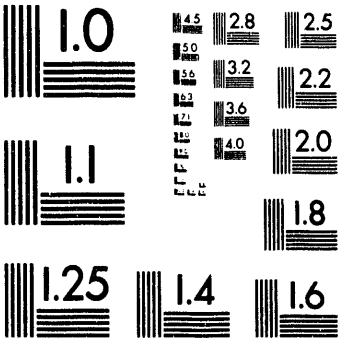
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PHYSICAL PROTECTION DESIGN APPROACH FOR THE COMPLEX 21/RECONFIGURATION FACILITIES*

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ABSTRACT

Sandia National Laboratories and Los Alamos National Laboratory have been designated as the technical lead for Security, Safeguards and Computer/Information Security systems for all the DOE Complex 21/Weapons Complex Reconfiguration (WCR) facilities. The physical protection systems in these facilities will be required to meet the most current DOE orders and incorporate the latest physical protection technologies, proven state-of-the-art systems and strategies. The planned approach requires that security assistance and information be provided to the designers (e.g. the Complex 21 Architect & Engineer and the Weapons Complex Lead Laboratories) as early as possible and throughout all design phases. The outcome should avoid the costly retrofits to existing facilities that have occurred in the past and result in effective and comprehensive protection against current and projected threats with minimal impact on operations, safety and costs. This paper will discuss the physical protection considerations being promoted for the integrated design effort for the Complex 21/Reconfiguration facilities, such as the tritium, uranium/lithium, plutonium processing and storage, high explosive and assembly and disassembly facilities.

INTRODUCTION

Sandia National Laboratories and Los Alamos National Laboratory have been tasked by the Department of Energy, Office of Weapons Complex Reconfiguration, to provide safeguard and security (S&S) assistance in support of Complex 21/Weapons Complex Reconfiguration (WCR) design activities. This paper will discuss the physical protection approach in the design of these facilities.

A main issue is the potential vulnerability of WCR facilities to S&S threats. If not adequately protected they may be subject to unauthorized intrusions, facility damage or sabotage and the theft or diversion of nuclear materials. As a result of these incidents, the public health and safety may be directly or indirectly endangered by exposure to radiation or toxic chemicals, costly shutdowns may occur and normal functions interrupted. Past experience has shown that S&S measures implemented during early design stages and integrated into the facility operations are more effective, more economical and less intrusive on operations.

The problems are (1) the increased S&S threats anticipated in the 21st Century, (2) uncertainties about how best to protect WCR facilities, and (3) deterrence of potential threats. Complex 21 facilities in most cases will be unique and must meet the highest S&S standards. Protection against malevolent acts must be integrated with facility operations, safety and other activities such as material, control and accountability and computer/information security. From the support given to Complex 21 new and improved S&S concepts, approaches and technologies will be developed which will be applicable to other facilities.

OBJECTIVES

The objectives of the WCR S&S team are to provide S&S support and assistance in parallel with the primary design activities, provide guidance on protection systems and strategies and minimize the risk against possible threats. The results of this effort will be a cost effective

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protection system which minimizes operational impacts and provides for (1) a comprehensive and effective protection program against the defined design basis threat, (2) elimination of potential threats to public health and safety, and (3) elimination of potential lose of production or functions.

APPROACH

The S&S approach includes (1) ensuring that S&S requirements are met by the WCR facilities and working with appropriate organizations to resolve any problems, (2) identifying and resolving S&S issues, (3) ensuring that the most appropriate S&S technologies and methodologies are adopted, (4) working with the architect and engineer and lead labs during all phases of the design, and (5) helping to develop the technical data, evaluations of alternatives and design reviews for the WCR facilities.

SAFEGUARDS & SECURITY DESIGN PROCESS

The S&S support for Complex 21 will be provided during all phases of the design. For each of the project design phases there are complimentary S&S design phases.

Design Phases	
Project	S&S
Conceptual Design	Requirements Analysis & Systems Definition
Preliminary Design (Title I)	Systems Engineering & Design
Detailed Design (Title II)	System Acquisition & Integration
Construction and Test & Setup	Implementation
Operations	Operations

Requirements analysis & system definition include the following:

- Define the threat
- Identify/review S&S requirements & standards
- Identify assets to be protected
- Determine programmatic/ES&H impacts
- Analyze site & operating environment
  - Understand facility mission, operations and processes
  - Identify admin/technical constraints
  - Identify environmental constraints
  - Identify budgetary constraints
- Develop basic S&S physical layout
- Develop basic protection strategies and concepts
- Develop S&S system design criteria and requirements
- Prepare initial system design descriptions and cost estimates
- Conduct technology survey/development
- Conduct preliminary vulnerability assessment (VA)
- Develop vulnerability countermeasures.

System engineering & design include the following:

- Develop system operational requirements
- Develop draft functional specifications
- Outline hardware/software requirements
- Develop preliminary test/acceptance criteria
- Identify S&S impact on facility design and layout
- Identify long-lead purchase items
- Evaluate applicable S&S systems or prototypes
- Conduct VA on preliminary design

System acquisition & integration include the following:

- Develop final detailed design package
  - Final drawings
  - System/component specifications
  - Construction/installation details
  - Cost estimates, schedules
- Develop final testing/acceptance specifications
- Conduct VA on detail design

Implementation includes the following:

- Provide S&S construction and installation support
- Conduct operational acceptance testing
- Perform preliminary testing of S&S systems
- Provide input to S&S documentation
- Final system engineering tests
- Conduct performance testing
- Develop/review facility's procedures and plans
- Develop and train S&S personnel in systems
- Conduct VA on final facility design

Operations includes the following:

- Integrate people, procedures and systems

- Conduct training and evaluations.

The above activities are not meant to be all inclusive but rather to give an indication of the type of actions needed during each design phase. Other personnel involved in S&S design activities have used similar concepts [1-7].

PHYSICAL PROTECTION DESIGN APPROACH

The physical protection design approach being used in support of Complex 21 design activities is a systematic approach which considers the three primary functions of a physical protection system: detection, delay and response. Detection is simply the discovery of an adversary action. Delay is the slowing down of the adversary's progress towards the target. Response is the protective force actions to prevent adversary success. Each of these functions must be performed in a period of time that is less than the time required for an adversary to complete his task. From a design standpoint it is generally better if detection is as far from the target as possible and significant delays nearer to the target. Major delay measures or barriers located too far from a target are generally very costly. The physical protection functions consist of many different components, such as entry control, intrusion detection, barriers and protective forces. Later in this paper specific design features for some of these components will be discussed.

The physical protection design approach combines the functions of a physical protection system with the current system or design (e.g. threat, site characteristics) and conducts trade-off analysis of the S&S effectiveness versus such things as cost, safety, environmental and operational impact. The result is a final design which is cost effective, on schedule and meets the concepts of a good physical protection system. It is characterized by protection-in-depth (which means having several protective measures in sequence), balanced protection (which is attempting to have detection and delay nearly equal on all adversary paths), graded safeguards (which is providing the level of protection appropriate for the asset being protected) and finally reliability (which includes protection against single point failure, minimal consequences of component failures and low maintenance requirements).

DESIGN CRITERIA

General Requirements:

A number of requirements, both implied and specifically stated in the design criteria guidance, govern Complex 21 S&S design activities. Some of these have been mentioned previously and include such things as meeting existing DOE requirements, following the basic principles of a good protective system, systems and components being reliable and maintainable and finally making sure that weaknesses identified in other existing DOE facilities or in the current design plans are corrected. Obviously, the security system must be affordable. The life cycle costs must be considered and the technology and manpower trade-offs considered in the design. The security system must also be compatible and functionally integrated with other systems such as safety and environmental areas. Security systems will support ALARA (as low as reasonably assurable) criteria.

There are other requirements which have been identified which are more specific, such as:

- Use proven state-of-the-art S&S systems and components. This includes protective measures which have been validated at other facilities or in R&D programs. Flexibility in the design will allow for future technology advances.
- S&S systems and components will be standardized throughout Complex 21 facilities.
- Every effort will be made to reduce the cost of S&S personnel operations by using technology or other measures.
- Compartmentalization within the facility will be used to minimize the number of personnel requiring access to critical areas. This will include separation of work areas and levels of access.
- Where possible S&S measures and functions shall be automated in order to minimize operational costs, access to nuclear materials and exposure of people to hazardous environments.
- Automation and robotic (A&R) systems will be used where possible and S&S will be integrated into the A&R design.
- Every effort will be made to reduce inventory requirements for nuclear materials.

- Nuclear materials will be kept on the process lines or areas when the facility is not in operation and not be required to be placed in vaults. On-line S&S measures will be utilized in these areas to assure control and protection of the nuclear material.

Protective Component Requirements:

Listed below are some of the necessary criteria for components of a physical protection system. Other criteria and requirements can be found in a number of different DOE orders and directives.

In the areas of detection and assessment the following criteria must be met:

- Sensors must effectively operate in all weather and light conditions.
- Sensors must effectively operate and be maintainable during all operational states or environments to include high radiation fields. S&S systems and components must be easy to install, maintain and operate.
- High level of protection shall require a combination of complementary sensors and multiple detection layers.
- Operational control elements which monitor sensitive or vital equipment will be utilized. These systems will be integrated with safety and health physics operations.

In the area of alarm communications and display (AC&D) the following criteria must be met:

- Communications paths will be redundant and independently routed to avoid single point failure.
- All alarm lines and enclosures for security equipment and other sensitive and/or vital equipment will be tamper protected.
- Automated alarm analysis will be included as part of the AC&D system.
- Human factors considerations of S&S systems and components will be considered during the design.
- Integration of safety and security activities (e.g. joint-use component status sensors, secure enclosures, common information processing and data links) will be done.

In the area of entry controls the following criteria will be met:

- Entry control requirements shall be layered such that at each succeeding security boundary the requirements for entry increase.
- Personal identity verification shall be used for areas requiring a high level of protection.
- Real-time personnel and material control and tracking shall be used where there is a high theft or sabotage concern.
- Entrances to and exits from nuclear material storage and processing areas shall be minimized consistent with safety concerns.

In the area of delay the following criteria will be met:

- Use of active and passive delay measures will be used to reduce protective force requirements.
- Consideration will be given to hardened construction for high security areas (e.g. underground or overburden).

In the area of protective forces the following criteria will be met:

- Guard towers on security areas perimeters will not be used unless absolutely necessary.
- Multiple communications means will link security locations within the facility.

CONCLUSION

In order to have effective and comprehensive protection against current and project threats with minimal impact on operations, cost and schedule S&S concerns must be addressed at all stages of the design process and the S&S systems and components must be fully integrated with other facility operations and requirements. These objectives will be met during the Complex 21 design process. Although many of the physical protection design approaches being used in support of Complex 21 activities come from previous design experiences and current protection concepts, there are some new and improved S&S approaches and technologies which will be applicable to other facilities.

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