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SANDIA LABORATORIES PLUTONIUM PROTECTION SYSTEM

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ABSTRACT

Sandia Laboratories is developing an improved plutonium protection system (PPS) to demonstrate new concepts for enhancing special nuclear materials safeguards. PPS concepts include separation of functions, real-time item accountability and improved means for control of materials, activities and personnel access. Physical barriers and a secure communications network are designed into the system to offer greater protection against sabotage, diversion and theft attempts. Prototype systems are being constructed at Hanford, Washington and Albuquerque, New Mexico and will be subjected to a comprehensive testing and evaluation program.

INTRODUCTION

Sandia Laboratories is developing an improved safeguards system to demonstrate new generic concepts for the protection and control of special nuclear materials (SNM). These concepts are based on a "protection-in-depth" philosphy which provides for a sequence of safeguards measures that must be defeated in order to steal, divert or sabotage SNM packages. The new plutonium protection system (PPS) is highly computerized and automated and is designed to enhance detection and control capabilities. It thereby aids and supplements security forces rather than replaces them. These forces are still required to assess any alarms and implement appropriate responses to counter any safeguard threats. Hardware and software development activities are nearing completion and two functionally equivalent systems, one at Hanford and the other at Albuquerque, are being constructed in order that these new concepts can be tested and evaluated. At Hanford, plutonium will be introduced into the system utilizing regular operating personnel. Thus, an operational environment, complete in all details, will be established in which to test and evaluate the PPS. The Systems Integration Laboratory (SIL) at Albuquerque will provide a simulated operational environment in which the PPS will undergo more extensive engineering evaluation and be subjected to a variety of safeguards threats.

SYSTEM DESCRIPTION

The PPS consists of a three computer control center complex--the Material Accountability Center (MAC), the Material Operations Center (MOC) and the Security Operations Center (SOC)--which is designed to separate the accountability, operations and security functions associated with a safeguards system. To this complex, a computer control center and appropriate hardware are added for each item control area (ICA)--storage or processing areas--within the system. A storage area and a container module packaging (CMP) room are the two ICA's in the current demonstration project. These areas are interconnected by a secure communications network. Figure 1 shows the layout of the demonstration facility at Hanford. As many as eleven ICA's could be accommodated by the present MAC/MOC/SOC complex.

DISCLAIMER

The MAC, MOC and SOC each contain a MODCOMP* II/26 minicomputer which has a 1 μsec cycle time. These have a basic 32K, 16 bit word, field expandable memory. Memories in the MAC and MOC computer have been expanded to 64K. In addition, there are five Motorola M-6800 microprocessors in the system. These are located at the verification chamber, the Secure Transport Module (STM) docks at the CMP room and the storage area, and one in each of the two electronic enclosures. Various peripherals included in the system are keyboard display terminals, disc storage devices, magnetic tape units, line printers, a card reader, dual tape cassette units and teletypes.

Cans containing SNM are placed in a container module (CM) which in addition to providing additional shielding and security, contains an electronics package which monitors temperature and pressure and maintains its security codes. These codes identify the CM and ensure that it has been handled as authorized and has not been subjected to any adverse action. The cans of SNM are placed and sealed in the CM's in the CMP room. A verification chamber in the CMP room qualitatively checks the weight and radiation emission of the CM and enrolls it in the PPS. It is then placed in the STM, transported to the storage area, and then placed in storage.

In the storage ICA at Hanford there are two secure storage modules (SSM's) containing four cubicles made up of a steel base plate, 20.3 cm (8 inch) steelcrete side and back walls, and a 1.3 cm (1/2 inch) steel door assembly on the front. The top is covered by a steel electronic enclosure assembly which houses the SSM control equipment. Within each cubicle there is a 2.1 m (7 foot) long, 45.7 cm (18 inch) diameter carrousel which has 35 CM storage locations arranged in 7 levels of 5 each. A complete SSM is about 3.4 m (11 feet) long, 2.7 m (9 feet) high, 0.8 m (2-1/2 feet) deep and weighs about 10.8 tonne (12 tons).

By appropriate orientation of the CM storage locations in the carrousel and alignment of the door opening, only one CM can be emplaced in or removed from the carrousel at any time. In addition, the CM's are positively locked into place. The security hardware in the storage area (locks, latches, switches, etc.) is controlled by the ICA computer. The CM, carrousel and SSM are depicted in Figure 2.

The MAC/MOC computers are used to establish transaction files for operations within the PPS. The who, what, when and where of each operation are transmitted via the secure communications network throughout the system and internal checks are automatically performed to validate the transaction. When an operation commences, the system controls it and verifies that the proper personnel are proceeding on schedule to perform the authorized operation. Only one operation is permitted at a time.

In the absence of any operations, security and inventory functions are performed. The system monitors the motion detectors (infrared and microwave) and security interlocks and transmits alarms to the SOC in the event infractions or intrusions are detected. The guard at the SOC (this is the only center that is continually manned) assesses these alarms by means of the closed circuit TV (CCTV) and intercom systems and takes appropriate response action. The guard at the SOC also verifies personnel identification as they enter and leave the storage and MAC/MOC areas.

The MAC maintains a real-time inventory of items within the PPS. It continually checks each carrousel location to ensure that the proper CM is there and initiates an alarm if any discrepancy is found between the data base and the inventory check.

Personnel access corridors are provided for the storage and MAC/MOC areas. These corridors contain magnetic loop badge readers for instant identification, pressure pads, metal and SNM detectors, TV monitors, motion and space monitors and ID booths.

At the ID booth, a TV camera transmits a picture to the SOC where the guard compares it with a slide picture of the individual to establish positive identification.

GENERIC CONCEPTS

The major new physical protection concepts that are being evaluated in this system are:

1. The status and inventory of SNM packages in storage are continuously monitored by computer. This provides for a continuous real-time inventory, as opposed to a periodic inventory. Movement of material is monitored by the computer and if problems occur, the SOC will be automatically notified.

2. When authorized personnel are in the storage area, their access is limited only to those SNM packages which are required as part of the transaction.

3. Transaction operations in the ICA's are continuously monitored and are constrained to be accomplished in a given time period. For example, computers keep track of the time elapsed and if the package transfer between the STM and the carrousel is not accomplished within a set time interval, then an alarm is sounded.

4. Positive personnel identification methods are utilized to guarantee that only authorized personnel have access to the storage area at the time prescribed by the transaction data.

5. The PPS physically separates the personnel who operate the three functional control areas--operations, accounting and guard security. The system requires that these control areas agree at all times that the transaction is proceeding properly. If they do not agree, the transaction is stopped and guards are dispatched immediately. This is done for protection against insiders who might desire to steal, divert or sabotage SNM.

6. Positive protection by means of the STM is provided for movement of CM's between the storage and CMP room ICA's. The STM contains a one-level carrousel having five storage positions. Rotation of this carrousel into the neutral position makes removal of a CM very difficult. Further, the computer allows a limited time for the STM to move from one location to another. If this time is exceeded, guards are dispatched.

In addition to implementing these concepts, the PPS is designed to minimize radiation exposure to operating personnel and provide means to detect

tampering with the CM.

TESTING AND EVALUATION

Testing and evaluation of the PPS will consist of the operational demonstration at Hanford and supplemental work at Albuquerque. This work will include operations and engineering evaluations at the SIL, analytical studies and destructive testing.

The demonstration at Hanford will be limited to normal operations. In addition to canning and uncanning of the CM's in the CMP room and movement of the CM's via the STM to the ICA's, five types of operations will be conducted. These are deposit, withdrawal, relocation within the SSM's, inspection/maintenance, and unoperative maintenance operations. These encompass all the operations which might occur in a storage facility.

A number of each type of operations will be conducted to develop statistically meaningful data to ensure that software, hardware and procedural inadequacies do not exist. Furthermore, any adverse impact of an operational nature will be defined and compared with the improvements that are realized in the level of safeguards provided and the potential elimination or mitigation of various operational problems. For example, the real-time inventory capability of the PPS, if proven to be accurate and dependable may offset the added operational complexities (canning and uncanning the CM, detailed personnel and material movement control, lengthening of operational times, etc.).

Detailed radiation exposure measurements will be made. These data will be analyzed to determine the reduction in exposure that is achieved.

The test and evaluation work at Albuquerque will emphasize vulnerability studies and rigorous engineering evaluations. The SIL-PPS will be subjected to a wide spectrum of threats and system responses will be carefully analyzed to ensure that adequate protection exists against these threats. Threats and defeat attempts will be in accordance with the six concepts given in the previous section.

Attempts will be made to induce inaccuracies in the inventory process by having one person try to make hardware and/or software changes in the system. As authorized persons proceed with an authorized transaction, they will attempt to obtain access to packages that are not part of the transaction. Action will be taken to defeat the TV monitoring capability and prolong transactions to determine system response. False credentials, erroneous personnel, "tag-along" personnel and "walk-ins" will be used to attempt to gain entry to secure areas in the system. MAC, MOC and SOC operators will attempt to perform control functions which by design are not within the capabilities of their operations center.

In addition, analytical studies will be conducted to aid in defining the level of safeguard protection that is provided within the PPS. The system will also be subjected to destructive testing to determine the equipment needed to forcibly defeat the system.

SUMMARY

The PPS has been designed and will shortly undergo extensive testing and

evaluation. Data obtained will be used to verify that the concepts and design goals established for the PPS are correct and complete and that they have been satisfied. Results will be analyzed to establish the need for any changes in the system to correct deficiencies and make the PPS more cost-effective.

Figures

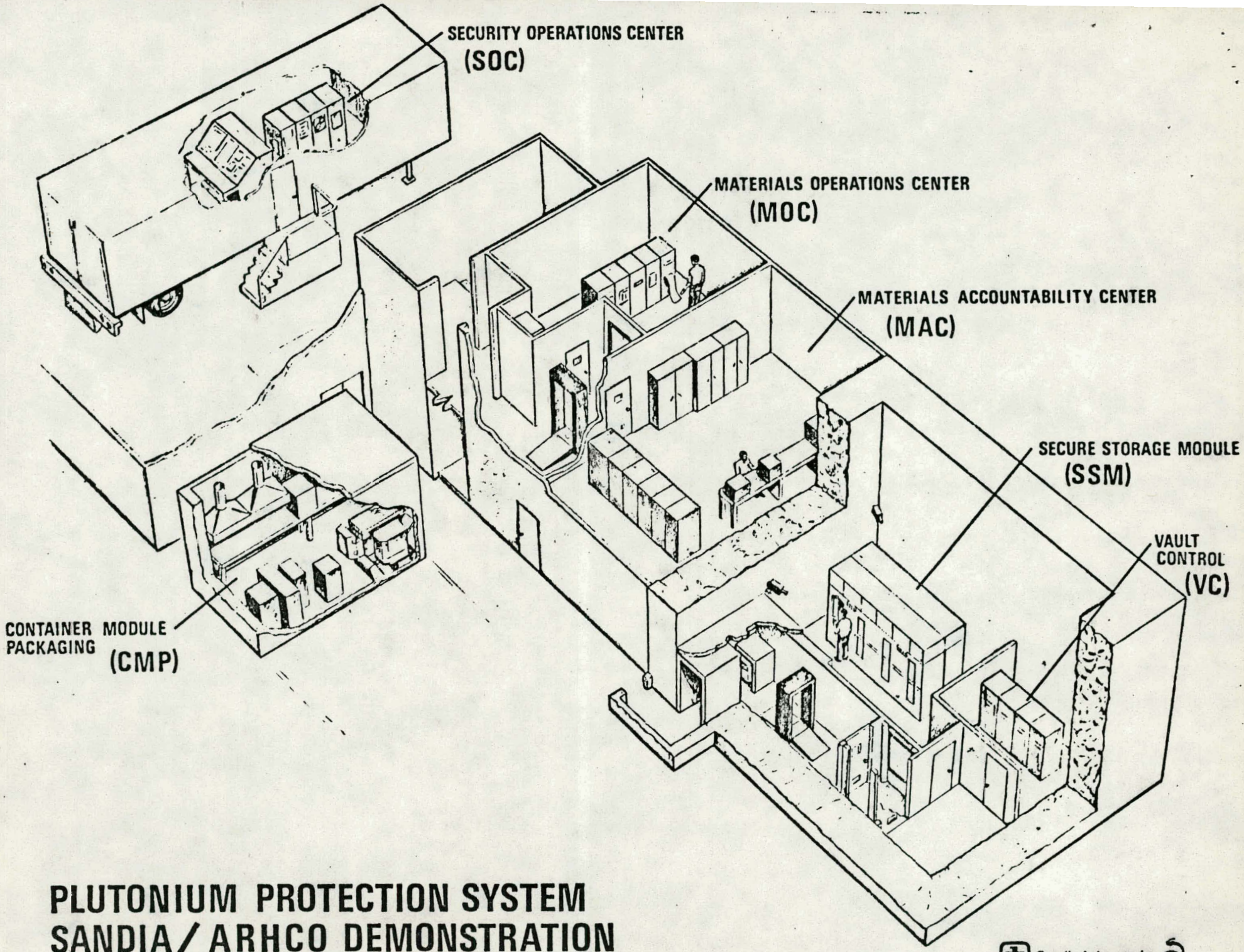
1. PPS Layout
2. CM, Carrousel and SSM

Abbreviations

ARHCO	Atlantic Richfield Hanford Company
CCTV	Closed Circuit Television
CM	Container Module
CMP	Container Module Packaging
ICA	Item Control Area
ID	Identification
MAC	Material Accountability Center
MOC	Material Operations Center
PPS	Plutonium Protection System
SIL	Systems Integration Laboratory
SNM	Special Nuclear Material
SOC	Security Operations Center
SSM	Secure Storage Module
STM	Secure Transport Module
TV	Television

Footnote

* Modular Computing Systems, Inc.



PLUTONIUM PROTECTION SYSTEM
SANDIA / ARHCO DEMONSTRATION

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FIGURE 1 PPS LAYOUT

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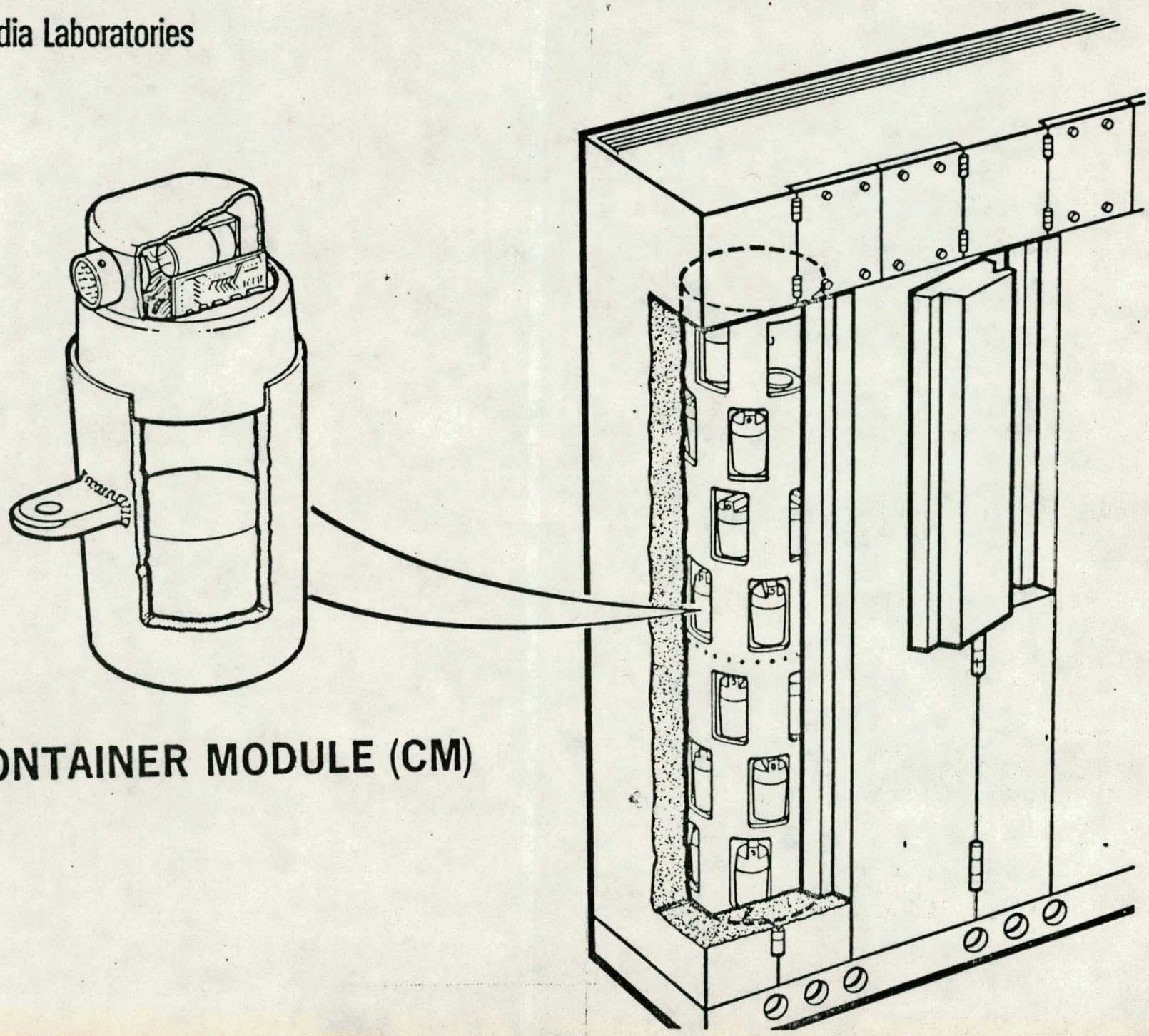

FIGURE 2 CM, CARROUSEL AND SSM