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Remote Monitoring Transparency Program

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Abstract

The objective of the Remote Monitoring Transparency Program is to evaluate and demonstrate the use of remote monitoring technologies to advance nonproliferation and transparency efforts that are currently being developed by Russia and the United States without compromising the national security of the participating parties. Under a lab-to-lab transparency contract between Sandia National Laboratories (SNL) and the Kurchatov Institute (KI RRC), the Kurchatov Institute will analyze technical and procedural aspects of the application of remote monitoring as a transparency measure to monitor inventories of direct-use HEU and plutonium (e.g., material recovered from dismantled nuclear weapons). A goal of this program is to assist a broad range of political and technical experts in learning more about remote monitoring technologies that could be used to implement nonproliferation, arms control, and other security and confidence building measures. Specifically, this program will: 1) begin integrating Russian technologies into remote monitoring systems; 2) develop remote monitoring procedures that will assist in the application of remote monitoring techniques to monitor inventories of HEU and Pu from dismantled nuclear weapons; and 3) conduct a workshop to review remote monitoring fundamentals, demonstrate an integrated U.S./Russian remote monitoring system, and discuss the impacts that remote monitoring will have on the national security of participating countries.

Introduction

Remote monitoring is not a new concept, and it is used in many industrial, commercial and nuclear activities. Security sensors monitor homes and businesses; data from seismic and meteorological stations are remotely transmitted. Remote monitoring has also played a major role in international safeguards. For example, one of the first international proposals was the "Recover" project (Remote Continue Verification) developed in the period 1976 - 1986. Since then several other concepts of remote monitoring and data transmission for safeguards purposes were proposed, developed and tested. Under the U.S. DOE International Safeguards Program, Sandia National Laboratories is engaged in an International Remote Monitoring Project. The objectives of this project are (1) to demonstrate that remote monitoring techniques can save inspection resources and strengthen the effectiveness of the safeguards, and (2) to promote international acceptance of remote monitoring for safeguards applications.

In 1994 under a lab-to-lab cooperation program between SNL and KI RRC a project to demonstrate a bilateral U.S. and Russian remote monitoring system for special nuclear materials was initiated. During March 1995 the first remote exchange of data and images took place between the U.S. and Russia in the framework of this bilateral project involving weapon-usable nuclear materials stored in vaults at the Kurchatov Institute and the Argonne National Laboratory West. To execute the project, Sandia National Laboratories worked with both sites to implement systems for demonstration and evaluation using technology developed as part of the DOE/NN44 International Remote Monitoring Project and the DOE/NN20 Cooperative Monitoring Program's Modular Integrating Monitoring System task. Participation of the KI RRC was funded by a SNL contract with Kurchatov Institute. The facilities continue to be monitored at the Cooperative

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DISCLAIMER

Monitoring Center of Sandia, the Kurchatov Institute, and Argonne-West. Moreover, this remote monitoring system is the first experience in practical application of such technology in the area of nuclear material control in Russia. The initial evaluation phase has provided the opportunity to identify and solve a number of problems of both an organizational and a technical nature, and it has also generated ideas on the development and use of this technology in the practice of nuclear material control, accounting and physical protection both in Russia and for international applications.

This demonstration of an operating system of mutual monitoring should be viewed as a window of opportunity to advance the widespread use of remote monitoring as a transparency measure with promising potential in national, bilateral and international applications in physical protection, containment and surveillance measures in international safeguards, in control of nuclear arms reduction and in other possible applications. The success of the first experience in mutual monitoring calls for extension of the project to provide for an incremental technical enhancement of the existing remote monitoring technologies of KI RRC and a broad-based dialogue on the impacts and applications of remote monitoring. One of the steps in this direction is developing and implementing the "Remote Monitoring Transparency Program."

The objective of the Remote Monitoring Transparency Program (RMTP) is to demonstrate that remote monitoring technologies can contribute to nonproliferation and transparency efforts without compromising national security. As a continuation of the aforementioned collaboration in remote monitoring, this program analyzes the technical and procedural aspects of the application of remote monitoring as a transparency measure to monitor inventories of direct-use HEU or plutonium. The program elements are:

1: Russian Technologies for Remote Monitoring Candidate Russian technologies that could be utilized in remote monitoring are being identified and a plan to integrate selected technologies as upgrades to specific systems is being developed.

2: The Impacts of Remote Monitoring on National Security and Transparency The application of remote monitoring and the impacts that remote monitoring will have on the national security of participating countries are being detailed and documented. Methods to minimize concerns and maximize benefits are being considered.

3: Remote Monitoring Transparency Workshop A remote monitoring workshop will be held at Kurchatov Institute at the end of October. The workshop will review remote monitoring fundamentals, demonstrate an integrated Russian/American remote monitoring system, discuss the application of remote monitoring to inventories of direct-use HEU and plutonium, and discuss the impacts that remote monitoring will have on the national security of participating countries and on a transparency regime. Attendees will include representatives from a broad cross-section of Russian institutes, industries, organizations, government ministries, and remote monitoring technology suppliers. This workshop will be presented in Russian and will be focused toward building Russian supporters of remote monitoring as a transparency measure.

Russian Technologies for Remote Monitoring Systems

If remote monitoring systems are to be widely deployed in Russia, a domestic infrastructure to supply products, service, research and development, and to act as an advocate for remote monitoring is necessary. To gauge the maturity of the existing infrastructure, Russian technologies that could be utilized in remote monitoring systems of direct-use HEU or plutonium are being surveyed. Each of the candidate technologies is being reviewed in terms of the criteria listed below:

- The impact of each technology in improving remote monitoring systems; i.e., the extent to which the measure provides increased confidence to outside observers that comprehensive remote monitoring has occurred;
- The operational intrusiveness incurred by the use of each technology; i.e., the disruption or interference with the ongoing activity that is being monitored;
- How well sensitive data can be protected depending on the technology;

- Top-level and approximate implementation and life-cycle costs of each technology in terms of hardware investment, maintenance, operational labor requirements, and other aspects as appropriate; and
- Approximate timeline for procurement, installation, and testing of each technology.

When dealing with suppliers of Russian remote monitoring technology, it is important to realize that previously in the FSU, safeguards systems were developed according to a "departmental" principle. Today, however, the barriers between departments are being erased by virtue of the economic independence gained by the enterprises. Recently, two independent non-governmental enterprises, "TEZA" and "Escort Center", have evolved from "ELERON", which has been the supplier of safeguards for Minatom facilities. As system integrators these two organizations carry out independent operations that include completion of orders for government institutions. As another example, the joint stock company "Okhrana" has been spun-off by the Interior Ministry. In addition, several other non-governmental enterprises have emerged to supply safeguard systems that are primarily assembled from inexpensive foreign parts.

The last few years have also seen a dramatic shift in a broad range of technology, design, and manufacturing capabilities within Russia. For example, the "NEVIS" firm in Novgorod is involved in international assembly-based production. They import CCD matrices from South Korea which they use in the production of TV cameras. Another avenue is the importation of technology. The "Tezor" plant in Dubna will soon begin production of infra-red detectors based on imported technology supplied by DSC, Inc. Dramatic shifts have also occurred within the existing Russian manufacturing infrastructure. Following the independence of the republics of the FSU, affiliated enterprises, branches, and regional representatives of system manufacturers separated into independent companies. It is possible that sensors that go under different names and are produced by different manufacturers may actually turn out to be the exact same product.

Even though the environment is changing very rapidly within the Russian business community, a broad range of remote monitoring capabilities and hardware is available. An initial review of Russian technologies that may be compatible with remote monitoring systems identified several security alarm systems and a multitude of sensors. The sensor technologies include radio frequency, capacitive, barometric, electrostatic, infrared (passive and beam break), piezoelectric, ultrasonic, radar, and microwave. Radiation detector technologies include CsI, NaI, He-3, BF-3, and organic plastic scintillators. The sizable number of systems and sensors and their voluminous technical specifications make it impossible to provide a comprehensive review in this report.

As the available Russian remote monitoring technologies are being identified and screened against the previously mentioned criteria and the experiences from the original U.S.-Russian remote monitoring experiment, several potential enhancements to the remote monitoring system installed at the Kurchatov facility are being identified. These upgrades focus on different sensor technologies, additional zones of detection, multiple sensor event processing, technologies appropriate for monitoring inventories of direct-use HEU or plutonium and the optimization of cost, schedule, and diversity of technologies to maximize the impact of the integration.

Impacts of Remote Monitoring on the Security of Participating Countries

By its very nature, remote monitoring for transparency involves materials and operations that are critical to national security, and some remote monitoring applications may include the transmission of sensitive data. Therefore in order to ease political and security concerns certain requirements should be observed in bilateral or international RMS applications. Below are four examples of requirements that would facilitate RMS acceptance:

1. The impacted governments must agree to and support the decision to apply remote monitoring. Legislative and regulatory conflicts must be resolved.
2. Practical rules and procedures for the remote monitoring scenario under consideration must be developed and approved.
3. A site-specific system design must be developed for the remote monitoring application that

integrates political, administrative, and technical requirements.

4. Remote monitoring equipment must be certified by authorized organizations, and remote monitoring systems must be demonstrated to prove that they operate without compromising sensitive data.

For the first criteria, the U.S. and Russian remote monitoring collaborations may refer to the Common Statement of the Presidents of the U.S. and Russia in May 1995. In this Statement, they pledged to negotiate agreements on transparency and irreversibility of nuclear arms reduction, which would foresee:

- regular exchange of information;
- cooperation in the field of mutual monitoring at the storage sites of fissionable materials extracted from nuclear warheads;
- other cooperation measures necessary for strengthening mutual trust.

Since this Statement was released, growing U.S./Russian collaborations in the areas of remote monitoring and transparency have provided further definition and implementation to this commitment.

The second and third criteria for procedures and design are site-specific in nature. One of the purposes of RMTP is to develop and evaluate such rules, procedures, and designs for specific remote monitoring applications and from that activity to draw general conclusions with broader implications. To address the fourth criteria, RMTP is beginning the process of identifying and evaluating remote monitoring sensors and systems.

Remote Monitoring Opportunities

Domestic Applications

The appropriateness of using the remote monitoring of nuclear materials and facilities for internal needs of Russia is obvious, primarily in the following areas:

- monitoring of nuclear materials transportation;
- integration of the remote monitoring with the physical protection systems of specially important nuclear facilities;
- monitoring of sensitive nuclear material storage facilities (such as storage facilities of fuel elements of naval reactors);
- monitoring of small unattended nuclear power plants in remote areas and areas with low population density (there is a large program of constructing such plants in Russia);
- ecological monitoring of nuclear facilities.

In addition, in Russia there are large possibilities of using this technology in non-nuclear areas.

Bilateral Applications

The participation of Russia in international remote monitoring projects requires, first of all, a corresponding political decision. This includes, primarily and most importantly, the control of nuclear weapon reductions and storage and/or use of nuclear materials resulting from this process. During their meeting in May 1995 in Moscow, Presidents of the U.S. and Russia expressed the desire "to develop, as soon as possible, specific steps to ensure a higher transparency and to make the nuclear weapon reduction process irreversible." However, the selection of technology for this purpose is a political problem itself. From the technical point of view, there are no doubts in the high potential of the remote monitoring efficiency to ensure the transparency and to make the control irreversible. Nevertheless, special work is required to convince decision makers that the use of this technology does not affect the national security. The development of special bilateral (multilateral) procedures of using the technology will be also required. Among other things they can include studies of the following:

- to ensure the application of similar equipment and equivalent functions of remote monitoring systems to be installed in each country, it can require the development of procedures of mutual certification of equipment and provisions to ensure its tamper resistance;
- to provide confidence that the transmitting side has full knowledge of the information transmitted by the computer system to the partner and that there is no unauthorized access to the information stored and transmitted;
- to develop procedures for subjecting materials and/or facilities to monitoring and of the monitoring termination (generally, this matter is not of direct relevance to the remote monitoring methods, but it is important for the analysis of their efficiency).

International Applications

Remote monitoring systems are in development and field trial stage at nuclear facilities in Australia, Sweden, Japan, Argentina, Germany, Italy, and the United States. The first experience of remote monitoring development and trial is available also in Russia in the common Sandia-KI RRC experimental project. This experience may be effectively used for potential new IAEA safeguards. In promoting remote monitoring applications for International Safeguards two goals should be accomplished:

1. To demonstrate that remote monitoring techniques can save inspection resources while at the same time maintaining or even strengthening the effectiveness of safeguards; and
2. To promote international acceptance of remote monitoring for safeguards applications.

The list of international projects of using remote monitoring technology, which can be implemented with Russian participation, can be generally presented as follows:

1. Participation in IAEA programs with the aim of developing remote monitoring technology to the level of a standard procedure of safeguards implementation that ensures an improved efficiency and reduced costs of inspection efforts of the Agency;
2. Studies of the remote monitoring technology capabilities in the context of the international efforts to improve the efficiency of the international non-proliferation regime of nuclear weapons and of safeguards, including the use of this technology to detect undeclared nuclear activities and undeclared nuclear facilities;
3. Inclusion of remote monitoring technology as standard equipment of nuclear facility designs exported by Russia, especially in case of exports to countries and regions which are sensitive from the point of view of the nuclear weapon non-proliferation; and
4. Use of the remote monitoring technology for bilateral and/or multilateral control of nuclear materials resulting from nuclear weapon reductions and to ensure the "transparency" of nuclear weapon reductions.

Remote Monitoring Applications for Inventories of HEU or Pu

There are several potential candidates for possible application of RMS to monitor inventories of HEU and Pu.

The first evident candidate for Remote Monitoring System application is the Fissile Materials Storage Facility at "Mayak Industrial Association" (Mayak IO). U.S. DoD and RF Minatom continue bilateral cooperation in designing and constructing a fissile material storage at Mayak IO for safe and secure storage of fissile materials from nuclear weapons dismantlement. The project is financed by U.S. DoD funds in the framework of the Cooperative Threat Reduction Program. After commissioning, this storage facility will contain 50,000 containers with fissile materials released by the nuclear weapon dismantlement process. It is foreseen that the material control and accounting system to be developed and installed should provide opportunity for transparent observation by the U.S.. The remote monitoring system for this storage facility may greatly facilitate such observation and transparency regime without compromising sensitive information. Because the design of this facility is not yet completed and the construction is only in the initial stage it is possible to incorporate features necessary for application of remote monitoring in the design of the storage facility. Therefore more detailed study of remote monitoring application for the Mayak Storage Facility is both urgent and important.

Other strong candidates for remote monitoring applications exist. The plutonium produced at the Tomsk and Krasnoyarsk production reactors that has been declared surplus for nuclear weapon production could be placed under remote monitoring without disturbing sensitive national security issues. Another potential remote monitoring application is for the verification of compliance with provisions of the weapon materials cut-off convention which is under negotiation now at the Geneva Disarmament Conference. There are also several stores of large amounts of HEU or plutonium at Nuclear Research and Development Centers such as Dimitrovgrad RIIAR, Obninsk IPPE, RRC "Kurchatov Institute" and others where remote monitoring may be effective in facilitating secure and safe storage and control of HEU and Pu.

Environmental Applications

The remote monitoring concept may be applied to environmental monitoring through concepts such as:

1. Environmental radiation monitoring aimed at registering the radiation levels in the vicinity of potential sources of radioactive fallout and radioactive discharges from nuclear facilities and to detect and signal abnormalities in the radiation situation (The Automated State System of Radiation Monitoring (EGASKRO) is under development in the Russian Federation.); and
2. Environmental monitoring aimed at detecting non-declared or other activities that contradict international or other obligations.

To this category may be related:

- Radiation monitoring of undeclared activities now being developed for the purpose of IAEA safeguards; and
- An International Monitoring System comprising seismological, radionuclide, hydroacoustic and infrasonic monitoring is foreseen in the Comprehensive Test Ban Treaty (CTBT) (This International Monitoring System should include not only monitoring devices and facilities but also communication support and a center where the data from monitoring stations could be remotely communicated, processed and evaluated.).

Long-Term Applications

In the long term the concept of remote monitoring may be extended to applications to monitor:

1. Nuclear weapons and nuclear materials submitted to international or bilateral verification program;
2. Conventional military forces to be controlled under international or bilateral control;
3. Weapon delivery systems;
4. Chemical weapon convention control system verification;
5. Comprehensive Test Ban Treaty; and
6. Other Remote monitor application such as:
    - Monitoring natural resources; and
    - Monitoring pollution; and
    - Monitoring natural disasters.

Remote Monitoring Transparency Workshop

The Remote Monitoring Transparency Workshop will be hosted by Kurchatov Institute October 29-31, 1996. The first day of the workshop will be devoted to reviewing the fundamentals and history of remote monitoring, and overviews of existing remote monitoring systems. A portion of the first day will focus on the integrated U.S./Russia Remote Monitoring System operating at KI RRC. The impacts of remote monitoring on the security of participating countries will be the focus of the second day. The prospects for domestic, bilateral, and international remote monitoring applications will be discussed and a round-table discussion on concepts and procedures for the applications of remote monitoring to inventories of direct-use HEU and plutonium as a part of a bilateral transparency regime will be included. The third day of the workshop will be devoted to Russian remote monitoring technology. Proposals for further development of U.S./Russian remote monitoring applications will be considered and vendors and suppliers will be given an opportunity to provide reports, comments and demonstrations. The current list of invitees includes representatives from a broad cross-section of Russian institutes, industries, organizations, ministries, and remote monitoring technology suppliers. This workshop will be presented in Russian and will be focused toward building Russian supporters of remote monitoring as a transparency measure.

Summary

Remote monitoring holds the prospect of being a powerful tool in the efforts to advance the nonproliferation and transparency regime being developed by Russia and the U.S.. To be viewed as effective so that it will be implemented, remote monitoring must address several issues. First, an infrastructure within Russia to provide research and development, hardware, system integration, and services is required. Hardware must be identified, tested and certified for remote monitoring applications. Second, the impacts of remote monitoring on national security must be identified and minimized. Acceptance by government officials is a necessary requirement to even begin preliminary discussions about remote monitoring applications. Finally, a broad-based outreach program to provide technical information and to provide a forum for discussion about the national security implications is essential if broad application of remote monitoring is to occur. The Remote Monitoring Transparency Program is beginning to address these issues.