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Plutonium Protection System (PPS) Final Report Volume 2: Hardware Description

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PLUTONIUM PROTECTION SYSTEM (PPS) FINAL REPORT

Volume 2: Hardware Description

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ABSTRACT

The Plutonium Protection System (PPS) is an integrated safeguards system developed by Sandia Laboratories for the Department of Energy, Office of Safeguards and Security. The system is designed to demonstrate and test concepts for the improved safeguarding of plutonium.

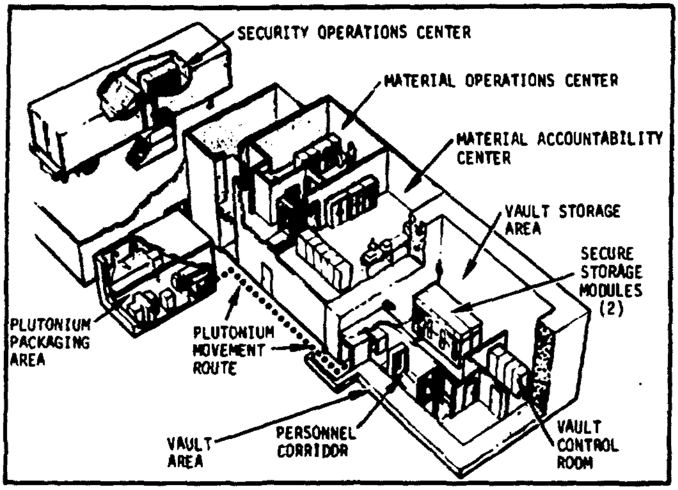
Volume 2 of the PPS final report describes the hardware elements of the system. The major areas containing hardware elements are the vault, where plutonium is stored, the packaging room, where plutonium is packaged into Container Modules, the Security Operations Center, which controls movement of personnel, the Material Accountability Center, which maintains the system data base, and the Material Operations Center, which monitors the operating procedures in the system. References are made to documents in which details of the hardware items can be found.

OVERVIEW

The Plutonium Protection System (PPS) is an integrated safeguards system developed by Sandia Laboratories for the Department of Energy, Office of Safeguards and Security. This safeguards development project was initiated in January 1975, and had as its overall goal the design and construction, for evaluation, of a prototype plutonium storage system which would provide positive, uninterrupted control of plutonium items. This control would begin at the time the item is received at the storage facility, continue through its storage life, and terminate with the authorized release of the item from storage. While at the storage facility, the item would be protected in such a way that any attempt to steal, divert, or sabotage material would be readily detected and alarms would be produced. The resultant system, designed to be compatible with a Hanford-like plutonium storage facility, has been successfully subjected to performance and safeguards testing. Performance testing of the PPS included an operational demonstration at the Hanford storage facility during which plutonium items were processed through the system by Rockwell Hanford Operations personnel.

Relative to existing systems, the PPS is designed to provide more positive control and accountability of packaged material and personnel access while reducing radiation exposure of personnel and complying with all safety requirements for the handling of plutonium. These functions are implemented through three computer control centers: the Material Accountability Center, the Material Operations Center, and the Security Operations Center (see accompanying figure: Overview of the PPS). Integrated with these centers are (1) a hardened vault area, which includes a personnel corridor, the vault control room, and the vault storage area where the secure storage modules are located and (2) a plutonium packaging area.

When operated as an integrated system, the three PPS centers provide stringent control and rapid accountability for each package of plutonium. To reduce vulnerability to insider threats, access to and movement of plutonium require active concurrence from the three



Overview of the PPS

physically separated control centers. These centers are individually programmed to separate the accountability, operations, and security functions. Overlapping of responsibilities, which provides an inherent set of checks and balances, is achieved by requiring independent and fail-safe approvals from the individual centers prior to implementation of PPS activities. To permit the requisite exchange of information, the control centers, the vault area, and the packaging area are interconnected by a data communications network.

Activities within the PPS are covered by four types of transactions: (1) deposit, (2) in-vault movement, (3) withdrawal, and (4) inspection/maintenance. When a particular transaction has been authorized, the appropriate data are entered into the system, thus establishing a transaction file. Data from this file are used by each computer center to set up the transaction and assure that it is conducted only as authorized.

At present, Rockwell seals plutonium items into foodpack cans for storage. In the PPS packaging area, each of these plutonium-containing cans is further sealed into an overpack container. Logic circuits and sensors which provide unit identification, material security, safety, and rapid inventory are integrated into the upper half of this container. A security tang which mates with a deadbolt to lock the container in its storage location is integral to the lower half of the container.

After the overpack container is sealed, each unit is logged into the system data base and the presence of a threshold amount of radioactive material is verified. A secure transporter is then used to move the containers from the packaging area to the vault area for storage via the route shown in the accompanying figure. In the vault area, the containers are placed into a secure storage module, which provides physical protection for each packaged item, controls access to the item, and provides the final link for maintaining plutonium accountability and inventory.

The secure storage modules are designed to provide in-depth protection for the plutonium, i.e., a vault within a vault. Each module contains four storage carrousels within a massive structure that has walls of precast, steel-reinforced concrete and steel doors. The storage slots in the carrousels are arranged in a cylindrical configuration designed for single-container-only access and positive locking of each container. Rotation of each carrousel is computer-controlled to allow only the prescribed container to be released at the appropriate time. While in the storage carrousels, the status of each container is continuously monitored by a microprocessor in communication with the vault computer. Although as many as 280 containers can be secured and monitored in the two-module configuration tested, additional modules can be added to accommodate thousands of containers.

An integrated entry-control, intrusion-detection, and assessment system is designed to detect unauthorized entry attempts and verify proper personnel access into critical areas. Major elements of this system include electronic credential readers, closed circuit TV cameras, an identification booth, metal and special nuclear materials detectors, and motion sensors.

In the design of the PPS, provisions have been made for supervised contingency operations to allow secure recovery in the event of personnel errors or system malfunctions.

The Plutonium Protection System (PPS) Final Report, SAND78-0660 consists of six volumes:

Volume 1: Executive Summary
Volume 2: Hardware Description
Volume 3: Software Description
Volume 4: System Operation
Volume 5: Operational Demonstration and Evaluation*
Volume 6: System Test and Evaluation

In addition to these volumes, there are a large number of detailed technical reports and a documentary movie. These sources are referenced in the appropriate volumes. A complete PPS bibliography is included in Volume 1: Executive Summary.

*Submitted by Rockwell Hanford Operations.

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SECTION 1

INTRODUCTION

The Plutonium Protection System (PPS) is an item protection system that demonstrates advanced storage concepts which integrate detection and delay elements with careful monitoring and control of operational procedures. The goal of the PPS is to provide a significant improvement in the securing of nuclear materials stored at a fixed site.

Chief among the physical techniques used is the "vault-within-a-vault" concept in which a sequence of vault-like structures must be breached before access to the special nuclear materials (SNM) is attained. Additional security is obtained by restricting vault access to only those personnel identified with the transaction in progress. Physical protection outside the vault is provided by a specially designed transport module.

Operational safeguards are achieved by means of three control centers, each of which has a distinct and separate function to perform before material can be released from the system. In this manner, diversion of material by insiders becomes a much more difficult task. The accomplishment of these safeguards features requires a complex combination of hardware and software elements. This volume describes the hardware elements which comprise the PPS.[1]

[1]Sandia Drawing T55421 documents the organization of the PPS and gives assembly drawing numbers for all components in the system.

The organization of the PPS is illustrated in Figure 1. There are five components in the PPS which are interconnected by a data communications network:

1. The vault area is an Item Control Area (ICA) in which advanced detection and delay elements are utilized to reduce the vulnerability to insider and forced entry threats. Personnel access is carefully controlled and the three control centers (see items 3, 4, and 5 below) continually interact to assure the proper movement of material.
2. The Container Module Packaging (CMP) room provides the point of entry to the PPS; it is here that material is packaged into standardized containers in preparation for storage. For this demonstration system, the CMP room is under direct control of the Material Operations Center (MOC). In an actual PPS application, the CMP room structure would be similar to that of the vault, access control procedures would be in operation, and all three control centers would be involved.
3. The MOC is a control center which monitors and controls all operations involving the movement of items in the system.
4. The Material Accountability Center (MAC) is a control center which maintains the accountability of all items in the system.

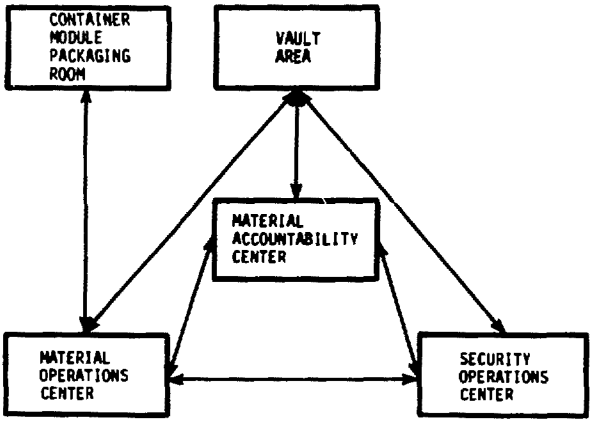

Figure 1. Plutonium Protection System (PPS) Organization

5. The Security Operations Center (SOC) is a control center which monitors and responds to all alarms in the system and permits personnel access to various parts of the system.

Movement of material between PPS areas is accomplished in a secure fashion by means of a Secure Transport Module (STM), which is essentially a minivault on wheels. The STM must be securely docked at a port in the wall at the vault or CMP room before material can be loaded or unloaded. The actual transport of material is carefully timed to minimize the opportunity for tampering or diversion.

SECTION 2

VAULT AREA

The vault area is an Item Control Area where SNM is stored. The principal elements of the vault ICA are (1) the personnel corridor, which controls the movement of personnel to the vault, (2) the Vault Control Room (VCR), which contains the vault computer, and (3) the Vault Storage Area (VSA), in which the SNM is stored (see Figure 2). The STM and its associated equipment are also discussed in this section.

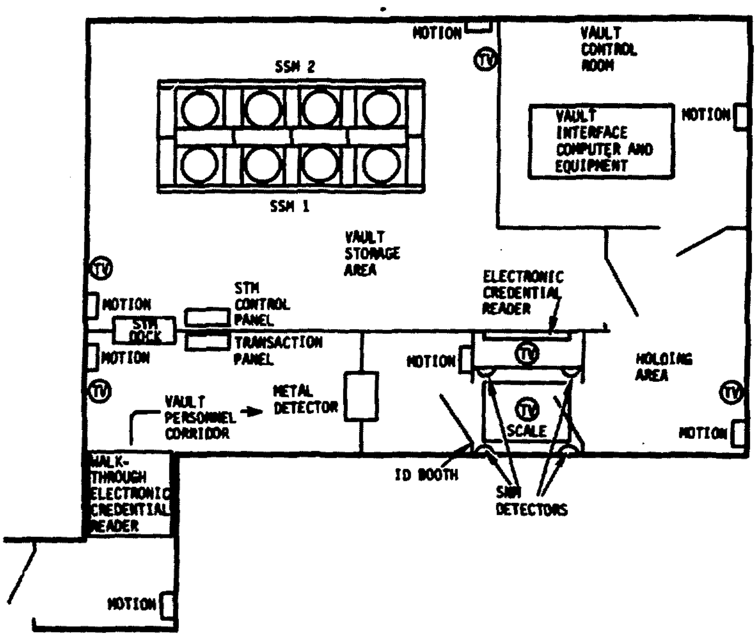

Figure 2. Vault Item Control Area (ICA)

Personnel Corridor

Entry to the storage area or to the control room is achieved through the personnel corridor shown in Figure 2, which contains devices to detect contraband material and unauthorized entry. A walk-through electronic credential reader (ECR) automatically reads the serial number of an electronic credential (EC) badge worn by an individual. An identification (ID) booth allows security personnel to identify individuals and check for contraband. A holding area is included between the ID booth and the storage area so that all personnel can be identified before the vault door is opened. A detailed description of the personnel corridor is contained in the Sandia document, SAND78-1153.[2]

Corridor Security Equipment -- The personnel corridor is monitored by motion sensors, which detect the presence of personnel, as well as by a metal detector and SNM detectors, which detect contraband material. The outputs of these elements are processed into a format compatible with the input requirements of the computer. The alarms are assessed by means of a closed-circuit television (CCTV) system, which is described in the Sandia document, SAND78-1559.[3]

Motion sensors[4] are placed in the personnel corridor to provide coverage of the corridor volume. Three types of sensors are used within the system:

1. An infrared sensor, Model 19-124, manufactured by Barnes Engineering, Stamford, Connecticut,
2. An ultrasonic sensor, Model Advisor VI, manufactured by Aritech, Inc., Allston, Massachusetts, and
3. A microwave sensor, Model 4400, manufactured by the Advanced Devices Laboratory, Inc., Reno, Nevada.

The outputs from these sensors are connected to a Sandia-designed Computer Interface Electronics chassis,[5] which provides signal

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[2] W. K. Ream, "Personnel Entry Corridors for the Plutonium Protection System," SAND78-1153, Sandia Laboratories, Albuquerque, New Mexico, to be published.

[3] D. A. Greenwoll, A TV Assessment & Identification System for the Plutonium Protection System, SAND78-1559, Sandia Laboratories, Albuquerque, New Mexico, February 1979.

[4] Intrusion Detection Systems Handbook, SAND76-0554, Sandia Laboratories, Albuquerque, New Mexico, revised October 1977.

conditioning required by the vault computer. These sensors are equipped with tamper-indicating switches whose outputs are also routed through the Computer Interface Electronics. The lines to the sensor are monitored for tampering by means of dc line-supervision techniques.[5]

The metal detector in the corridor is manufactured by the Solco Engineering Company, Chatsworth, California (Model XI).[6] The sensitivity of the detector has been set to alarm on large metal objects (e.g., a crowbar) to reduce the number of false and nuisance alarms caused by interference and by small metal objects carried by personnel.

The SNM detectors are located in the ID booth and therefore are discussed in the subsection, Identification (ID) Booth.

Walk-Through Electronic Credential Reader (ECR) -- A walk-through ECR is used to monitor the presence of badged individuals entering the personnel corridor. The Sandia document, SAND78-2156,[7] describes this system in detail. A self-energized EC badge is worn by personnel and is monitored by the ECR, which consists of two multiturn orthogonal wire loops, a transmitter/receiver, and a decoder. The multiturn wire loops are mounted in the frame of the reader housing and serve as both a transmitting and a receiving loop for the magnetic field; a diplexer is used to separate the outgoing and incoming signals. A crystal oscillator and a power amplifier are used to drive the loop at a frequency of 110 kHz.

The self-energized EC badge internally incorporates a set of electronic elements which contain a unique ID code. The electronics is normally passive but becomes active when powered up by the field generated by the ECR wire loops. The badge then transmits a pulse-modulated 55-kHz magnetic field, which is filtered and detected to generate a 16-bit digital ID number. If the proper conditions of parity bits and start-and-stop bits are met, the ECR generates an interrupt to the computer. The computer then reads the 16-bit ID number which uniquely identifies the badge that has passed through the loop.

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[5] W. K. Ream, "Computer Interface Electronics for the Plutonium Protection System," SAND78-1152, Sandia Laboratories, Albuquerque, New Mexico, to be published.

[6] Entry-Control Handbook, SAND77-1033, Sandia Laboratories, Albuquerque, New Mexico, revised September 1978.

[7] D. E. Barnes and T. W. H. Caffey, The Self-Energized Credential System for the Plutonium Protection System, SAND78-2156, Sandia Laboratories, Albuquerque, New Mexico, January 1979.

Identification (ID) Booth -- The personnel corridor contains a Sandia-designed ID booth that allows security personnel in the SOC to identify individuals. The booth consists of a pair of remotely controlled doors which enclose about 1.2 metres (4 feet) of corridor space. Special identification equipment, such as an ECR, a CCTV system, an electronic scale, and SNM detectors, is used to assist the security personnel in identifying an individual and verifying that no contraband is present.

The ID booth ECR is similar to the walk-through ECR discussed earlier except that only a single multiturn wire loop is used. The EC badge is read while the individual stands in position facing a one-way mirror which hides a face-on CCTV camera. An overhead camera assists SOC personnel to verify that no contraband is being carried through the booth. The personnel identification system is further discussed in Section 4: Security Operations Center, which describes the equipment used in the SOC.

The SNM detection system is designed to detect small quantities of plutonium passing through the booth. The system consists of four cylindrical plastic scintillators (one in each corner of the ID booth), a photomultiplier detector for each scintillator, a single-channel pulse height analyzer, and timing and alarm circuitry. The electronics chassis is located on a shelf behind the one-way mirror in the ID booth. Only alarm signals are sent to the computer. Plastic, rather than sodium iodide, scintillators have been chosen because of the sensitivity of plastic to the neutron radiation emitted by the SNM. The outputs of the four photomultiplier detectors are electronically summed, and the single-channel analyzer is used to establish a count rate. A background rate is established by counting for 32 time intervals (the time interval is switch-selectable from the front electronics panel) and is updated every 32 intervals thereafter. The single count rate is based on a "sliding" set of five time intervals; as new data are gathered, the oldest data are eliminated. If the signal count rate increases above the background rate by $N \cdot \sigma$, an alarm is generated. (The value N is selectable; σ is the standard deviation of the background.) A separate alarm is generated if the count rate decreases below the background rate by $N \cdot \sigma$ in order to guard against shielding of the detectors.

An electronic scale (Model No. 4638, Electroscale Corp., Santa Rosa, California) is located on the floor of the booth in such a way that any object in the booth is weighed when a threshold weight is exceeded. The purpose of the scale is to weigh individuals entering and exiting the vault so that weight discrepancies between the two readings can be detected. An interrupt is sent to the vault computer when the scale has a 16-bit digital word representing the weight on the scale. Four readings are taken by the vault computer over a 2-second period and averaged to reduce the effects of personnel movement in the booth. Weights are measured to tenths of a pound.

Entry into the ID booth is allowed by the SOC in response to the operation of a pushbutton on the outside of the booth. Although the present booth has a glass insert in the booth door, a BOOTH OCCUPIED light has been provided just above the pushbutton. Remotely operated door latches (Model 310-2, Folger Adams Company, Joliet, Illinois) are used to open the ID booth doors; magnetic door switches (Model MS5WTI, Mosler Safe Company, Hamilton, Ohio) detect the opening of the doors. A microswitch is provided in the door latch to monitor the unlocking of the latch.

Vault Control Room (VCR)

The VCR provides a secure area for the vault computer and its peripheral equipment, the Computer Interface Electronics, the Vault Portal Controller (discussed in the subsection Secure Transport Module (STM) and Associated Equipment), and the communications equipment (discussed in Section 7: System Aspects). Activity in this room is monitored using interior motion sensors, and the entrance door is monitored by a magnetic door switch. Entry into the room is remotely controlled by the SOC and is obtained through the use of a remotely operated door latch. The room is normally unoccupied, and access should be required only for maintenance.

The VCR also houses the control electronics for the metal detector, the walk-through ECR, and the ECR in the ID booth.

Vault Computer -- The heart of the Vault Control Room is the vault computer, an unattended computer that continually monitors all alarms and controls movement of personnel according to instructions received from the computers in the MAC, MOC, and SOC. In addition, the vault computer interrogates individual items stored in the vault in response to instructions received and returns the data to the requesting computer.

This computer (ModComp Model II/26) is manufactured by Modular Computer Systems, Fort Lauderdale, Florida. Its major features are a 32K memory, a 1-μs cycle time, a system of vector priority interrupt levels, and easy access for maintenance and real-time multitasking. A serial communication subsystem (RS-232C compatible) is used for communications between the computer and the microprocessors in the Secure Storage Module (SSM). An input/output interface subsystem is used to interface alarms, switch conditions, control the door latches, etc. on a bit-by-bit basis by the computer.

Computer Interface Electronics -- Input information and output controls are interfaced to the vault computer through an input/output interface subsystem that has a capacity of 16 channels of 16 bits each. The channels are divided into five groups:

1. Individual information input bits in which each bit represents the status of an item in the vault ICA,
2. A 16-bit word input in which each word represents the reading of a device such as the scale weight,
3. A 16-bit output which is used to reset the input lines of the first group,
4. A 16-bit output which is used to turn on power to selected items, and
5. A 16-bit output which is used to turn on annunciator lights and reset microprocessors in the vault ICA.

Information is transferred by channels, i.e., 16-bit parallel transfers. Since the input channels are not latched, a latching circuit has been developed. Outputs from the computer are held until a new output is generated. Details of the Computer Interface Electronics are discussed in the Sandia document, SAND78-1152 (see Reference 5).

The alarm latch chassis accepts status inputs from door-related hardware, motion sensors, ECRs, the electronic scale, and other items in the vault ICA. This status information can involve alarm signals, expected changes in monitor status, or a notification that a 16-bit digital word, such as a badge number, is ready to be transferred to the computer. The alarm latch chassis circuits output a logical "1" that is held until a reset is received from the computer. By waiting for an active reset from the computer, the system is assured that the data inputs have been accepted.

A 110-volt junction box uses a 16-bit computer output channel to control door latches and supply power to computer-controlled outlets. Solid state switches are used to translate the transistor-transistor logic computer signals into 110-volt ac outputs.

A guide and status lights chassis is used to activate the following lights in the vault ICA:

- BOOTH OCCUPIED lights,
- Lights at the vault transaction panel (discussed in the subsection, Secure Transport Module (STM) and Associated Equipment), and
- Lights at the vault map which indicate which SSM is involved in the transaction.

This chassis also provides the interface for the reset pulses for the microprocessors in the vault ICA as well as for the "hold" commands to certain devices, such as the electronic scale, whose output must be held constant while being read by the computer.

Vault Storage Area (VSA)

The VSA is designed to provide in-depth protection for the stored plutonium; it is designed so that the breaching of a barrier presents the adversary with another barrier. This protection is achieved by packaging the plutonium in an instrumented Container Module (CM) which, in turn, is locked into one of the 140 locations within an SSM. There are two SSMs in this system and they are heavily instrumented with intrusion-sensing detectors. Magnetic switches monitor the material transfer port and all doors within the VSA, motion sensors monitor the interior of the VSA, and a CCTV system is used for assessment of alarms. Tamper switches are also located in the SSM to monitor its integrity.

Secure Storage Module (SSM) -- The SSM (Figure 3) contains four storage carrousels mounted in four concrete cubicles and is approximately 3.4 metres (11 feet) long, 75 cm (30 inches) deep, and 2.7 metres (9 feet) high. It weighs approximately 10.9 tonnes (12 tons). Access to a carrousel is obtained through a steel door assembly; each cubicle has two such doors for each carrousel. A steel enclosure rests on the

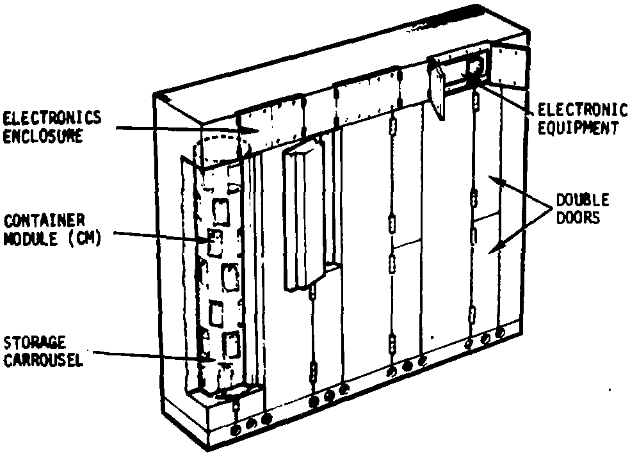

Figure 3. Secure Storage Module (SSM)

cubicles and houses the electronics that control the SSM. The SSM is described in more detail in the Sandia documents, SAND78-0686[8] and SAND78-0689.[9]

Each storage cubicle provides a space 60 cm (24 inches) wide by 50 cm (20 inches) deep for the carrousel and its mounting hardware. The walls of the cubicle are of precast reinforced concrete panels with structural steel on certain faces and edges. These are welded together and anchored to a steel plate on the vault floor.

The door assemblies restrict access to the stored material and also provide radiation protection. Each narrow door restricts access to only one CM at a time; a top door accesses the upper four levels and a bottom door accesses the lower three levels of a carrousel. The front face of each door assembly is constructed of 1.3-cm (0.5-inch) thick

[8] R. S. Howard, "A Secure Storage Module for the Plutonium Protection System," SAND78-0686, Sandia Laboratories, Albuquerque, New Mexico, to be published.

[9] H. D. Arlowe, "Wiring for the Secure Storage Module for the Plutonium Protection System," SAND78-0689, Sandia Laboratories, Albuquerque, New Mexico, to be published.

carbon steel plate, which serves to provide physical protection as well as to reduce the gamma dose rate in the aisle. In addition, enclosed plastic shielding is provided to reduce the neutron flux in the aisle. A bilevel magnetic switch with two sets of contacts is installed in each cubicle door. The first set of contacts closes at a slightly higher magnetic field level than the second set so that a narrow magnetic field "window" can be established for proper operation. Remotely controlled deadbolts prevent unauthorized opening of the doors.

Each storage carrousel is a cylindrical storage rack with a capacity of 35 CMs in 7 levels of 5 locations each. The carrousel can be rotated ±180° with a bidirectional stepper motor and is locked in position by means of a deadbolt located between levels 4 and 5 (counting from the top). Through rotation of the carrousel, the stored items are accessible to an operator, one item at a time. Each storage location is equipped with a 26-pin connector as well as with a mechanism for locking the CM into the carrousel. A cowling and a support bracket form a niche for the CM. Ribbon cable is used for signal and data lines because of its flexibility and compactness, and printed circuit boards are used at the breakout junction boxes at each level to reduce fabrication costs.

The electronics enclosure rests on the four concrete cubicles and houses the electronics for the SSM, which consists of the SSM Controller, the AC Controller, the Motor Driver, and the ADC/Multiplexer. Access to the electronics is provided through three pairs of doors which swing out above the cubicles. The doors are held shut by bolts which actuate a switch when inserted. An alarm signal is generated if one of the bolts is removed. The rear of the electronics enclosure contains a grate for exhausting air from the storage cubicles.

The SSM Controller is the microprocessor assembly that controls all functions of the SSM. The controller is an assembly of five wire-wrapped, plug-in modules which accepts and executes commands from the vault computer and delivers information back to the computer. Two of the cards (modules) in the controller contain microprocessors that have a master/slave relationship. The master microprocessor is the heart of the SSM Controller and directs all operations. The slave microprocessor is responsible for monitoring the presence of the 140 possible CMs in the SSM. The remaining three cards provide the means of inputting and outputting data and control signals. The control functions include the release of the cubicle door-locking and carrousel-locking deadbolts, the release of the CM-locking deadbolt, the rotation of the carrousel, and the lighting of the operator guide lights. The input functions include the status of the microswitches that monitor the deadbolts and door switches, the state-of-health monitors in the CMs, and the reading of the static and dynamic ID codes in the CMs. The design of the SSM Controller is oriented to make four of the five cards form a general purpose core; the fifth card (the slave microprocessor) has a special design which is adaptable to the need being addressed. (The slave microprocessor is not used in the Vault Portal Controller and is replaced by a more complex card in the CMP Room Controller.) The SSM Controller is described in more detail in the Sandia document, SAND78-0384.[10]

The AC Controller receives logic level signals from the SSM Controller and supplies ac voltages to the ADC/Multiplexer, Motor Driver, solenoids, and power supplies for the guide lights. The AC Controller also supplies 36 volts dc to all the security switches on the SSM and converts the outputs of these switches into logic levels for use by the microprocessor. This chassis is described in more detail in the Sandia document, SAND78-0696.[11]

The Motor Drive Chassis receives logic level signals from the SSM Controller and supplies the necessary drive power to turn the desired carrousel in the direction requested. This chassis is described in more detail in the Sandia document, SAND78-0697.[12]

The ADC/Multiplexer receives analog signals from the CMs as well as the signal from the carrousel position-sensing potentiometer. Upon direction from the SSM Controller, the ADC/Multiplexer selects the desired input, digitizes the analog signal, and sends it to the controller. This chassis is described in more detail in the Sandia document, SAND78-0692.[13]

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[10] L. H. Minnear, "A Family of Digital Controllers for the Plutonium Protection System," SAND78-0384, Sandia Laboratories, Albuquerque, New Mexico, to be published.

[11] A. L. Shaut, An Interface and Controller Chassis for the Plutonium Protection System, SAND78-0696, Sandia Laboratories, Albuquerque, New Mexico, February 1979.

[12] A. L. Shaut, "A Motor Drive Chassis for the Plutonium Protection System," SAND78-0697, Sandia Laboratories, Albuquerque, New Mexico to be published.

[13] H. D. Arlowe, An Analog System for the Plutonium Protection System, SAND78-0692, Sandia Laboratories, Albuquerque, New Mexico, January 1979.

Container Module (CM) -- The CM is an overpack container into which the foodpack can presently used to contain the plutonium is sealed. It is designed to provide security, safety, and rapid inventory of the plutonium. The Sandia document, SAND78-0695,[14] describes the CM in more detail.

The CM (shown in Figure 4) is approximately 12.7 cm (5 inches) in diameter and 22.9 cm (9 inches) high and has a solder seal at about midsection. The lower half of the CM features a security tang which is used to lock the module into a carrousel in the SSM. The upper half of the CM contains enough space for an electronic circuit board, an electrical connector, and a Schraeder valve. The two halves of the CM are hermetically sealed in the CMP room by means of an induction

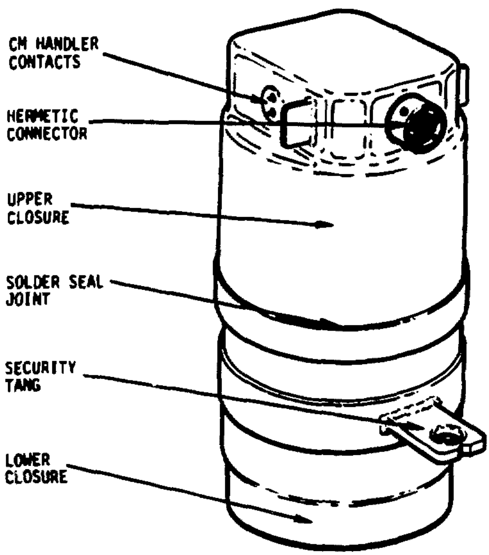

Figure 4. Container Module (CM)

[14] H. D. Arlowe and R. S. Howard, "A Special Nuclear Material Container Module for the Plutonium Protection System," SAND78-0695, Sandia Laboratories, Albuquerque, New Mexico, to be published.

heater. Solder is placed in a channel at the top of the lower half, and the upper half is lowered into place so that it rests on the solder. (A sealing/unsealing fixture, described in the Sandia document, SAND78-0687,[15] is used to achieve the precision control required during the sealing process.) The induction heater then melts the solder, the upper half of the CM is lowered into the molten solder, and the assembly is allowed to cool.

The CM contains a number of logic and sensor elements which are used to assure its safety and security (see Figure 5). A serially

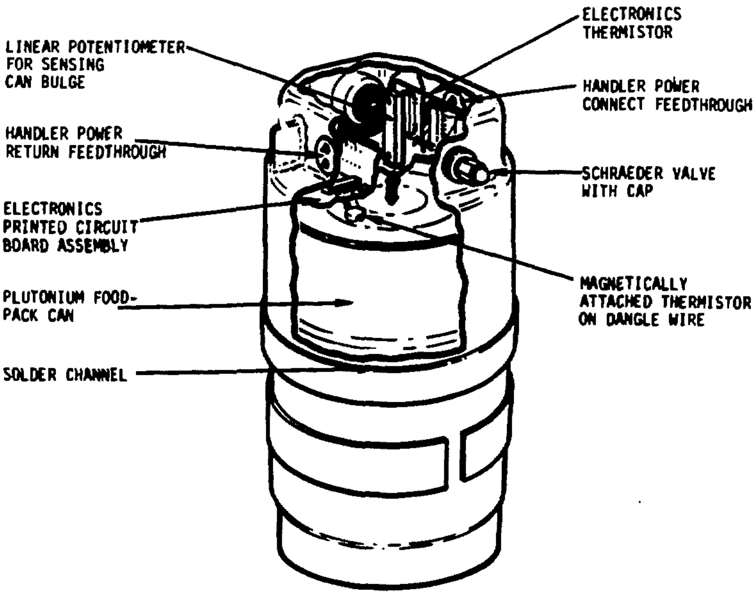

Figure 5. Electronic Features of the Container Module (CM)

numbered static identification (SID) code, which is permanently stored in a read-only memory, allows a real-time inventory of the CMs in

[15] R. S. Howard, "A Container Module Sealer for the Plutonium Protection System," SAND78-0687, Sandia Laboratories, Albuquerque, New Mexico, to be published.

storage. A volatile memory stores a dynamic identification (DID) code, which is used to detect tampering or substitution attempts while the CM is being transferred. A deformation sensor detects bulging of the foodpack can so that proper action can be taken to prevent its rupture. A tamper switch is used to destroy the DID code if the CM is penetrated. During transfer of the CM, external battery power is supplied to the dynamic memory to maintain the DID code. This external power is provided by the CM handler (see Figure 6). This handler also serves as a

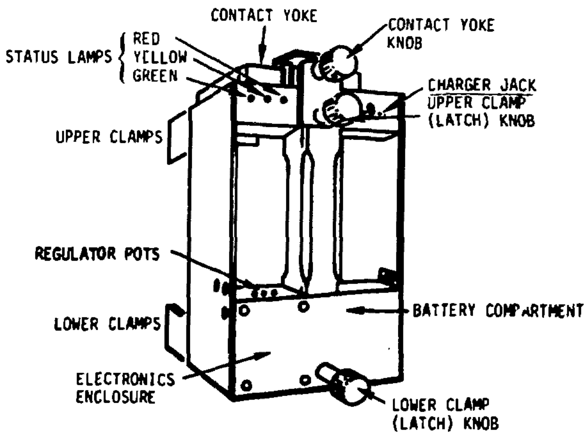

Figure 6. Container Module (CM) Handler

mechanism for loading and unloading the carrousel as well as for reducing hand exposure to radiation. The CM handler contains special contacts which engage hermetic feedthrough pins on the CM. Three indicator lamps aid the operator in properly transferring control of the CM from the handler to the SSM and vice versa. This handler is described in more detail in the Sandia document, SAND78-0691.[16]

The intent of the DID code is to provide detection in case of substitution of a bogus CM containing no plutonium or the cutting open

[16] H. D. Arlowe, "A Container Module Handler and Charger for the Plutonium Protection System," SAND78-0691, Sandia Laboratories, Albuquerque, New Mexico, to be published.

of a CM and removal of the plutonium before the CM is inserted into the storage carrousel. Since the present PPS is not fully automated, some direct handling of the CM by operations personnel is required. During this "hands-on" or transfer period, substitution or tampering could occur. After the transfer has been accomplished, the system interrogates the CM for the proper DID code; if it is not present, an alarm is generated by the system. The DID code is lost (destroyed) if power to the volatile memory is interrupted; this takes place if the tamper-indicating device is activated. A photodetector, which is activated if light is allowed to enter the CM, has been used as a tamper indicator. A more expensive but much more effective device would be a baroswitch used in conjunction with a slightly pressurized or evacuated CM.

Preliminary testing of the use of the DID codes during material transfers indicated that the number of successful transfers (no inadvertent DID code losses) was strongly dependent on the proficiency of the operator. The loss of a DID code during a transfer was generally due to a momentary loss of the power being supplied from the handler to the CM. Even after a considerable redesign of the CM handler electronic contacts, operator experience was essential to the achievement of a high rate of successful transfers. This dependence on operator proficiency was deemed undesirable for system testing; therefore, use of the DID codes was discontinued.

The CMs utilize transistor-transistor logic circuits for the volatile memory because of their tolerance to radiation effects. At the time the PPS was designed, complementary metal-oxide semiconductor technology did not have the radiation hardness to reliably survive extended (up to 20 years) storage of high-burnup plutonium. However, in anticipation of future complementary metal-oxide semiconductor radiation resistance capabilities, about a dozen CMs were constructed using this type of semiconductor for the volatile memories. Because of the lower power requirements of this semiconductor, a large capacitor could be used in the CM electronics which would provide more than 5 minutes of standby power to the volatile memory and would greatly increase the tolerance of the CM to power fluctuations. Tests have been conducted which compare the performance of the transistor-transistor logic and the complementary metal-oxide semiconductor electronics during transfer operations. The results of these tests indicate that the memory of the latter virtually eliminates dependence on operator handling proficiency.

<u>Secure Transport Module (STM) and Associated Equipment</u> -- The STM (shown in Figure 7) provides security for the SNM while it is being moved. The STM has many of the features of the SSM carrousel and, in fact, can be described as a minivault on wheels. The mechanical aspects of the STM are described in the Sandia document, SAND78-0688.[17]

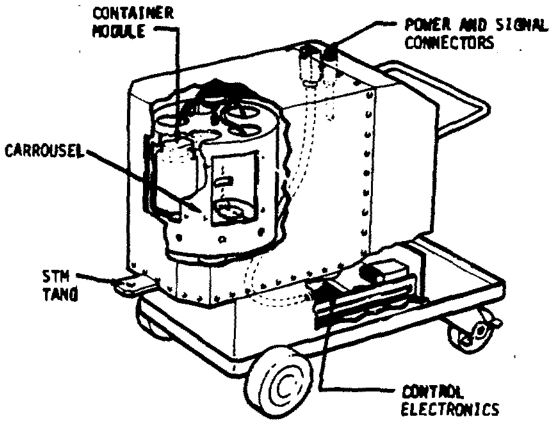

Figure 7. Secure Transport Module (STM)

Storage for the CMs is provided by a carrousel which consists of a single five-can layer located within a secure housing. The system of carrousel rotation, indexing, and position locking is identical to that used in the vault SSM; the hardware associated with the storage of the CM is also the same. A major difference between the STM and the SSM is the absence of a door assembly in the STM. Since the carrousel can be rotated to a position in which the opening in the housing is either completely blocked or unblocked by the carrousel shell, a door assembly is not required. In addition, the logistics of opening both a door in the STM and a door in the STM dock are formidable. The STM features a protruding tang which is similar to that on the CM and which serves a similar purpose, i.e., when the STM is properly docked, a deadbolt falls through a hole in the tang to secure the STM to the dock. The STM is

[17] R. S. Howard, "A Secure Transport Module for the Plutonium Protection System," SAND78-0688, Sandia Laboratories, Albuquerque, New Mexico, to be published.

mounted on a portable cart and weighs approximately 230 kg (500 pounds). The STM must be properly docked into the STM portal and the two umbilical cables plugged in before any of the CMs are allowed to be removed. An electronics chassis is located near the bottom of the STM. In addition to the electronics required to support the five-can carrousel, an electronics package from a CM is used in the STM to provide it with a unique static identification number. Although they are not used at present, the tamper feature and the DID code of the CM electronics package are available to detect tampering with the STM. The electronics in the STM is discussed in the Sandia document, SAND78-0690.[18]

A welded assembly forms a dock that is bolted into an opening in the wall of the CMP room and VSA. The dock contains a door through which material is passed between the inside of the secure area and the STM, which is located outside the secure area. When the STM is locked in the dock assembly, unauthorized access to the dock is prevented by the STM itself. Verification of proper docking of the STM must be obtained before opening of the door is permitted. The present system utilizes a magnetic switch in the STM dock that is carefully matched to a magnet in the STM. The closure of this switch, along with the proper inventory of the contents of the STM, provides the proper verification.

A transaction panel is located outside the VSA and CMP room near the dock to provide information to the operator on the docking of the STM and to enable him to enter the number of the transaction to be executed. The panel contains four thumbwheel switches, a pushbutton, and five indicator lights. The transaction number of the current transaction is entered into the thumbwheel switches and the pushbutton is energized to notify the computer that the switches are ready to be read. Two of the indicator lights are used to denote a valid/invalid entry. Three of the indicator lights are used to advise the operator of the proper docking of the STM.

A control panel is located inside the vault next to the STM dock. This panel has a pushbutton, four status lights, and two vault map lights. The operator uses the pushbutton to notify the computer that he is ready to start movement of material. The status lights tell the

[18] H. D. Arlowe, "Wiring for the Secure Transport Module and Vault Dock for the Plutonium Protection System," SAND78-0690, Sandia Laboratories, Albuquerque, New Mexico, to be published.

operator how to proceed through a loading/unloading operation, and the map lights direct him to the proper SSM where the material is to be deposited.

Operation of the STM and the control panel in the VSA is under the auspices of the Vault Portal Controller (in the VCR), which, in turn, is guided by the vault computer. This controller contains four of the five cards of the SSM Controller, as discussed earlier. The card not present in the Vault Portal Controller is used in the SSM Controller to check on the presence of the CMs in the SSM. Since there are only five CMs (maximum) in the STM, their presence is checked through spare input channels. The Vault Portal Controller provides the interfaces for commands, status, and messages between the vault computer and the portal hardware (including the docked STM). Although the physical arrangement of the vault portal/STM combination differs from that used for the SSM, the two configurations are functionally equivalent, i.e., the carrousel must be rotated, the dock door opened, the CM released, the operator guide lights activated, etc. Docking and undocking operations are also under the control of the Vault Portal Controller.

SECTION 3

CONTAINER MODULE PACKAGING ROOM

The CMP room, shown in Figure 8, is the area where the foodpack cans containing plutonium are packaged into the Sandia-furnished CMs. Certain operating procedures and checks have been established to ensure that material is entered into the PPS in a secure and reliable manner. A CM sealing/unsealing fixture is used to package the material into the Sandia CM. The contents of the CM are then verified in a nuclear verification station, and the computer-generated DID code is entered into

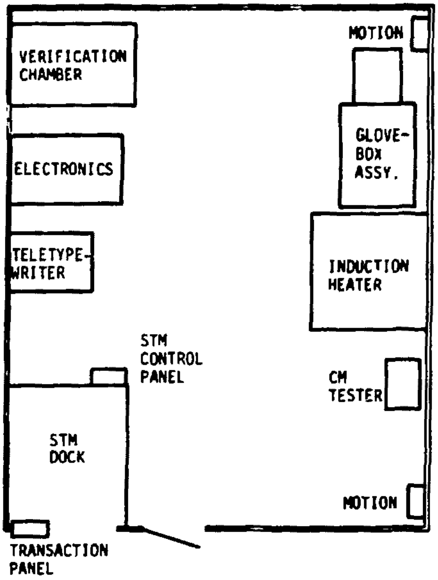

Figure 8. Container Module Packaging (CMP) Room

the CM memory. A teletypewriter provides two-way communications with the MOC during the verification process. The CM handler is used to move the CM from the verification station into the STM in preparation for transport to the vault. The CMP room is equipped with two motion sensors and a key-operated locked door. A dock for the STM which is identical to the vault dock is located in a corner of the room. (Since all the entry-control features are being demonstrated at the vault, these similar features were not implemented for the CMP room.)

Packaging Equipment

The packaging equipment used in the CMP room includes CMs, a CM tester, an induction heater, and a CM glove-box assembly. Prior to a packaging operation, the CM is tested for proper operation by the CM tester, which is described in the Sandia document, SAND78-1050.[19] The tester can read the SID code by interrogating the proper memory location in the CM electronics. The temperature sensors are digitized and displayed by means of light-emitting diodes, as is the output of the "bulge" sensor on the surface of the inner can. Front panel switches can be used to exercise the dynamic memory in the CM.

The induction heater, which is used to melt the solder during closure of the CM, is manufactured by the Taylor Winfield Corporation of Warren, Ohio (Model B-750-LF). It operates at a frequency of about 450 kHz and utilizes eddy-current and hysteresis losses for heating the CM located in the Sandia-designed induction loop.

The CM glove-box assembly is shown in Figure 9 together with the induction heater. The glove-box assembly, the induction heater, and the sealing/unsealing process are described in detail in the Sandia document, SAND78-0687 (see Reference 15). The CM glove-box assembly consists of a sealing/unsealing holding fixture located inside a glove box. Here induction heating is applied, which results in the sealing or unsealing of a CM. After the top and bottom halves of the CM have been properly positioned in the holding fixture, an automatic sequence is initiated which applies the required heat and brings the two halves together. The glove box is an industrial model built by the Vacuum

[19] M. A. Konkel and J. P. Watterberg, Container Module Tester, SAND78-1050, Sandia Laboratories, Albuquerque, New Mexico, October 1978.

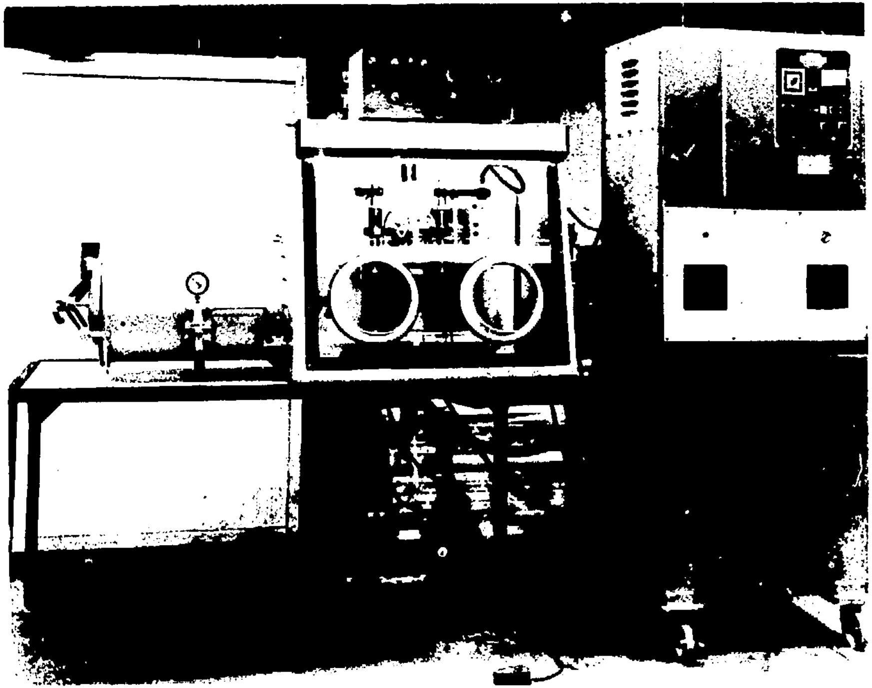

Figure 9. Glove-Box Assembly and Induction Heater

Atmospheres Company, Hawthorne, California (Series DL), and the holding fixture and controls are custom-designed products of the L. C. Miller Company, Monterey Park, California.

Container Module Packaging (CMP) Room Controller

The CMP Room Controller is responsible for directing the activities which occur in the CMP room. In an actual operational installation, a minicomputer would be used as in the vault, but, for the purposes of this demonstration, a microprocessor assembly was deemed sufficient. This microprocessor has a wider range of responsibilities than the other microprocessors in the PPS have. In addition to its input/output duties, it also handles communications with the MOC computer through the Data Communications Network. To accomplish the communications function, one of the original cards was replaced with a card containing a communications microprocessor, which transfers messages between the Data Communications Network and the host microprocessor.

The CMP Room Controller is under the direct command of the MOC computer. Commands issued by the MOC are processed and executed, and information on the status of equipment in the CMP room is sent to the MOC. A typical interchange might consist of the following steps:

1. The MOC issues a command that is executed by the CMP Room Controller, e.g., "unlock the dock door,"
2. The CMP Room Controller echoes the command to indicate that an output signal has been sent to the dock door deadbolt to "unlock,"
3. The CMP Room Controller then transmits a status "mask" to the MOC which should show that the dock door is now unlocked, and
4. The MOC issues its next command.

The CMP room motion sensors, door switches, and monitors on the STM dock are all treated as status indicators; the MOC computer has the resident software to determine if an alarm condition or procedural irregularity occurs.

Verification Chamber

The purpose of the verification chamber[20] is to confirm that the material being input to the PPS is indeed plutonium. A scale weighs the CM while gamma and neutron readings are being made with detectors provided by the Los Alamos Scientific Laboratory. The nuclear electronics chassis is also supplied by Los Alamos; the interface to the PPS is a switch closure provided to an input port of the CMP room controller when both neutron and gamma count rates exceed a predetermined level. Once verification has taken place, the CM and its contents are considered part of the PPS and must be properly accounted for. While the CM is in the verification chamber, its SID code is read, and the computer-generated random DID code is entered for the first time. The analog parameters, such as the temperature of the inner can and electronics and the "bulge," are also read at this time. The DID code is checked after the CM has been moved into the STM to ascertain if any tampering or substitution has taken place.

When a CM is removed from storage, the verification chamber is used to confirm that the material being removed from the system is indeed plutonium. In the present system, no provision is made for transmitting the gamma and neutron counts to the MAC for recordkeeping; therefore, comparisons between entry data and exit data cannot be made. The verification chamber is further discussed in the Sandia document, SAND78-0694.[21]

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[20] N. Nicholson, R. D. Hastings, C. N. Henry, and D. R. Millegan, "Verification Station for Sandia/Rockwell Plutonium Protection System," LA7728-MS, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, to be published.

[21] H. D. Arlowe, "Wiring for the CMP Room and Verification Chamber for the Plutonium Protection System," SAND78-0694, Sandia Laboratories, Albuquerque, New Mexico, to be published.

SECTION 4

SECURITY OPERATIONS CENTER

The Security Operations Center serves two major functions, the handling of alarms and the controlling of the movement of personnel in the PPS. Messages from the other sites in the PPS are analyzed by the SOC computer, and then appropriate action is taken. Figure 10 shows a security patrolman at the SOC console where information on the status of the PPS is displayed.

Figure 10. Security Operations Center (SOC) Console

Alarms are displayed to the operator by means of a color cathode-ray tube (CRT), Intelligent Systems Corporation Model Intecolor 8001, which is located at the left of the console. This color CRT generates alarm messages and area maps with a blinking format to indicate activated alarms or open doors. A traditional alarm display map, located in the center of the console, features the total floor plan of the PPS. A red light indicates an alarm in a room or corridor. Assessment of alarms is achieved by selection of certain real-time scenes for display on the array of four TV monitors on the right of the console (discussed in Section 7: System Aspects).

Control of personnel is accomplished by interaction between the security operator and the SOC computer. For example, the computer displays the message, REQUEST VAULT DOOR BE UNLOCKED, DEPRESS YES OR NO, on the color CRT. Both YES and NO buttons are provided for the guard response. Personnel identification is accomplished through the use of the photoslide callup system, which is discussed below in the subsection, Personnel Identification System.

The SOC is intended to be part of the security system of the host facility and is to be manned on a 24-hour basis; hence, no motion sensors or magnetic door switches are located in the SOC. The door to the SOC can be locked and is equipped with a viewing port which allows observation of the area just outside the door.

Security Operations Center (SOC) Computer

The SOC computer is a ModComp Model II/26 minicomputer manufactured by Modular Computer Systems in Fort Lauderdale, Florida. The major features of this computer were discussed in the subsection, Vault Computer. The peripheral equipment at this site includes a magnetic tape unit for backup storage of data, two moving-head discs for program and data storage, a line-printer for hard-copy records, and an input/output interface subsystem.

Computer Interface Electronics

Input information and output controls are interfaced to the SOC computer through 16 channels of 16 bits each, although only 4 channels are used. These channels are

1. A 16-bit output used to control the photocarrousel of the personnel identification system,
2. A 16-bit output used to control the alarm buzzer, the alarm lights on the display board, and the CCTV scenes brought up on the TV monitors,
3. A 16-bit input used to interface the pushbuttons, such as the YES and NO buttons, on the display board to the computer, and
4. A 16-bit output used to reset the latches set by the pushbuttons mentioned in the preceding item.

information is transferred by channels, i.e., 16-bit parallel transfers. The input channels are not latched at the computer, so latching circuits have been developed for the pushbuttons. Outputs from the computer are held until a new output is generated. The interface electronics for the SOC computer are discussed in the Sandia document, SAND78-1922.[22]

Alarm Display Board

The alarm display board shown in Figure 11 is a panel etched with the floor plan of the PPS. Within each room or corridor is a round red indicator lamp that is lit whenever any alarm in that area is activated in an unauthorized fashion (as determined by the SOC computer). The lamp is latched in the ON condition by the computer and can be turned off only by depression of the lamp housing, an action that requires guard response. Also on the display board are square white pushbuttons that are used to select which TV camera to display on Monitor No. 1. This monitor is totally under guard control, and any camera in the PPS can be displayed. Rectangular pushbuttons are included on the display board for the selection of the map to be shown on the color CRT; either the vault ICA, the CMP room, or the MAC/MOC area can be displayed on the color CRT. At the lower right of the alarm display board, there are three pushbuttons (YES, NO, and SILENCE) which are used by the guard to respond to inquiries by the SOC computer. Incoming messages trigger a buzzer in the electronics chassis of the display board; depressing the SILENCE button acknowledges the message and silences the buzzer.

Personnel Identification System

The process of personnel identification consists of a guard comparing a stored photoslide image of the badge holder requesting access to a real-time display of the person in the booth. Photographs of personnel who have authorized access to the PPS are stored as a file of 35-mm slides in a Kodak photocarrousel projector. A CCTV camera with the proper optical system views the slide being projected and transmits that image onto a monitor selected by the SOC computer. Selection of the desired slide is based on the number received from the employee's EC badge by the ECR; the SOC computer uses this number to determine the

[22] C. E. Ringler, "SOC Interface and Display Console," SAND78-1922, Sandia Laboratories, Albuquerque, New Mexico, to be published.

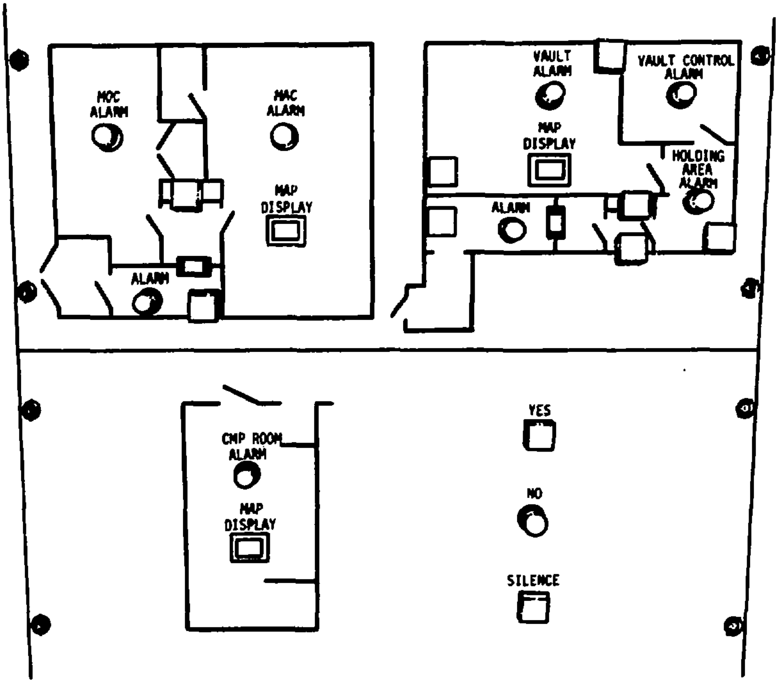

Figure 11. Alarm Display Board

location of the employee's photoslide in the Kodak photocarrousel. If the photoslide and face-on CCTV displays match, the guard depresses the YES button, which initiates the door unlatching sequence for the ID booth. A NO response by the guard generates an alarm condition. The personnel identification system is discussed in the Sandia document, SM VIDCOMP-1.[23]

[23] R. G. Swier, Operations Manual for a Video Comparator System, SM VIDCOMP-1, Sandia Laboratories, Albuquerque, New Mexico, August 1978.

SECTION 5

MATERIAL OPERATIONS CENTER

The Material Operations Center, shown on the left of Figure 12, is a protected site that has the responsibility of ensuring that all operations taking place during transaction activity are proper and authorized. The MOC computer monitors all activity in the PPS automatically, and no action is required by the operator under normal circumstances. In the event of certain human errors or equipment malfunctions, the MOC operator becomes an active participant by controlling the operations in the vault on a step-by-step basis. The MOC computer has the responsibility of monitoring alarms in the MOC, the MAC, and the personnel corridor because of the close proximity of these areas.

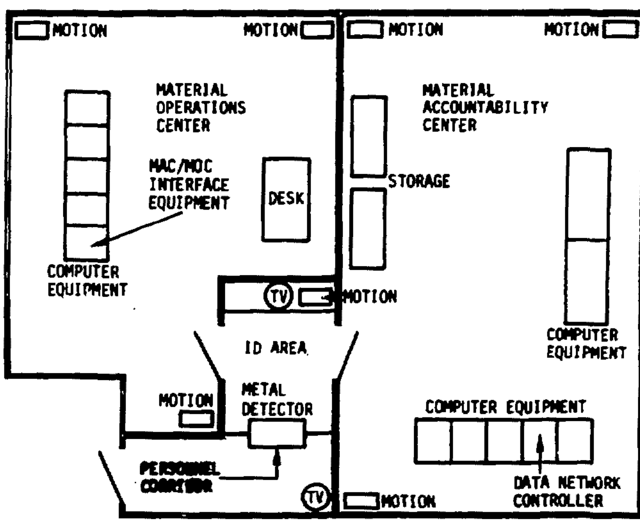

Figure 12. *Material Operations Center (MOC), Material Accountability Center (MAC), and Personnel Corridor*

If the MOC and the MAC were separated by a greater distance, each center would have its own entry-control system and would monitor its own alarms. The MOC is equipped with infrared motion sensors (Model 19-124, Barnes Engineering, Stamford, Connecticut), but TV coverage is not provided. Entry to the MOC is through a personnel corridor very similar to that in the vault ICA.

Material Operations Center (MOC) Computer

The MOC computer is a ModComp Model II/26 minicomputer manufactured by Modular Computer Systems in Fort Lauderdale, Florida, and has a 64K memory. The major features of this computer are discussed in Section 2 under the subsection, Vault Computer. The peripheral equipment at this site includes a CRT terminal for operator interaction, a dual floppy disc for use in program storage and transaction-file generation, a line-printer for hard-copy records, and an interface subsystem used to interface with other equipment.

Material Accountability Center/Material Operations Center (MAC/MOC) Personnel Corridor

The MAC/MOC personnel corridor (see Reference 2) is similar to the vault personnel corridor except that it has no formal ID booth and the corridor controls access to both the MOC and the MAC. The layout of equipment is shown in Figure 12. Entry to the corridor is allowed by the SOC in response to the operation of a pushbutton on the outside of the corridor. BOOTH OCCUPIED lights have been provided just above the pushbutton to inform personnel of the status of the corridor. Remotely operated door latches (Model 310-2, Folger Adams Company, Joliet, Illinois) are used to open the corridor doors; magnetic switches (Model MS5WTI, Mosler Safe Company, Hamilton, Ohio) detect the opening of the doors. A microswitch is provided in the door latch to monitor its unlocking.

The metal detector in the corridor is identical to the one used in the vault corridor (Model XI, Solco Engineering Company, Chatsworth, California). The Model 4400 microwave motion sensor, manufactured by the Advanced Devices Laboratory, Inc., Reno, Nevada, is used to monitor activity in the personnel corridor. The CCTV system described in Section 7: System Aspects is used to assess any alarms in the corridor.

Identification of personnel follows procedures identical to those used in the vault corridor. An ECR determines the ID number of the EC badge being worn by the individual; this number is sent to the SOC via the MAC. Upon receipt of the badge ID number, the SOC activates the personnel identification system, and the photoslide of the badge holder is displayed on a CCTV monitor next to the real-time display of the face-on camera in the corridor. If the guard determines that the real-time display matches the stored photoslide and answers YES to the computer inquiry DO PHOTO AND FACE MATCH?, then the door unlocking sequence is permitted to proceed. The individual must depress a pushbutton on the inside of the corridor next to the door he wishes to be opened. If his personnel file in the MAC allows him access through that door, it is opened; if it does not, access is denied, and another door selection must be made.

Computer Interface Electronics

In the Computer Interface Electronics (see Reference 5), input information and output controls are interfaced to the MOC computer through an input/output interface subsystem. This subsystem has a capacity of 16 channels of 16 bits each, 8 of which are used in the MOC. The channels are divided into five groups, as in the vault computer. These five groups are

1. Individual information input bits in which each bit represents the status of an item in the MOC, MAC, or MAC/MOC corridor,
2. A 16-bit output which is used to reset the input lines of the preceding group,
3. A 16-bit word input which is used for the EC badge ID number from the ECR,
4. A 16-bit output which is used to turn on power to selected items, and
5. A 16-bit output which is used to turn on annunciator lights and reset the CMP Room Controller.

Information is transferred by channels, as in the vault computer. The alarm latch chassis, the 110-volt junction box, and the guide and status light chassis are discussed in Section 2: Vault Area. The alarm latch chassis accepts status inputs from the door-related hardware, the motion sensors, the ECR, and the metal detector. The tamper indicators in these devices are also monitored, and the door-request pushbuttons are interfaced through this chassis. The 110-volt junction box controls power for the ECR, the corridor lights, and the remotely operated door latches. The guide and status light chassis controls the BOOTH OCCUPIED lights and the reset for the CMP Room Controller.

SECTION 6

MATERIAL ACCOUNTABILITY CENTER

General

The Material Accountability Center, shown on the right of Figure 12 (see Section 5) is a protected site that is responsible for maintaining a data base of all items under the direct supervision of the PPS. All transaction information is authenticated by the MAC in conjunction with the MOC in order to provide operational safeguards against the single-insider threat, i.e., two independent transaction entries must agree with each other. On an hourly basis, the MAC requests from the vault a complete inventory of the items stored and compares the results with the data base. Notices of any discrepancies are transmitted to the SOC and MOC for appropriate action.

The MAC is equipped with infrared motion sensors (Model 19-124, Barnes Engineering, Stamford, Connecticut). Alarm outputs and tamper-indicator outputs are wired to the alarm latch chassis in the MOC. The MAC door hardware (door latch and magnetic switch) has been discussed in the MAC/MOC personnel corridor subsection of Section 5.

Material Accountability Center (MAC) Computer

The MAC computer is a ModComp Model II/26 minicomputer manufactured by Modular Computer Systems in Fort Lauderdale, Florida, and has a 64K memory. The major features of this computer were discussed earlier in Section 2 under the subsection, Vault Computer. The peripheral equipment at this site includes a CRT terminal for operator interaction, a card reader for inputting information, two magnetic tape units for permanent storage of data, two moving-head discs for program and data storage, a floppy disc for preliminary programming purposes, and a line-printer for hard-copy records.

SECTION 7

SYSTEM ASPECTS

The PPS consists of three control centers (the MOC, the MAC, and the SOC), the vault ICA, and the CMP room. Information and instructions are exchanged among the five sites by means of the Data Communications Network. Because all data are transmitted through this network, additional intersite wiring is necessary only for the intercom and the CCTV.

Data Communication Network

The Data Communications Network for the PPS consists of a Data Network Controller (DNC), Data Link Controllers (DLCs), full duplex modems, and hardwire connecting links (see Figure 13). Twisted-pair cables connect the modems, and data between modems consist of serial bit streams. Each DLC has a parallel interface with the host computer (the microprocessor at the CMP room), and the interface shown between the DNC and the DLC at the MAC is also parallel because of the heavier communications traffic and the colocation of the two chassis (the DNC resides at the MAC). The Data Communications Network is divided into primary and secondary links. The primary links connect the DNC to each of the five sites in the system. The secondary links interconnect two DLCs, providing an alternate message path in the event one of the primary links fails. The network operates under a Sandia-designed message-switching protocol[24] and the Electronic Industries Association RS-232-C interface standard. Network intelligence is provided by the Motorola M6800 microprocessor, which is the basic element in both the DNC and the DLCs. The modems used are manufactured by the International Communications Corporation, Miami, Florida (Model Comm-link II). Approximately 30 minutes of battery backup power is provided for all elements of the network.

[24] M. S. Rogers, A Computer Network Data Communications Controller for the Plutonium Protection System, SAND78-0612, Sandia Laboratories, Albuquerque, New Mexico, November 1978.

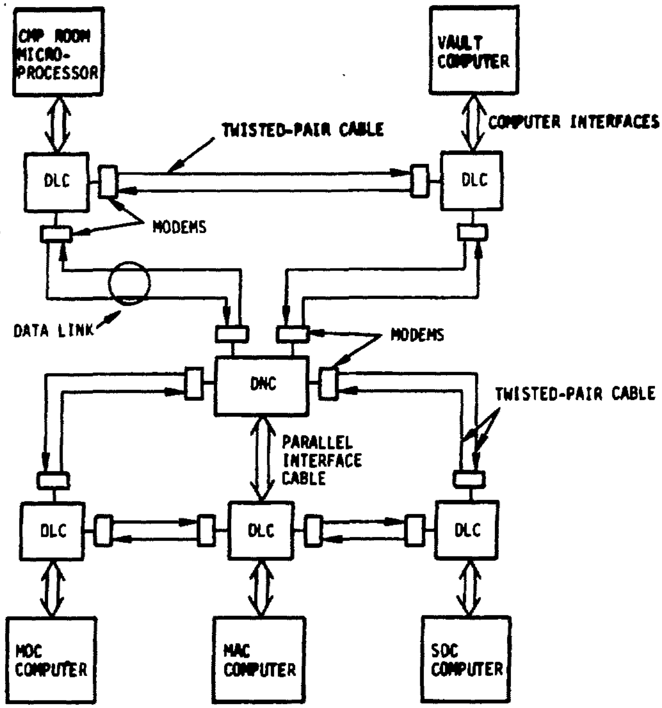

Figure 13. Plutonium Protection System (PPS) Data Communications Network

<u>Data Network Controller (DNC)</u> -- The DNC supervises communication and data transfer between sites in the PPS by ensuring that messages are routed to the proper destination in an efficient manner. The DNC design can handle up to 14 network stations and routes data input from any site to any or all remaining sites. The DNC is a transparent part of the data network; when working properly, the receiving station does not know that the DNC exists. Details of the DNC are discussed in Reference 24.

Data Link Controller (DLC) -- The DLC is concerned with the communication requirements of its resident site, e.g., interfacing with its resident computer, error control, and alarm bypassing. DLC hardware consists of the Motorola M6800 microprocessor and its associated support circuitry, which provides data storage and signal buffering. Emphasis has been placed upon software implementation of data input/output, transfer, processing, formatting, and manipulation. Such an approach provides flexibility and reliability. Details of the DLC are discussed in the Sandia document, SAND78-1560.[25]

CCTV Alarm Assessment

CCTV is used at various locations throughout the PPS to assess alarms caused by motion sensors, door switches, metal detectors, or other operational malfunctions. The cameras are manufactured by Cohu Electronics, San Diego, California (Model 2820B) and use standard antimony trisulfide image tubes. Multiconductor cables are run from the cameras to control units (Cohu Model 2380-100) in the SOC; this cabling allows the cameras to be remotely adjusted and thereby greatly reduces the required on-site maintenance. Outputs from the control units are supplied to the video clamper units (Model CL-1050B, Dynair Electronics, Inc., San Diego, California), which eliminate the ac power signal induced into the video lines. The filtered signals are then fed into a remote video switcher (Cohu Model 9100), which directs the signals to the desired TV monitors (Model SNA9, Conrac Corporation, Stamford, Connecticut). Details of the alarm assessment system are discussed in the Sandia document, SAND78-1559.[26]

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[25] F. M. Raymond, "A Data Communications Network for the Plutonium Protection System," SAND78-1560, Sandia Laboratories, Albuquerque, New Mexico, to be published.

[26] D. A. Greenwoll, A TV Assessment and Identification System for the Plutonium Protection System, SAND78-1559, Sandia Laboratories, Albuquerque, New Mexico, February 1979.

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Drawings

Sandia Drawing T55421. This drawing documents the organization of the PPS and gives assembly drawing numbers for all components in the system.

GLOSSARY OF TERMS, ACRONYMS, AND ABBREVIATIONS

(Note: Some of the following may not occur in this volume but may be found in other volumes of this report.)

	Bay--Another term for a Secure Storage Module.
	Bulge--An indication of deformation of the plutonium foodpack can measured by the Container Module electronics.
	Carrousel--A cylindrical device located in the Secure Storage Module into which as many as 35 Container Modules may be secured.
CRT	Cathode-ray tube--An electronic tube which converts electrical signals into pictures of scenes, messages, and drawings.
CCTV	Closed-circuit television--A system composed of a TV camera, a TV monitor, and interconnecting equipment.
CM	Container Module--A Sandia-designed overpack container for special nuclear materials. The term CM is also used to denote the complete, packaged assembly.
	Container Module handler--A device used by personnel to move individual Container Modules.
CMP room	Container Module Packaging room--The area in which the Container Module Packaging operations of sealing the Rockwell plutonium cans into the Sandia Container Modules are performed.
	Container Module tester--The electronic unit used to test Container Module electronics.
	Data Communications Network--A system of electronics over which messages, including data, are transmitted between computers.
DLC	Data Link Controller--An electronic device, resident at each site of the communications network, that contains a microprocessor and supervises the communications between each site and the Data Network Controller.
DNC	Data Network Controller--An electronic device central to the communications network that contains a microprocessor and supervises the communications between all sites.
	Deadbolt--A metal bolt that is inserted into a mating device to serve as a lock and requires the actuation of a solenoid for unlocking.

DOE/OSS	Department of Energy/Office of Safeguards and Security
	Disc--A rotating platter having a magnetizable surface on which information may be stored.
	Dock (STM)--A welded steel assembly at which the Secure Transport Module is locked into place with a deadbolt and through which Container Modules are moved to/from the Secure Transport Module.
DID code	Dynamic identification code--A hexadecimal number which is randomly generated and inserted into the Container Module electronics for use as a tamper detector.
EC	Electronic credential--An electronic badge which, when properly activated, transmits a unique identification number.
ECR	Electronic credential reader--A device used to activate the electronic credential and receive the identification number.
	Electronics enclosure--A massive enclosure with tamper detectors atop the Secure Storage Module containing microprocessors and other equipment to control the Secure Storage Module hardware.
	Floppy disc--A flexible magnetic disc used to store computer data or programs.
ID	Identification
	Identification booth--A booth which contains an electronic credential reader and a TV camera and is used to identify individuals remotely.
	Inventory--The Material Accountability Center conducts two types of inventories: a full inventory and a quick inventory. Inventory discrepancies produce system alarms. 1. A full inventory is a periodic inventory presently programmed hourly (or on demand by MAC sense switch 11) which checks the contents of each vault storage position (CM IDs, bulge and temperature data) for Material Accountability Center comparison to the material data base. 2. A quick inventory is an inventory taken at the conclusion of a transaction in the vault area. The transaction team/party is detained in the holding area while all vault material is checked for proper position in the Secure Storage Modules and for absence of tampering before the transaction team is released.
ICA	Item Control Area--An SNM processing or storage area within the PPS having physical protection and personnel access control features.

JPA — Job Performance Aid--Rockwell Hanford operations procedures required for use in performing assignments.

LASL — Los Alamos Scientific Laboratory

Manual mode--A contingency mode under control of the Material Operations Center operator which is used to move Container Modules after hardware or operational malfunctions.

Mask--A method of selectively examining certain bits of a binary word. In the Plutonium Protection System, masking is used, under appropriate conditions, to nullify the sensor actuation segments of status messages.

MAC — Material Accountability Center--A protected site which maintains the data bases for the Plutonium Protection System.

MOC — Material Operations Center--A protected site which supervises and/or monitors activity in the Plutonium Protection System.

Metal detector--A walk-through device used to detect metal.

Microprocessor--A small computer used in the communications network, the Container Module Packaging room controller, the Secure Storage Module controller, and the Vault Portal controller.

Modem--A modulator/demodulator used to condition signals for transmission on the Data Communications Network.

ModComp — Modular Computer Systems--A computer manufacturer.

Motion sensor--An electronic device that detects motion.

NMIS — Nuclear Material Information System--An identification system for special nuclear materials items.

Photocarrousel--A computer-actuated slide projector which contains photographic slides of persons assigned a specific electronic credential.

PACS — Plutonium Access Control Software--The software package developed for the Plutonium Protection System.

PPS — Plutonium Protection System--A safeguards system which uses advanced technology to provide improved protection for special nuclear materials.

Program--A set of software instructions that controls the computer.

Sealing/unsealing fixture--A semiautomatic holding and soldering device used in a glove-box assembly for sealing or unsealing Container Modules.

SSM	Secure Storage Module--A group of four storage cubicles and carrousels, with its electronic enclosure, which is used to store up to 140 Container Modules.
STM	Secure Transport Module--A minivault on wheels used to transport up to five Container Modules between secure areas.
SOC	Security Operations Center--A manned center which authenticates the identity of personnel, visually monitors activities, and assesses alarm conditions.
SSW	Sense switch--One of 16 switches located in a row on a computer console. Activation of a sense switch causes a computer to perform a programmed function, e.g., report generation.
	SNM detector--A radiation-sensitive device which detects the presence of radioactive materials.
SNM	Special nuclear materials
SID code	Static identification code--A unique hexadecimal number stored in the electronics of Container Modules used for accountability and identification purposes.
	STM control panel--Control panels near the vault and Container Module Packaging room docks that indicate STM status and guide and aid the operator during STM insertion/removal operations.
SIL	System Integration Laboratory--A special laboratory at Sandia Laboratories, Albuquerque, at which the PPS was developed and evaluated.
	Tamper--A device which causes an alarm if an unauthorized adjustment or entry is attempted.
	Tang--A metal tab on the side of a Container Module or the front of the Secure Transport Module. The tang has a hole through which a deadbolt is inserted to lock the item in place.
	Terminal--A keyboard and cathode-ray tube used to send commands to and receive messages from a computer.
	Transaction--Well-defined authorized activities performed in the Plutonium Protection System. There are four types: deposit, withdrawal, in-vault movement, and inspection/maintenance.
	Transaction panel--A group of buttons, lights, and code wheels located at each Secure Transport Module dock used to initiate/complete transactions and aid Secure Transport Module docking/undocking.
	Vault--The primary storage location for the special nuclear materials (also called VSA).

VCR Vault Control Room--The room which contains the computer and peripherals that control access to the vault and command the vault hardware.

VIC Vault interface computer--The vault Item Control Area computer located in the Vault Control Room (also called vault computer).

Vault Item Control Area--The Item Control Area, which consists of the Vault Storage Area, the Vault Control Room, and the personnel corridor. (This area is also referred to as the vault area.)

VSA Vault Storage Area--The room in which the Secure Storage Modules are located and the special nuclear materials are stored (also called vault).

Verification chamber--A unit designed by the Los Alamos Scientific Laboratory in which the sealed Container Module is assayed and weighed, the static ID code is checked, the dynamic ID code is inserted, and the information is entered into the Plutonium Protection System.

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