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INTERIM REPORT

PHYSICAL PROTECTION OF NUCLEAR FACILITIES

Progress Report

July 1979

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7 August 1979

PHYSICAL PROTECTION OF NUCLEAR FACILITIES
Progress Report

SUMMARY

During July, facility characterization activities primarily concentrated on the vital area analyses of various nuclear facilities, additional post-accident analyses of the Three Mile Island incident, and continued coordination with Science Applications, Inc. (SAI) on their work in expanding and revising Sandia-developed generic sabotage fault trees (GSFTs). Vital area analyses continue to be performed for a number of boiling water reactor (BWR) and pressurized water reactor (PWR) facilities and for the Standard Nuclear Unit Power Plant System (SNUPPS). The applicability of GSFT-related analytical techniques to reliability evaluation model development was discussed with a representative from the Nuclear Regulatory Commission Probabilistic Analysis Staff (NRC/PAS) on 18 July 1979. It is anticipated that the technology base already established for the vital area analyses will provide a major portion of the structure required to develop a program for utilizing reliability evaluation models.

The development of maintenance software for use in the Safeguards Engineering and Analysis Data-Base (SEAD) and an optimized FORTRAN interface between SEAD and the Safeguards Automated Facility Evaluation (SAFE) methodology continued during this reporting period. A demonstration of the SEAD/SAFE interface and the report-generating capability of SEAD was given to conference participants in a technical tour of Sandia Laboratories which was conducted as part of the Institute of Nuclear Materials and Management (INMM) annual meeting held in Albuquerque on 16 to 18 July.

Work continued on the application of the SAFE methodology to various nuclear facilities. Analyses have been completed for the Allied-General Nuclear Services (AGNS) mixed-oxide and separations facilities and for the baseline design of SNUPPS. Digitized layouts for a reactor facility have been reviewed by Los Alamos Scientific Laboratory (LASL) and the analysis of this facility will commence immediately.

Modifications and improvements continue to be made to the stochastic pathfinding code, PATHS, and the Brief Adversary-Threat Loss-Estimator (BATLE) model. Test data generated from the use of the Multiple Integrated Laser Engagement System (MILES) have been incorporated into the BATLE model in order to provide a comparison of BATLE results with MILES test data.

Two papers were presented at the 1979 Annual Meeting of the INMM. A paper entitled "Application of SAFE to an Operating Reactor" was presented by L. D. Chapman. A method for the evaluation of physical protection systems at nuclear facilities developed at Sandia was described and illustrated by examples. The five major phases considered in the paper were: (1) facility characterization, (2) facility representation, (3) component performance, (4) adversary path analysis, and (5) effectiveness evaluation.

A second paper entitled "Safeguards Network Analysis Procedure (SNAP)" by L. D. Chapman and D. Engi was presented by D. Engi. This paper described a convenient and standard analysis methodology for the evaluation of physical protection system effectiveness through the use of a standard set of symbols which characterize the various elements of safeguards systems and an analysis program to execute simulation models built using the SNAP symbology.

FACILITY CHARACTERIZATION

In-House Activities

Vital Area Analysis

The vital area analyses of operating reactor facilities, which are being performed jointly with LASL for the NRC Office of Nuclear Reactor Regulation (NRR), continued in July. The current status of these analyses is as follows:

BWR2	Location corrections made and analysis redone.
BWR4	Corrections and additions made and analysis redone.
BWR5	Location changes made and analysis redone.
PWR10	Tree trimmed and analysis redone.
PWR11	Event-location analysis run for location analysis.
PWR12	Cards received from LASL, plot generated, and analysis begun.
PWR13	Cards received from LASL, plot generated.

Several copies of the plots of the GSFTs were made for use in other analyses.

The application of probabilistic values to assist in rank ordering vital areas continued during this reporting period. A technical report which outlines the theoretical background for this approach is in preparation. A computer code for calculating these probabilistic values was completed at the end of July and is currently undergoing further testing. Preliminary tests indicate that the algorithm used in this code will be capable of handling medium- to large-size fault trees within reasonable time limits.

Efforts to characterize the SNUPPS facility also continued in July. Location changes were made and the location analysis rerun. An event-location analysis fo. Type I vital areas was also run.

On 18 July 1979, a briefing was given to J. Murphy, NRC/PAS, on the vital area analysis procedures, and a demonstration of the interactive computer system used to develop facility-specific fault trees.

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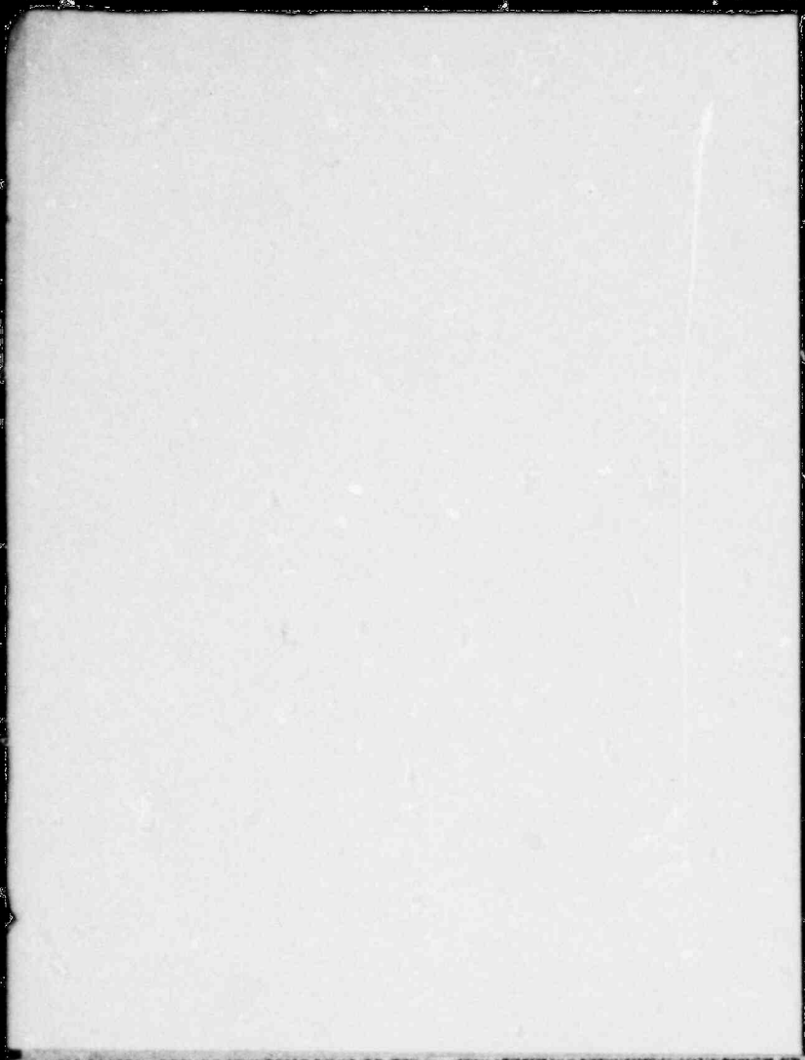
from the GSFTs was presented. PAS is planning to initiate a program which would produce reliability evaluation models for all operating reactor facilities. The GSFTs which have been generated and the experience gained in developing sabotage fault trees for specific facilities are directly applicable to the development of these reliability models. It is anticipated that the technology base already established to support the vital area analyses will provide a major portion of the facility modeling structure required for the new program.

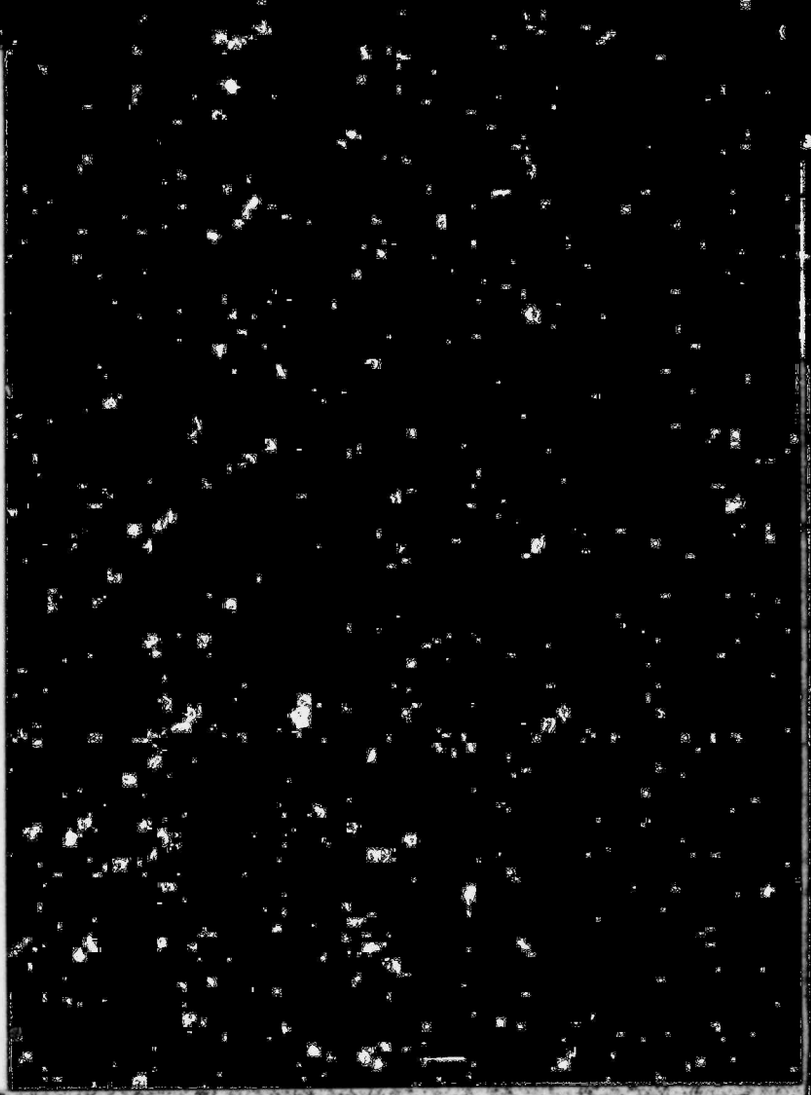
Three Mile Island Support

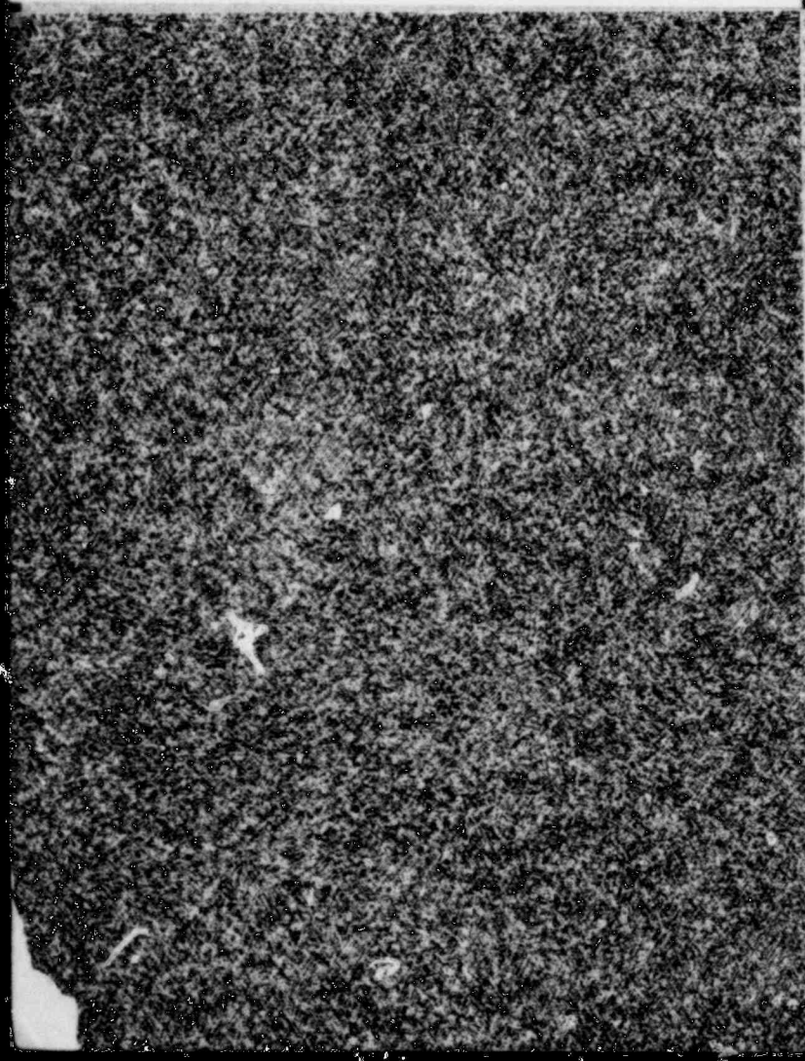
Sandia personnel made two Sandia ORIGEN computer runs to support post-accident analyses of the Three Mile Island--Unit 2 incident. One computer run, which provides decay times from 0.5 to 1000 days at relatively short time intervals, will be used by Sandia in the analysis of the hydrogen production problem. The other run, which was made for EG&G, a Department of Energy (DOE) contractor, will be used to correlate airborne samples taken by EG&G during the accident with specific nuclides predicted by ORIGEN to be present in the core.

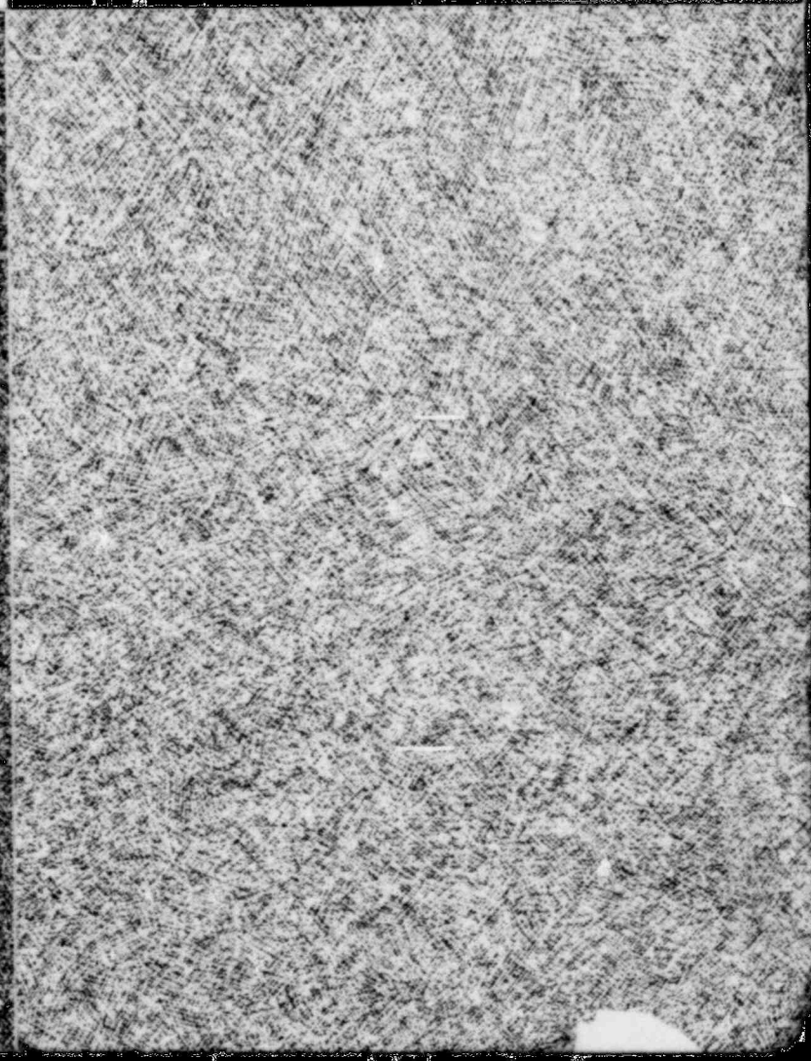
Contractual Support

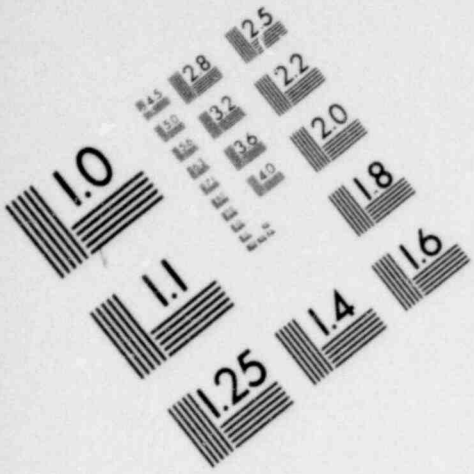
A representative of SAI met with Sandia personnel to discuss progress on the SAI contract for supporting the expansion and revision of Sandia-developed GSFTs. This discussion covered the following topics: (1) a review of major tasks outlined in the contract, (2) a list of issues requiring further clarification by Sandia or NRC, (3) problem areas affecting ease of GSFT formulation and analysis, (4) events which may need expansion to ensure comprehensive applicability of the GSFTs, and (5) events which may be deleted from the GSFTs.











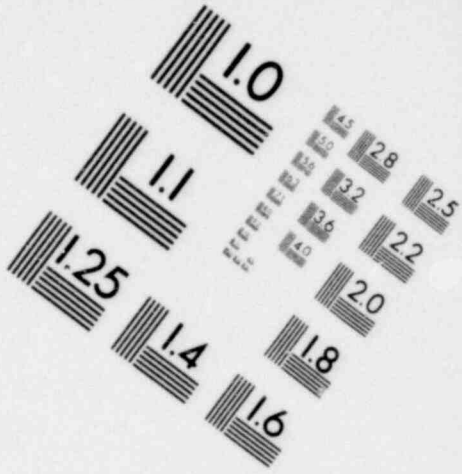
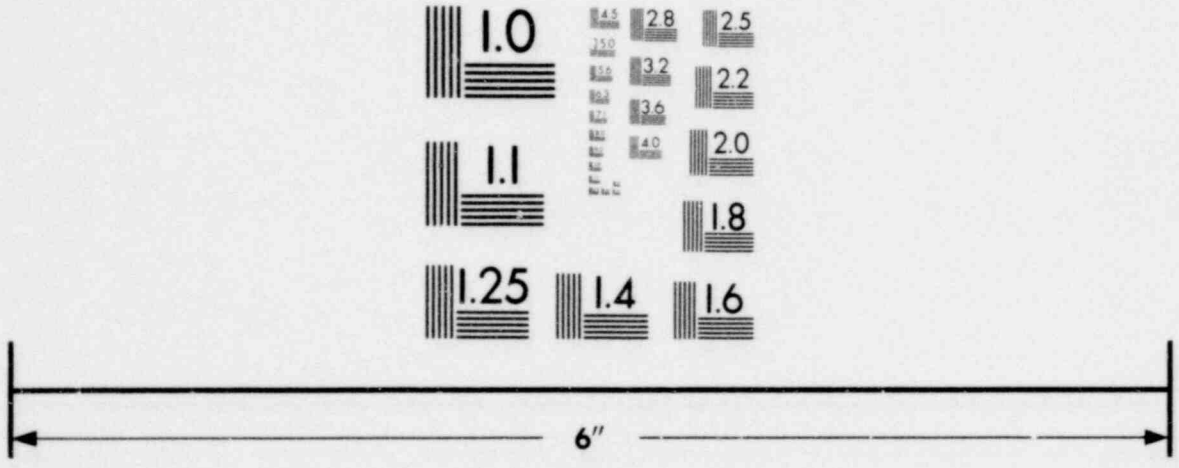
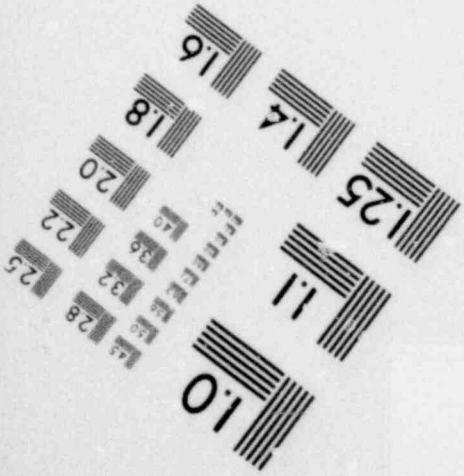
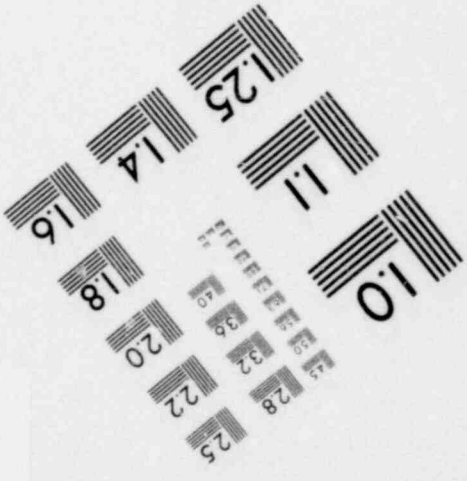


IMAGE EVALUATION TEST TARGET (MT-3)







COMPONENT FUNCTIONAL PERFORMANCE CHARACTERIZATION

In-House Activities

Safeguards Engineering and Analysis Data-Base

The development of COBOL maintenance software for all of the SEAD modules continued during July. Also, an optimized FORTRAN interface between the BARRIER module of SEAD and the SAFE methodology was demonstrated to participants in a tour of Sandia Laboratories sponsored and conducted by the INMM organization during their annual meeting in July in Albuquerque. Work on SEAD is being jointly funded by the DOE and NRC.

The report-generating capability of SEAD was also demonstrated to the INMM tour participants. A COBOL interface which can produce offset masters of a quality suitable for printing and which features mixed upper and lower case type has been developed. At present, this capability is available only as an ancillary to the SAFEREF module of SEAD.

EVALUATION METHODOLOGY

In-House Activities

Automation of System Evaluation

INMM Technical Exhibit -- A demonstration of the SAFE methodology was prepared as one of the examples of Sandia-developed safeguards technology presented to the INMM technical tour. The demonstration included the use of the facility digitization, pathfinding, and path evaluation modules of SAFE.

SAFE Applications -- The application of SAFE to the AGNS mixed-oxide facility was completed, and the results were forwarded to AGNS. A second study of the AGNS separations facility was also completed and returned to AGNS. This second analysis of the separations facility was necessitated by AGNS changes to the original data.

The analysis of the baseline design of SNUPPS was completed in July. An appreciable portion of this effort was devoted to generating guard response times to be used as input for the determination of critical interruption paths. The stochastic pathfinder, PATHS, was used to generate minimal time paths from each guard starting position to each target under consideration. The expected response time to a particular target was generated by taking a weighted sum of the minimal times from each guard start node to that target. The minimal times were weighted according to the percentage of time a guard spent at that particular node.

Digitized layouts of a LASL-selected reactor have been reviewed, and certain input data for the facility have been provided. With this latest input, the reactor is now ready for final preparation for analysis.

SAFE Documentation -- Volume 2 of the SAFE documentation, "Description of SAFE Method," is undergoing extensive review. Following this review, Volume 2 will be prepared in final draft form. The computer programs which comprise SAFE are being collected for inclusion in Volume 4 of the documentation.

PATHS Modification -- A modification that collapses virtually identical paths has been added to the stochastic pathfinding code, PATHS. Previously, paths that differed only by the inclusion of a stairwell node between two other nodes in the same stairwell were saved as distinct paths; the present modification allows PATHS to recognize these paths as being physically identical.

Contractual Support

SNAP Application Development

Pritsker & Associates, Inc., has outlined a project schedule for the application of the Safeguards Network Analysis Procedure (SNAP) to site X. Specific items which have been completed to date include:

1. The development of a preliminary model of the site X facility. (The facility has been subdivided into sectors which reflect levels of detail similar to those developed for the Guard Tactics Simulation (GTS) application. The SNAP model for this subdivision of the facility has been developed, and the basic input data have been formulated and entered into the computer.)
2. The development of a preliminary model of four adversary scenarios. (Procedures for the characterization of all aspects of adversary actions have been included in this model, and SNAP networks have been developed for each of these scenarios. These models are preliminary in nature and will require additional enhancements based on the completion of the guard model.)
3. An initial model of the guard patrol procedures. (The development of this model will permit a representation of patrol movements throughout the facility. Modeling of other aspects of the guard procedures is underway.)

Current data collection requirements appear to have been satisfied. The available information will allow models of the adversary attack scenarios, guard defnse procedures, and the site X facility to be built. Additional data requirements will be identified as the modeling effort progresses.

Future plans include

1. The completion of a detailed model of the site X facility and a preliminary Safeguards analysis by the end of 1979.
2. The detailed analysis of neutralization points within the model and the publication in early 1980 of additional documentation concerning the site X application and general SNAP applications procedures.
3. The incorporation of limited technical modifications to the program which were identified as a result of the applications. These modifications include the implementation of a "virtual" network processing technique which will permit any size network to be executed within existing Sandia NOS core constraints.