Technical Preview of the United States Demonstration of an Attribute Measurement System with Information Barrier

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Introduction

This paper complements Duncan MacArthur's paper, *Attribute Measurement System with Information Barrier (AMS/IB)—Conceptual Description*, which describes the goals of the AMS/IB design team and the concepts and ideas used to meet those goals, including inspectability and authentication. This paper focuses on the implementation of those ideas. Figure 1 is a conceptual diagram of the AMS/IB. Figure 2 shows the implementation of those concepts—the shielded electronics rack and the shielded detectors.

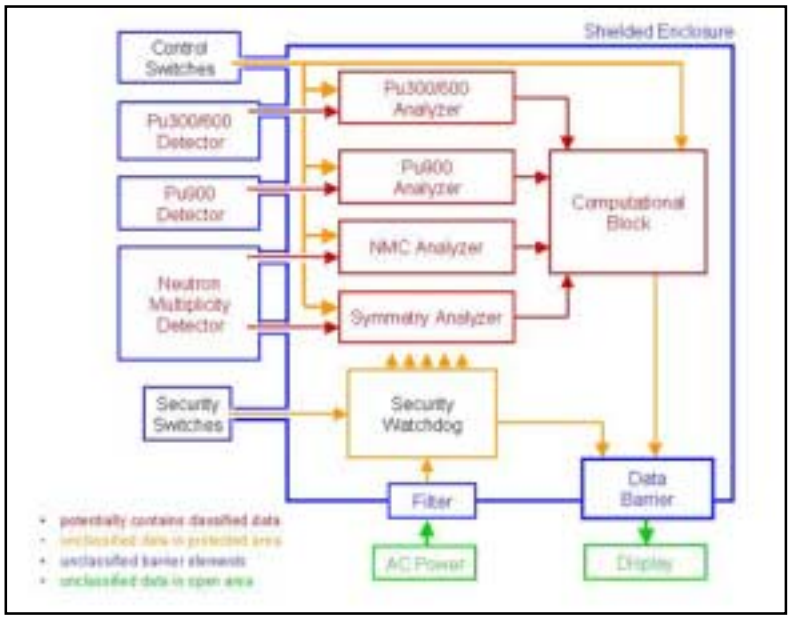

Fig. 1. The AMS/IB concept.

Fig. 2. The shielded AMS/IB. The shielded electronics rack contains the computational block, data analyzers, and security watchdog and is connected to the detectors by shielded cables.

The large blue cabinet in Fig. 2 is the neutron multiplicity counter (NMC). The item to be measured is placed within its well. The Pu300/600 detector and the Pu900 detector in their shielded boxes are positioned so that all detectors may operate at the same time. The shielded electronics rack (Figs. 2 and 3) contains the data analyzers, computational block, and security watchdog. The cables through which the detectors transmit data to the analyzers are also shielded, so the entire system is effectively shielded as shown by the blue outline in Fig. 1.

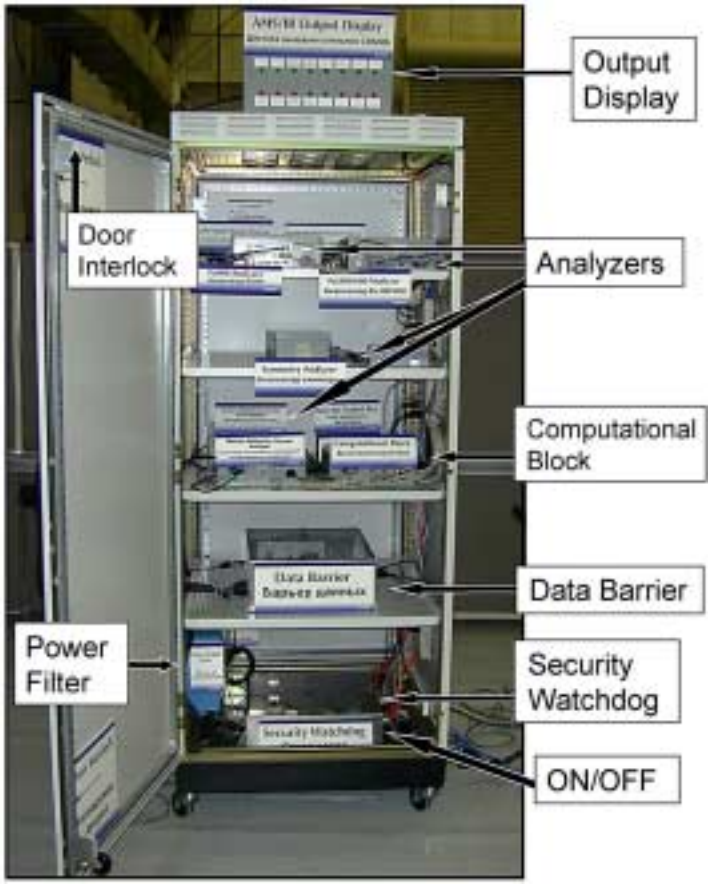

Fig. 3. The shielded electronics rack with the access door open.

Detection is controlled by an operator. The only input possible is the selection of the type of operation: background, measurement control, gamma calibration, or assay. The selection is achieved by pushing a button on the detector control box, shown in Fig. 4.

Fig. 4. The AMS/IB detector control box.

The AMS/IB contains five computers. These are the Pu300/600 analyzer, the Pu900 analyzer, the neutron multiplicity analyzer, the symmetry analyzer, and the computational block, as shown in Fig. 1. All of these computers boot off PROMS. They have no hard drives and store no data. During assay there are no monitors or keyboards attached to any of the computers. During authentication measurements monitors are attached so that measurement data can be viewed. For simplicity and ease of authentication, the computers all use a PC/104 CPU board and run the DOS operating system. The applications were written in Visual C or FORTRAN programming languages.

The analyzers compute the values for the attributes to be measured and pass them to the computational block. The computational block holds the agreed-upon threshold values for each attribute, performs the comparison of the actual value with the threshold, and determines pass or fail for each attribute. It generates a measurement-complete signal when all measurements and comparisons are completed. If there is an error of any kind, from the detectors or analyzers, or if the computational block is unable to complete its operation, an error signal is sent. This error signal is sent after the same fixed time used for all measurements. Thus no further information can be deduced from the timing of the measurements or from an error signal.

The computational block contains five types of memory:

- PROM—This nonvolatile memory (Atmel 27C080) contains the executable program. It is read-only memory and thus cannot be written to.
- CMOS—This is disabled and has no battery.
- RAM—4 MB of volatile memory
- Flash ROM—This nonvolatile system BIOS memory is write-disabled with pin 11 lifted or Jumper W2 missing.
- EEPROM—This nonvolatile memory can be written to. It is necessary for system configuration information and has minimum data storage (256 bytes).

All output from the computational block is transmitted to the data barrier and then to the display.

There are two modes in which measurements may be made: open and secure. In the open mode, unclassified measurements may be performed for background, measurement control, gamma calibration, or for authentication measurements on unclassified items. In the secure mode, classified measurements may be performed for assay, because the measurement data are protected as though they are classified. The measurement mode is determined by the container itself. No operator input affects the measurement mode. If the detector well is empty or if there is an unmodified container in the well, a measurement can only proceed in secure mode. Only when the well contains a specially modified container can the measurement mode be open.

The AMS/IB can operate with its access doors open or closed. When the access door is closed, a red and green LED display is the only output from the system. In this configuration, either classified items or unclassified reference materials can be measured, but only the simple unclassified display is possible. When the access door is opened, all power is immediately removed from the system. Since no data are stored in nonvolatile memory, this power removal in combination with an active purge procedure ensures that no classified information can remain in the AMS/IB after the door is opened. If, and only if, no classified material is present in the AMS, the security watchdog will restore power to the AMS following a delay of approximately 20 seconds. This will allow authentication measurements to take place using unclassified reference materials. If a classified object is placed in the system while the door is open, all power to the system will be immediately cut off and will remain off until the classified item is removed or the access door is closed.

The security switch in the AMS/IB consists of four switches in series, any of which is sufficient to indicate a classified container (thus preventing the system from operating in the open mode). Two of these switches (normally closed) will open if any container other than the specially modified one (for unclassified materials) is placed in the NMC. The other two switches, normally open, will be closed when any container (modified or not) is placed in the NMC. The AMS/IB can be operated with the door open only if all four switches are closed.

A key element of the AMS/IB is the security watchdog that controls power to all other elements of the AMS/IB. If any shielded enclosure is opened, power is immediately removed from the rest of the AMS/IB and all data are purged. Only if this occurs in open mode is power restored after a delay. As an additional protection, there is a SCRAM switch that removes all power and purges all data from the system at any time the operator demands it.

The data barrier provides an extra layer of defense between the areas where potentially classified data are processed and the unclassified display. It controls the flow of data across the IB and can output only 1 bit of data per input line.

The display (Fig. 5) receives unclassified data from the data barrier via fiber optic coupling. There are eight paired red-light/green-light outputs.

- The outputs for the six attributes (12 possible results) and the Measurement Complete/Error message (2 possibilities) are controlled by the computational block.
- The output for the security mode indication (2 possible modes) is controlled by the security watchdog.

The display has no data logging capability.

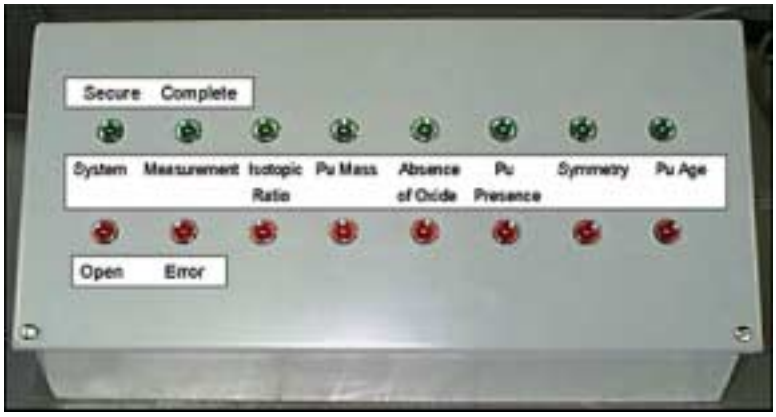

Fig. 5. The AMS/IB display can only present measurement results that are unclassified.