Safeguards Evolution Towards Unattended C/S Systems

ABSTRACT

This paper shows the development and evolution of safeguards towards the use of different Containment and Surveillance Systems, which involve the possibility of working unattended. They are designed to transmit safeguards relevant data remotely. It is believed that they would increase safeguards efficiency while maintaining or even enhancing their effectiveness. At present, unattended C/S systems with or without remote transmission are in place at several installations. In addition, some other possible applications are being tested. One of these is the Remote Monitoring System (RMS) field trial at Embalse NPP to cover the transfers of spent fuel from the ponds to the dry storage.

Some of the matters to be addressed are of general nature (i.e. applicable to any unattended/remote system) while others depend on the specific application in a nuclear installation. Among others, the following are particularly important:

- Sharing of data with the SSAC
- Impact of a failure of the RMS on the operator, IAEA and the SSAC
- Provision of relevant operational and accounting information
- Review of the current safeguard approach for the selected installation
- RMS cost-effectiveness assessment

This paper describes the status of the RMS field trial as well as the current C/S system in place at Embalse NPP.

INTRODUCTION

The development of new technology, which is used as a tool to improve safeguards effectiveness and efficiency, has resulted in new approaches to deal with a better cost effectiveness of IAEA safeguards.

One possible new approach will be to rely more heavily on the value of a comprehensive, transparent, and open regime. The credibility in such a regime will be funded in timely data collection and transmission. A local data network can be extended to allow remote monitoring by the addition of the necessary control functions, and interfaces, to allow communication over long-distance data paths, such as telephone lines or satellite links.

The remote transmission of safeguards relevant data directly to the IAEA from integrated systems of unattended sensors located in nuclear facilities world-wide could permit timely data collection and remote interrogation. The remote monitoring system could reduce the number and duration of safeguards inspections in the field. Furthermore, taking into account the need to implement the new safeguards measures within the available resources, it seems advisable to
employ this technique in those cases when it results in a better cost-effectiveness and in less intrusiveness to nuclear facility operators.

In several CANDU NPP the increasing amount of spent fuel are transferred to dry storage in concrete canisters, which are normally put under the Agency C/S measures. The verification of these transfers is consuming rather large inspection resources. This number is likely to go up as more power stations opt for dry storage measures for the spent fuel. In almost all the existing cases the fuel is loaded into baskets in the spent fuel pond area and then transported to the concrete canisters at another nearby location. Work is under way to define the system needed to perform the verifications above mentioned through unattended mode equipment.

SAFEGUARDS EVOLUTION.

CONTAINMENT AND SURVEILLANCE SYSTEMS – UNATTENDED/REMOTE MONITORING SYSTEMS

The IAEA safeguards approach of fundamental importance to any facility is based on nuclear material accountancy complemented by containment and surveillance measures. The most desirable combination of these measures is that which permits the safeguard objective to be achieved at acceptable costs and with minimum intrusion into routine plant operations.

The application of C/S measures is aimed at verifying information on movement of nuclear or other material, devices and samples or preservation of the integrity of safeguards relevant data. In many instances C/S measures cover the periods when the inspector is absent and this contributes to cost effectiveness.

Generally, C/S is used to maintain the continuity of knowledge of previously verified inventories of nuclear material and to facilitate or reduce the inspection effort. To some safeguards approaches C/S systems are considered essential, thus a failure in them normally originates an anomaly that requires the re-verification of nuclear material inventories.

The Agency continues to introduce, in co-operation with States and the Regional Systems like the Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and as safeguards technology development permits, new safeguards measurement and surveillance systems that can operate in an unattended mode and transmit safeguards relevant data remotely. The use of such equipment, particularly in “difficult-to-access” areas, can also lead to more effective safeguards. The extent to which such equipment can be used in a facility depends on facility design and operating practices and on the co-operation of States in developing and installing the equipment and in its use by the Agency. Existing cases of equipment functioning unattended include bundle counters, core discharge monitors, containment and surveillance and NDA measurement systems. A broad range of remote monitoring possibilities which include among others electronic seals, radiation and motion detectors and video surveillance are being demonstrated through a series of field trials under the International Remote Monitoring Project (IRMP). Other possibilities involving commercially available satellite networks for direct communications, data transmission and photo surveillance are also being examined.

Remote monitoring would allow the IAEA, and the Regional and the State Systems to acquire data via telephone lines or satellite links, therefore maintaining oversight of ongoing nuclear activities with fewer onsite visits by the inspectors.

Since the safeguards system is being reviewed towards its integration with the new measures, it might be advisable to review in depth the role of C/S. The IAEA already started this review since Program 93+2, now with the integration of safeguards there is a new momentum.

Remote transmission of safeguard data out of a facility and the boundaries of a State is considered as one of the new powerful and cost-effective measures to strengthen safeguards and to increase its efficiency.
Successful safeguard applications of this tool depend on the requirements and features to fulfil safeguards goals on one hand and the associated costs and other related issues on the other hand.

CHARACTERISTICS OF THE REMOTE MONITORING SYSTEMS (RMS)

The cost-effectiveness of RM applications will depend on a case by case analysis and on the definition of their scope from the safeguard point of view. However, there are certain basic issues applicable to the RM concept as such. This paper points out some of them:

a) Sharing of data with the State System of Accounting for and Control (SSAC)

Firstly, RM application in safeguards is based on and could only work in an environment of increased cooperation between the IAEA, Regional Systems and Member States.

An important issue is the acceptability of RM concept for the operators and the States. In this regard, the importance of sharing all data to be remotely transmitted has been highlighted during the discussions of RM in the Board and in its Committee 24. During these discussions the relevance of sharing such information was stressed as an essential part of the transparency regime. Therefore a basic principle to guide RM applications is to share with the States all the information generated at the facilities and transmitted remotely to IAEA Headquarters, Regional System (RS) and the SSAC.

On the other hand, it is important to identify in which cases it is possible to increase current cooperation between the Agency, the RS and the SSAC. It is supposed that in many of the RM applications, the SSAC and RS can carry out certain activities to improve the implementation of these systems. Therefore, it is expected that the Agency will seek for the increasing cooperation with both of them in such a way that the IAEA is able to conduct its safeguards activities with less effort or cost, or more effectively, or both.

b) Impact of a failure of the RMS on the operator, IAEA, ABACC and the SSAC

The “Performance Requirements for an Unattended/Remote Monitoring System for the Transfers of Irradiated Fuel Bundles from the Pond to the Canisters”, were established at EMBALSE Working Group integrated by the IAEA, the ABACC and the Argentine Nuclear Regulatory Authority (ARN). It should be considered that these requirements were specifically prepared based on the CANDU NPP situated at Cordoba Province, Argentina. Any other case should be studied particularly.

Any proper unattended system shall not only satisfy safeguards requirements but also shall give a reasonable assurance that the probability of false alarms or failures should be reduced to an acceptable level to all parties concerned. In case of lost of continuity of knowledge of spent fuel stored at the ponds, re-verification implies an important effort not only for the IAEA and the ABACC but also for the SSAC and the operator. Thus, under a RM application it is important to define and agree in advance what will constitute such an anomaly and what will be the remedy actions to solve it.

c) Provision of relevant operational and accounting information

In each RM application it is important to identify and decide in advance which information is essential for remote transmission and which can be kept at the facility for later use. As a general guiding principle the Agency should review current safeguards approaches to only request the remote transmission of data that are really fundamental.
An important aspect of the provision of the information is the security and integrity of the data. In a monitoring organization this would depend on the procedures in place within the organization, which would not be directly part of a remote monitoring system, but features could be incorporated in the data processing and presentation system to help achieve high security. These may include:

- Passwords and electronically readable identity cards.
- Additional levels of access and authorization control for sensitive activities.
- All data transferred, which should be encrypted and authenticated.
- Computer equipment and cables with good electromagnetic shielding properties should be considered, to prevent unauthorized reception of images and data from electrical interference.

d) Current Safeguard Approach at Embalse NPP

Embalse NPP is a standard CANDU 600 facility, except for the addition of the welding station and the canister yard for dry storage of spent fuel with six or more years of cooling time.

The welding station is a facility annexed to the main bay building in the opposite corner of a spent fuel transfer channel, at the corridor level. In this place there is a pedestal crane that lifts the pond flask out of the main bay and places it over one of the two wheeled carts. These carts are on rails running inside of the welding cell. The welding cell is a heavily concrete and shielded room, containing the welding machine in one side and two lifting devices in the roof. In the middle of this roof is located a penetration through which the welded basket is loaded into the transfer flask parked on the top of this cell. The transfer flask is loaded on a third wheeled cart pulled by tractor and leaving the welding station through a gate opposite to the entrance gate.

The canister yard is located in front of the auxiliary-turbine-service building. The transfer flask travels along a perimeter road and reaches the yard through a gate located in the farther left corner. A gantry crane lifts the transfer flask on the top of the canister with the main hook and the canister plug is moved with its auxiliary hook. After the basket is unloaded the transfer flask comes back to the welding station by the same way.

The nuclear material stored in this type of canister has been designated by the Agency as a “difficult-to-access”. According to Annex D of the Agency Safeguards Criteria, this nuclear material has to be verified by item counting, item identification (where feasible) and NDA gross defects with random high probability detection sampling plans, prior to its becoming “difficult-to-access” and dual C/S is applied.

The safeguards approach for the spent fuel transfers is based (as in the general case) on a combination of accountancy and application of NDA-C/S measures.

At present, IAEA, ABACC and the State inspectors verify in-situ all the transfers of the spent fuels to the canisters by applying to the activities described.

e) RMS cost-effectiveness assessment

The development of these systems are relevant for improving the cost-effectiveness of safeguards. This may become true by obtaining a reduction in the number of routine inspections for the verification of nuclear material in the field. It is important to assess its cost before a decision to implement it for routine safeguards use is taken.
REMOTE MONITORING SYSTEM

The IRMP was coordinated by Sandia National Laboratories (SNL), USA. The field trials began in 1994. In 1995, the IAEA became involved IRMP and invited participants to establish bilateral arrangements. These field trials were mainly based on transmission of radiation, motion, temperature and video monitoring data via telephone links, Internet and satellite.

At Embalse NPP the first phase of this project was to test detector in the canisters of spent fuels. Later on, an action sheet was established between the Department of Energy (DOE) and the ARN to test the RMS at Embalse. In addition, Argentina and the US started to co-operate with the IAEA and the ABACC on this issue. As part of the second phase of this project, arrangements have been made to develop and test safeguards equipment and procedures for the implementation of unattended and remote verification of transfer of spent fuels from the ponds to dry storage. The instruments were installed for field test in April 1998 and in May 1999 and evaluation of the performance and procedures is in progress.

Verification of the nuclear material is based on a successful 100 per cent coverage of NDA gross defects method which ensure spent fuel properties by using gamma-spectrum radiation detection. In order to keep the continuity of knowledge of the verified nuclear material through the transfer process a combination of radiation sensors with C/S devices have been displayed. These components are supported or complemented by those belonging to the standard CANDU 600 safeguards approach. Special attention should be paid to the reliability of the process and system components by applying the diversity and redundancy concepts in order to avoid any possibility of tampering or system failure.

REMOTE MONITORING SYSTEM AT EMBALSE NPP

The current status of RMS installed at Embalse NPP consists of an integrated system formed by:

- Radiation chain of custody with six detectors, five of them communicate using radio frequency (RF) transmission and the other one is hardwired because it is mounted inside the welding station:
  - D1 detector is under development between ARN and DOE technician.
    It will be installed in a fixed position at the pond bottom to measure and to count the spent fuels, which are charged in the canister recording the gamma spectrum of each one.
  - D2 detector is a gamma sensor installed on the lid of flask 1 to follow its movement from the pond to the welding cell.
  - D3 detector is a gamma sensor installed on the welding station wall in a fixed position.
  - D4 detector is a gamma sensor installed on flask 2 to follow its movement from the welding station to the canister.
  - D5 and D6 detectors are gamma sensors installed at the top of each canister to maintain the charged information during its charge.

-Integrated surveillance:
  - Underwater camera located inside the spent fuel storage pond, which will begin capturing images as soon as a scene changes.
  - Camera on the top of the door between the pond and the welding cell to see flask 1 movement.
  - Cameras from MUX system in pond and welding cell buildings.
- Red/Green Light indicators: The first one, located at the spent fuel pond building, counts the number of spent fuels that have been loaded into flask 1. The second one, located in the welding cell building, provides an indication that the radiation sensors D1, D2 and D3 are functioning properly so that the welding process can commence.

- Global Position System (GPS): This is a differential system and consists of two receptors, one in stationary mode and the other in motion mode to follow flask 2 position.

CONCLUSIONS

- In applying a RMS it is of fundamental importance the sharing of information between interested parties. That is essential to increase the co-operation and transparency in the strengthened safeguards regime.

- A cost-effectiveness assessment of each RM application for a candidate facility should be carried out. This analysis should include, among others, the identification of the minimum amount of data to be remotely transmitted and its frequency (due to the impact in the communication costs). It is expected that the inspection effort in the field will decrease as a consequence of a RM application that will also result in a reduction in radiation exposure for inspectors and operators and less intrusiveness in facility operations.

- Current safeguards approaches need to be re-examined. This examination should take dully account to the strengthening of safeguards that is obtained through a RMS application and other new measures. It should not be a simple addition or modification to the current approach. For example, a successful store or transmission of key safeguards data should permit to change current criteria for annual PIV and interim inspections of the spent fuel at OLRs. Moreover, it might be appropriate to evaluate the current role of C/S for certain type of reactors like the OLRs.

- It is of great importance to define and agree what will constitute an anomaly due to a failure of a RMS and the remedy actions to resolve it. It is also important to determine the impact of such a failure on the operator, IAEA and the SSAC in advance the RM is used with safeguards purposes. It is expected that remedy actions that follows a failure of the RMS be realistic and take into account the increased confidence obtained by its application.

REFERENCES

[5] The IAEA RMP.