NEW PAMTRAK FEATURES

Bruce Dahl
Sandia National Laboratories
Department 5845
Albuquerque, NM 87185
(505)844-0093

Jonathan Anspach
Allied Signal/Kirtland Operations
P. O. Box 4339, Station A
Albuquerque, NM 87196
(505) 844-9889

Abstract

Recent developments throughout the world as well as a desire to decrease the federal budget deficit are changing the United States' policies toward nuclear weapons and materials. Many existing nuclear weapons are being dismantled, their contents joining raw material and waste already in short-term storage. Environmental cleanup is adding to the amount of radioactive waste that must be stored.

There are significant costs associated with protecting stored nuclear and radioactive material. Much of the material is attractive to terrorists or agents of foreign countries. If stolen, some of it could be used to build nuclear weapons to be used against the United States. These concerns necessitate the use of hardened vaults within intrusion detection perimeters and round-the-clock, rapid-response guard forces.

Benefits to Using PAMTRAK

The Department of Energy defines a baseline vault and corresponding inventory interval. A site can implement additional security or monitoring measures to a vault above and beyond the baseline to extend the inventory interval of that vault. Such additional measures can take any of the following forms:

- Physical barriers or hazards that further restrict access to the vault or material within the vault
- Continuous observation of the material or monitoring of material movement
- Continuous measurements of intrinsic material attributes such as weight, temperature or radiation emission

In general, barriers and hazards provide the shortest inventory extensions while measuring material attributes provides the longest. For
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more specific information about extending inventory intervals see chapter VI entitled "Alternative Physical Inventory Measures" of the Guide for Implementation of DOE 5633.3B "Control and Acceptability of Nuclear Materials".

Sandia National Laboratories is developing, under the sponsorship of the United States Department of Energy, a Personnel and Material Tracking System (PAMTRAK). PAMTRAK uses a variety of techniques to monitor material inside a vault in real-time. It can detect material movement using video cameras to continuously observe the interior of the vault or motion sensors attached to the material. It also contains two prototype attribute monitoring systems that continuously measure material weight, temperature or movement. A site can use any of these capabilities alone or together to extend physical inventory intervals.

A surveillance system such as PAMTRAK can reduce the cost of storing material by reducing inventory frequency and radiation exposure to workers. An analysis done at the Savannah River Site in 1992 estimated that installing PAMTRAK in the seven active and future vaults at that site would save $1,073,000 per year by reducing inventory frequency from once a month to once a year. Performing similar calculations now, assuming lower radiation exposure limits of 700m Rem per year, new inventory reduction guidelines allowing a baseline interval of six months, and an achieved inventory interval of three years, results in an estimated average savings of approximately $400,000 per year.

There are two notable drawbacks to relying exclusively on physical inventories to prove the integrity of stored material. The first is that material theft may not be detected until months after it has taken place, with no hope of recovery. PAMTRAK, since it is a real-time system, can detect theft or diversion soon enough to give the guard force a realistic chance of recovering the material and apprehending the perpetrator. The second drawback is that in performing an inventory a site typically checks only a fraction of the material using random, statistical sampling methods. In contrast, PAMTRAK monitors all material in the vault.

In addition to static environments such as vaults, PAMTRAK can be used to protect material in active work areas. Several of the sensor types can ignore activity around material but still report alarms if the material is moved or handled. PAMTRAK includes a personnel tracking capability that allows a site to monitor and restrict personnel movements. It can exclude workers from designated areas unless they have explicit permission to be there. It can also enforce the 2-person rule by requiring a worker to be accompanied by at least one other qualified worker in designated areas. These capabilities can help ensure that material is protected even when not locked in a vault.

In developing PAMTRAK we have also tried to produce a flexible, customized and extensive system that is relatively inexpensive for sites to install and maintain. A site can use any subsystem or combination of subsystems that PAMTRAK supports. We provide a comprehensive set of security rules from which a site selects those it wants to enforce. As a result, we can install PAMTRAK in a variety of sites with widely differing requirements without having to make modifications to the system software. To keep costs down we run PAMTRAK on IBM PC-compatible computers and use existing technologies and commercial products whenever possible.

PAMTRAK incorporates various sensor subsystems that offer a variety of techniques to protect material. We have five material monitoring subsystems available for use. In addition, we have three prototype subsystems that would require more development before being ready to use. We briefly describe the subsystems below.

The Wireless Alarm Transmission of Container Handling (WATCH) subsystem employs motion sensors packaged together with radio-frequency (RF) transmitters to report attempts to move material.

During the past year we have added the Authenticated Item Monitoring (AIMS) subsystem. AIMS starts with the basic WATCH sensor and adds authentication features to reduce the possibility of counterfeit messages. The sensors for both subsystems are attached directly to the material being monitored.

We are currently evaluating a prototype polled RF sensor subsystem developed by RANDTEC Corp.
The RANDTEC hardware was developed to overcome some of the drawbacks of the WATCH and AIMS subsystems. Its chief differentiating feature is that it sequentially polls the transmitters in order to minimize transmission collisions. It also has the potential to be more effective than the WATCH or AIMS subsystems because it can support material attribute-measuring sensors (weight, temperature or radiation, for example).

We also offer three video motion detection (VMD) subsystems. The first is an SNL-designed VMD called the Material Monitoring Image Processing System (MMIPS). The second, Monitor, was designed by Los Alamos National Laboratories. The third is a commercial VMD, called the TSI 20/20 by Tech. Services International, that we have added in the last year. Although they have different features, they all work by using video cameras to detect and report movement within predefined regions of interest. All three VMDs are described in more detail in “New PAMTRAK Video And Interface Capabilities” by Jonathan Anspach, INMM 35th Annual Meeting Proceedings, Naples, FL, July 1994;

We have two wireless personnel tracking subsystems available to track workers as they move through a facility. Personnel tracking can be used to exclude workers from, or enforce a two-person rule in selected areas. It can also be used to verify the presence of workers who are performing remote transactions (described below). One of the subsystems uses RF technology; a new one for this year uses infrared (IR) technology. Both personnel tracking subsystems are described in more detail in “Insider Protection Technology Developments” by James Foesch, Peter Bortniak, and Ivan Waddoups, INMM 35th Annual Meeting Proceedings, Naples, FL, July 1994.

A biometric identification subsystem (hand geometry) can control entry to a facility and/or assign personnel tracking badges to workers.

A remote transaction entry subsystem allows workers to perform transactions such as placing sensors on material or shipping material between locations in a controlled fashion without having direct access to the PAMTRAK computer.

We also have two prototype canister monitoring subsystems. They are designed to measure physical attributes of material such as weight and temperature. However, both subsystems need further development before being ready for deployment in a real-world environment. They are described in more detail in “Incorporation of an Item/Material Attribute System into PAMTRAK” by DeNise A. Anspach, Ivan G. Waddoups, and Eric T. Fox, INMM 35th Annual Meeting Proceedings, Naples, FL, July 1994;

Figure 1 shows a block diagram of a fully configured PAMTRAK system.

Reports from the subsystems to the PAMTRAK computer (such as sensor WATCH movement or personnel tracking badge location) do not automatically result in alarms. The PAMTRAK computer evaluates the reports as they come in against a user-defined, site-specific security rule database. If any reported condition violates the security rules the PAMTRAK computer reports an alarm.

In addition to the new subsystems, we have made other enhancements to PAMTRAK within the last year. We have substantially reduced the hardware requirements of the system by eliminating some of the peripheral subsystem computers and moving their processing functions into the central PAMTRAK computer. We have improved the alarm annunciation capabilities by adding voice announcements and a relay closure interface that can control lights, physical barriers, or other mechanical systems.

This year we have also integrated a radiation sensor into the WATCH with some success though that effort is not finalized. We integrated a 5G, micromachine accelerometer (for motion detection). While it worked successfully, we felt that it drew too much power (1mA) for our current battery. We have evaluated other types of batteries and found several that would offer longer life to the WATCH, though some were cost prohibitive. We are currently evaluating a rechargeable lithium battery in conjunction with photovoltaics. Preliminary research suggests that a 5 inch square PV might be able to keep a WATCH charged indefinitely for as little as $25 (based on several factors including overhead lights being available and turned on 24 hours per day).

We have been doing some radiation testing of the WATCH to determine its life expectancy in high radiation areas. That work is not complete but we believe that it demonstrates that some shielding may
be desirable in extending the life of the WATCH electronics. The greatest contribution to life extension to date was due to designing the WATCH (and the RANDTEC tag) to “sleep” most of the time and only be fully powered during periodic state-of-health or tamper transmissions (or polling cycles in the case of the RANDTEC unit).

We developed an interface between PAMTRAK and PC-Dymac, a UNIX-based Material Control and Accounting system currently being supported by LANL at ANL-W. We have begun to develop online user documentation which will eventually have a tutorial, context-sensitive help, and hypertext support in PAMTRAK.

**Future Enhancements Planned**

We have plans to employ several techniques to improve PAMTRAK, some of which are designed to resolve suggested defeat mechanisms, some to reduce cost, etc. In order to provide greater reliability and better performance we plan to port PAMTRAK to a symmetric multiprocessor computer (a PC with more than 1 CPU inside). Such computers are now available for as little as $10,000 and typically offer dual, redundant power supplies and disk drives, built-in UPS devices, error correcting memory, and two or more CPUs. This should resolve the hardware component failure vulnerability and any concerns about system performance.

We plan to employ wireless LAN technology to avoid the cost in time and labor of running cables and conduit between the vault (or storage area) and the PAMTRAK computer during installation. Spread spectrum, IR, and encryption techniques may be used to ensure security during data transmission. We also intend to replace the hardwired bar code readers with wireless units.

One vulnerability has been suggested in which someone in a vault could wear two personnel monitoring tags and thereby spoof the system into “believing” that two authorized persons were in the vault and so not alarm for violation of the 2-person rule. We are working on several techniques to foil this defeat mechanism. One is to use a technology under development at SNL in which a sensor worn, for example like a wristwatch, could uniquely identify an individual by his/her heartbeat “signature”. If removed or worn by someone other than its rightful owner the wristwatch tag would send an alarm to PAMTRAK. Another technique is to “sensor-fuse” inputs from our video personnel tracking system and a personnel tag. In this scenario the video system could confirm that the number of persons in a vault matches that number of personnel tags detected, and send an alarm if they do not coincide. Yet another technique might be to use pressure sensitive floor mats covering the entire vault floor. The number of persons detected from this sensor could be compared with the video camera input and/or that of the personnel tag subsystem.

To defeat the vulnerability in which cameras using visible light could fail to detect an intruder if the lights were turned off, we hope to integrate SNL’s LADAR (scannerless, laser radar) technology to permit the camera to “see” in the dark and to offer 3 dimensional imaging capability.

To reduce overall system cost we hope to be able to use semiconductor ASIC (Application-Specific Integrated Circuit) technology to shrink the WATCH sensor/transmitter functionality to a chip. We hope this could reduce the cost of each sensor/transmitter to under $50 from the current $175.

**Installations**

We have installed PAMTRAK in the Fuel Manufacturing Facility at Argonne National Laboratories - West. That installation includes the WATCH, MMIPS video motion detector (VMD), and remote transaction entry via bar code readers. We are planning to install the IR personnel tracking subsystem there next month.

We are near the end of a preliminary evaluation of the RANDTEC material monitoring subsystem with PAMTRAK in a vault with low-level radioactivity at the Savannah River Site. We are planning to do a longer evaluation in another storage facility in the presence of higher radiation at SRS later this year.

**Conclusion**

PAMTRAK is a full-featured, stable system for monitoring material and people. It offers user selectable features and site specific rules. An installation can choose to use any or all of the subsystems independent of the others, e.g. material monitoring without personnel monitoring. PAMTRAK adds safeguards, extends inventory intervals, and can save money overall through
reduced inventory frequency and lower human radiation exposure. The DOE has encouraged its use for this purpose. SNL supports and welcomes new users.

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