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SNAP: A Tool for Nuclear Physical Protection System Modeling

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SNAP:
A TOOL FOR NUCLEAR PHYSICAL PROTECTION SYSTEM MODELING*

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ABSTRACT

Nuclear safeguards systems are concerned, in part, with the physical protection of nuclear materials. The function of a physical protection system is to define the facility against adversary activities which could lead to theft of nuclear material or sabotage resulting in a radiological release. The Safeguards Network Analysis Procedure (SNAP) provides a convenient and standard analysis methodology for the evaluation of physical protection system analysis. This paper describes a detailed application of SNAP to a hypothetical nuclear facility.

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INTRODUCTION

Nuclear safeguards systems are, in part, concerned with the physical protection of nuclear materials. The Safeguards Network Analysis Procedure (SNAP) provides a convenient and standard analysis methodology for the evaluation of physical protection system effectiveness. That is, SNAP provides a method for the analyst to develop a model of his facility, his guard tactics, and a hypothesized adversary attack. He may then "play" various adversary attack scenarios against the defined guard tactics and obtain information concerning the performance of his system. A standard set of symbols which characterize the various elements of safeguards systems and an analysis program to simulate SNAP models are available to the analyst. The reports provided by the SNAP simulation program enable analysts to evaluate guard defense tactics in response to adversary attack scenarios.

One objective of the paper is to present a discussion of a highly detailed application of SNAP to a hypothetical nuclear facility. The following sections of this summary will provide an overview of SNAP and a brief discussion of the hypothetical nuclear facility modeled.

SNAP OVERVIEW

The modeling philosophy of SNAP may be defined on two levels. On the general level, SNAP employs the network modeling approach. On the specific level, SNAP provides a structure for safeguards systems analysis by dividing safeguards systems into interacting

submodels of the facility, guard procedures, and adversary attack scenarios. SNAP then provides procedures for developing each of these submodels as well as the means for their interaction.

In the network modeling approach to problem solving, a network is developed by characterizing each system element by a symbol to represent that element. The analyst then links these symbols together to form a network model of his particular system of interest. SNAP provides a set of symbols (shown in Figure 1) which are specifically designed for modeling the facility, the guard, and the adversary actions in nuclear safeguards systems. Through straightforward input procedures the analyst then communicates this pictorial representation of his system to the SNAP analysis program. The SNAP program automatically simulates the actions of the guards and adversaries as they move and interact throughout the facility.

Monte Carlo elements are incorporated in SNAP to provide random variation during multiple executions of the SNAP model, and summary reports are automatically generated to provide the analyst information which may be utilized to evaluate the performance of his system.

SNAP APPLICATION

Specific modeling procedures have been defined for developing SNAP models. Initially, one constructs a representation of the facility using the SNAP symbology. Based on this representation, the user then develops models of the guard defense tactics and

FACILITY Model Definition

SPACE

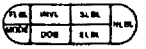
BARRIER

TARGET

adjacency
precedence

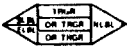
ADVERSARY and GUARD Model Definition

ENTER



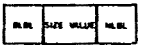
TASK

SIGNAL



WAIT

RTB: Return to base



ALLOCATE guards for response

EXIT

Figure 1. The SNAP Symbology

adversaries attack scenarios of interest. The model is then executed and summary results are obtained.

Figure 2 provides an overall schematic of the hypothetical facility which was modeled using SNAP. The facility consists of a fence enclosed area containing a security building and two laboratories. The Central Alarm Station (CAS) is located in the security building. The two laboratories each contain nuclear material and are potential adversary targets for theft. Laboratory 1 also has offices attached to it, as well as a Secondary Alarm Station (SAS) which provides back-up monitoring of the facility. Numerous alarms and closed circuit TV cameras are located throughout the facility as shown in the dotted areas.

A set of guard patrol and defense tactics were defined for this facility. The SNAP model of these tactics was designed to be general in nature and not tied to any particular adversary attack scenario. Several adversary attack sequences were designed and tested against the guard procedures. The results of these applications indicated potential weaknesses in the guard procedures and possible solutions were explored.

CONCLUSION

The Safeguards Network Analysis Procedure (SNAP) provides analysts with a technique for modeling and evaluating various safeguards system design alternatives. The SNAP symbology also

provides analysts with a vehicle for communication, thereby enhancing the model building process.

SNAP is being tested with applications to real-world nuclear facilities as well as the generic facility discussed in this summary. SNAP is easy to use and should prove to be a meaningful technique for analyzing the safeguards effectiveness of a given nuclear site.

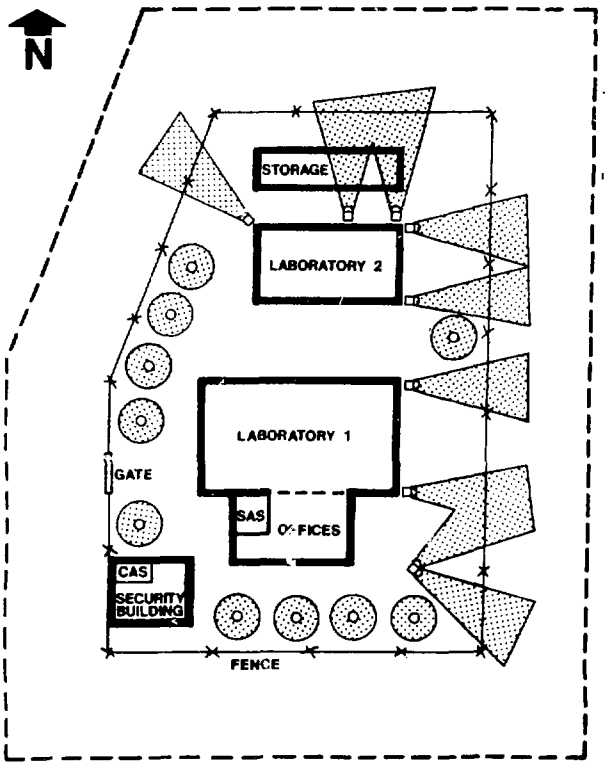


Figure 2. Example Facility Schematic