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Author(s):

Koichi Asakura, Tetsuo Ohtani, Mark E. Abhold, Steven E. Buck, and Howard 0. Menlove

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DEVELOPMENT OF REMOTE MONITORING SYSTEM FOR THE UNATTENDED MODE NDA IN PFPF

Koichi Asakura, Tetsuo Ohtani
Power Reactor and Nuclear Fuel Development Corporation(PNC)
Muramatsu 4-33, Tokai-mura, Ibaraki, 319-1112 Japan 29/282-3320 FAX:29/292-3326

Mark E. Abhold, Steven E. Buck, Howard O. Menlove
Los Alamos National Laboratory, NIS Division
Los Alamos, NM87545 USA 505/665-1430

Abstract

Remote monitoring is one of the important elements to strengthen the International Atomic Energy Agency's (IAEA's) safeguards system. With the progress of digital processing technology for image data, remote monitoring for containment and surveillance has been greatly advanced and already is nearly the stage of IAEA use. Another important technical element in safeguards implementation is the use of unattended mode Nondestructive Assay (NDA) systems. PNC has introduced and demonstrated various kinds of unattended mode NDA systems in the Plutonium Fuel Production Facility, PFPF, since 1989 in the cooperation with Los Alamos National Laboratory, LANL. To maximize the utilization of those systems, remote monitoring for NDA information should be developed. PNC and LANL have initiated the development of a remote monitoring system for the unattended mode NDA system at PFPF in 1997 in a joint study program. In November 1997, the first phase of the remote monitoring system successfully demonstrated its ability to send NDA data to a remote location with data authentication and encryption. This paper discusses the outline of the remote monitoring system for the unattended mode NDA at PFPF and new ideas for the international safeguards implementation scheme.

INTRODUCTION

<u>BACKGROUND</u> PNC constructed a MOX fuel fabrication facility, the Plutonium Fuel Production Facility (PFPF), to supply MOX fuel for the proto-type Fast Breeder Reactor (FBR) "MONJU" and the experimental fast reactor "JOYO" in 1987. PFPF utilizes state-the-art robot automated technologies to efficiently process and produce up to 5 tons of MOX fuel per year[1]. In 1988, a bilateral safeguards agreement between PNC and the U.S. Department of Energy (DOE) was signed to develop and demonstrate nondestructive assay (NDA) systems to provide continuous safeguards measurements for material accountancy in the robot automated PFPF. Under this agreement, NDA systems have been developed by PNC and LANL to be compatible with automated process and installed to give complete coverage of all plutonium in the facility since 1988[2,3,4,6,7,8,9,10,12].

The PFPF NDA systems were required to operate in unattended mode with a size and fuel mass capability to match the robotics fuel manipulators[5]. Unattended NDA systems reduce the inspector's workload and improve inspection efficiencies[11]. Additionally, unattended measurements become essential when facility constraints limit access of inspectors to the operation area during material processing. Authentication techniques were incorporated into

NDA systems so that the data obtained from unattended assays could be used by independent inspectors such as the IAEA. Table 1 lists the NDA measurement systems utilized in PFPF.

Table 1. NDA systems used in the PFPF

NDA System	Operation Mode
PCAS-Plutonium Canister Assay System (input)	Unattended
PCAS-Plutonium Canister Assay System (output)	Unattended
FAAS-Fuel Assembly Assay System	Unattended
FPAS-Fuel Pin Assay System counter	Attended
MAGB-Material Accountancy Glove-Box counter	Unattended
SBAS-Super globe-Box Assay System, holdup counter	Attended
WDAS-Waste-Drum Assay System	Attended
INVS-Inventory Verification Sample counter	Attended
PSMC-Plutonium Scrap Multiplicity Counter	Attended
FRAM-Shielded plutonium isotopic system	Attended

To best utilize these systems and to improve the efficiency of safeguards implementation, PNC and LANL started in 1997, to develop the remote monitoring system for unattended mode NDA used in PFPF.

DEVELOPMENT OF REMOTE MONITORING SYSTEM

Since commercial technology to send data over long distances is readily available, the largest efforts needed to implement remote NDA are essentially the same as for integrated monitoring; selection of set of NDA measurements appropriate to safeguards the facility, development of reliable unattended monitoring hardware and software, a local network, and integrated review software., Much of the latest technology developed at LANL for integrated continuous monitoring is also capable of remote transmission of NDA data. The technology was developed with the objective to make NDA systems "remote ready" and therefore, current designs provides for an interface with existing data transmission networks. Some desired capabilities of a remote NDA system are following :

(1) Reliable continuous unattended mode operation.
(2) Integration of all component data types (operator declaration, NDA, and C/S)
(3) Ability to transfer raw NDA data and system state-of health information to a remote location (Japan Atomic Energy Bureau (JAEB), Vienna, or IAEA regional office).
(4) Authentication of the transferred data.
(5) Automatic archival and backup of the raw data.
(6) Controlled access to the facility data, including perhaps limiting outside access to approved users at pre-defined periods of time.
(7) Use of same review software in the facility and the remote location. Using the same software to review the data eliminates unnecessary additional training.

Development of the remote monitoring system has been carried out in two phases. In the first phase, hardware and software were developed to demonstrate the ability to send encrypted and authenticated NDA data to a remote location.

HARDWARE The hardware used for Phase I system is shown in Figure 1 and briefly described below.

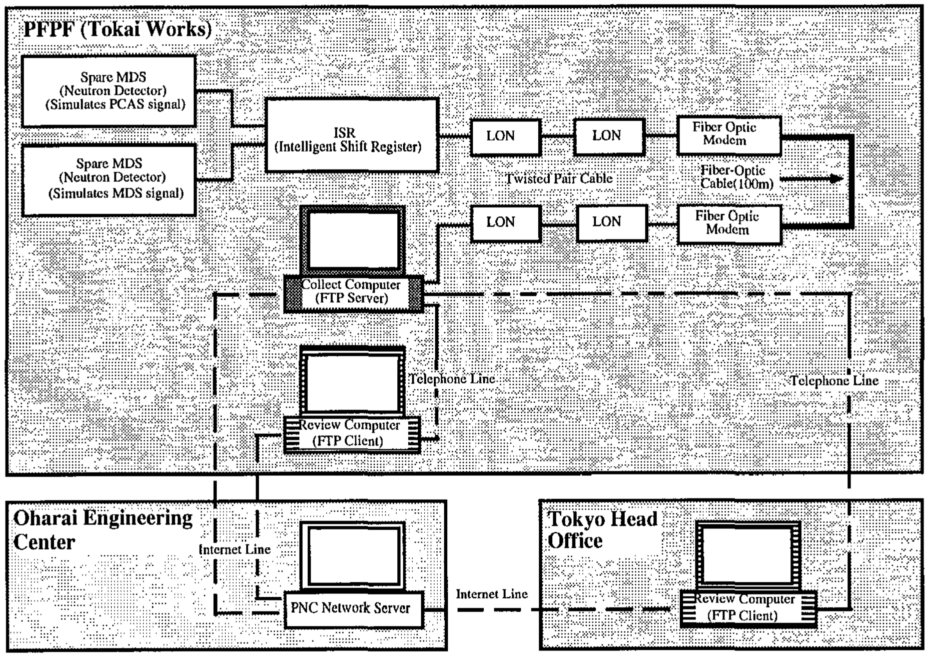

Figure 1. Hardware for Phase I System

(1) Intelligent Shift Register (ISR)
This instrument is one of the LANL intelligent instrument family members. The foundation of family is a basic set of system boards and built-in software. The system boards include a simple, internal, optimized bus low power requirements, and a significant amount of battery backed up memory which provides data buffering for network connection. The ISR board supports shift-register coincidence counting multiplicity counting and has two additional scalars allowing for the connection of Motion Detection Sensors (neutron counter). Also, common to all designs in the LANL intelligent family of instruments is the low-voltage power supply board and bias board set.

(2) Intelligent LON Modules (ILON)
The Intelligent LON (ILON) module provides a means by which many instruments may be connected together over wide area. The ILON was initially implemented as an extension cord between the instrument and collect computer. Due to the embedded microprocessor in the ILON, it can do more than merely pass serial data as an extension cord but also perform such function as transmitting binary signals from the radiation monitor to trigger the operation of a camera. One of the features of the ILON network is used to transparently authenticated the data massages. Although ILON is used for the current demonstration network, other networking technologies could be implemented in a similar fashion.

SOFTWARE The software utilized for Phase I system is shown in Figure 2 and briefly described below.

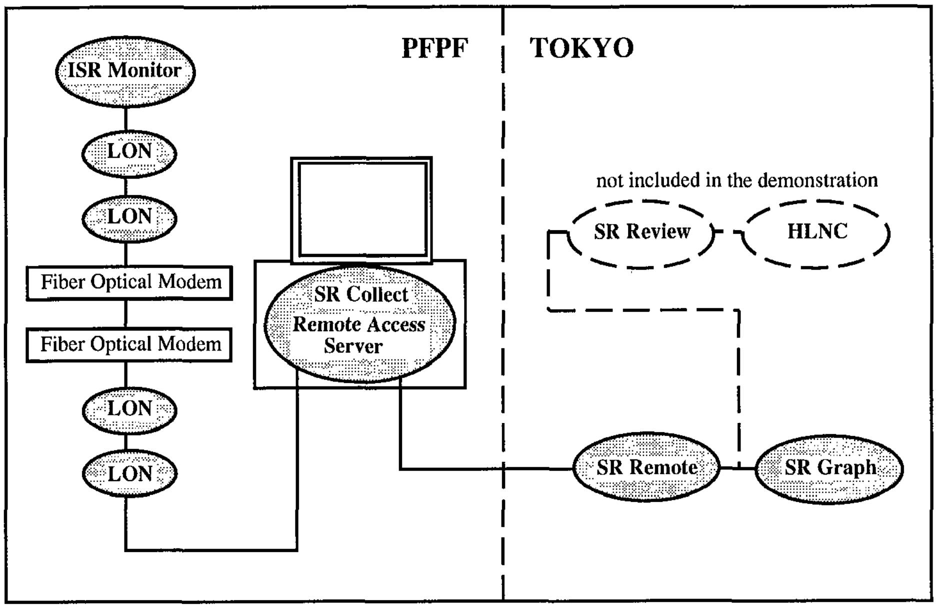

Figure 2. Software for Phase I System

(1) Data Collection Software
The data collection software is divided into two main parts: the Monitor program which resides in the ISR and the Multi-Instrument Collect (MIC) program which resides on the central data collection computer. The ILON module interconnects the instruments and the computer.

The Monitor programs contains the traditional features of acquiring the data at preset intervals, doing adaptive processing to determine how much data should actually be saved, monitoring and recording the instrument state of health, temporarily storing data in its battery back-up memory and sending the data to collect upon request. In addition, the Monitor program performs time synchronization and contains the ability to trigger other devices when radiation is present. The Monitor trigger through a parallel port interface; the ILON module transmits the trigger to the appropriate devices. This capability will be used in the Phase II demonstration system to trigger a MOS camera to take a frame of the Pu canister's ID number.

The MIC program provides the capability for data from several instruments to be received by a single computer at a central location. One collect program is capable of being used for multiple types of instruments. The main task of MIC is to offload the data stored in the intelligent instruments when needed. All instruments are polled for current status and amounts of stored data; when requested, data are transmitted to the collect computer where they are organized and stored. The program also provides a user interface by which the inspector can copy the data to floppy disk, other mass storage device, or transfer the data to a remote location.

DEMONSTRATION OF PHASE I SYSTEM In November 1997, the Phase I system for remote monitoring was successfully demonstrated to have the ability to send NDA data over a network, collect that data, and send the data from PFPF to the PNC head office located in Tokyo. It was also demonstrated that the Collect Computer in the inspection room at PFPF has the capability to be remotely accessed from the computer installed in the PNC head office over both telephone lines and the PNC intranet.

FUTURE SAFEGUARDS

Remote monitoring of a bulk processing facility such as PFPF where accountancy is the primary safeguards measure presents new safeguards challenges. Unattended measurements on in-plant material movements that provide assay information for material accountancy with the potential to enable near-real-time accountancy (NRTA) which meets and improves timeliness goals for IAEA safeguards. Integrating the NDA and material accountancy safeguards systems developed for unattended continuous monitoring in fuel fabrication facilities is a feasible approach to improving the effectiveness and efficiency of safeguards inspections[11]. Extending the integrated system to provide unattended monitoring and remote transmission of data has the possibility of allowing continuous inspection overnight away from the facility by safeguards personnel. A remote accountancy monitoring system for bulk facilities could provide safeguards inspectors an improved option for application of resources at facilities based on needs determined from review of continuous unattended monitoring data performed at the regional office or IAEA headquarters.

Enhancements to data review capabilities are being developed in Phase II of the remote NDA system. These enhancements will allow efficient review of the large amounts of data collected during an inspection period. The ability to remotely review multiple types of data at a high level and in a quick, easily understandable, and integrated manner is needed. In the case of PFPF, review tools that integrate NDA data with operator declarations can improve review efficiency. This new set of software review tools under development is called the PFPF Review Manager, built, in part, using components from the LANL Integrated Review System(IRS).

The suite of tools operate that will operate under the control of the PFPF Review Manager consists of multiple data review tools designed with common qualities:

(1) Each review tool reviews a single type of data;
- Radiation Review for radiation monitoring data,
- INCC ver. 3.1 for coincidence counter data,
- Operator Review for operator declarations.

(2) Each review tool can be used in a stand-alone mode as a separate application.
(3) Each review tool can be configured together with any of the other review tools to act as a single application for a complete inspection solution.

The PFPF Review Manager will automatically reconcile the operator declaration with the NDA system results.

SUMMARY

The following points were concluded through the demonstration of the Phase I system.

(1) Hardware is available to network NDA systems
(2) Public telephone line is expensive and slow for large amounts of data such as video or Gamma-Ray and Neutron Detector (GRAND).
(3) All network computer systems have security vulnerabilities.

(4) A standard security approach applicable to current and future safeguards systems is needed.
(5) Network security should be as robust as practical/affordable keeping the application in mind
(6) Ultimate security is provided by an isolated backup copy of data in the local a sealed cabinet.

The results of the Phase I system demonstration shows that remote monitoring unattended mode NDA has the possibility of improving the effectiveness and efficiency of safeguards inspection in combination with integrated review of operator declaration of the material movements in the facility.

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