CONF-771109--20

AUTOMATED APPROACH TO NUCLEAR FACILITY SAFEGUARDS EFFECTIVENESS EVALUATION

Introduction

Concern over the security of nuclear facilities has generated a need for a reliable, time efficient, and easily applied method of evaluating the effectiveness of safeguards systems. Such an evaluation technique could be used 1) by the Nuclear Regulatory Commission to evaluate a licensee's proposal, 2) to assess the security status of a system, or 3) to design and/or upgrade nuclear facilities. The technique should be capable of starting with basic information, such as the facility layout and performance parameters for physical protection components, and analyzing that information so that a reliable overall facility evaluation is obtained.

Responding to this expressed need, an automated approach to facility safeguards effectiveness evaluation has been developed. This procedure consists of a collection of functional modules for facility characterization, critical path generation, and path evaluation combined into a continuous stream of operations. The technique has been implemented on an interactive computer-timesharing system and makes use of computer graphics for the handling and presentation of information.

Using this technique a thorough facility evaluation can be made by systematically varying parameters that characterize the physical protection components of a facility according to changes in perceived adversary attributes and strategy, environmental conditions, and site status.

Automated Evaluation Procedure

Methods for facility characterization, path generation, and path evaluation have been developed; however, these functional modules have previously been linked manually. In contrast the

DISCLAIMER

design of the interface between these independent routines is the heart of the automated procedure.

An important part of facility characterization that must be done manually is the determination of locations of vital components and sensitive material that would be attractive targets for an adversary and the identification of reasonable access points to these areas. The analyst's resources in performing this task are the facility layout, a detailed fault tree analysis, and personal knowledge. The vital areas and access points become nodes in a graphical representation of the facility.

The pertinent facility layout information must be digitized and organized into computer usable data. Lines and nodes are identified by x,y coordinates, and nodes are further defined by type, penetration delay time, standard deviation of delay time and probability of detection. The process continues with automatic identification and weighting of arcs between nodes. The final output of the facility characterization module--a graph in which nodes represent access points or targets and arcs represent paths between nodes--is the input to the path generation module.

The path generation function may be accomplished by several alternate techniques. One generator used supplies the shortest path from a node exterior to the graph to every node in a facility graph, minimizing time or detection[1] probability. Another generator finds up to the k^{th} shortest paths from an exterior node to every node of the graph[2]. Another pathing routine based on the Very EASI[3] evaluation method finds paths which initially minimize detection probability and then minimize time[4].

The output of the path generator is a collection of ordered sets of node identifiers which represent paths. This information, combined with data concerning the node parameters, is the input to a path evaluation module such as the EASI[5] (Estimate of Adversary Sequence Interruption) path evaluation method. EASI is an analytical technique and, therefore, makes efficient use of computer time. Extra information required by this model includes expected response time of onsite guards, standard deviation of the response time, and probability of communication of an alarm. The output of EASI is an estimate of the probability of adversary interruption along the specified path.

This evaluation can be used in two modes--single path or multi-path. During a single path evaluation by EASI, the probability of interruption is calculated and the user may request two or three-dimensional plots which show probability of adversary interruption as a function of one or two of the other input variables. These graphs illustrate sensitivities related to upgrading the facility based upon the probability of interruption.

The multi-path option displays, in tabular form, the EASI probability of interruption, the traversal time for each path, and the frequency at which nodes appear in the set of critical paths. The multi-path evaluation acts like a filter, identifying paths which are particularly vulnerable and thus candidates for study by more elaborate evaluation, simulation models such as FESEM[6] and ISEM[7].

Based upon the results of the evaluation, the given facility may be judged to be adequately safeguarded, thus ending the procedure. However, if there were some deficiencies, changes in the original facility characterization data could be made to reflect upgrades in the system, and the automated evaluation procedure would be repeated.

Conclusions

This automated technique of evaluating the safeguards effectiveness of a nuclear facility is an efficient method of evaluating many paths at one time since the algorithms used for path generation and evaluation are analytical. It is easy to use because the information required is well defined, and the interactive nature of this procedure lends itself to straightforward operation. The modular approach which has been taken allows other functionally equivalent modules to be substituted.

The automated evaluation technique has broad applications in both the nuclear facility safeguards field as well as the security field in general. Any fixed facility having valuable material or components to be protected from theft or sabotage could be analyzed using this same automated evaluation technique.

References

1. Hulme, B. L., and D. B. Holdridge, "SPTH3: A Subroutine for Finding Shortest Sabotage Paths," SAND77-1060, Sandia Laboratories, Albuquerque, NM, 1977.

2. Hulme, B. L., and D. B. Holdridge, Personal Communications to the Author.

3. Bennett, H. A., "The 'EASI' Approach to Physical Security Evaluation," SAND76-0500, NUREG760145, Sandia Laboratories, Albuquerque, NM, 1977.

4. Hulme, B. L., Personal Communications to the Author.

5. Bennett, H. A. "The 'EASI' Approach to Physical Security Evaluation," SAND76-0500, NUREG760145, Sandia Laboratories, Albuquerque, NM, 1977.

6. Chapman, L. D., "Effectiveness Evaluation of Alternative Fixed-Site Safeguards Security Systems," SAND76-6159, Sandia Laboratories, Albuquerque, NM, 1977.

7. Boozer, D. D., and D. Engi, "Simulation of Personnel Control Systems with the Insider Safeguards Effectiveness Model (ISEM)," SAND76-0682, Sandia Laboratories, Albuquerque, NM, 1977.