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REMOTE MONITORING: A GLOBAL PARTNERSHIP FOR SAFEGUARDS

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ABSTRACT

With increased awareness of the significant changes of the past several years and their effect on the expectations to international safeguards, it is necessary to reflect on the direction for development of nuclear safeguards in a new era and the resulting implications. The time proven monitoring techniques, based on quantitative factors and demonstrated universal application, have shown their merit. However, the new expectations suggest a possibility that a future IAEA safeguards system could rely more heavily on the value of a comprehensive, transparent, and open implementation regime. With the establishment of such a regime, it is highly likely that remote monitoring will play a significant role. Several states have seen value in cooperating with each other to address the many problems associated with the remote interrogation of integrated monitoring systems. As a consequence the International Remote Monitoring Project was organised to examine the future of remote monitoring in International Safeguards. This paper provides an update on the technical issues, the future plans, and the safeguards implications of cooperative programs relating to remote monitoring. Without providing answers to the policy questions involved, it suggests that it is timely to begin addressing these issues.

BACKGROUND

From the beginning, equipment to support IAEA Safeguards has been characterised as that which is used to measure nuclear material, Destructive Assay (DA) and Non Destructive Assay (NDA), and that which is used to provide continuity of knowledge between inspection intervals, Containment & Surveillance (C&S). The development of integrated monitoring systems, based on NDA and C&S equipment, for safeguards applications has to date been limited.

In the late 1970s and early 1980s, the US POTAS program evaluated a remote continual verification system (RECOVER) for international safeguards. In 1981 the Japanese support program used the RECOVER concept to develop a prototype system called JAEMS. Between 1981 and 1983, a local remote monitoring system termed LOVER, was developed by the German support program, and several other local systems were developed including the PFPF system in Japan and the CONSULHA system at the French reprocessing facility in La Hague. In recent years, technology has advanced at an extremely rapid rate, and continues to do so. The IAEA R&D program however is focused on solutions to its immediate implementation problems, and because of limitations to its resources is unable to turn its attention to long range development projects which examine the potential of new technology. They however have recognised the need for such work and encourage member states to keep them informed of any possible uses of new developments in technology. Several states have over the past decade been involved in national projects which have developed integrated monitoring systems which may have safeguards relevant features. Perhaps the most interesting aspect of this evolution, and that which indicates the way of the future without much question, is the integration of video surveillance and electronic seals with a variety of monitors, as well as unattended NDA equipment. This is demonstrated by integrated safeguards systems installed in several nuclear facilities in France, Germany, Japan, the UK, the USA, and elsewhere. The terminology of Integrated Monitoring Systems (IMS) has emerged with the employment of network technology capable of interconnecting all desired elements in a very flexible manner. Also, the technology for transmission of a wide variety of information to off-site locations, termed Remote Monitoring, is in widespread industrial use, but significant adaptation will be required for international safeguards use.

REMOTE MONITORING

Remote monitoring is not a new concept, one only needs to recall the images presented on a daily basis on the television networks throughout the world. There are many examples of everyday applications of remote monitoring: security sensors monitor homes and businesses; data from seismic stations are

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remotely transmitted; land mobile satellite communication systems send and receive messages to and from mobile vehicles as well as determine the location of the vehicles. Currently, the US Department of Energy's International Safeguards Division, Sandia National Laboratories (SNL) and other DOE National Laboratories, and a number of international partners are engaged in a project termed the "International Remote Monitoring Project" (IRMP).

The objectives of this project are to:

- examine and, through field trials, define the technical parameters related to communications protocol, digital standards, sensor and sub-system interfaces, data display and management, overall reliability, authentication and confidentiality of transmitted data, and others as deemed 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

Remote monitoring systems are being deployed in an incremental manner in all the countries participating in the IRMP, including Argentina, Australia, Finland, Germany, Japan, JRC-Ispra, Sweden, and the USA (SNL, Idaho National Engineering Laboratory - INEL, and Oak Ridge National Laboratory - ORNL). Additional participants are expected to include South Korea, Brazil, and others. In addition, both the IAEA and ABACC are participating in the project. Operational systems are also installed at SNL and INEL, and, to the extent practical, the systems contain one of all types of detectors and video systems used in the various installations of the IRMP. The SNL and INEL systems are connected to the remote monitoring system, and are used as test beds for detectors provided by the DOE Laboratories and the DOE international partners. Technology exists to enable the IMS to be interrogated via various communication links such as telephone, satellites, or radio frequency transceivers. The data can be collected from storage devices on the network or the individual sensors can be polled to determine their status. A large amount of information has been collected from systems currently installed and under evaluation. Analysis of this data is in progress and provides a sound basis for addressing the limitations and problems found. Further, periodic system upgrades are performed based on the experience gained.

It should be noted, however, that significant technical and policy work remains before widespread safeguards implementation should be considered. Technical work is required in a number of areas, including: vulnerability assessment, equipment reliability, improved interactive display equipment, authentication, encryption key management, technical comparison of communications modes (telephone and satellite), information management, data format standards, information screening for decision making, advanced integration, advanced communications methods, increased network architecture flexibility, sensor fusion, etc. Further, data management, including presentation will present a technical challenge when a large number of facilities are to be monitored.

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/rights of worker associations (unions) and "sovereign rights". It is quite clear that remote monitoring across national borders can be seriously considered only in the context of a comprehensive, transparent, and open implementation regime. If remote monitoring is used, it is generally assumed that the data must be encrypted. It then becomes important to consider in what form must it be encrypted. In addition, the entire subject of encryption and the use of keys and procedures requires careful examination. Another issue addresses the requirements of the facility or State having access to the information transmitted. In the past there has been concern raised regarding the facility or State having access to the data acquired by the IAEA - again a subject related to the 'open' regime previously discussed. The overall cost effectiveness of remote monitoring must also be considered here. Very important issues must be addressed; e.g ., can acceptable safeguards assurances be achieved through acquisition of data from remote monitoring and a reduced level of inspection effort ?

This discussion on the implications related to remote monitoring has not been intended to be exhaustive. It simply illustrates that the use of remote monitoring in the International Safeguards context is a very complex subject.

ROLE OF REMOTE MONITORING IN CURRENT SAFEGUARDS APPROACHES

When discussing the use of remote monitoring within current safeguards approaches there are a number of factors that have to be considered. Timeliness goals of less than one year mean that inspector presence at facilities is required more frequently than just for the annual Physical Inventory Verification (PIV). But thanks to technology in the form of C/S, the actual work done during inspections for timeliness purposes can be minimised. For example at Light Water Reactors (LWRs), if video surveillance of spent fuel pond provides a conclusive result, it is not necessary to reverify the spent fuel inventory. Seals on the reactor core maintain IAEA

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knowledge about the core fuel. In fact, at timeliness inspections of LWRs using only low enriched uranium (LEU) fuel, if C/S measures provide conclusive results, the IAEA's Safeguards Criteria only require the inspector to examine the books, review surveillance data and check/replace seals. Plainly it would be advantageous if technology could be used to make these interim inspections superfluous. Under current criteria, however, that can only be achieved if the IAEA has more or less continuous access to information about the inventory of nuclear material; either in Vienna or at a regional office.

We believe that remote monitoring can provide such access to safeguards data. The use of sensors and detectors such as those currently used in physical protection and the remote monitoring field trials could together provide the IAEA with information necessary to assess the site activities for safeguards purposes. The IAEA inspectors responsible for the site could, for example, evaluate the data from Vienna and, through the cooperative nature of the installation, attempt to resolve anomalies through direct communication with the site operator or the national authority. If the anomaly cannot be resolved in such a manner, the Agency would still be aware of the anomaly sooner than they would without remote monitoring, and appropriate action could be arranged. It may even be possible that the flow of nuclear material, such as the loading and sealing of spent fuel casks at LWRs, could be verified by the use of integrated systems coupled with remote monitoring.

LOCAL MONITORING

Remote monitoring as discussed so far may be possible at facilities where there is only a limited number of movements of nuclear material. Other facilities, such as reprocessing and mixed-oxide fuel fabrication plants, are much more dynamic. It is probably impossible to develop a technology-based safeguards approach for them capable of rendering inspector presence between PIVs unnecessary. However, it should be possible to reduce inspection effort by using integrated systems, such as those exemplified in the LOVER or CONSULHA systems, to cover parts of the facility. The information collected by these systems could be interrogated by inspectors at a local office, perhaps within the facility.

ROLE OF REMOTE MONITORING IN NEW SAFEGUARDS APPROACHES

For many years the international safeguards community has been discussing alternative safeguards concepts to the ones currently used. Such alternative concepts include, for example randomisation of inspections, greater reliance on State Systems for Accountancy and Control (SSACs) and changes to timeliness goals.

Alternative safeguards approaches which can match the level of assurance currently achieved are typically either heavily dependent on manpower, or heavily dependent on technology, or a mixture of both. That is mainly a result of the current timeliness goals. The IAEA has stated that the detection goals are not used in a purely mechanical way, but as guidelines in designing safeguards approaches and establishing inspection goals. The Agency has also said that the detection goals were set on a provisional basis, and that it foresees that new goals will be developed which will help to improve the effectiveness of safeguards. In addition, the IAEA has stated that the detection time should correspond in order of magnitude to conversion time. The conversion time for spent fuel has been determined to be one to three months. A detection time of six to twelve months for irradiated fuel certainly corresponds with that in an order of magnitude. Changing the timeliness goal for irradiated fuel would mean that some of the current interim inspections could be discontinued.

However, even under a safeguards approach such as one based on changes to the timeliness goal, the need for flow verification would still remain. It should be possible to design an integrated surveillance system which, with the cooperation of facility operations staff, would allow IAEA inspectors to verify shipments or receipts of spent fuel without leaving Headquarters. Such a system might be based upon above-water and under-water cameras, the placement (or removal) of electronic seals by the operator, and perhaps gross gamma detector data.

SUMMARY

Despite their relative maturity, Integrated Monitoring Systems and Remote Monitoring Systems present technical challenges in the areas of standardisation, authentication, tamper resistance and other technical areas. Equally important, the subject of the safeguards use of remote monitoring is influenced by issues related to State rights, transparency, safeguards criteria, etc. The IRMP field trials underway today will provide valuable information for the design of tomorrow's safeguards systems. Any future system for safeguards applications should have the capability to be remotely monitored and the capability to have a sensor network attached to provide sensor data to supplement image information and to selectively trigger the collection of images. While remote monitoring technology exists today, it may be some time in the future before numerous constraints, technical and policy, can be resolved.

The time-proven verification techniques, based on quantitative factors and demonstrated universal application, have shown their merit. However, the new expectations suggest a possibility that a future IAEA safeguards system could rely more heavily on the value of a comprehensive, transparent, and open implementation regime. Within such a regime, one important element will be remote monitoring using integrated monitoring systems. Once confidence is established with the remote monitoring system, and other

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factors such as transparency, openness, and extended short-notice access are resolved, the implementation of such remote monitoring techniques could provide for increased efficiency and effectiveness of IAEA safeguards.

The IAEA and the international safeguards community must address the current safeguards procedures and criteria, because it is necessary to recognise that this technology offers the potential for making significant contributions to the goals of safeguards. It is essential that safeguards-relevant systems using the new technology considered by the IAEA be tested and evaluated in a generic way. That is, the concepts of qualitative safeguards criteria, and increased cooperation in the resolution of anomalies must be included in the assessment. It is also important to define appropriate ways to evaluate and use the new technology. This necessarily includes the ability to share data and to exchange information about the system and its operation. The result will be openness in the operation of all nuclear facilities and materials control, the right of short-notice inspections, and the ability to jointly analyze system performance. The latter will include resolution of data anomalies, and timely correction of system failures or problems without prejudice to the long-term outcome of the anomaly resolution.

~~The IAEA and the international safeguards community must therefore address the new technology in light of the revision of current safeguards procedures and criteria.~~ Only by resolving these issues can all the promise of the technology be realized. However, it is doubtful that these contributions can be realized to their maximum benefit unless much more importance is placed on the qualitative parameters that could contribute to safeguards evaluation.

REFERENCES

1 CS Sonnier, CS Johnson, S Fernandez-Moreno, E D'Amato, J Bardsley, DL Sorokowski, K Veevers, M Cuypers, F Sorel, B Richter, G Stein, K Koyama, P Ek, G af Ekenstam, " The International Remote Monitoring Project - An Update". *Proceedings of the 17th Annual ESARDA Symposium on Safeguards and Nuclear Material Management*. ESARDA 27, May 1995.

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