeguards activities will be affected by the implementation of remote monitoring. Resolution of this issue requires that another very important problem be addressed: To what extent can acceptable safeguards assurances be achieved through acquisition of data from remote monitoring combined with a reduced level of on-site inspection?

This discussion on the implications of remote monitoring to international safeguards is not intended to be exhaustive. It simply illustrates the fact that the use of remote monitoring in international safeguards is a complex subject.

## 13. Conclusions

There are many significant issues that must be addressed before remote monitoring will be accepted by the responsible agencies and the host countries. When these issues are addressed and resolved, however, the authors believe remote monitoring will contribute to an acceptable verification regime that permits an effective compromise among the international concerns about nonproliferation, competition within the burgeoning nuclear industry, and the fiscal and labor constraints placed on the responsible monitoring agencies.

As this paper indicates, an abundance of technology supports the implementation of integrated and remote monitoring systems. However, there are a number of challenges in the areas of standardization, tamper resistance, authentication, encryption, data processing and display, and others. Equally important, the subject of remote monitoring is heavily influenced by issues related to State sovereignty, facility transparency, and safeguards requirements. While remote monitoring technology exists today, it may be some time before the numerous constraints, technical and policy, can be resolved. The IRMP, involving a number of IAEA Member States, is aimed at helping to resolve these issues.

In the past several years, particularly since the commencement of inspections in Iraq, there have been significant changes in the functions and procedures of the IAEA. This has occurred simultaneously with continuing economic constraints imposed on the agency. Within this environment, it is perhaps appropriate to reflect on the future direction of nuclear safeguards. The traditional monitoring techniques have shown their merit. However, future IAEA safeguards systems could rely more heavily on a comprehensive, transparent, and open implementation regime. Within such a regime, one important element will be remote monitoring using integrated monitoring techniques. Once confidence is established with remote monitoring systems, and other factors such as data transmission across State boundaries are resolved, such techniques could provide for increased efficiency and effectiveness of IAEA safeguards.

As the IAEA and the international safeguards community address the current safeguards procedures and criteria, it is necessary to realize that technology can make significant contributions to the goals of safeguards. However, it is doubtful that these contributions can be realized to their maximum benefit unless much more importance is placed on qualitative parameters. Current field trials of remote monitoring systems are providing practical data and operational experience to aid in the design of tomorrow's systems. The technical performance data gained with the present systems will provide the insight needed to develop the equipment that will operate reliably as part of the next generation of safeguards.

## Acknowledgment

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# IAEA Field Trials of the Remote Monitoring System for Safeguards Applications at the Oak Ridge Y-12 Facility

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## Abstract
*The International Atomic Energy Agency (IAEA) has monitoring tasks associated with monitoring the status of nuclear materials stored around the world. In support of the IAEA, the U.S. Department of Energy (DOE) has been developing and applying technologies that can enhance the efficiency of the inspectors for various facilities. The DOE has had an International Remote Monitoring Program (IRMP) to support demonstrations with several bilateral agreements between the U.S. and other countries. The DOE demonstrated the IRMP during the 1995 IAEA General Conference, Sept. 18–20, in Vienna, Austria. A facility at the Oak Ridge, Tenn., Y-12 complex was configured to allow for satellite transmission of data to the IAEA. As a result of the General Conference demonstrations, the DOE and IAEA have developed a plan for a field trial to be conducted by the IAEA to evaluate the technologies associated with the remote monitoring system.*

## Introduction
The International Atomic Energy Agency (IAEA) and the U.S. Support Program are conducting a series of field trials to evaluate the application of remote monitoring to routine IAEA safeguards. The project's first phase involved a remote monitoring demonstration given by U.S. Secretary of Energy Hazel O'Leary to IAEA Director General Hans Blix and the heads of delegations during the IAEA General Conference on Sept. 18, 1995, in Vienna, Austria. Secretary O'Leary's demonstration included satellite transmission of data from a prototype remote monitoring system installed at the Oak Ridge, Tenn., Y-12 vault, which stores U.S. fissile material no longer used for defense purposes. In addition, a mock nuclear handling facility complete with remote monitoring system was constructed in the Austria Center in Vienna to allow interactive demonstration of the system and sensors to the conference attendees. This report describes the two demonstration systems, their operational performance, and concluding remarks.

## Oak Ridge Y-12 Facility
*System Description*

The remote monitoring system (RMS) deployed at the Y-12 vault consists of five basic systems:

- Safeguards sensors (including video),
- Data collection network,
- Data acquisition system,
- Remote communication system, and
- Data and image review station.

Figure 1 (page 32) shows the interconnection of the system components.

The authenticated item monitoring system (AIMS) item motion monitors were deployed on the end of the tray. In this position, the sensors will detect movement of the tray if an attempt to access the material is made. The sensor will signal both the start and end of motion to the network via an authenticated radio frequency (RF) path.

The AIMS fiber optic (FO) seals were deployed as a seal to detect access to the individual tube. The FO seal will trigger an event action if the fiber cable is broken. The FO seals function as a perimeter or boundary monitoring device. The AIMS FO also transmits via an authenticated RF path.

The image frame capture component consists of a camera mounted near the corner of the aisle providing a field of view that is across the end of the tubes. In this field of view, the image will capture personnel access to the tube if one of the sensors is triggered either by motion or the breaking of the fiber optic cable. A sample image from the system is shown in Figure 2 (page 33).

The data acquisition system (DAS) performs the logging of event data, as well as the digitization and storage of the video images. It also provides for remote access to the data. The data are archived on a Bernoulli disk as well as a backup disk. The Bernoulli disk was selected for the demonstration phase to ease the issues of classification.

The remote access is provided through a satellite communications link using commercially available software for remote access via the disk operating system (DOS). The satellite provider is Comsat/RSI. Comsat provides the service via a VSAT system using a 1.2-meter antenna with all electronics mounted on the antenna feed. For the Y-12 experiment, the software used is the pcAnywhere package. pcAnywhere allows for access control to the system through the use of passwords and disk access control. Certain features of the pcAnywhere software restrict its data transfer rate by satellite communications because of the proprietary protocol.

The system will operate up to one hour on an uninterruptible power supply (UPS) system. The data network and the DAS are powered through the UPS. The network communications is based upon the Echelon LONWorks technology. The Y-12 system implementation is implemented by a twisted pair cable. The cable used at Y-12 also distributes the 12-volt DC power to the network components. The network power supply contains a network node, which monitors the AC voltage source for the UPS. In the event of a power failure to the UPS, the power supply node would send an event message to the DAS, which in turn would log the event into the database.

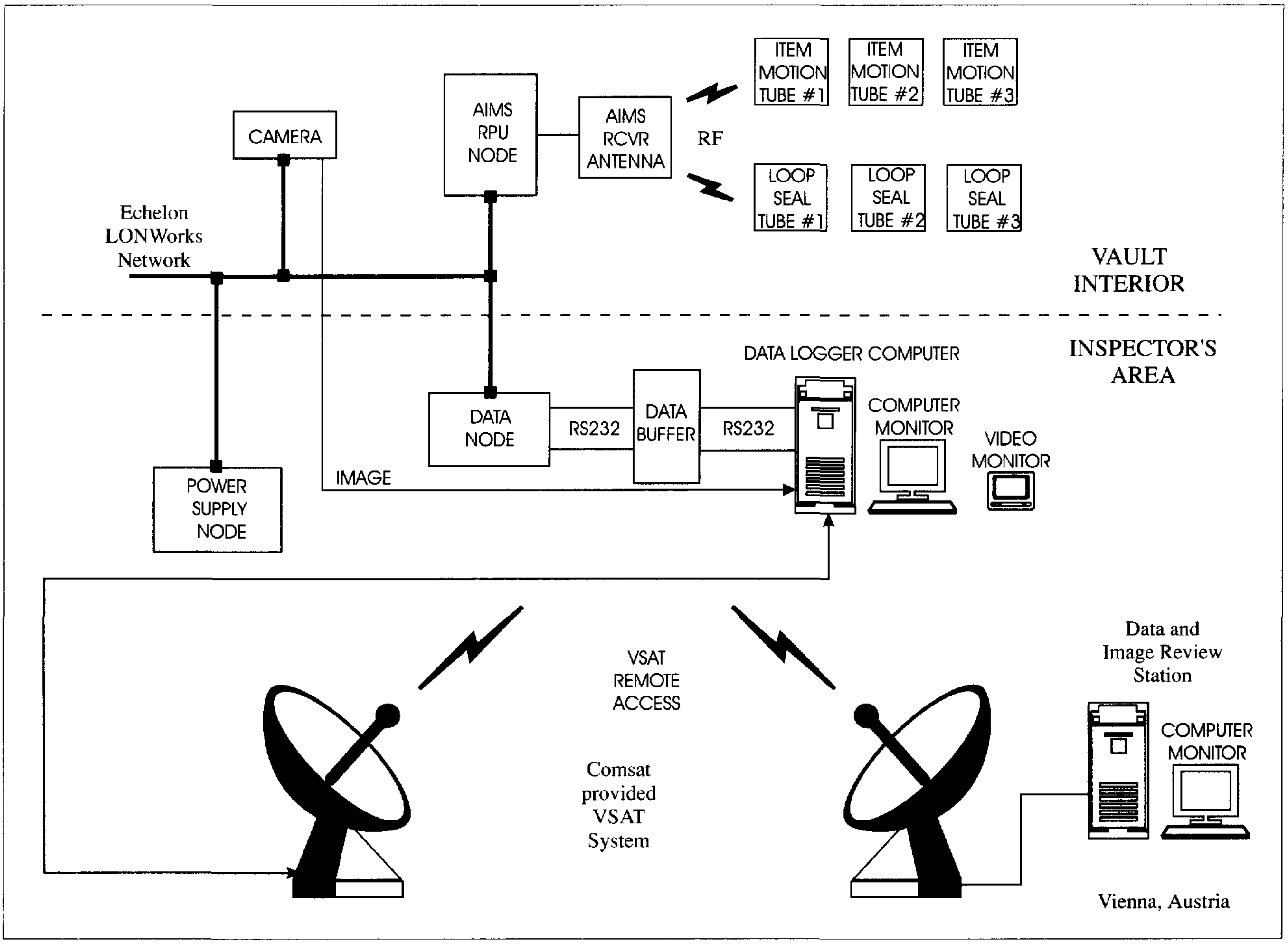
The data and image review station (DIRS) was deployed in Vienna for the IAEA General Conference. Data were transferred and displayed during demonstration sessions at the Austria Center.

### *Installation*

Installation of the integrated monitoring system (IMS) occurred Aug. 22–25, 1995. Equipment was installed Aug. 22 and 23. An IAEA inspector was on site Aug. 24 when the sensors were installed on the individual tubes. A total of three tubes were instrumented for the demonstration at the IAEA General Conference. The satellite communications equipment was deployed outside the warehouse.

All aspects of the installation went smoothly, with the exception of the data classification issues. These issues were resolved on a case-by-case basis for the demonstra-

**Figure 1: Remote monitoring system block diagram**



tion and will be worked to a final resolution during the reconfiguration time before the field trials are scheduled to start. The preparatory activities were complete before the installation actually began, allowing the installation to proceed at a pace faster than had been anticipated.

Because of the varied data classification requirements, both domestically and internationally, data protection will require negotiation by the parties involved in the safeguarding of nuclear materials. The central data protection theme contains both technical and political aspects.

*Operation*

The system operated continuously from Aug. 25 through Sept. 20 with only one outage occurring. This outage was caused by personnel activity at the DAS and a failure to restart the DAS program. There were three modes of operation during this time period.

On Aug. 24, simulated access to the material was performed to test the equipment and provide a scenario to be available for data review and presentation at the IAEA General Conference. These scenarios also provided data to be reviewed and analyzed for resolution to the data classification issues. These data were treated as classified until all reviews were completed.

From Aug. 26 through Sept. 13, the camera was disconnected from the system but the rest of the sensors continued to operate. The sensors logged no activity on the monitored tubes during this time, resulting in no missed image capture activity.

The system was checked for operation on Sept. 14 in preparation for the demonstration at the General Conference. On the morning of Sept. 18, a new scenario was performed in support of the IAEA General Conference. These data were reviewed for classification and information release before being transferred to the DIRS in Vienna. The camera was again disconnected from the video capture system for the interim period between Phase 1 and Phase 2 of the field trials.

*System Status*

The system is still logging sensor event data, but the image capture system has been disconnected. In this configuration, there is no possible collection of classified data on the system.

*Phase-2 System Expansion*

A Phase-2 system design is under wayto expand the current system. Phase 2 will be a field trial conducted jointly by the U.S. Department of Energy (DOE) and the IAEA for potential application to IAEA safeguards monitoring.

**Figure 2: Sample image**

## Vienna Facility

*RMS Demonstration Facility Description*

The remote monitoring system demonstration facility was constructed in the Austria Center in Vienna (ACV) using a three-meter-square transportable room. The layout of this facility simulation is shown in Figure 3 (below). Three different monitoring scenarios were simulated: material storage area, material transport system, and material processing area. Several sensors were associated with the monitoring of each material scenario. Storage consisted of a door-position sensor, a beam-break sensor, and simulated storage containers with item motion sensors and active fiber optic loop seals. Transport was monitored by three proximity location sensors and a cart motion microwave detector. Process monitoring was simulated by a load cell, active fiber optic loop seal, dual vibration-magnetic field sensor, and temperature sensor. Sensor information, including alarm, tamper, state-of-health, and authentication, were collected using the AIMS local RF network and the Echelon LONWorks hardwire network. The DAS computer was programmed to record single digitized compressed video frames triggered by several of the monitoring devices. During each group demonstration, a short sequence of activities in the demonstration facility was recorded for display using the DIRS user-interface software and a computer video projector.

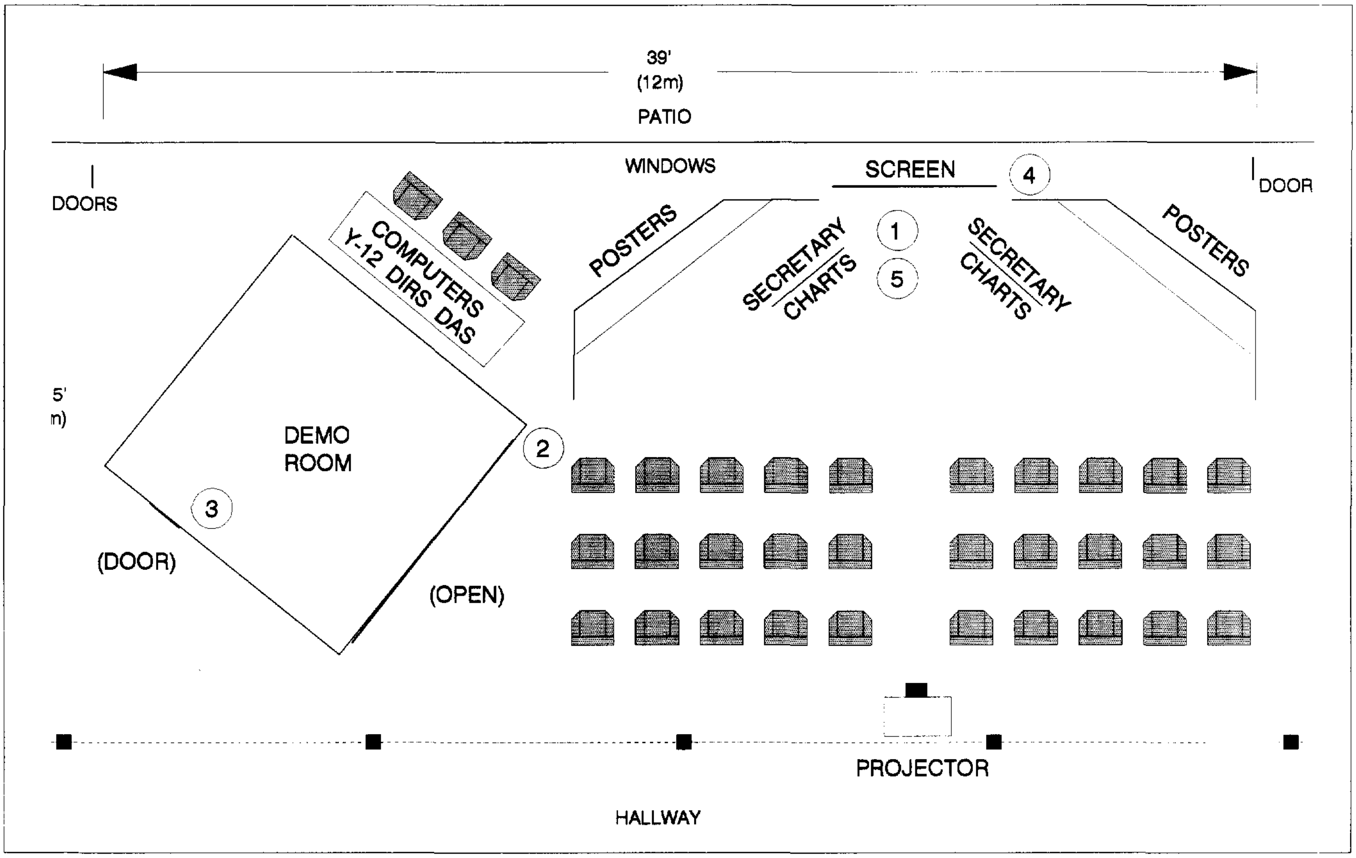
*General Conference Demonstration*

Secretary O'Leary presented the RMS to the IAEA General Conference on Sept. 18, 1995, during her presentation and in a special demonstration for IAEA Director General Blix. During the next two days, all organizations in the IAEA Safeguards Directorate were invited to one of eight additional scheduled demonstrations. Each presentation included a short briefing, demonstration of the model facility, and display of data and images from Y-12, other bilateral field trials, and the demonstration room activity. An archived database and the DIRS interface were used to show data and images from joint bilateral field trials in Argentina, Australia, Japan, Russia, Sweden, and the United States. During the General Conference, recent data and images were transferred from the Kurchatov Institute in Moscow by telephone and from the Y-12 plant by satellite. Real-time sensor status displays were presented by satellite for Y-12, and by telephone for Kurchatov, Argonne, and the Japan Atomic Energy Research Institute (JAERI).

*Vienna Operation*

The RMS demonstration facility at the ACV operated as designed and expected with two noteworthy conditions. First, there was considerable RF communication traffic in

**Figure 3: Vienna remote monitoring system demonstration facility**



the ACV, as indicated by an RF diagnostic indicator lamp in the AIMS RF receiver. This was presumed to be caused by a combination of RF transmissions from numerous security details in the area and from broadcast of the simultaneous foreign language translations in the several conference rooms. This is believed to be responsible for the delayed receipt of the AIMS fiber optic seal "open" transmission during O'Leary's speech and during one of the later demonstrations. It should be noted that the AIMS RF transmitter is designed to — and did — overcome these conditions by repeating its transmission several times and at different radio frequencies. Second, the wood floor in the ACV demonstration area was flexible and coupled energy into the AIMS motion sensor when someone walked heavily near the demonstration facility. This resulted in several item-motion alarms. Although this sensor has a sensitivity adjustment, its dynamic range was not adequate to filter out these events. This should be an item for consideration before deploying this sensor until its sensitivity algorithm is modified.

*System Status*

The demonstration room was disassembled and returned to Sandia National Laboratories in New Mexico for future demonstrations. During the Phase-2 system evaluation, a DIRS system will be configured at both the IAEA headquarters in Vienna and IAEA field office in Toronto.

## Field Trial

Phase 2 involves the reconfiguration of the Phase-1 remote monitoring system at the Y-12 highly enriched uranium (HEU) storage vault using new sensors and video cameras in a manner that obtains IAEA inspection goals while providing adequate protection of U.S. classified data. The system will collect authenticated data from the unattended sensors, store the data on site, and transfer the data on demand to IAEA headquarters in Vienna via both satellite and telephone lines.

The key Phase-2 objectives include:

- Identify individual sensors and sensor combinations that provide a reliable, durable, and cost-effective way of obtaining IAEA verification goals at a storage facility while operating in a totally unattended mode. Two types of radiation sensors will be evaluated providing independent material attribute measurements of each storage container. Fiber optic loop seals and motion detectors will provide access monitoring to the tubes. Identification tags will provide for a continuous in-place inventory measurement.
- The satellite and telephone links will have transmission capabilities of 38.4 kbps and 14.4 kbps, respectively. The links will be examined for transmission efficiencies and economic comparison to support the IAEA in long-term communications planning. The major objective is to identify the cost-benefit trade-offs for satellite vs. telephone transmission of the data from the remote site.
- Video images will be recorded using two methods. The first will be front-end triggering, and the second will be fixed interval recording. The front-end triggering method of video-frame recording will be evaluated to confirm that, compared with the current method of interval recording, a significant reduction of data can be accomplished without loss of any significant event images.
- Authentication and encryption solutions will be identified that satisfy IAEA and DOE information protection requirements.
- The system will be exercised at regular intervals during the normal IAEA inspections. The various sensor subsystems will be tested to verify that the sensors are functioning properly. The data storage will be exercised to confirm that all data and images are stored and accessible by the IAEA. The communications will be used to transfer the data to the IAEA headquarters in Vienna for review and analysis.

## Conclusions

- All systems operated as expected during the Phase-1 demonstration period.
- The issues just discussed are being resolved for implementation during Phase 2 of the field trials.
- The software issues restricting the effective data transfer rates through the satellite are being reviewed to increase the transfer rates.
- The data outage at the Y-12 facility will not occur under an operational mode because the DAS will be locked in a cabinet and personnel access to the computer system will be restricted.
- The classification issues are being worked out by the DOE, and a resolution is expected before the beginning of the Phase-2 field trial.
- The RF background environment caused a brief interference with the AIMS transmission, but its RF design overcame signal masking.
- The motion sensors demonstrate the requirement for the sensor installations to be tested for the specific conditions of the deployment.
- It is anticipated that the remote monitoring system will aid the IAEA by improving efficiency of inspector days expended in monitoring material stored in a static manner.
- The remote monitoring system will provide the IAEA with new tools in its continuing struggle to monitor the global use and storage of nuclear materials.

## Acknowledgment

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# Bilateral U.S. and Russian Remote Monitoring System for Special Nuclear Materials

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## Abstract
*In the context of U.S. and Russian laboratory-to-laboratory initiatives, Sandia National Laboratories in New Mexico contracted with the Kurchatov Institute Russian Research Center in Moscow to demonstrate the feasibility of remotely monitoring the storage of nuclear material. The cooperative experiment was to demonstrate the remote monitoring system with a minimum of 10 kg of highly enriched uranium in storage at reciprocal facilities. The Kurchatov Institute selected a site at their facility, and the U.S. Department of Energy selected a site at the Argonne National Laboratory–West facility. At Kurchatov, there is material stored in a floor vault, storage cabinet, and shipping containers. At Argonne–West, material is stored in two types of storage systems. The monitoring system as implemented is discussed in this paper. This technology provides the capability of remotely monitoring the access to the stored nuclear materials but is not designed as a real-time security alarm system. Several next steps have been identified for possible expansion of the remote monitoring system.*

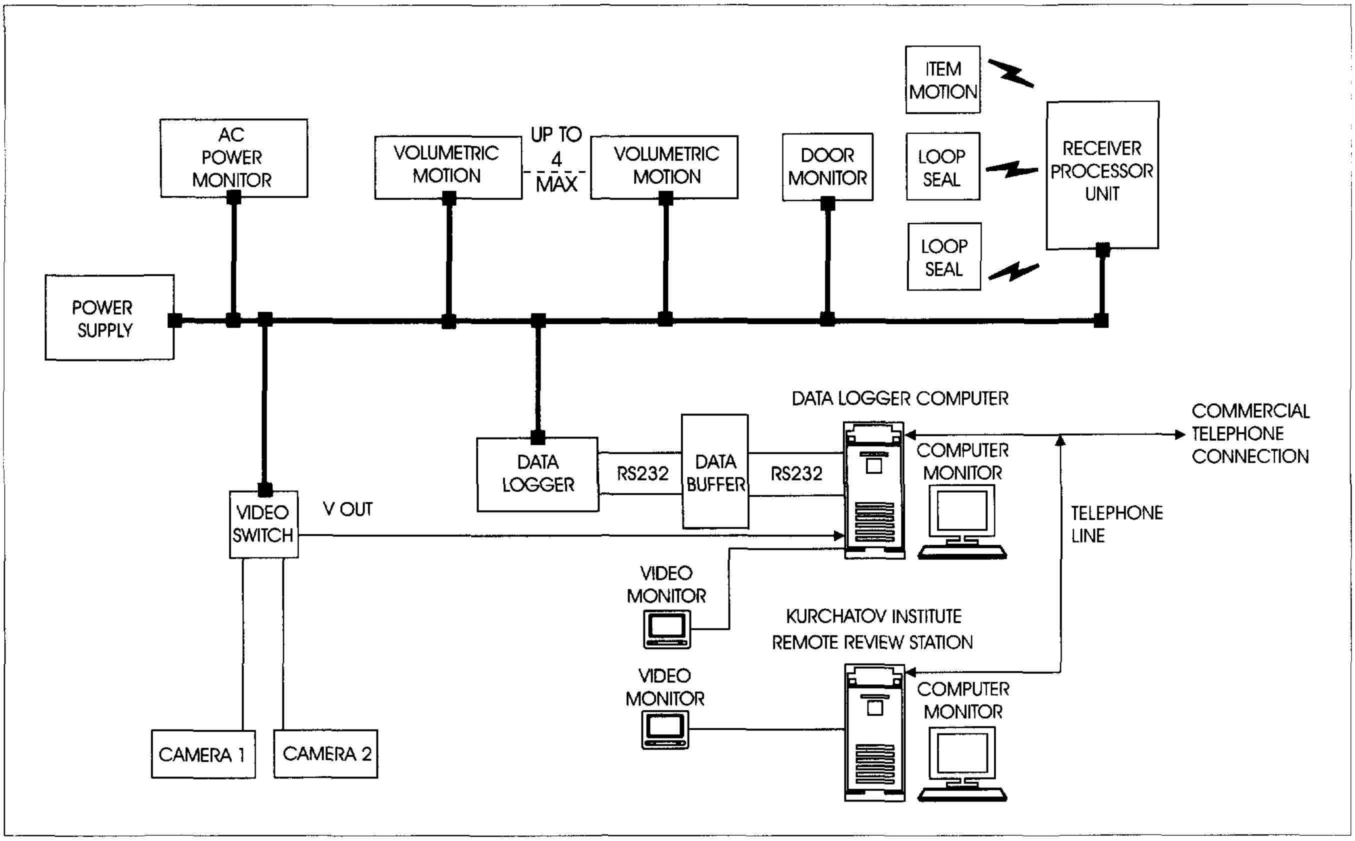
## Introduction
Over the past few years, several organizations in the United States and Russia have been working together on numerous initiatives related to nuclear material safeguards. These cooperative activities are being conducted both as government-to-government programs and laboratory-to-laboratory projects. There has been considerable sharing of methods and equipment for domestic safeguards and security. Concurrently, John Rooney of the U.S. Department of Energy (DOE), Tom Sellers of Sandia National Laboratories (SNL) in New Mexico, and Vladimir Sukhoruchkin of the Kurchatov Institute in Moscow foresaw an opportunity to demonstrate cooperative international monitoring of weapons-usable nuclear material. This evolved into a cooperative remote monitoring experiment between the Kurchatov Institute, Russian Research Center (KI,RRC) in Moscow and the Argonne National Laboratory–West (ANLW) in Idaho. SNL worked with both sites to implement systems for demonstration and evaluation using technology developed under the sponsorship of the DOE. Participation of the Kurchatov Institute has been funded by an SNL contract with Kurchatov. In this paper, we present a description of the two experimental systems and discuss our recommendations for extending this cooperative activity.

## System Description
### *Kurchatov Institute*
The KI,RRC selected a facility known as the gas plant as the participating storage facility for the program. Specifically, Building 209 was selected for the material storage. Within this building, an area 8.55 m by 5.55 m by 7 m high was selected. The facility contains an underground vault filled with water for storage of spent nuclear fuel. In addition, six storage containers and a storage cabinet were provided for above-ground storage of fresh nuclear material. There are 70 kg of highly enriched uranium (HEU) stored in Building 209 for this program. A video image of this area is shown in Figure 1 (opposite page).

A block diagram of the KI,RRC remote monitoring system (RMS) is shown in Figure 2 (opposite page). The system includes monitoring nodes communicating over the Echelon network. Sensors associated with these nodes include door monitors, microwave and infrared volumetric sensors, item motion and fiber loop seals with the authenticated item monitoring system (AIMS) radio frequency (RF) communications, break beam monitor, video cameras for image snapshots, AC power monitor, and a data acquisition system (DAS). The DAS performs data acquisition, storage and long-term archiving of event and image data to an optical storage disk. The types and configuration of the sensors were selected based upon site specifications and a site survey visit during January 1995.

Figure 1: Kurchatov Institute video camera image

Figure 2: Kurchatov Institute remote monitoring system block diagram



Data transfer is accomplished via commercial dial-up telephone access. The telephone line is a dedicated circuit for remote access to the monitoring system data. A data image and review system (DIRS) was provided to KI,RRC for remote access to both the KI,RRC DAS (national data review) and the ANLW DAS (remote data review).

*Argonne National Laboratory–West*

The facility within ANLW that was selected as the participating site for this program is the fuel manufacturing facility (FMF). The area selected within the FMF consists of one aisle with "bird cage" storage units on one side and "drum" storage units on the other side of the aisle. The aisle is approximately 1.2 m wide and 6 m long. The height of the aisle is approximately 5.5 m. There are 130 kg of HEU stored in the FMF that are being monitored in this program. A video image of this área is shown in Figure 3 (opposite page).

A block diagram of the ANLW RMS is shown in Figure 4 (opposite page). The system includes monitoring nodes communicating over the Echelon network. Sensors associated with these nodes include door monitor, infrared volumetric sensor, item motion and fiber loop seals with AIMS RF communications, break beam monitor, video camera for image snapshots, AC power monitor, and a data acquisition system (DAS). The DAS performs data acquisition, storage and long-term archiving of image data to an optical storage disk. The selection and configuration of the sensors were selected based upon site specifications and a site survey visit during January 1995.

Data transfer is accomplished via commercial dial-up telephone access. The telephone line is a dedicated circuit for remote access to the monitoring system data. A data image and review system was provided to ANLW for remote access to both the ANLW DAS and the KI,RRC DAS.

## System Installation

Installation was performed in a similar manner at the ANLW and KI,RRC facilities. ANLW installation was performed between March 6 and March 9, 1995. The KI,RRC installation was performed between March 15 and March 27, 1995. Facility personnel provided physical installation of the cabling and sensor nodes and general support to SNL. SNL performed the installation of the computers and software.

At both sites, the installation went smoothly and expeditiously. The successful installation in this manner is evidence for the maturity of the RMS technology and design.

## System Performance

KI,RRC and ANLW continue to provide technical support for the system evaluation, which requires additional on-site analysis and review. While the systems are different implementations of the RMS, the ongoing site support is in the area of validation of unidentified events and the resolution of any technical problems in the system.

The systems are exercised in two manners: (1) normal activities associated with the storage facility, and (2) special requests, including demonstration scenarios, troubleshooting, and sensor evaluation.

All three participants have the capability to access the DAS at both facilities. The data at both sites are under review for system performance. Performance parameters include data availability, nuisance alarms, communications link performance, image clarity, and verification of material access.

With very short familiarization times during the installation, site personnel have demonstrated that the RMS is an easy system to troubleshoot. Troubleshooting has occurred in two modes: (1) site personnel have identified and evaluated the system status, and (2) SNL has requested site personnel to perform specified troubleshooting activities.

The software has been upgraded to a new version at both facilities since the system installation.

*Remote Data Transfer*

Data are transferred via dial-up telephone access to a remote site for data review. In the program, there are three remote facilities involved: ANLW; KI,RRC; and SNL. As part of the evaluation process, SNL personnel transfer data from each storage facility daily, Monday through Friday. Access by ANLW and KI,RRC to the opposite facility is on a limited basis because of programmatic funding. The database of events is transferred along with the system configuration. Any images that have been recorded are then transferred. The data are transferred and then reviewed off-line. If any additional information is required, the analyst then calls the monitoring facility and downloads the additional information.

*Sensor Issues*

At Kurchatov, the microwave sensors have produced numerous nuisance alarms. Possible causes for these alarms are sensor misalignment, local radio interference, and/or motion outside the camera field-of-view, where the microwave energy may have penetrated or reflected. The microwave alarms were reduced to a minimum when Kurchatov personnel realigned the sensor sensitivity, gains, and threshold settings.

At Argonne, one item motion sensor has produced numerous nuisance alarms. These are probably caused by vibration of the containers coupled into the barrel frames from other containers and frames that are rigidly attached in a matrix structure in the vault. Both problems illustrate that the optimum sensor selection and installation is site dependent.

*Communication Issues*

The data are transferred via dial-up commercial telephone access. Several problems have been encountered using this mode of communications. These problems have centered primarily on the use of international telephone circuits,

Figure 3: Argonne National Laboratory–West video camera image

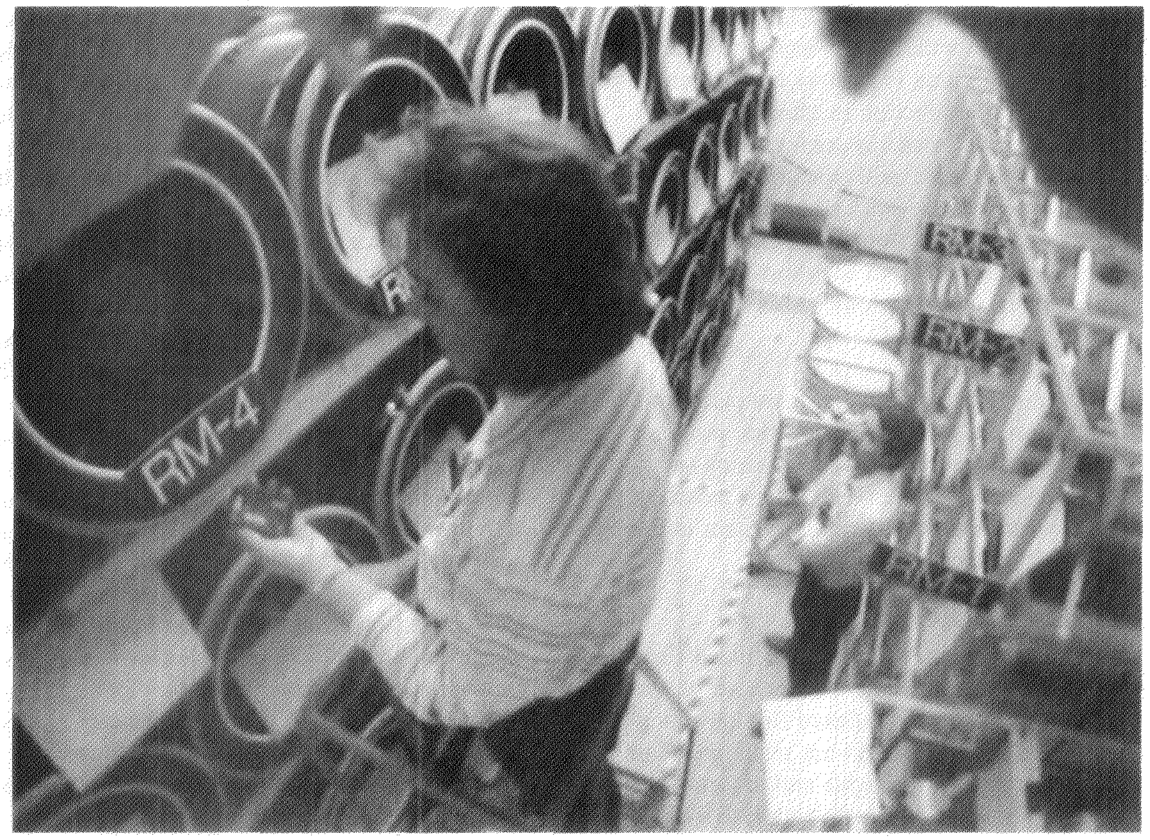
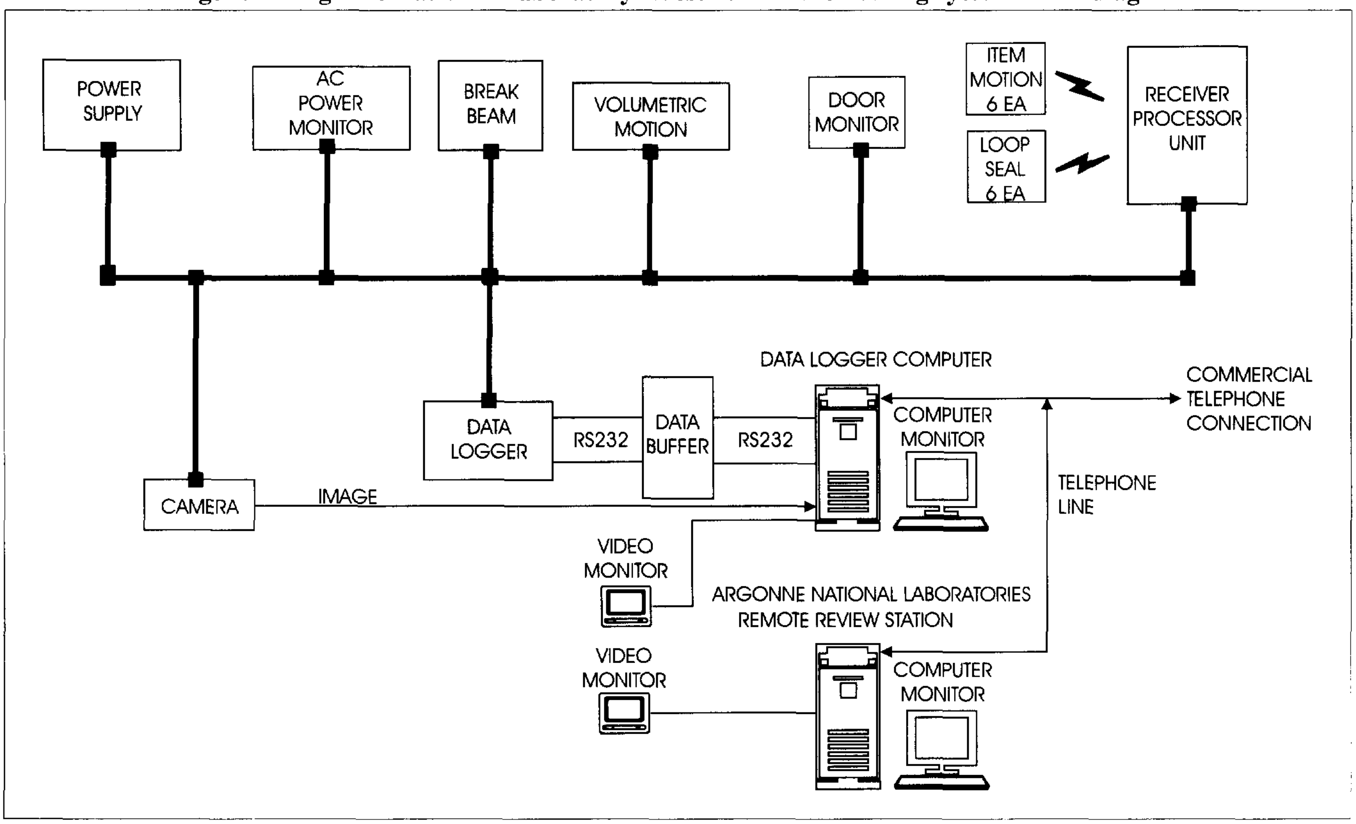



Figure 4: Argonne National Laboratory–West remote monitoring system block diagram



where crosstalk and line access have caused problems with the communications software. The modem configuration files were reconfigured to allow for the highest data transfer rates. The software can be configured to operate in noisy environments with a resulting reduction in effective transfer rate. For example, with the modems configured to operate at 9,600 bps, the software will operate at approximately 2,400 bps when set for the noisy environment. Effective transfer rates have ranged from 2,400 bps to 9,600 bps; the higher rates have occurred for short-term intervals (less than one hour) during specific times of the day.

*Data Acquisition Delays*
The data acquisition system appeared to have periods of suspended data collection. The data acquisition program enters a delayed logging mode when data are being transferred to a remote data review site. The data are stored in a local data buffer and retrieved once the system is returned to the acquisition mode.

*Lights and Camera Synchronization*
The installation at the Kurchatov facility included light nodes to provide lighting for cameras. Because of the length of the network cable, the infrared line drop was large enough that the batteries could not recharge. This resulted in the appearance of the lights and cameras not being synchronized. The lights require the battery to support the current required during operation. Charging circuit modifications were provided to Kurchatov personnel. They were implemented in the light nodes during October 1995.

## Next Steps

This bilateral cooperative remote monitoring experiment has been both politically successful and technically valuable. It was an unprecedented step for two Nuclear-Weapon States to jointly demonstrate remote monitoring of direct-use nuclear material at reciprocal facilities. There were technical lessons learned about the use for data transmission of international public telephone in general and the Russian and American telephone systems in particular. The stage is now set to take the next significant steps in remote monitoring to further demonstrate the mutual commitment to nonproliferation by these two Nuclear-Weapon States. Kurchatov and SNL staff have begun discussing topics and tasks that could be conducted to further this end.

Kurchatov has indicated interest in installing a remote monitoring system at a facility that is on the voluntary Russian Federation list for IAEA safeguards. They have been invited to join the DOE International Remote Monitoring Project (IRMP). IRMP began as a U.S. bilateral program with partners in several other IAEA safeguards States to demonstrate and evaluate remote monitoring. It has advanced to the stage where joint field trials are being conducted with the IAEA in some states. A Russian facility in the IRMP could also lead to a joint field trial of remote monitoring between IAEA and Russia.

Another major interest at Kurchatov is the establishment of a Cooperative Russian-American Nuclear Monitoring Center. Such an institution could become a clearinghouse of information and expertise on remote monitoring for domestic, bilateral, and international safeguards for other Russian organizations with nuclear material. This monitoring center could also maintain a database from other Russian nuclear facilities with remote monitoring systems and provide that information to national regulatory agencies and international monitoring partners.

Kurchatov is also considering installing a remote monitoring system at their central storage facility (CSF). This would place a much greater quantity of direct-use material under remote monitoring. The remote monitoring system could also supplement the CSF physical security system.

Two other applications for remote monitoring of nuclear activities have been discussed by Kurchatov and SNL personnel. Remote tracking and monitoring of nuclear shipments can be accomplished using satellite systems for both data communications and position location. Environmental monitoring of nuclear processing and storage facilities is another potential remote monitoring application.

Kurchatov has also presented some proposals that are more directly related to system and technology development. Until now, all the technology and components in the remote monitoring system at Kurchatov have been provided by the United States. There is a mutual interest in integrating Russian devices into the system. Along these lines, Kurchatov has some ideas for the development of new passive and active fiber optic seals and detection based on image processing and analysis for linear arrays and video cameras.

Modified system architectures also have been conceptualized. The DAS at Kurchatov could be attached to its computer communications network. A server for the remote monitoring system could be developed for this network. Finally, the server could be a node on Internet.

It is clear that much interest and many ideas exist for advancing and implementing remote monitoring systems. We are evaluating and prioritizing these proposals and identifying potential funding mechanisms.

## Conclusions

All RMS components operated as expected during the demonstration period.

This program demonstrated the success of U.S.-Russian laboratory-to-laboratory initiatives. The RMS demonstrated technology applicable to the concerns of monitoring access to stored nuclear materials. Descriptions of next-step possibilities provide the basis for continued work to reduce the concerns about nuclear material proliferation.

## Acknowledgment

Part of this work was supported by the U.S. Department of Energy under contract DE-AC04-94-AL8500.

**Nuclear Waste Technical Review Board undergoes changes**

In the summer of 1995, President Clinton appointed three new members to the Nuclear Waste Technical Review Board (NWTRB), one of whom is INMM member John Arendt. Arendt is a private consultant with extensive experience in uranium processing, handling, accountability, shipping and production. Previously, he spent 40 years as senior engineer at Union Carbide, providing technical and management assistance in uranium enrichment, operations, standards, waste management, reactor activities, quality assurance and control, uranium handling and shipping, and safeguards and accountability.

The NWTRB was established as an independent federal entity by the Nuclear Waste Policy Act of 1982. The board is responsible for evaluating the technical and scientific validity of the activities undertaken by the Office of Civilian Radioactive Waste Management. It is required to report its findings, conclusion and recommendations to Congress and the secretary of energy at least twice a year. To date, the board has issued 11 reports that have included 143 specific recommendations.

**Canberra will perform waste characterization for EG&G Mound**

EG&G Mound Applied Technologies, Miamisburg, Ohio, awarded Canberra Industries a contract to perform gamma spectroscopy radiological waste characterization on containers of waste that have been stored on-site at Mound since 1978. The majority of the containers are presumed to contain transuranic (TRU) waste. However, with the state-of-the-art instrumentation used, it is anticipated that approximately 25 percent will be downgraded to low-level waste. There is significant cost savings in handling and storing of containers if they can be classified as low-level waste instead of TRU waste. Canberra will temporarily install a $Q^2$ low-level-waste quantitative and qualitative assay system at Mound and provide a system operator to characterize the drums. Based in Meriden, Conn., Canberra is the world's commercial leader in the manufacture of nuclear radiation detection equipment.

**ISA dissolves its international subsidiary, develops home page**

The International Society for Measurement and Control (ISA) dissolved its international subsidiary, ISA International. Effective Jan. 1, all international members will be folded into ISA and an International Development Council will be created to assure foreign members balanced representation.

Internet browsers can now find ISA on-line at its new home page at http://www.isa.org/isa. Browsers will find a broad range of ISA activities and services, including industry news and events, technology updates, membership news and information, training opportunities, industry standards, ISA journals, the ISA Directory of Instrumentation, ISA services and staff contacts, mail, forums and more. New information is added daily. The ISA fosters advancement in the theory, design, manufacture and use of instruments, computers and systems for measurement and control.



## ADVERTISER INDEX

# CALENDAR

*March 11–15*
Materials Accounting for Nuclear Safeguards, Los Alamos National Laboratory, Los Alamos, N.M. *Sponsors*: U.S. Department of Energy and Los Alamos National Laboratory. *Contact*: Training Coordinator/NIS-5/ MS E540, Los Alamos National Laboratory, Los Alamos, N.M. 87545; (505) 667-5258.

***March 18–21***
**Technical Workshop: International Safeguards on U.S. Department of Energy Excess Materials, Washington, D.C. *Sponsors*: INMM Materials Control and Accountability, International Safeguards, and Nonproliferation and Arms Control Divisions. *Contact*: INMM headquarters, 60 Revere Dr., Suite 500, North-brook, IL 60062; (847) 480-9573; fax (847) 480-9282.**

***April 23–25***
**Low-Level Radioactive Waste Technical Seminar, Troyes Holiday Inn Resort, Troyes, France. *Sponsors*: INMM and ANDRA (national radioactive waste management agency in France). *Contact*: INMM headquarters, 60 Revere Dr., Suite 500, Northbrook, IL 60062; (847) 480-9573; fax, (847) 480-9282.**

***May 14–17***
**International Conference on Nonproliferation and Safeguards of Nuclear Materials in Russia, Moscow. *Sponsors*: INMM Russian Federation Chapter, Nuclear Society of Russia and the Russian Research Center Kurchatov Institute. *Contact*: Sergei Kushnarev, Russian Research Center Kurchatov Institute, 123182 Moscow, Russia; (7) 095-196-7300; fax (7) 095-196-2073.**

***July 28–31***
**INMM 37th Annual Meeting, Registry Hotel, Naples, Fla. *Contact*: Barb Scott or Melanie Epel, INMM headquarters, 60 Revere Dr., Suite 500, Northbrook, IL 60062; (847) 480-9573; fax, (847) 480-9282.**

*November 6–8*
Superfund XVI Conference, Sheraton Washington Hotel, Washington, D.C. *Contact*: Susan Newman, E.J. Krause & Associates, 7315 Wisconsin Ave., Suite 450, Bethesda, MD 20814; (301) 986-7800; fax, (301) 986-4538.