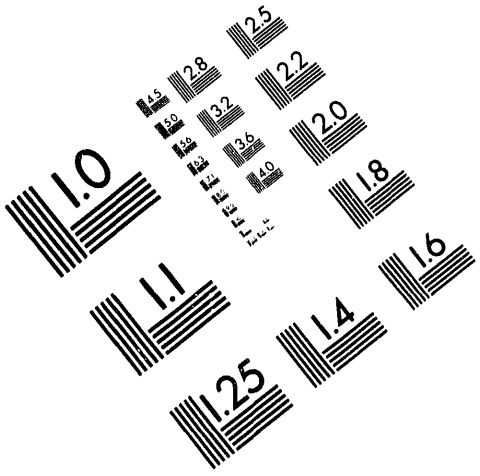

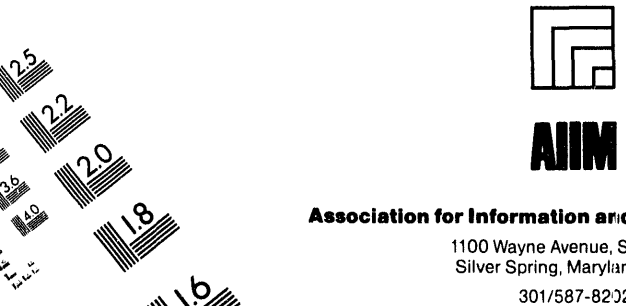

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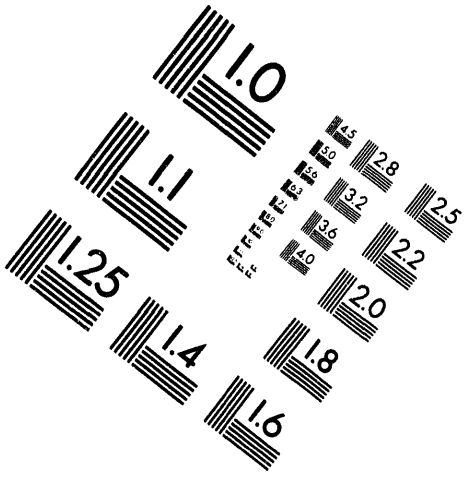

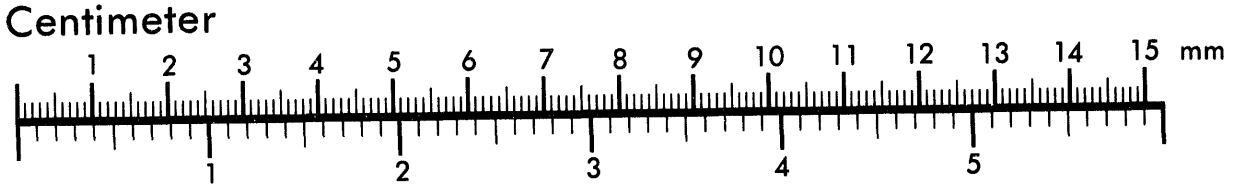

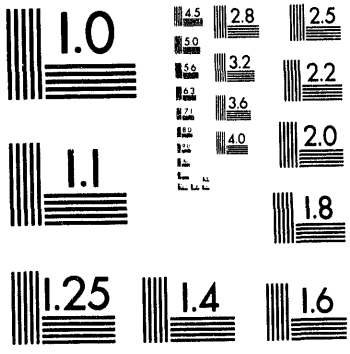

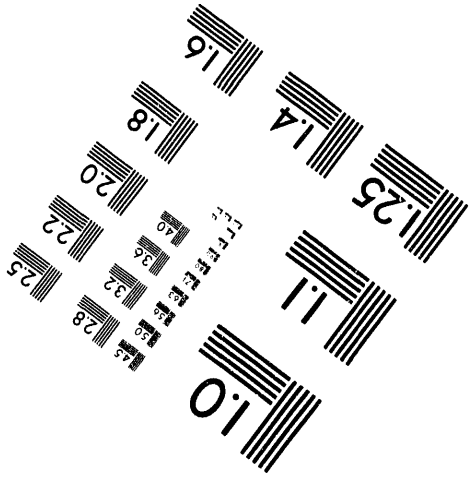

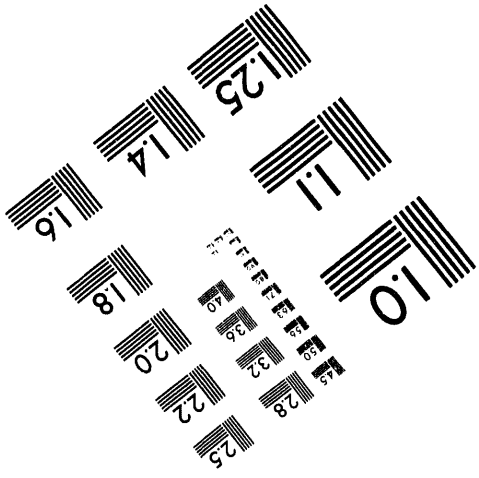

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Physical Protection Technologies for the Reconfigured Weapons Complex

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Abstract

Sandia National Laboratories was a member of the Weapons Complex Reconfiguration (WCR) Safeguards and Security (S&S) team providing assistance to the Department of Energy's (DOE) Office of Weapons Complex Reconfiguration. New and improved S&S concepts, approaches and technologies were needed to support both new and upgraded facilities. Physical protection technologies used in these facilities were to use proven state-of-the-art systems in such areas as image processing, alarm communications and display, entry control, contraband detection, intrusion detection and video assessment, access delay, automation and robotics, and various insider protection systems. Factors considered in the selection of these technologies were protection against the design basis threat, reducing S&S life-cycle costs, automation of S&S functions to minimize operational costs, access to critical assets and exposure of people to hazardous environments, increasing the amount of delay to an outsider adversary and having reliable and maintainable systems.

This paper will discuss the S&S issues, requirements, technology opportunities and needs. Physical protection technologies and systems considered in the design effort of the Weapons Complex Reconfiguration facilities will be reviewed.

Background

The Department of Energy's Office of Weapons Complex Reconfiguration (WCR) was formed in early 1992 to establish a nuclear weapons manufacturing capability that was consistent with national security requirements for the 21st century (Complex 21). Sandia National Laboratories, along with Los Alamos National Laboratories, became involved with this program in the Spring of 1992. A safeguards and security (S&S) team was formed which provided S&S assistance to DOE, the architect and engineering firm and the Lead Laboratories for the various functions within the program. This support was provided in parallel with the primary design activities.

In early 1994, there was a major reorganization of reconfiguration activities and two organizations were formed. The DOE Office of Reconfiguration's primary areas of concern are tritium production and related activities and the DOE Office of Nuclear Materials Disposition is concerned with disposition options for excess plutonium and highly enriched uranium. A number of different disposition options are being considered and include a geologic repository, reactors, accelerators and immobilization. Safeguards and security support is to be provided for both of these efforts.

Objectives

The support given to the WCR program involved S&S assistance in parallel with the primary design activities. Support was given to the DOE, the architect and engineer and the Lead Laboratories for the respective WCR areas (e.g. storage, processing, assembly/disassembly). The effort involved both high and low-level approach. At the high level, guidance on protection systems and strategies was provided, S&S issues and concerns identified, and technological opportunities identified. At the low level, S&S requirements and criteria were developed and facility operations and designs were evaluated.

In last year's INMM annual meeting, the physical protection approach and requirements were discussed for the WCR design effort [1]. The objectives of this paper are to discuss the S&S issues, technology opportunities and needs, and physical security technologies and systems considered in such areas as image processing, intrusion detection and assessment, access control, contraband detection, alarm communications and

display, access delay, insider threat, automation and robotics and material monitoring and tracking. The efforts in support of the WCR facilities identified S&S needs and opportunities but more work is needed to identify specific S&S approaches and technologies.

Issues

There are many S&S issues which were considered during the support to the WCR facility design activities. Listed below are some of them:

- Every effort was made to reduce the costs for S&S. In particular, life-cycle costs were considered when evaluating particular S&S options. Because S&S personnel represent such a large percentage of the typical operating S&S costs for facilities, ways to reduce the S&S personnel requirements by using technology were given serious consideration.
- Risks to both outsider and insider adversary threats were minimized consistent with the cost/benefits. Preliminary vulnerability assessments were performed to identify facility weaknesses and to analyze possible design alternatives.
- Automation and robotics (A&R) was to be used quite extensively in many of the WCR facilities. Although the use of A&R provided definite advantages such as reducing personnel access to nuclear materials and to hazardous environments, many new S&S issues which had not previously been fully addressed needed to be considered.
- The S&S functions of physical protection, material control and accountability, nuclear measurements and information security were to be integrated along with other non-S&S activities such as safety, environmental monitoring and emergency preparedness.
- In addition to meeting domestic S&S requirements, some facility designs needed to also consider the possibility of third party/international inspections. These inspections might possibly be required as part of bilateral or International Atomic Energy Association (IAEA) agreements.
- Finally, there are considerable efforts within DOE to extend the inventory requirements for special nuclear material (SNM). Consideration was given to using technologies and approaches which supported this effort.

Requirements

In addition to the requirements identified in the different DOE orders and other regulations, criteria was provided to the designers to help develop the most effective protective system . Physical protection requirements for WCR facilities included: (1) reducing S&S life-cycle costs, (2) where feasible automating S&S functions to minimize operational costs, access to critical assets and exposure of people to hazardous environments, (3) using state-of-the-art S&S systems and components and standardizing their use throughout the complex, (4) using on-line S&S measures so that SNM does not have to be removed from the process line at the end of the work day, (5) compartmentalizing the facility to control access to SNM and personnel movement within the facility, (6) develop approaches to extend the physical inventory frequency for SNM, (7) increasing the amount of delay to outsider adversary attack, (8) having reliable and maintainable S&S systems, (9) integrating S&S with other facility operations and (10) supporting as-low-as-reasonably-achievable (ALARA) criteria.

Technology opportunities and needs

Many opportunities and needs were identified for S&S technology areas. State-of-the-art proven S&S systems and components were to be considered for the various WCR facilities. Basic approaches, concepts and types of S&S systems and components were identified for some facilities but specific technologies, to include manufacturers, were not identified. Automation and robotic (A&R) systems were to be used to meet specific S&S applications and facility processing and operational requirements. Through the use of A&R systems personnel access to nuclear materials and hazardous environments can be reduced. Real payoffs can be realized if the intervals between SNM inventories can be extended. Personnel access to SNM and also radiation exposure can be reduced which means fewer personnel would be required to perform these functions. A number of different technologies have been developed which provide real-time continuous monitoring and remote inventory of SNM. These measures along with other S&S systems can enhance the assurance that SNM is adequately protected.

The operational costs of S&S personnel represent a very significant percentage of most facilities' S&S budget. Every attempt was made to reduce the S&S personnel requirements, particularly for protective forces involved in access control, security checks of facility locations and response activitie s. For facilities with nuclear material which was considered very attractive to adversary theft,

underground or bermed construction was considered. Such facilities with "enhanced delay characteristics" provide opportunities for new S&S approaches and technologies. For example, traditionally around certain security areas an isolation zone containing intrusion detection and assessment systems is constructed. These systems provide a very high level of detection probability but are quite expensive to install and operate. If a facility has significant passive delay in its design it may be feasible to utilize other S&S measures which provide an acceptable level of protection but at a lower cost. Finally, every effort was made to integrate physical security with other S&S activities (e.g. material control and accountability, nuclear measurements, computer/information security) as well as non-S&S activities such as safety, environmental monitoring, health physics, emergency preparedness. Part of this integration effort includes a command and control system which helps bring together all of the various pieces of information (e.g. from S&S, ES&H, emergency preparedness) for the facility operator. S&S analysis tools were used to perform vulnerability assessments and to evaluate design alternatives. Opportunities exist to expand these tools as part of S&S design, evaluation and training.

S&S Technologies

Image processing

A number of different image processing technologies were being considered. They include integration of image processing with other intrusion detection systems, video motion detection and object recognition. Ways of "looking beyond" the perimeter were being considered and included a number of range imaging technologies such as laser and synthetic aperture radar. In addition to ground-based warning systems, airborne early warning systems were considered. Image processing was also an integral part of other S&S measures such as alarm assessment and surveillance, biometrics (e.g. facial and iris recognition), contraband detection and access control.

Intrusion detection and assessment

Alternatives to a perimeter intrusion detection and assessment system were being considered as part of an integrated total system. The use of digital signal processing of alarm data was being looked at as a way to reduce nuisance alarms and enhance protection against tampering. Ways to more completely evaluate events which occur very quickly such as pre-alarm video assessment were being considered. Fiber optic sensors were being evaluated for possible use in both external and internal applications.

Access control and contraband detection

Consideration was given to a number of existing systems, especially systems which integrate a number of operations. A number of biometric devices were being considered, with hand geometry the technology currently selected by DOE as the standard device. The DOE standard badge was to be used with possible enhancements such as the use of smart card technology and proximity badges for certain applications. A lot of effort has been expended in the area of both vapor and bulk explosives detection. This area is a critical technology for adequate contraband detection and must not only detect explosives entering a facility on personnel or vehicles but also in packages and mail.

Alarm communications and display

A major effort in alarm communications and display was to make existing systems more robust and intelligent with respect to data processing and analysis. The concept of having an integrated command and control (C2) system for a facility was being developed. This C2 system would integrate a number of different functions to include intrusion detection and assessment; nuclear material control and accountability; critical equipment monitoring; environmental, health physics and safety areas and also emergency response operations. Wireless communications (e.g. using radio frequency transmission) was being considered for A&R and in areas where the costs to installing new communications lines would be too costly.

Access delay

Increased delay can result in reduced life-cycle S&S costs and an enhancement in security. Consideration was being given to underground or bermed construction for some WCR facilities. This would provide enhanced delay features for the protection from certain adversary attack scenarios. Although this type of construction is not a technology area, it can have a significant impact on a facility's protection strategy and systems. In particular, alternatives to traditional perimeter intrusion, detection and assessment systems were being considered. Another area which deserves attention, particularly for facilities which need temporary storage capability, is modular vaults. These vaults can be constructed in a variety of

configurations and be tailored to meet the needs of the particular facility.

Insider threat

A number of different technologies were being considered to help mitigate the insider threat. They include integrated personnel and material tracking systems, such as PAMTRAK (Personnel and Material Tracking System) or AIMS (authenticated item monitoring system), which includes entry control, personnel tracking and material monitoring. Use of these systems would have many benefits to include enforcement of two-person control, compartmentalization, radiation exposure monitoring and personnel accountability during emergency situations. Although not necessarily design impacting, a number of information security systems were being considered to include paperless systems for classified information. Tamper protection, including such areas as seals, enclosures and line supervision, were to be incorporated into the security system.

Automation and robotics

There were two basic areas where automation and robotics (A&R) were to be used in a facility. The first included A&R systems for specific security and nuclear material accountability purposes. Consideration was given to using A&R technologies to perform such functions as sensor testing, remote assessment, inventories and also as part of a response force to a security or ES&H event. These systems would reduce personnel involvement, reduce operating costs and minimize personnel radiation exposure. In addition to mobile systems, permanently mounted devices which can give an external stimuli for volumetric sensor testing were being considered. Many of the WCR facilities planned to use considerable A&R in support of their operations. Many of these operations involved special nuclear material and/or classified operations. The S&S ramifications of these activities needed to be carefully analyzed to include such areas as software control, data communications, computer system architecture and the use of on-line S&S measures.

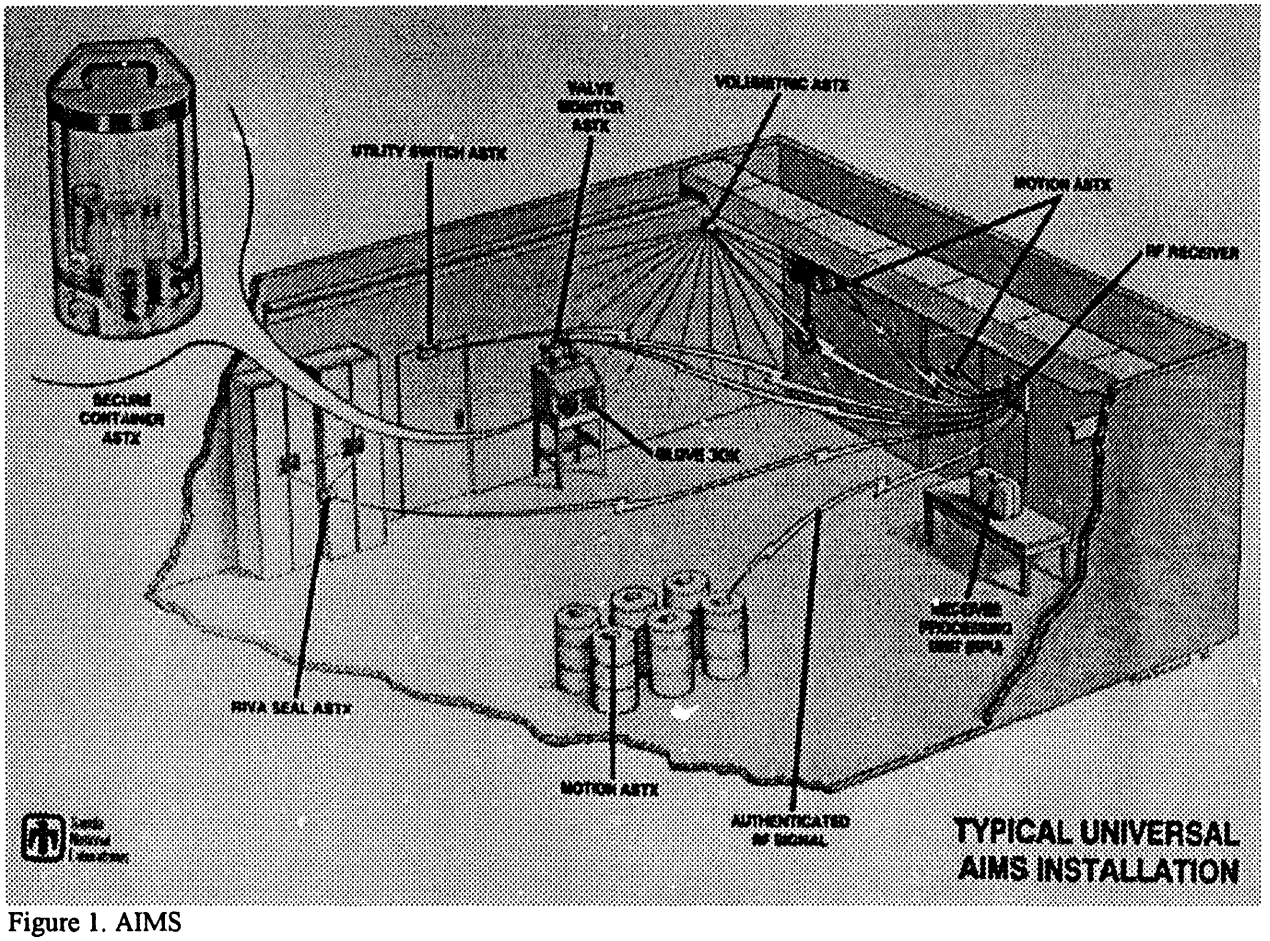

Figure 1. AIMS

Material monitoring and item tracking

The purpose of material monitoring and item tracking is to provide increased assurance that nuclear materials are accounted for and adequately protected. The combination of various measures can result in an extension of the SNM inventory interval. A number of different technologies have been develop to provide real-time, continuous monitoring. The attributes measured vary depending upon their purpose. They could help confirm material presence, enhance security and provide a state-of-health indication of materials being stored.

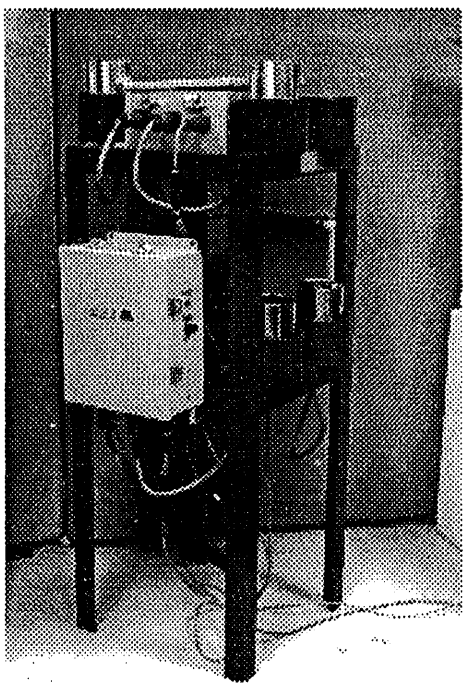

Figure 2. Prototype Item monitoring system

S&S System Analysis Tools.

A combination of expert analysis and the use of ASSESS (analytic system and software for evaluating safeguards and security) were used to support the analysis effort. In addition to providing an assessment on the S&S effectiveness and identifying weaknesses in the design the ASSESS tool was used to evaluate design alternatives and provide cost/benefit tradeoff analysis. With some changes to these tools they could be even more useful to the designer. The ability to utilize computerized drawings of the facilities, in both two- and three-dimensions, could help in not only evaluating S&S effectiveness but could also be used in S&S system and component design layouts and possibly as a training tool for the protective forces.

Summary

The S&S support given to the Weapons Complex Reconfiguration design effort helped ensure that S&S issues and concerns were identified early in the design, helped identify measures which would result in savings in life-cycle S&S costs and identified technological approaches which reduced risks to adversary action and reduced S&S personnel requirements. Technology opportunities and needs were identified for WCR facilities. Integration of physical security systems with other S&S and non-S&S measures helped provide a more effective and less costly command and control system for the facilities. Much of the S&S efforts in support of the WCR design effort were very high level and considerable opportunities exist for further work in developing specific S&S measures.

Acknowledgments

The success of this program would not have been possible without the considerable support of a large number of people who provided their technical skills and vision to this program.

The following people participated as part of the Sandia WCR S&S team:
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1. Jaeger, C.D., Zack, N.R. and Hunteman, W.J., *Physical Protection Design Approach for the Complex 21/Reconfiguration Facilities*, Proc of 34th INMM Meeting, pg 614, July 1993.

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