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INTERIM REPORT

PHYSICAL PROTECTION OF NUCLEAR FACILITIES

Progress Report

June 1979

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9 July 1979

PHYSICAL PROTECTION OF NUCLEAR FACILITIES

Progress Report

SUMMARY

New Activities

Activities which were initiated during June included (1) the investigation of a new, simplified method for event location analyses, (2) an in-house study of the fault tree analysis process, and (3) the design of a COBOL interface for ad hoc retrievals from SAFEREF.

Continuing Activities

Facility characterization work during June concentrated on (1) vital area analyses of operating reactor facilities, (2) analysis of the Lawrence Livermore Laboratory (LLL) digraphs, (3) documentation of the Set Equation Transformation System (SETS) bottom-up technique, and (4) discussions with Science Applications, Inc. (SAI) personnel regarding the SAI effort to develop generic sabotage fault trees (GSFTs) for nuclear reactor facilities.

The random access disk files which contain the results of the vital area analyses have been transferred onto magnetic tape to provide a backup in case of system failure and to facilitate future use of these data. In addition, a demonstration of the analysis techniques used for developing specific trees from GSFTs was given to individuals from SAI, the Nuclear Regulatory Commission (NRC), and Illnois Power and Light.

Other continuing activities included (1) the design of COBOL maintenance interfaces required for the Safeguards Engineering and Analysis Data-Base (SEAD), (2) the incorporation of further changes to the Brief Adversary-Threat Loss-Estimator (BATLE) model, (3) application of the Safeguards Automated Facility Evaluation (SAFE) methodology to several nuclear facilities, (4) further experimentation related to defining guard arrivals for SAFE, and (5) the development of the mode to be exercised for the Safeguards Network Analysis Procedure (SNAP) user suitability test.

FACILITY CHARACTERIZATION

In-House Activities

The principal facility characterization activities during June included (1) vital area analyses of operating reactor facilities, (2) a demonstration of specific tree development techniques, (3) the interlaboratory effort on the analysis of the TLL digraph, (4) documentation of the SETS bottom-up technique, (5) attendance at a System Reliability Engineering and Risk Assessment Course, and (6) meetings with SAI personnel to discuss their continued work on the GSFTs.

Vital Area Analyses

The vital area analyses of operating reactor facilities are being performed jointly with Los Alamos Scientific Laboratory (LASL) for the NRC Office of Nuclear Reactor Regulation (NRR). The current status of these analyses is as follows:

PWR9	Locations and omega-phi list changed, analysis redone.
PWR11	Two new sets of input received and two complete analyses done.
BWR3	Locations changed twice during June, two complete analyses redone.
BWR4	Locations changed, analysis redone for BWR4B. Event-location analysis done for BWR4A.
BWR5	Locations changed, analysis redone.
BWR7	Fault tree changed, plot redone, and complete analysis redone.
BWR8	Locations changed, analysis redone.
BWR9	Analysis completed.
BWR10	Input received and analysis completed.

A new, simplified method for the event-location analysis of the control room and remaining Type I vital areas of PWR6 was investigated. The results of this analysis were compared with results obtained using the current analytical method. This comparison indicated that the two results were in perfect agreement.

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An in-house study of the fault tree analysis process for reactors has been undertaken. Several steps to improve the efficiency of the fault tree construction process were identified.

The random access disk files which contain the results for all the facilities analyzed to date for NRR have been copied onto magnetic tape. This transfer of data provides a backup in case of system malfunctions or programmer error. It also facilitates data availability for re-evaluation as well as the possible later correlation of results from all facilities to identify common results, generic requirements, etc.

A demonstration of the current techniques used for developing a specific tree from GSFTs was given to individuals from SAI, NRC, and Illinois Power and Light. The representative from Illinois Power and Light expressed the desire to be able to utilize the vital area analysis techniques and the GSFTs as design tools for the development of the physical protection system for the Clinton Unit (currently under construction). This application would significantly assist the company in arriving at an integrated facility and physical protection system design. It could also minimize retrofit problems after construction is completed.

LLL Digraph

A memorandum which summarizes the assistance provided to LLL for the evaluation of their material accounting and physical security digraphs was sent to NRC/SAFER this month. An alternate approach which has been suggested for solving the LLL digraph was described in this memorandum.

SETS Code

A paper which documents the bottom-up technique used in the SETS vital area analysis methodology is being written. This paper describes the bottom-up solution technique used to identify the vital areas and the subsequent event-location analysis of selected vital areas. The paper should facilitate the transfer of this methodology, particularly to LASL personnel.

Vital Area Importance

Research during June on vital area importance measures was investigated in part in collaboration with consultant Dr. Richard Engelbrecht-Wiggans of Yale University. A seminar was held by Dr. Engelbrecht-Wiggans in which he presented the concepts of existing game theoretic techniques which might help to rank order targets within a nuclear power plant. This rank ordering of targets would permit a priority assignment of the response forces to protect the more critical areas of the facility.

Miscellaneous

A System Reliability Engineering and Risk Assessment course, which was conducted by J.B.F. Associates in Las Vegas, Nevada, on June 11-15, was attended by Richard Worrell of Sandia Laboratories. This course was enlightening and useful to the extent that attempts are being made to arrange a 2 to 3 day consultation at Sandia with the course instructor, J. B. Fussel.

Contractual Support

Representatives of SAI met with Sandia personnel to discuss the SAI work on the development of GFTs for nuclear reactor facilities. The following subjects were discussed during this meeting: (1) an approach to the development of failure criteria for various systems found in the mid-section of the GSFTs, (2) similarities found in systems developed by the same vendor and the possibility of categorizing systems based on the identity of the vendor, and (3) the difficulties presented by systems, such as service water systems, which tend to differ considerably from facility to facility.

COMPONENT FUNCTIONAL PERFORMANCE CHARACTERIZATION

In-House Activities

Safeguards Engineering and Analysis Data-Base

Design of the COBOL maintenance interfaces required for all SEAD modules was completed during this reporting period, and a substantial amount

of code to support this activity was written. Also, a prototype FORTRAN interface between SEAD and SAFE has been developed, and some optimization of this interface has been attained. This work is being jointly funded by the Department of Energy (DOE) and NRC.

A new activity for this period was the design of a COBOL interface for ad hoc retrievals from SAFEREF, a bibliography of all Sandia and contractor reports dealing with facility safeguards which were available as of 30 September 1978. Design and implementation of the SAFEREF module of SEAD are sponsored solely by the DOE.

EVALUATION METHODOLOGY

In-House Activities

Model Development

Expansion of the BATLE Model -- Several changes have been made to the BATLE model. New shotgun data are currently being incorporated into BATLE. For each weapon and target posture combination, three-dimensional curve fits are being generated to represent the kill fraction data as a function of range in meters and target coverage. Fire rate data are being fit with two-dimensional curves as a function of range. Methods for computing attrition degradation with fire posture and target illumination are being considered. The framework of the new BATLE code has been written to accept these new data.

Automation of System Evaluation

SAFE Demonstration -- A demonstration of the SAFE methodology was given to Mr. Ken Wilson of Stone and Webster. Included in this demonstration were illustrations of the Graphical Representation through Interactive Digitization (GRID) program, the deterministic and stochastic pathfinders, the Estimate of Adversary Sequence Interruption (EASI) Graphics, and the BATLE model. A copy of the SAFE output generated during the demonstration was provided to Mr. Wilson.

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SAFE Applications -- A first analysis of the Allied-General Nuclear Services (AGNS) separations facility was completed. Representatives of AGNS were supplied with an edited data listing, a layout of the facility, some sample runs of the pathfinders, and a summary of the results. It is expected that this information will be reviewed again and that some changes will be made. If there are changes, the analysis of the facility will be repeated.

Analysis of the Standardized Nuclear Unit Power Plant System (SNUPPS) continued during June. More corrections to the facility layout data have been made, and some analysis has been performed on the Type I targets. Critical paths in the facility have been generated through the use of the stochastic pathfinder, PATHS. As a result of this analysis, some modifications of the data have been made to more accurately represent the facility. Sensitivity analyses based on modification of some of the data are being considered. Modification of the probability of detection on the outer fence of the facility and the response times to targets will receive special attention.

Once the data have been established for the baseline facility, changes in the physical design of the facility can be considered. Different approaches for comparing the relative effectiveness of different designs are being considered.

SAFE Documentation -- Another draft of Volume 2 of the SAFE documentation was prepared in June. Changes have been made to this draft, and three of the six sections are in the process of being rewritten.

Guard Arrivals for SAFE -- Experimentation is being performed in order to calculate guard response times in the analysis of the SNUPPS facility. PATHS has been used to generate minimum time paths from certain start nodes in the facility to the targets. The start nodes are chosen to be either those nodes that a guard might be stationed at (or near) or those nodes located along the path of a guard patrol. The mean shortest times and standard deviations produced by PATHS can be used to define response time distributions to targets, which can then be used as input

for the selection of critical adversary paths. Note that these response times are optimal for the guards in that they assume the guards will respond immediately to the correct location. More realistic response times could be generated by adding some time for assessment or for other delays.

Contractual Support

SNAP Application Development

Discussions were held with NRC staff members regarding the data necessary for development of the mode to be exercised for the SNAP user suitability test. All SNAP data input items were discussed in detail, and the information which will be necessary to collect during future site visits was identified. Four adversary attack scenarios were provided by NRC/SGPD personnel. These scenarios were discussed in detail, and problems associated with their content were resolved. A preliminary version of the SNAP facility model which will be used in the user suitability test was developed. This model will be refined based on additional facility and guard procedural data as this information becomes available. Development of the guard tactics and the adversary attack models has been initiated. Preliminary models of all adversary attack scenarios have been completed. In addition, a preliminary model of the guard patrol procedures has been developed. The guard response model will be refined based on data to be collected in the future.

Implementation of the virtual memory processing scheme has been completed for SNAP. This scheme will allow any size SNAP network to be executed under current Sandia NOS core constraints. Since virtual storage processing may require additional execution time, a separate version of SNAP has been maintained without this virtual processing capability in order to permit the timely execution of smaller models.