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Performance Results from the First Integrated NDA VXI Safeguards System

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The IAEA has expressed a formal need for equipment standardization starting in 1992 with the establishment of the IAEA Integrated Safeguards Instrumentation Programme (I^2SIP). Periodic I^2SIP consultants and advisory group meetings have resulted in recommendations and guidelines. In particular, the VXIbus standard has been recommended as a first choice for unattended monitoring systems. As a result, in late 1992, an effort was started by the Canadian Safeguards Support Program (CSSP) to develop truly integrated and modular safeguards system hardware and software. This effort was directed at fulfilling the need to be able to integrate large monitoring systems into an easy to manage safeguards instrument package.

This need was related to IAEA experience with the large scale Core Discharge Monitor (CDM) system which was installed at one multi-unit CANDU station. This was a large system consisting of 64 detectors spread out over 1 kilometer distance. While quite successful, the original CDM was very complex, consisting of 3 main computers and 17 additional pieces of computerized equipment spread out across the plant. The original system also required expensive custom software to be developed, which could not be easily adapted to other installations. The project that resulted from this need was entitled the VXI Irradiated Fuel Monitor or VIFM system.

The basic concept behind the VIFM system was to provide a totally scaleable system that could accommodate from one to 96 detectors without the need for either hardware or software redesign. This functionality was further expanded to provide the ability to integrate multiple NDA systems into one software package. Examples of such a subsystem approach is the integration of the core discharge monitor and spent fuel bundle counter into one user interface. These totally unrelated systems operate seamlessly in the VIFM environment sharing both main computer and data acquisition resources thereby simplifying the operation, service and architecture of the system as well as providing excellent economies of scale.

In early 1997, the first of the VXI based radiation monitors were installed at several nuclear power plants around the world. These systems varied in configuration from simple bundle counters to complex integrated systems involving up to 5 different NDA systems in one cabinet. Although these configurations differed widely, all systems utilize exactly the same software and hardware components.

This paper presents the operational results obtained from these first systems and provides details of the performance of the integrated system concept. Of particular interest in examining the data collected thus far is the very high fidelity of the recorded signals as well as

the very good time resolution of the system. This fidelity and resolution is unsurpassed in any existing IAEA system and opens the possibility on "fine structure" signal analysis of the radiation signal. This type of analysis has been shown to be able to provide detailed information regarding the spent fuel transfer process. Automation of this process may allow the determination of previously unobtainable or obscure details.

In addition to radiation data, the VIFM system provides a history of the user's interaction with the system. This capability has proven very useful in fine tuning the usability aspects of the system and can also be used to determine which areas of operation may need emphasis during inspector training.

In one set of the VIFM system installations, a new technique has been pioneered that has allowed the use of simple reactor control type cabling as the interconnect between the electronics cabinet and detectors. This development has allowed the installation of critical NDA systems that were either not technically feasible or prohibitive in cost to even consider previously. As part of this paper, further details on the performance of systems equipped with this connection scheme will be presented.

In specific terms , the paper presents details on the following items:

1. System performance, including data on detector, computer and data acquisition sub-systems.

2. Presentation of recorded data, with specific details on the wide dynamic range and resolution of the system.

3. Evaluation of the system user interaction log as a guide to usability problems.

4. Present data on the performance of the new cabling scheme.

The final part of the paper outlines the current efforts aimed at expanding and enhancing the capabilities of the VIFM system. These additional items consist of VXI compliant hardware modules that seamlessly integrate with the existing hardware via the system's software. The additional functions include enhanced authentication and tamper indication of NDA detectors, precision time keeping capability, high speed remote transmission and dialog, increased NDA functionality, video integration and finally very large scale detector networking capability.