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Application of Sandia Physical Protection Methods

Prepared by C. J. Pavlakos, L. D. Chapman/Sandia National Laboratories
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ABSTRACT

The applications of four safeguards evaluation models to two different example facilities are presented in order to demonstrate and evaluate the overall utility of the models. The models used are (1) Safeguards Automated Facility Evaluation (SAFE), (2) Safeguards Network Analysis Procedure (SNAP), (3) Forcible Entry Safeguards Effectiveness Model (FESEM), and (4) Insider Safeguards Effectiveness Model (ISEM). A series of observations is made on the utility of the models based on the applications. Pros and cons for each of the models are identified, model inputs and outputs are summarized, resource requirements are specified, and the utility of the models, both general and for Nuclear Regulatory Commission (NRC) purposes, is discussed. Finally, recommendations are made regarding the use of these models for safeguards system evaluation and for operational use by the NRC.

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APPLICATION OF SANDIA PHYSICAL PROTECTION METHODS

1. INTRODUCTION

This report is the culmination of a project performed for the Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards (NRC/NMSS), entitled "Application of Sandia Physical Protection Methods." The purpose of this project was to apply four existing safeguards evaluation models to two different example facilities in order to demonstrate and evaluate the overall utility of the models and to specifically address their utility with regard to possible future operational use by the NRC. The four models used were

1. Safeguards Automated Facility Evaluation (SAFE),[1,2]
2. Safeguards Network Analysis Procedure (SNAP),[3,4]
3. Forcible Entry Safeguards Effectiveness Model (FESEM),[5,6] and
4. Insider Safeguards Effectiveness Model (ISEM).[7]

The two example facilities considered were a fuel cycle facility and a nuclear reactor facility. All four models were applied to the nuclear reactor facility; however, only SAFE and SNAP were applied to the fuel cycle facility.*

The applications are presented to illustrate the use of the models for the evaluation of safeguards systems; results should not be interpreted as absolute performance measures for actual facilities. Also, model outputs are only estimates of system performance. The accuracy of the results is subject to the accuracy of the data and the modeling assumptions used. The value of these evaluation models does not lie in a precise estimation of the vulnerability of a system; rather, their

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*The SAFE and SNAP applications to the fuel cycle facility were actually performed for the NRC Office of Regulatory Research (RES) under a different contract. These applications are only reviewed briefly in this report for the purpose of discussing model utility.

value is derived from the insights gained into the effectiveness of a particular system and into important factors, or combinations of factors, which affect system performance the most.

1.1 REPORT ORGANIZATION

The main body of this report is concerned primarily with the utility of the four models used and with general approaches for using these models to evaluate safeguards systems. A brief overview of each model application is presented in order to illustrate the utility of each of the models. The applications of SAFE and SNAP to the fuel cycle facility are presented first, followed by the applications of SAFF, FESEM, ISEM, and SNAP to the reactor facility. A series of observations on the utility of each of the models is made based on each particular application. After the applications have been presented, advantages and disadvantages of the models are identified, model inputs and outputs are summarized, resource requirements are specified, and the utility of the models, both general and for NRC purposes, is discussed. Finally, recommendations are made regarding the use of these models for safeguards system evaluation and operational use by the NRC.

A detailed description of the SAFE, FESEM, ISEM, and SNAP applications to the reactor facility are presented in Appendices A through D, respectively. The SAFE and SNAP applications to the fuel cycle facility are not detailed in this report.*

1.2 CHARACTERIZATION OF SAFEGUARDS EVALUATION MODELS

In general, the scope of a safeguards evaluation model can efficiently address one of two issues: (1) global safeguards effectiveness or (2) vulnerability analysis for individual scenarios. The global approach considers the entire safeguards system of a facility, i.e., the composite system of hardware and human components, in one analysis and produces a figure of merit for the facility. The single-scenario approach considers a single adversary scenario and the vulnerabilities of that portion of the safeguards system which participates in the scenario. This approach evaluates how effectively a safeguards system can defend against a specific adversary scenario.

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*The SNAP application to the fuel cycle facility will be documented at a later date.

A complete evaluation of a safeguards system should provide global performance measures and yet should also include consideration of detailed scenarios. A safeguards evaluation method can be termed globally complete if it can feasibly be used to evaluate or bound the effectiveness of a safeguards system for all reasonable scenarios. A safeguards evaluation method can be termed scenario-complete if it can feasibly be used to evaluate the safeguard system's effectiveness for each scenario considered in sufficient detail to accurately represent all relevant considerations.

Figure 1 shows a family of completeness curves. The extent to which a safeguards evaluation is complete is a function of three factors: (1) the degree of global completeness, (2) the degree of scenario completeness, and (3) the amount of resources expended to perform the evaluation (includes analyst and computing resources). Ideally, a single evaluation method would provide a high degree of both global and scenario completeness along with reasonable resource requirements. However, based on current generation models, current computer technology, and limited analyst time, such a model is simply not feasible. Currently, global evaluation techniques do not allow an in-depth consideration of scenario detail, while the scenario techniques may require an unacceptably excessive amount of analyst and computing time in order to evaluate a sufficient number of scenarios to approach global completeness.

Some combination of global and single-scenario techniques offers a promising approach to achieving a reasonable level of overall completeness. First, a global model could be applied to an entire facility to evaluate its overall capability to interrupt and neutralize adversaries. Then, a scenario model could be applied to specific individual scenarios which were generated by the global model in order to address more detailed or procedural aspects of the safeguards system (e.g., guard tactics, alarm hierarchies, random patrols, etc.). The scenarios examined could be limited to those found to be most vulnerable by the global model. The scenario model could also address special adversary attack sequences of concern that have been devised by experts.

Development of physical protection models has evolved along the two orientations described above: global and scenario.[8] The single-scenario approach provides the capability of representing individual scenarios in detail; it allows representation of complex tactics that

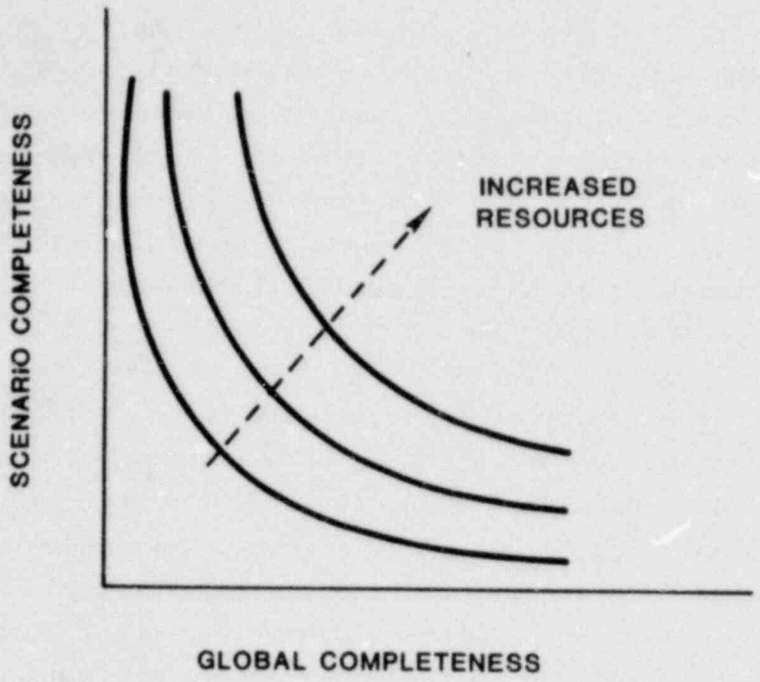

Figure 1. A Family of Completeness Curves

might be used by adversaries as well as by the security force. The ability to reflect this detail lends credibility to the evaluation of individual scenarios. However, an evaluation of the effectiveness of a physical protection system (PPS) in countering individual adversary scenarios merely reflects the ability (or inability) of the system to deal with those scenarios--it is likely to imply little about the safeguards system as a whole. Consequently, to address this deficiency, a global approach to the problem of evaluating safeguards system effectiveness is also warranted.

The SAFE technique was developed with a global orientation. The SAFE method consists of a collection of functional modules for facility representation, component performance, adversary path analysis, and effectiveness evaluation. SAFE combines these modules into a continuous stream of operations. Through the use of this technique, a global evaluation of a safeguards system can be provided by systematically varying the parameters that characterize the physical protection components of a facility to reflect the perceived adversary attributes and strategies, environmental conditions, and site-operational conditions. Global worst-case paths or scenarios are generated for each target in the analysis using SAFE.

SNAP, FESEM, and ISEM are scenario-oriented techniques. FESEM and ISEM are early generation scenario models. FESEM was developed mainly to address the outsider threat, whereas ISEM mainly addresses the insider threat. SNAP is actually a simulation language developed specifically for the evaluation of PPSs. SNAP consists of a set of safeguards symbols and rules for interconnecting these symbols into network representations of individual scenarios. In the context of vulnerability analysis, scenario techniques can provide insights into the strengths (or weaknesses) of a safeguards system's ability to counter specific adversary scenarios. The user of scenario models must provide a method for generating scenarios, and the issue of how many scenarios should be considered will always be a major concern in terms of a comprehensive analysis of PPSs.

2. MODEL APPLICATIONS

In this section, the applications of the four evaluation models (SAFE, SNAP, FESEM, and ISEM) to the two different example facilities (a fuel cycle facility and a nuclear reactor facility) are briefly summarized. The applications of SAFE and SNAP to the fuel cycle facility are presented first. The fuel cycle facility is representative of very simple facilities, i.e., facilities that have a minimum number of building floors or levels, a small number of buildings, and a minimum number of targets which need to be considered. The applications of each of the four models to the reactor facility follow. The reactor facility is representative of complex facilities which may have many levels and many targets to be considered. The reader is reminded that the resulting output of these models is not necessarily representative of any specific facility but merely represents example applications of these evaluation methods.

2.1 FUEL CYCLE FACILITY APPLICATIONS

2.1.1 Fuel Cycle Facility Characterization

The fuel cycle facility is a very simple single-level facility.* The base case facility safeguards approximate those of a fuel cycle facility prior to the implementation of the physical protection Upgrade Rule 10 CFR 73.45. This facility contains two main targets, both of which are material access areas (MAAs) from which special nuclear material (SNM) can be removed. Although sabotage is also a concern, the main concern in the case of the fuel cycle facility is theft of SNM. The two targets are situated in two separate buildings. One target represents a storage area in a warehouse, and the second represents a vault in a process area.

*In the SAFE analysis, two levels were represented in order to consider access into one of the facility buildings via a stairwell from the roof.

The entire facility is surrounded by an outer fence; a second (inner) fence surrounds much of the interior of the facility. In general, adversary paths to the target would require breaching the outer fence, perhaps the inner fence, an exterior building door, and, in the case of the vault, a vault door.

Base case security force assumptions include the presence of an on-site security force consisting of five guards with access to shotguns.

2.1.2 SAFE Analysis of the Fuel Cycle Facility

Global Analysis -- Worst-case interruption* paths were generated by SAFE for the fuel cycle facility. Access paths (which do not include removal) as well as complete theft paths (which do include removal) were generated to each of the two facility targets. Base case probability of neutralization** measures were generated based on the base case response force assumptions and an adversary force of three. Interruption and neutralization measures were used to calculate overall effectiveness measures (see Table 1).

Table 1

Overall Effectiveness
(Base Case)

Scenario	Probability of Interruption	Probability of Neutralization	Probability of System Win
To vault	.95	.30	.29
To vault and exit	.99	.30	.30
To warehouse	.48	.30	.14
To warehouse and exit	.88	.30	.26

NOTE: Probability of System Win = Probability of Interruption x Probability of Neutralization

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* The probability of interruption is the probability that the adversary is detected with sufficient time remaining in his sequence for the security force to respond and confront the adversary prior to completion of his goal.

** The probability of neutralization is the probability of the security force defeating the adversary during an engagement, given an interruption.

Sensitivities were performed to consider the effect of additional guards and/or different guard weapon types. Table 2 presents overall performance results for a case in which there are seven response guards equipped with semiautomatic weapons.

Table 2

Overall Effectiveness
(Seven Guards with Semiautomatic Weapons)

Scenario	Probability of Interruption	Probability of Neutralization	Probability of System Win
To vault	.95	.99	.94
To vault and exit	.99	.99	.98
To warehouse	.48	.99	.48
To warehouse and exit	.88	.99	.87

Specific Path Studies -- Sensitivity studies were performed using the EASI Graphics[9] capability within SAFE to consider the effect of specific parameters, such as response time, detection by certain sensors, and delay times for certain barriers, on the probability of interruption. The effects of changes in certain path-specific engagement parameters, such as available cover and distance between combatants, were also examined.

Observations -- The following observations were made on the use of SAFE for the fuel cycle facility analysis:

1. For simple facilities such as the fuel cycle facility, it may not be necessary to use a technique as sophisticated as SAFE for physical protection evaluation. Rather, it may be possible to identify worst-case adversary paths purely by inspection using expert opinion. The analyst may then use any desired method, such as one of the scenario techniques discussed in this report, to evaluate performance along the particular paths chosen. In addition, the models used internally by SAFE for path evaluation, the Estimate of Adversary Sequence Interruption (EASI)[10,11] and the Brief Adversary Threat Loss Estimator (BATLE)[12] models, may be used for scenario evaluations.

2. Although techniques currently exist for treating theft problems with SAFE, modifications could be made to SAFE which would improve analysis of theft problems.

2.1.3 SNAP Analysis of the Fuel Cycle Facility

Scenario Selection -- SNAP was applied to four detailed base case attack scenarios which were designed to test the safeguards system at the fuel cycle facility under a variety of conditions. While not intended to be exhaustive, these scenarios were viewed as reasonably representative of the type of threats which might occur at the fuel cycle facility. The scenarios ranged in complexity from attacks during the day by a small adversary force using diversionary tactics to attacks at night by a large adversary force which included the aid of an insider who was a member of the facility guard force.

Scenario Description -- The first scenario analyzed focused on the use of a diversionary force by the adversaries in conjunction with a primary attack force. In Scenario 2, the adversary force included an insider (non-guard) and a small diversionary force. The third scenario investigated the resistance of the facility to a night attack by a three-man adversary force. Finally, the fourth scenario utilized a guard-insider as part of the adversary force in conjunction with a well-equipped three-man adversary force attacking at night.

Guard Response Procedures -- The SNAP model of guard procedures developed for the fuel cycle facility was designed to be general in nature; that is, the model was not tied to a specific adversary attack sequence but rather could be used to model the responses of the guards to any adversary attack configuration. The model developed included a wide range of guard response actions including response to such stimuli as external alarms, internal alarms, engagements in the facility, diversionary fire, and missing guards. Highly detailed communication actions were also included as well as random guard patrols.

In addition to guard response actions, typical guard defense procedures were included in the model. All aspects of guard patrol, any change of personnel responsibilities, communications with the local law enforcement agency (LLEA), as well as the presence of other guards on

site were modeled in detail. Finally, the actions of guards while monitoring sensors and the closed circuit television (CCTV) were explicitly represented. A detailed specification of guard response actions as a function of various system conditions is provided in Table 3.

System Performance -- Subsequent execution of the simulation models and associated analysis yielded system performance chacteristics for the fuel cycle facility. Probability of system win or the four scenarios ranged from 0% to 38%. It should be noted that these were base case analyses and that potential safeguards improvements could have increased the probability of system win. No sensitivities were actually performed for this analysis; the application was performed under a prior contract to demonstrate the suitability of SNAP for analyzing safeguards effectiveness for fuel cycle facilities.

Table 4 shows the interruption and neutralization characteristics for the four scenarios. System performance could be improved by special attention to and modification of guard procedures as a function of the important model parameters discussed.

Observations -- The following observations were made on the use of SNAP for the fuel cycle facility analysis:

1. A relatively small facility was successfully modeled, incorporating a high degree of detail. This was seen to be feasible for a small facility but might cause difficulties in attempts to model larger facilities, as will be seen in the reactor discussion (Subsection 2.2.5).
2. A highly detailed model of guard operating procedures was developed in SNAP. The model was general in nature and could provide response to any adversary attack scenario.
3. Four realistic SNAP models of attack scenarios were successfully developed based on NRC specifications. These models, though not exhaustive in nature, were assumed to be representative of the type of threats to which a fuel cycle facility might be subject.
4. SNAP analysis results for the facility provided valuable insights into the safeguards system performance.
5. For the small facility, the SNAP methodology was felt to provide useful tactical information on guard procedures and upgrades to these procedures. It was felt, however, that the

Table 3

Guard Response Actions

Group	CONDITION						
	Missing Guard	Noise, e.g., Artillery Simulator	Noise: Weapon Fire	External Alarm	Internal Alarm	Engagement Initiation	Engagement Termination
Patrol guards	One guard to investigate; others to defensive positions	One guard to investigate; others to defensive positions	One guard to investigate; others to defensive positions	One guard to alarm location to assess; others to facility perimeter	Move to building and cover perimeter. Move to door, if door alarm	Move to defensive positions near engagement	Assume defensive positions
Response guards	Assume defensive positions	Assume defensive positions	Assume defensive positions	Move to facility perimeter defensive positions	Move to building and cover perimeter	Move to defensive positions near engagement	Assume defensive positions
PAS (Primary Alarm Station)	Wait for assessment; monitor como, sensors, etc.	Wait for assessment; monitor como, sensors, etc.	Wait for assessment; monitor como, sensors, etc.	Wait for assessment; monitor como, sensors, etc.	Wait for assessment; monitor como, sensors, etc.	Direct guard response; monitor como, sensors, etc.	Direct guard response; monitor como, sensors, etc.
SAS (Secondary Alarm Station)	Wait for assessment	Wait for assessment	Wait for assessment	Wait for assessment	Wait for assessment	Call local law enforcement agency (LLEA): assist defense	Return to post
SS (Shift Supervisor)	Wait for assessment	Wait for assessment	Wait for assessment	Stay in office .9 Go to PAS .09 Assist .01	Go to PAS .50 Assist .50	Assist defense	Return to post

Table 4

Interruption/Neutralization Characteristics

Scenario	Interruption Location	Conditions for Guard Success	Important Model Parameters
I	West of MAA 2	• Guards successfully completing response and engagement with decoy adversary	• Response time of guards
	South of MAA 2	• Sufficient guards south of MAA 2 simultaneously to engage and neutralize adversaries	• Position of guards at time of attack
II	Southwest of MAA 1	• Timely guard response such that the guards are in range of adversary exiting with SNM	• Time at which adversary initiates theft • Guard response time • Adversary cover fire from parking lot
III	South of MAA 1	• Sufficient number of guards arriving at the same time to engage the adversary • Elimination of adversaries who are responsible for acquiring SNM	• Procedures for guard response • Number of guards who respond at the same time • Guard response speed
IV	Southwest and northeast of MAA 1	• Sufficient guards south of MAA 2 to engage adversary at the same time • Thwarting adversary separation of cover fire and SNM acquisition functions	• Guard response time • Degree to which guards respond as a unit • Additional guards

effort required to develop the generalized guard model was excessive. Future analyses might realistically focus on more specific models designed to represent highly specific response procedures to adversary attack scenarios.

2.2 REACTOR FACILITY APPLICATIONS

2.2.1 Reactor Facility Characterization

The nuclear reactor facility is a very complex facility. The base case facility safeguards approximate in modeling complexity those required for power reactors. It is a multilevel facility that contains nine levels in all: the ground level, two underground levels, and six aboveground levels.

A digitized drawing (as produced by SAFE) of the ground level of the facility is depicted in Figure 2. The facility is surrounded by an outer fence and contains numerous buildings including a radwaste building, a fuel building, a diesel generator building, a control building, a reactor containment building, auxiliary buildings, and a turbine building. A complete set of digitized facility drawings (generated by SAFE) is contained in Appendix A, Figure A-1. Symbols on the drawings represent access points, stairwells, and targets; node labels are also included on the drawings for reference. (Definitions of the symbols used on the facility layout drawings can be found in Table 7, page 29.)

The facility contains 32 targets in all. Table 5 contains a listing of these target node labels. All of the targets represent vital areas where an adversary can perform certain events which contribute to his accomplishing a goal of sabotage. Five of the targets are Type I and twenty-seven are Type II. Type II targets must be visited in combination with another target(s) in order to achieve sabotage, while Type I targets need not be, i.e., a Type I target includes sufficient vital component(s) to achieve sabotage.

The Type II combinations of targets which could result in successful sabotage if visited by the adversary are listed in Table 6. For doubles, the adversary must visit two different targets; for triples, the adversary must visit three targets; and for quads, the adversary must visit four targets.

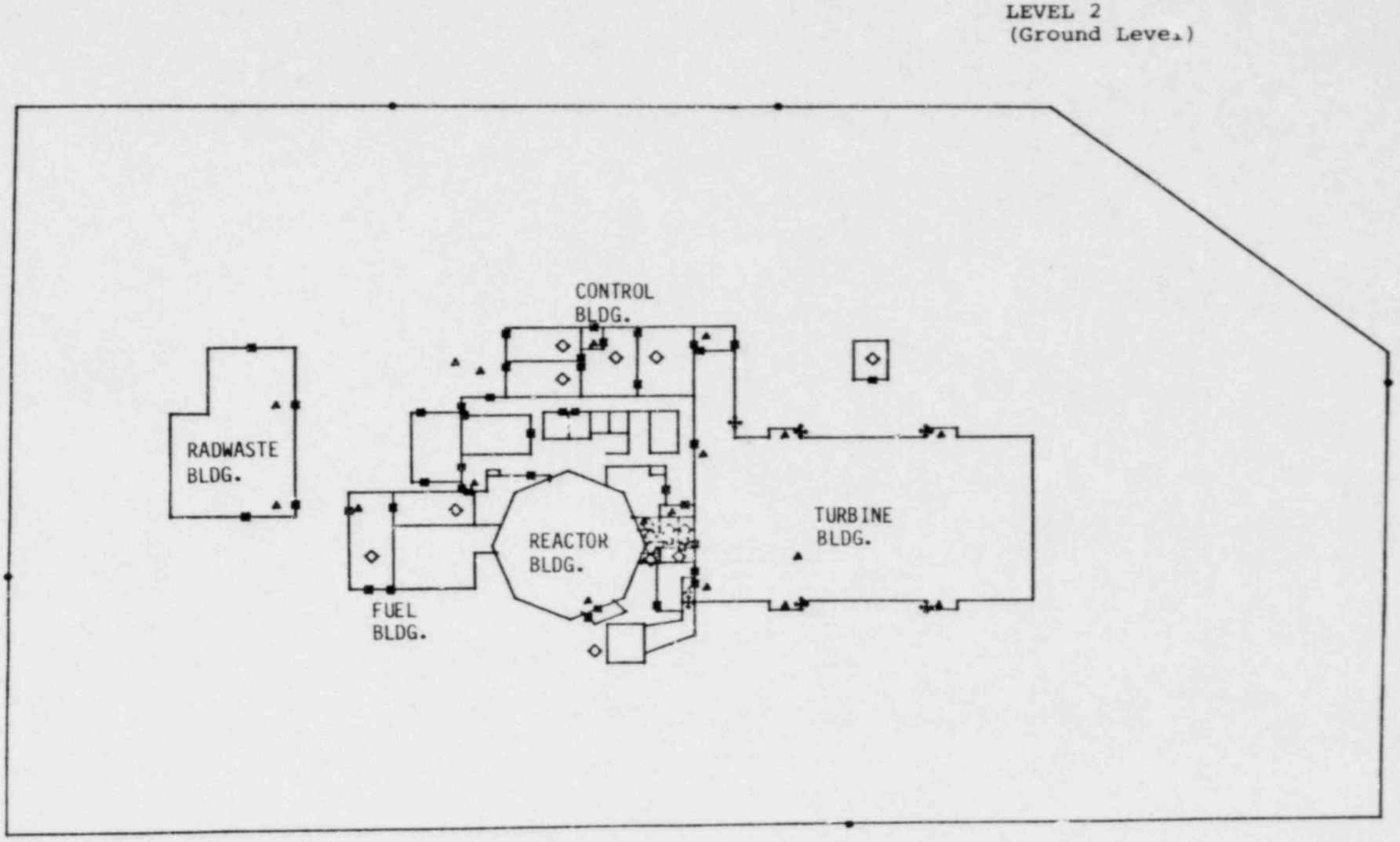

Figure 2. Reactor Facility--Ground Level

Table 5

Vital Areas

Vital Area Location	Target Node Label
Type I Vital Areas (5)	
Level 2	293
	295
Level 4	426
Level 6	611
	618
	619
	620
Type II Vital Areas (27)	
Level 0	37
Level 1	116
	117
Level 2	203
	204
	205
	206
	253
	262
	263
	276
	277
	278
	279
	280
	281
	290
Level 3	306
	307
	314
	315

Table 5 (Continued)

Vital Area Location	Target Node Label
Type II Vital Areas (27)	
Level 4	411
	412
	421
Level 6	631
	632
	636

Table 6

Type II Vital Area Combinations

Doubles (23)

307-306	262-306	206-203	631-632
203-307	262-203	206-421	412-411
205-307	262-205	205-206	276-636
204-306	276-290	263-206	618-636
204-203	276- 37	116-117	253-636
205-204	206-306	314-315	

Triples (10)

281-307-306	281-304-306	281-262-421
281-421-307	281-421-204	281-262-263
281-263-307	281-263-204	
281-307-306	281-262-306	

Quads (1)

280-279-278-277

NOTE: Target combinations are designated by node labels

The on-site security force includes five response guards. All guards are stationed in a security building, which is located at the fence (at node 284 on the facility drawings). Periodically, a guard is sent out to patrol the fence perimeter area. Guards are assumed to have handguns and access to shotguns.

Problem Complexity -- In order to obtain global performance measures for the reactor facility, all targets and all possible sequences of targets which can be visited by the adversary must be considered. Combinations of targets which can be visited contribute heavily to problem complexity since, not only must each combination be considered, but each possible sequence of targets for each combination must be considered. For example, the combination 307-306 can be visited by the adversary in the order 307 → 306 or 306 → 307. For each double combination, there are 2 possible sequences which must be evaluated or bounded in terms of physical protection performance; for each triple, there are 6 possible sequences; and for each quad, there are 24 possible sequences. For a Type I target, of course, there is only one possible sequence. For this particular facility, the number of possible sequences of targets that must be considered totals 135; this total does not account for the virtually unlimited number of paths which can be used by the adversary in conjunction with each possible sequence.

The nuclear reactor facility clearly presents a very complex problem that requires an efficient technique such as SAFE for global evaluation.

2.2.2 SAFE Analysis of the Reactor Facility

Facility Representation -- The nine levels of the nuclear reactor facility were digitized to represent the facility. A complete set of the digitized facility layout drawings is available in Appendix A. Different node symbols on the drawings represent different types of access points, stairwells, or targets. Table 7 illustrates the set of node symbols used and their corresponding definitions. Node labels on the drawings allow referencing of particular nodes.

Global Interruption Studies -- SAFE was used to generate worst-case probability of interruption paths to each target in the facility for a number of different cases. A number of cases in addition to the base case were considered to analyze global sensitivities to changes in

Table 7

Definitions of Node Symbols Used on Facility Layout Drawings

Node Symbol	Definition
○	Fence node
▩	Vehicle roll-up door
□	Watertight door
×	Containment airlock door
✣	Standard, unlocked door or personnel portal
⊠	Locked door or containment hatch
△	Stairwell
◇	Target

certain parameters or facility characteristics. The cases considered were the following:

1. Base Case -- This case is characterized by component performance data and response force data which represent the baseline facility.

2. No Fence Detection -- This case indicates how dependent the PPS is on detection at the perimeter.

3. Response Times Increased 1 Minute -- This case considers the effect of a delay in response, perhaps due to alarm assessment, redirection of response, or some other delay.

4. No Fence and No Exterior Building Door Detection -- Besides allowing consideration of the effect of failing to detect an outsider at both the fence and the exterior door, this case provides insights into PPS performance against the insider since it results in undetected adversary access into the buildings.

5. Zero Sabotage Times -- In this case, all target sabotage times were set to zero. This case considers how effectively the PPS can prevent access to target areas. It also may provide insights into whether the neutralization phase is most likely to occur at the target area (if at all) or at some prior point along the adversary path.

6. Sabotage Time Sensitivities -- Two cases were evaluated to consider the effect of changes in target sabotage times:
   a. Minimum Sabotage Times -- Sabotage times were reduced to estimated minimums to consider the possibility that base-case sabotage times are overestimated.
   b. Maximum Sabotage Times -- Sabotage times were increased to estimated maximums (for a knowledgeable adversary) to consider the possibility that base case sabotage times are underestimated.

7. Exterior Building Doors Upgraded -- Three cases were evaluated to consider the effect of a design upgrade to the facility. These cases assume that all exterior building doors are upgraded, where necessary, to a locked, alarmed door with a 1-minute delay and one of the following:
   a. Base Case otherwise,
   b. No Fence Detection, or
   c. Zero Sabotage Times.

After probability of interruption measures were generated for each of the targets and combinations of targets, the targets and combinations which showed up as most vulnerable were identified for each global interruption case. The worst-case Type I targets and Type II combinations for each global interruption case are listed in Table 8. Note that, although only interruption measures are listed, SAFE also supplies worst-case paths. The reader is reminded that results represent estimates for performance and should be used for relative comparisons.

Results show that the facility's safeguards system fares well in the base case, although results for many other interruption cases indicate performance is somewhat sensitive. Results for the cases which considered the upgrade to the facility indicate some improvement for particular targets and combinations, although the amount of improvement for the facility as a whole is small.

Many of the targets which were found to be worst-case targets appear consistently for many of the global interruption cases. Target 618 occurs frequently as a worst-case Type I target. Type II combinations which occur frequently as worst-case targets include 203-204,

Table 8

Reactor Analysis Using SAFE
(Worst-Case Results)

Case	Type I Target (PI)*	Type II Combination (PI)*
Base Case	618 (.95)	203-204 (.88) 116-117 (.88) 276- 37 (.89)
No Fence Detection	618 (.73)	276- 37 (.17) 203-204 (.23) 116-117 (.28)
Response Times Increased 1 Minute	618 (.77)	203-204 (.48) 116-117 (.59) 276- 37 (.78)
No Fence, No Exterior Door Detection	619 (.04) 618 (.38)	203-204 (.00) 276-290 (.00) 116-117 (.12) 276- 37 (.15)
Zero Sabotage Times	618 (.05) 611 (.08) 426 (.12)	205-206 (.03) 203-204 (.04) (many others < .10)
Minimum Sabotage Times	611 (.68)	203-204 (.47) 116-117 (.62) 276- 37 (.74)
Maximum Sabotage Times	(all $\geq$ .99)	276- 37 (.96) 203-204 (.97) 116-117 (.97)
All Exterior Building Doors Hardened and Alarmed, plus one of the following:		
Base Case	618 (.97)	203-204 (.89) 276- 37 (.95) 116-117 (.96)
No Fence Detection	618 (.77)	203-204 (.23) 276- 37 (.60) 116-117 (.70)
Zero Sabotage Times	618 (.21) 611 (.39)	203-204 (.12) 276-636 (.20) (many others < .50)

*PI = probability of interruption. The method used for finding the PI of a combination of targets was the maximum of the PIs of the targets which belong to the combination.

116-117, and 276-37. These targets are excellent candidates for further consideration by techniques such as EASI Graphics or the scenario techniques discussed in this report.

EASI Graphics Studies -- Particular paths were studied with the EASI Graphics capability within SAFE in order to consider the sensitivity of these paths to certain parameters, such as detection at the perimeter fence, response time, and target sabotage time. Paths considered included a path to target 618 and paths to targets 203 and 204. A path to target 611 was also considered. These particular paths are illustrated in Figure 3. EASI Graphics plots generated for these paths are included in Appendix A.

Neutralization Studies -- The BATLE model within SAFE was used to perform neutralization studies on the reactor facility. Two base case engagements were considered. One was set up to reflect an engagement outside the facility buildings (in an open area), and the other was set up to reflect an engagement inside (in a more confined area).

The adversary force consists of three adversaries with automatic rifles. The adversaries are engaged first by an initial response force and then by a secondary force which arrives later. The base case, Case A, assumes that the initial response force consists of a single guard with a handgun and that the secondary force consists of four guards equipped with shotguns. Two cases were also considered for an initial force of two guards and a secondary force of five guards--equipped in Case B with base case weapons and in Case C with weapons upgraded to semiautomatic rifles. A number of arrival times (ranging up to 4 minutes) were considered for the secondary guard force in each case.

Probability of neutralization results for both the inside and the outside engagements for each of the cases considered are plotted as a function of secondary force arrival time in Figure 4. The results for Cases A and B are, in general, not good; the results are insensitive to secondary force arrival times greater than 30 seconds. In the curves for Cases A and B, the early dip indicates that the initial response force is neutralized before the secondary force can arrive. Results for Case C are very high and show that upgrades for the security

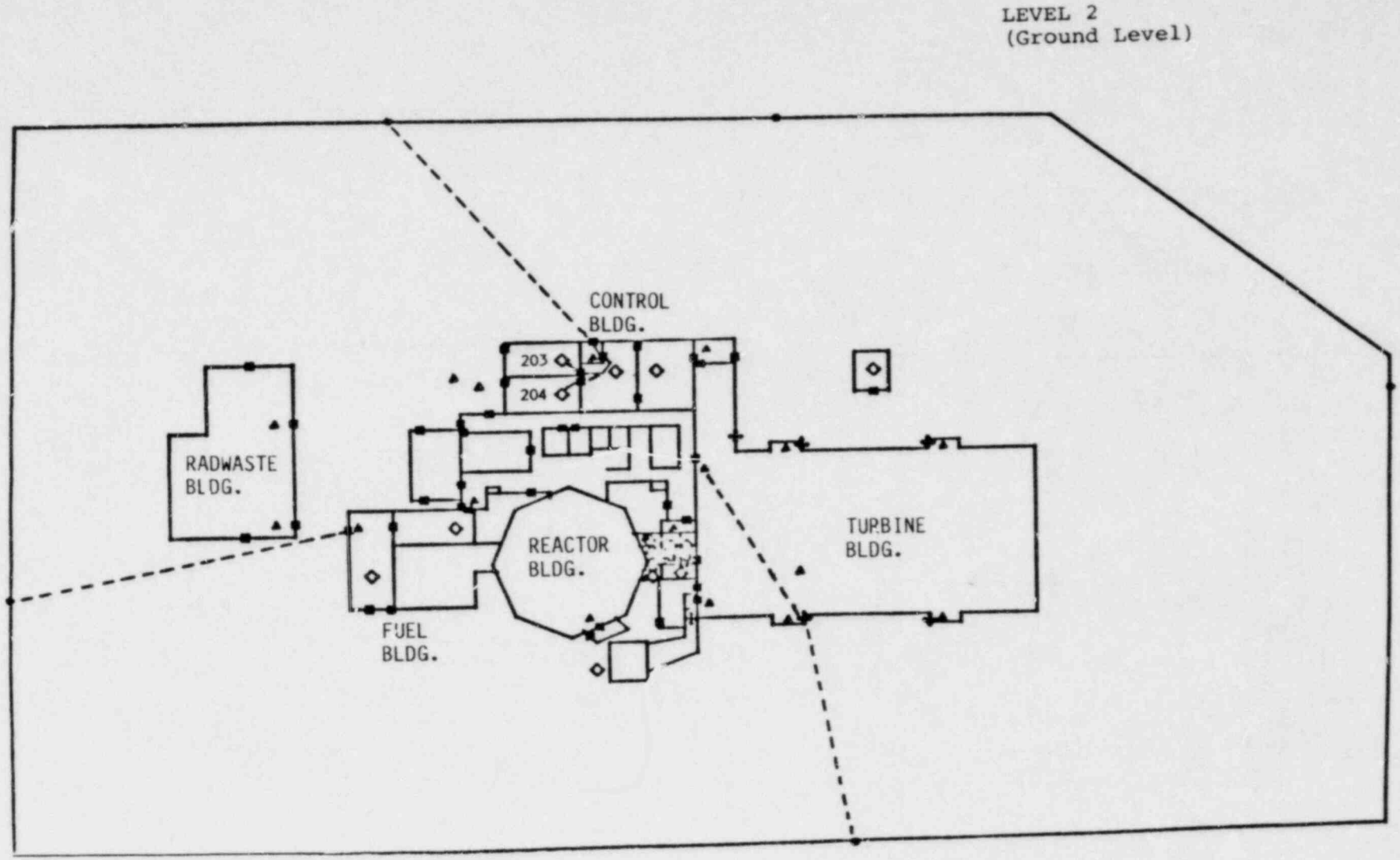

Figure 3. Paths Analyzed Using EASI Graphics

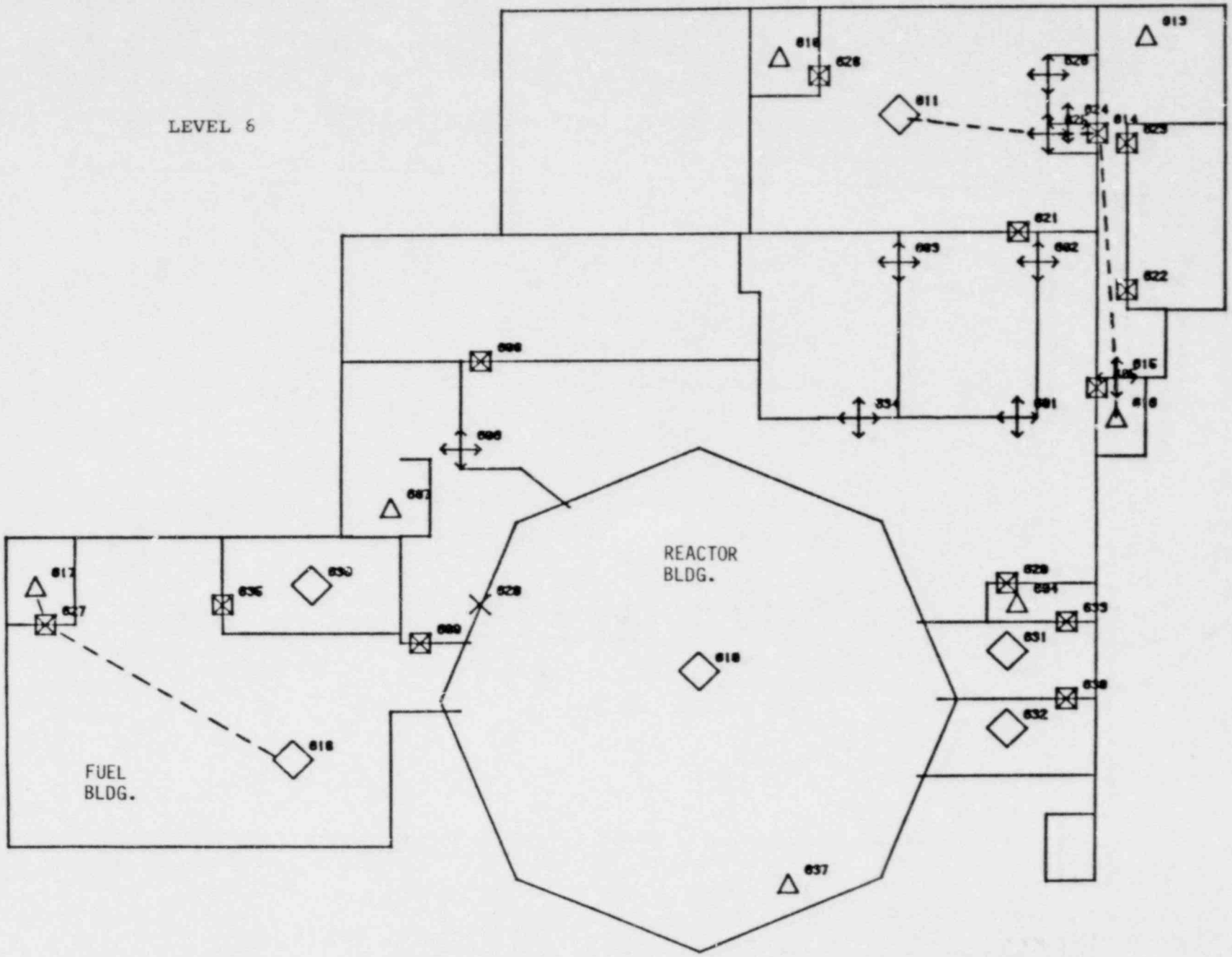

Figure 3. Continued

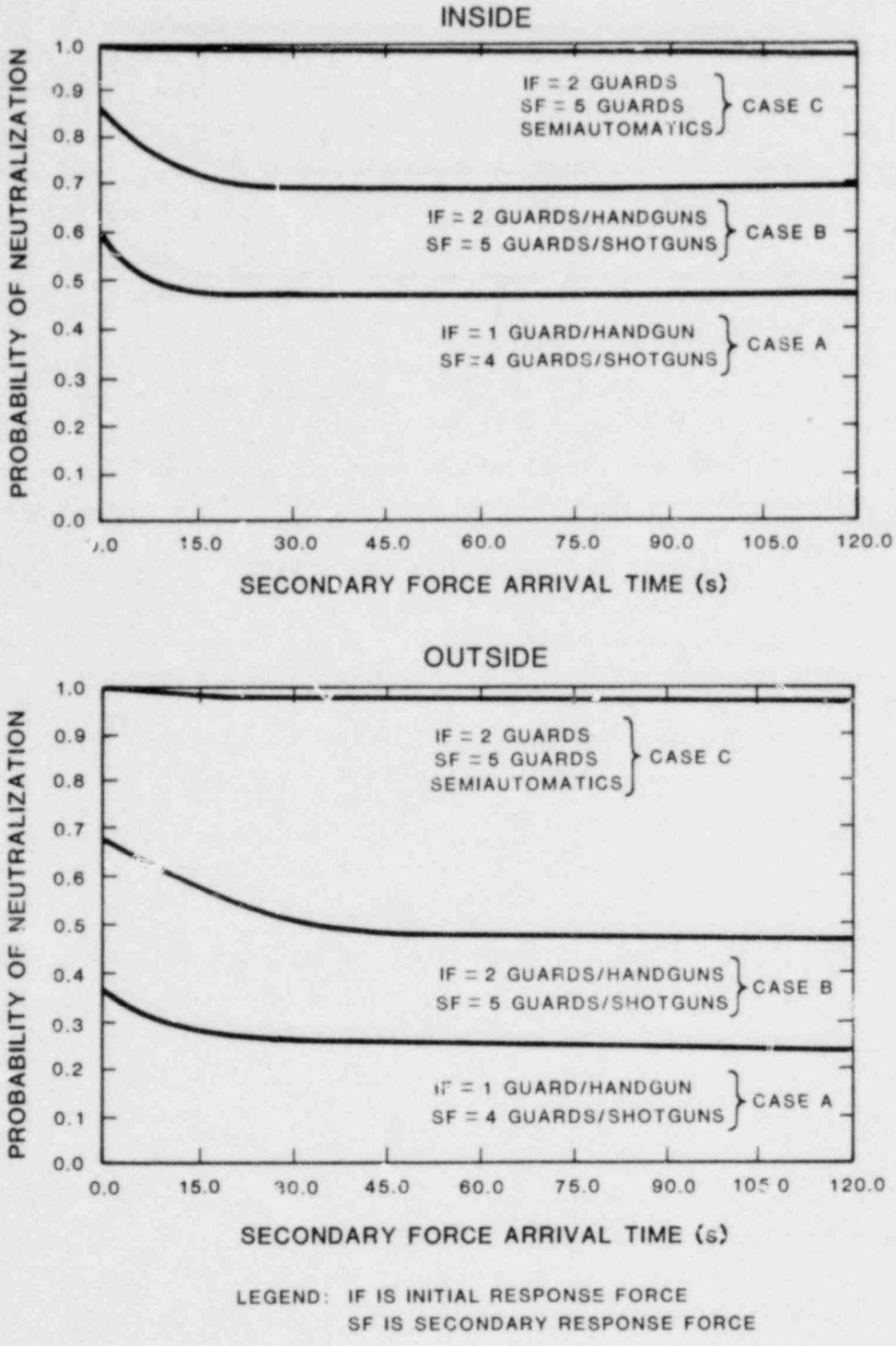

Figure 4. Probability of Neutralization Results--Inside and Outside Engagements

force can be made to achieve a reasonable probability of neutralization, which together with a high probability of interruption, results in reasonable overall system win measures.

Note that all neutralization results assume that the adversary is neutralized before sufficient time has elapsed for the successful completion of the adversary goal (in this case, sabotage). The likelihood that this assumption will hold decreases as the arrival time for the secondary response force or the total engagement time increases.

Observations -- The following observations were made regarding the use of SAFE for the reactor facility analysis:

1. SAFE is very useful for global consideration of complex facilities. The reactor facility presented a complex problem, with many targets and combinations to evaluate. SAFE provided an efficient technique for generating bounds on global performance.
2. SAFE provides an efficient and effective method for generating a set of worst-case scenarios. These scenarios are excellent candidates for more detailed analysis using a scenario model.
3. SAFE is not well-suited for consideration of detailed scenarios. It lacks the capability for modeling detailed adversary and guard procedures.

2.2.3 FESEM Analysis of the Reactor Facility

Path Selection -- Paths chosen for FESEM analysis were suggested by the global interruption analysis performed with SAFE. The paths considered are illustrated in Figure 5. They include a path to target 618, paths to targets 203 and 204, and a path which considers targets 203 and 204 in series.

Base Assumptions -- Base case adversary characteristics include three outsider adversaries who are on foot, equipped with tools and high explosives, and armed with automatic weapons. Base case guard characteristics include five response guards who are divided into two response forces: Force 1 consists of a single guard and Force 2 consists of the other four guards. Force 1 responds to alarms first, with Force 2 responding when alerted. All the guards are equipped with automatic weapons.

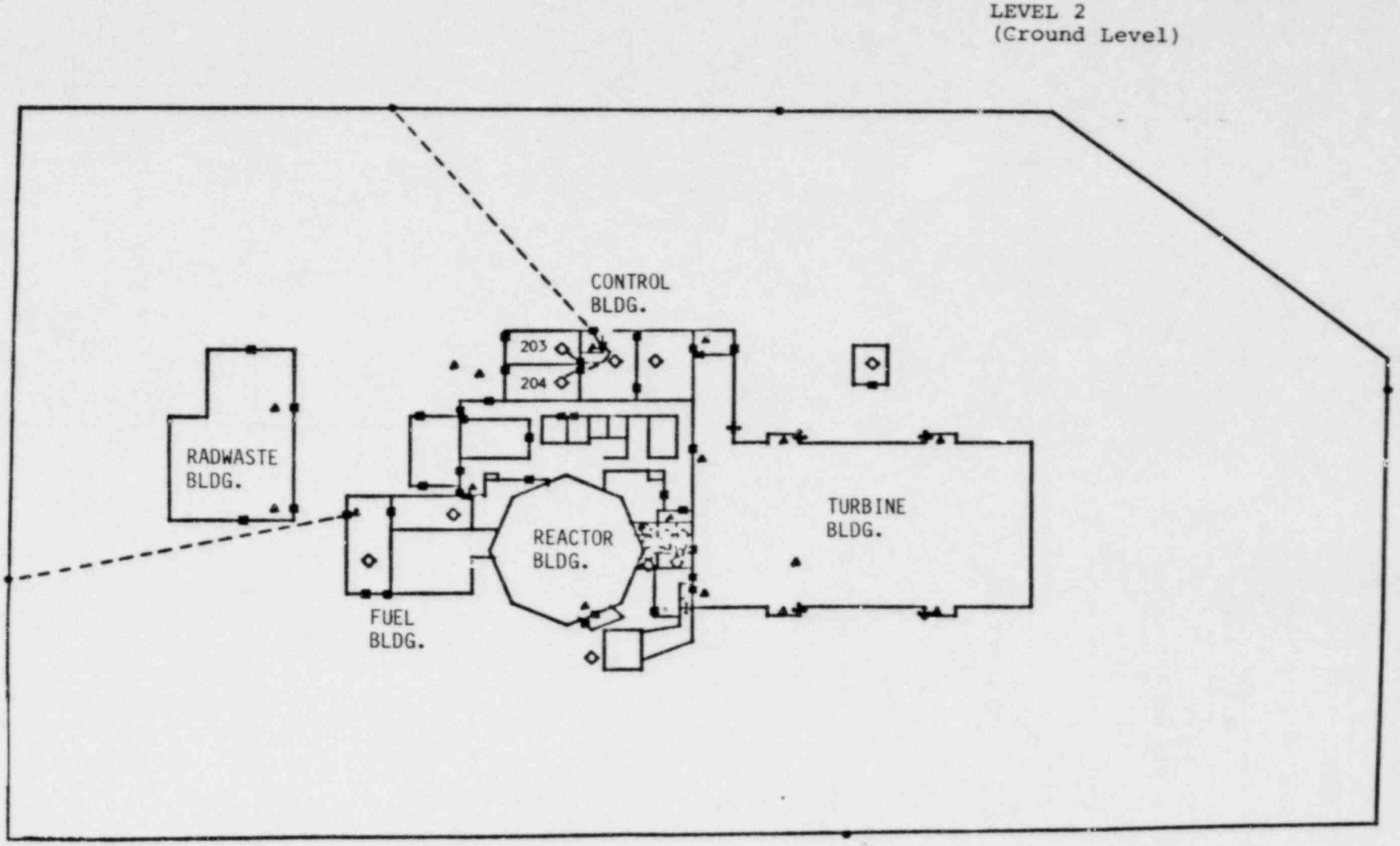

Figure 5. Paths Analyzed Using FESEM

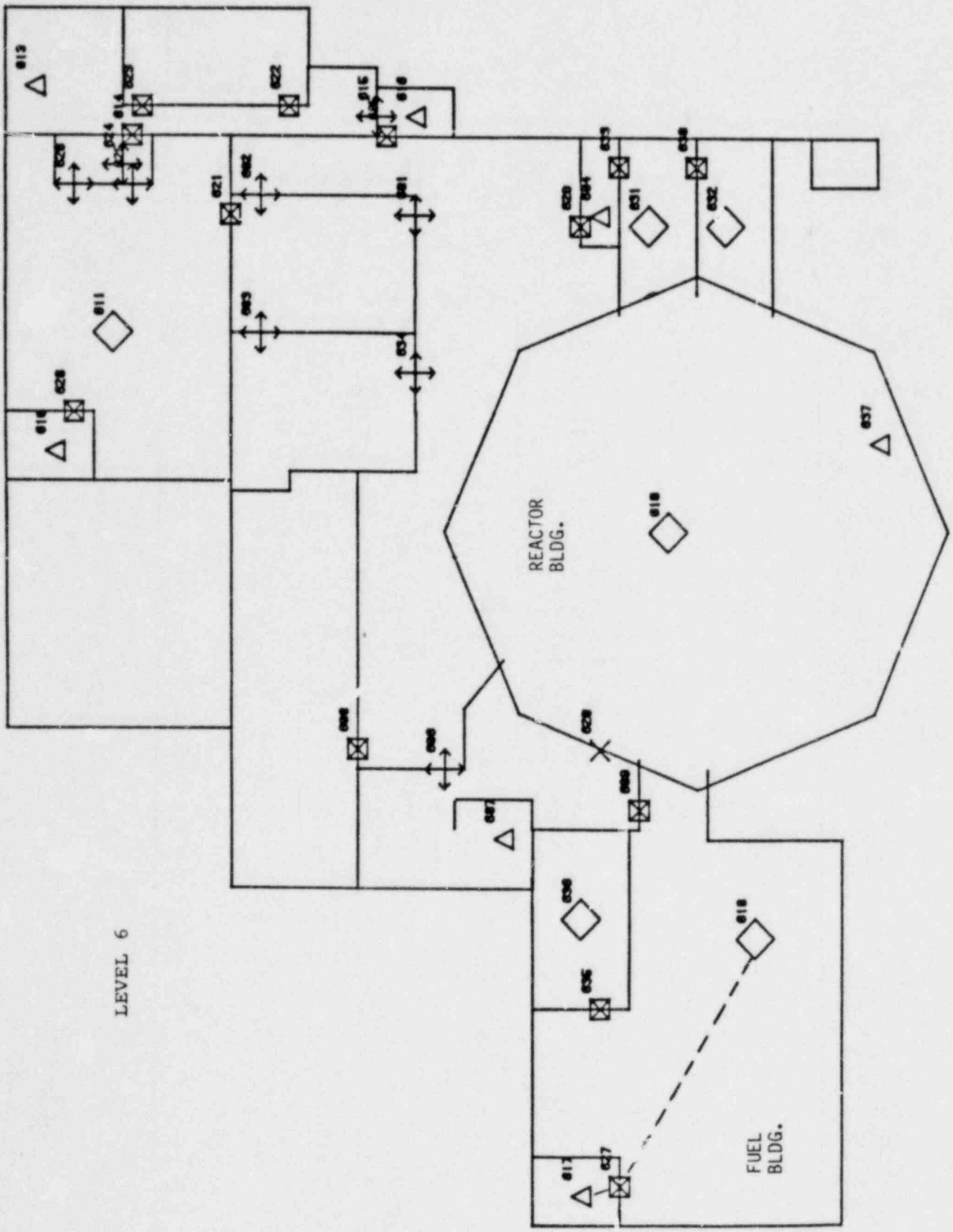

Figure 5. Continued

Data used for barrier time delays, alarm probabilities, and area crossing distances for the paths considered reflect the data specified as base case in the SAFE analysis.

Analysis -- A variety of cases was run using the particular paths chosen. Cases that were run included cases that assume no patrol, cases that assume Force 1 is on patrol around the perimeter fence area, and cases that assume additional response guards and an upgraded exterior building door. Differences in "patrol" versus "no patrol" in the analysis are reflected by a difference in response times for Force 1 in the two cases.

Analysis results for the cases run are presented in Table 9. Probability of interruption and overall probability of defenders' success are listed for each case. Note that the upgrades considered result in a significant improvement in overall performance.

Observations -- The following observations were made regarding the use of FESEM for reactor facility analysis:

1. FESEM is easy to learn to use and to apply.
2. FESEM has limited response procedure flexibility. Multiple response forces can be specified, but only a single overall response time can be input for each force.
3. The neutralization model within FESEM lacks detail.
4. A particular scenario or path must be input for evaluation by FESEM. This is a general constraint of all scenario models.

2.2.4 ISEM Analysis of the Reactor Facility

Path Selection -- The path chosen for analysis with ISEM is an insider path leading to target 618. Target 618 was chosen since it showed up as one of the more vulnerable targets in the SAFE analysis, including the "No Fence and No Exterior Building Door Detection" case which offers some insights into insider performance. The path used is illustrated in Figure 6. This path is a little different from the worst-case outsider path to target 618 in that it uses the standard personnel access system for access through the facility.

Table 9

FESEM Results

Target	Special Case	Probability of Interruption	Probability of Defenders' Success
618	Patrol	1.00	.01
618	No patrol	.97	.00
618	No patrol Force 1 = 2 guards Force 2 = 5 guards	.97	.31
618	Patrol Force 1 = 2 guards Force 2 = 5 guards 1-minute exterior building door	1.00	.79
203,204	Patrol	.98	.01
203,204	No patrol	.92	.00
203,204	Patrol Force 1 = 2 guards Force 2 = 5 guards 1-minute exterior building door	.98	.75
203→204 (in series)	No patrol	1.00	.88
203→204 (in series)	Patrol Force 1 = 2 guards Force 2 = 5 guards 1-minute exterior building door	1.00	1.00

Note that, although the SAFE analysis results were used to some extent to select this insider path, global techniques for generating worst-case insider scenarios are somewhat lacking.

Base Assumptions -- For the ISEM analysis, it is assumed that a single insider adversary is trying to gain access through the personnel access system. Initial entry into the facility is through the security building at the perimeter fence. The adversary is carrying a concealed handgun and concealed explosives.

Guard characteristics include the five guards assumed for the reactor facility as base case. One guard is assumed to be on patrol around the perimeter fence area, and the other four are stationed in the security building. The guards are armed with shotguns.

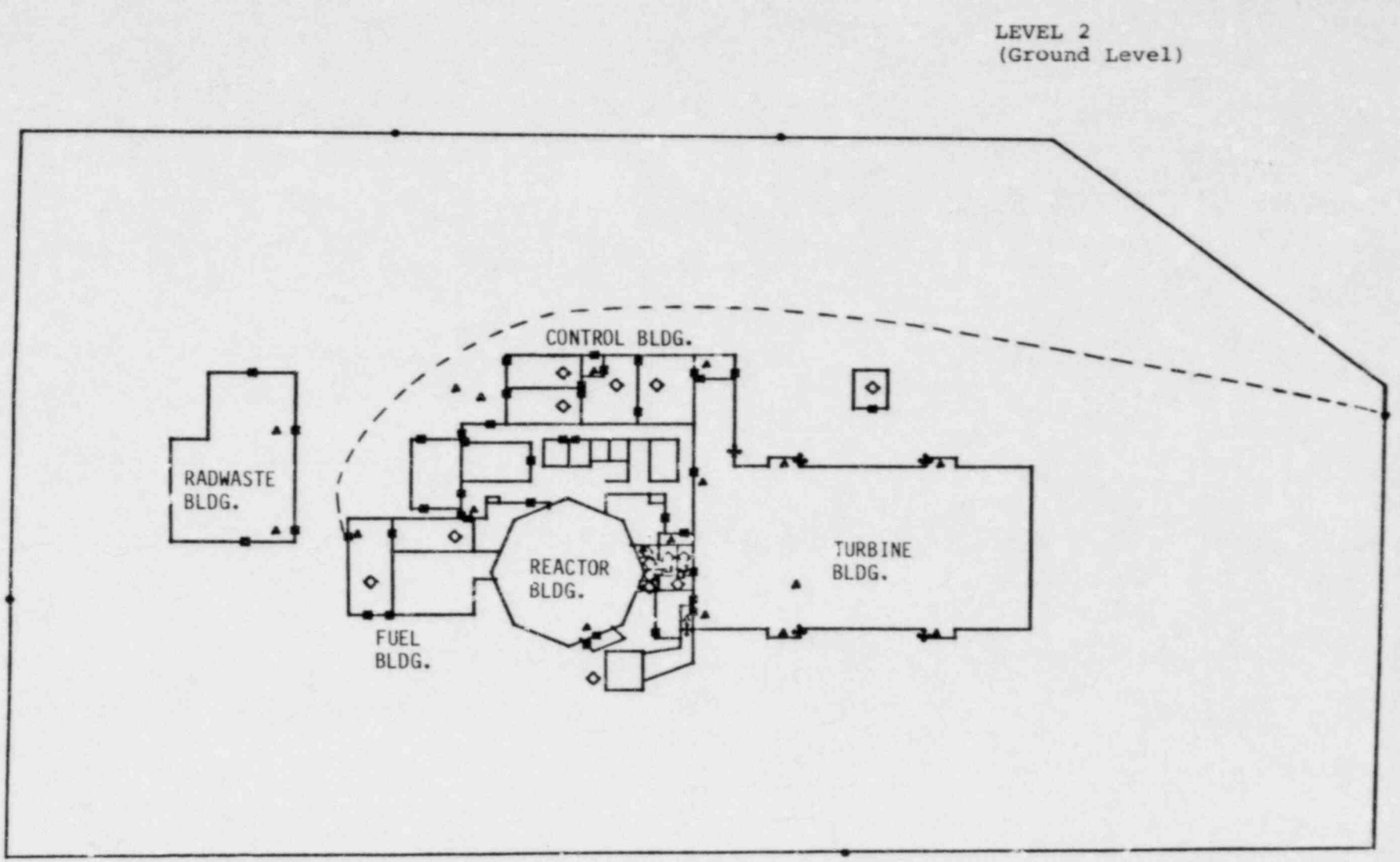

Figure 6. Paths Analyzed Using ISEM

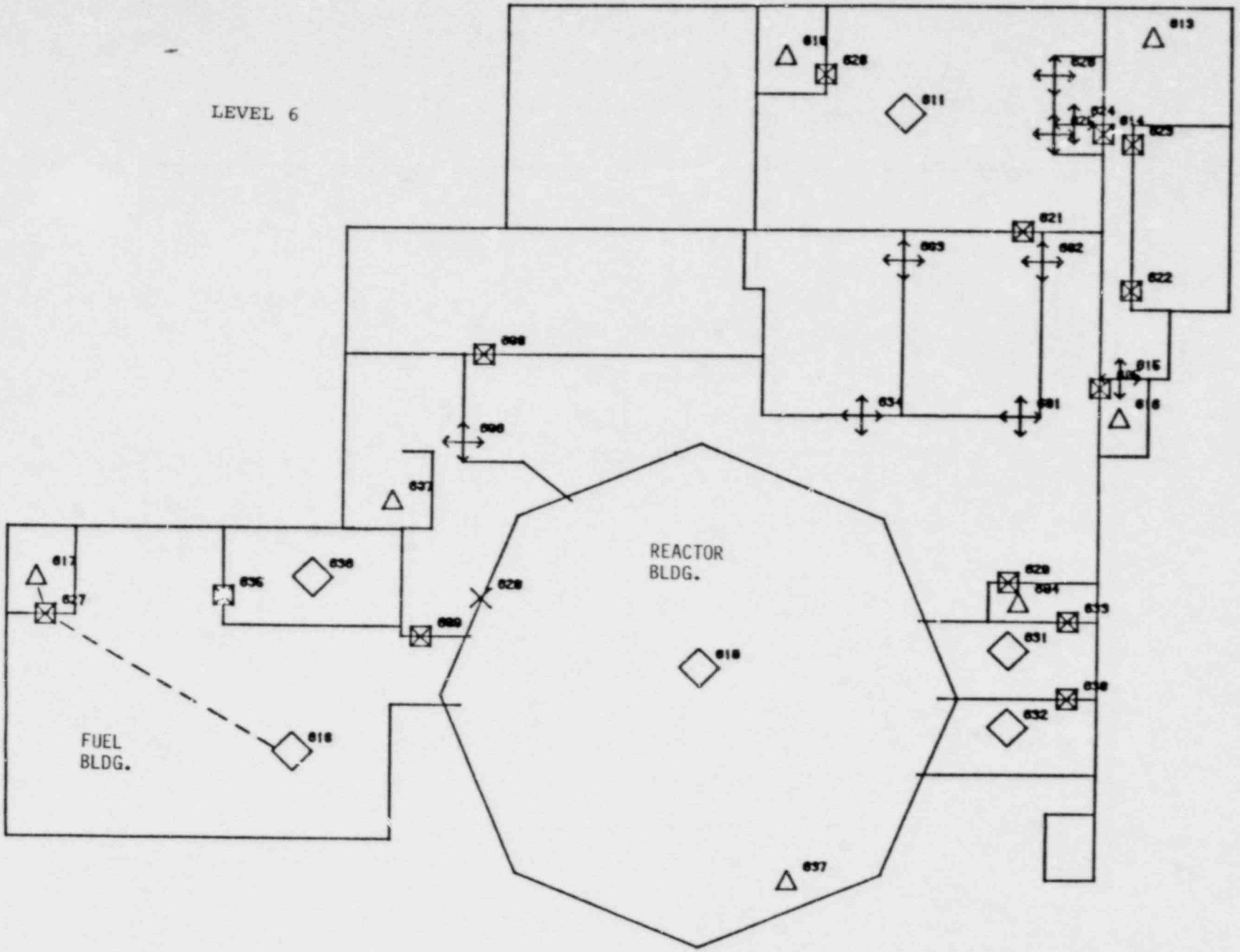

Figure 6. Continued

Sensors along the adversary path for insider adversary detection are listed in Table 10.

Table 10

Sensors for Insider Adversary Detection

Path Location	Sensors
Perimeter fence portal (284)	Metal, explosives detectors
Exterior building portal (269)	Metal, explosives detectors
Target area	Closed circuit television

Since the probability of detecting certain explosives may be low, detection at the outer portals is based largely on detection of the concealed handgun.

Guard response procedures based on different alarms are represented in Table 11.

Table 11

Guard Response Procedures

Alarm	No. of Guards Responding	From	To
At Portal 284	1	Security building	Portal 284
At Portal 269	1	Patrol	Portal 269
CCTV detection at target area	All	Anywhere	Target area
Battle	All	Anywhere	Target area

Analysis -- The base case insider scenario described was evaluated. The effect of initiating a search at the security building entrance in the presence of two guards was also considered. Probability of interruption and overall probability of system win results for the scenarios are listed in Table 12.

Table 12

ISEM Results

Case	Probability of Interruption	Probability of System Win
Base case	.06	.03
Search at entrance portal	.95	.95

Note that performance is significantly improved in the second case. Other potential upgrades include more effective detectors at access portals.

Observations -- The following observations were made regarding the use of ISEM for a reactor facility analysis:

1. ISEM is oriented for treatment of insider problems. This is particularly reflected by the fact that only one adversary can take part in the neutralization phase.
2. ISEM is fairly easy to learn to use and to apply.
3. ISEM provides for some response procedure flexibility. Guards can respond from specified locations to other locations based on different alarms, and guards can be redirected to a limited extent.
4. A particular scenario or path must be input for evaluation by ISEM. This is a general constraint of all scenario models.

2.2.5 SNAP Analysis of the Reactor Facility

Scenario Selection -- Based on the detailed SAFE analysis of the reactor facility, three particularly vulnerable adversary attack scenarios (A, B, and C) were generated for analysis with SNAP. The paths considered are illustrated in Figure 7. In conjunction with expert opinion, specific scenario details were incorporated into the SNAP model of the adversary attack scenario. The additional scenario detail was incorporated to illustrate SNAP capabilities in terms of a representative external threat to the reactor facility.

Scenario Description -- In Scenario A, three adversaries penetrate the fence at the west side of the facility, run to the fuel building, penetrate the exterior door, and ascend a stairwell to level 6. On

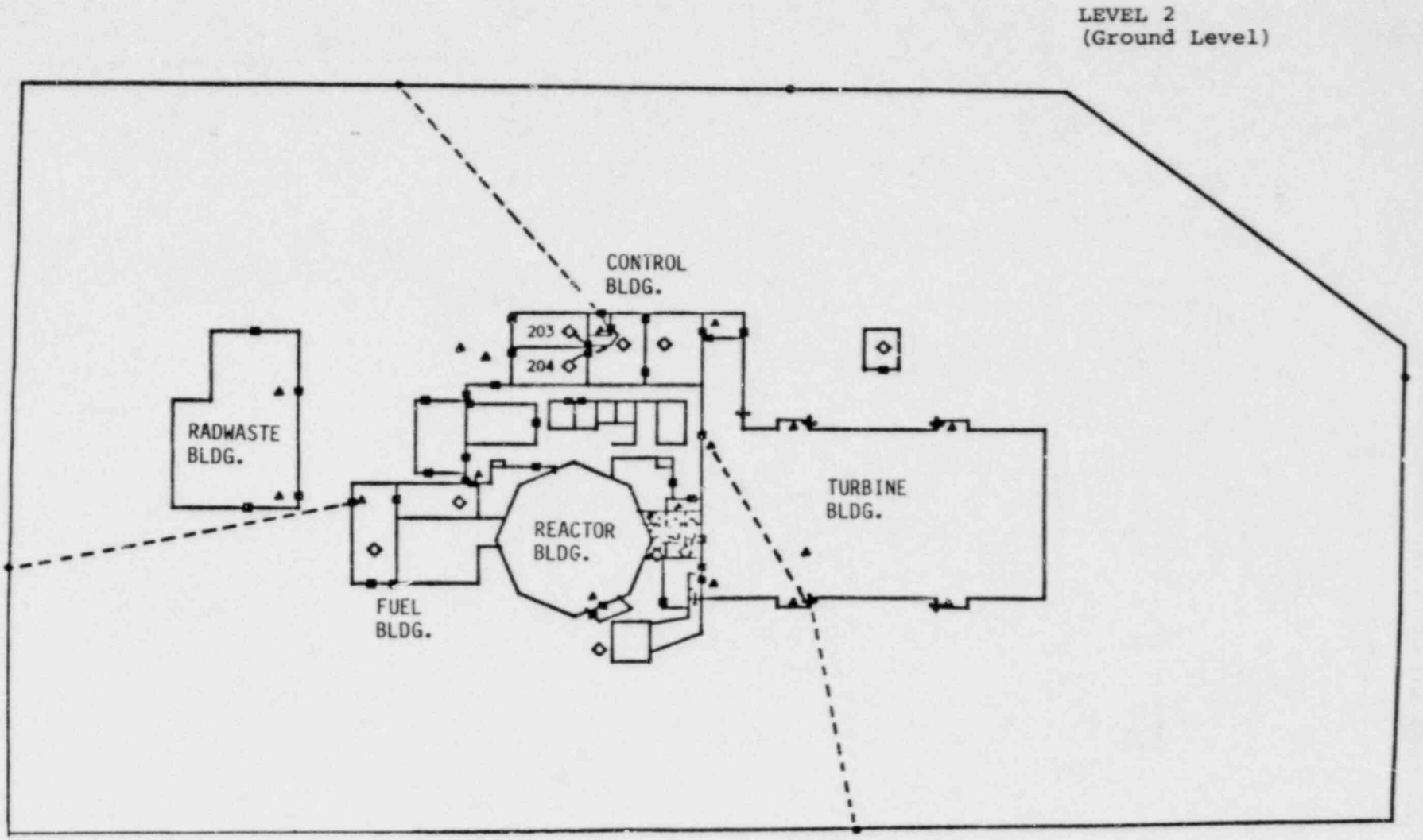

Figure 7. Paths Analyzed Using SNAP

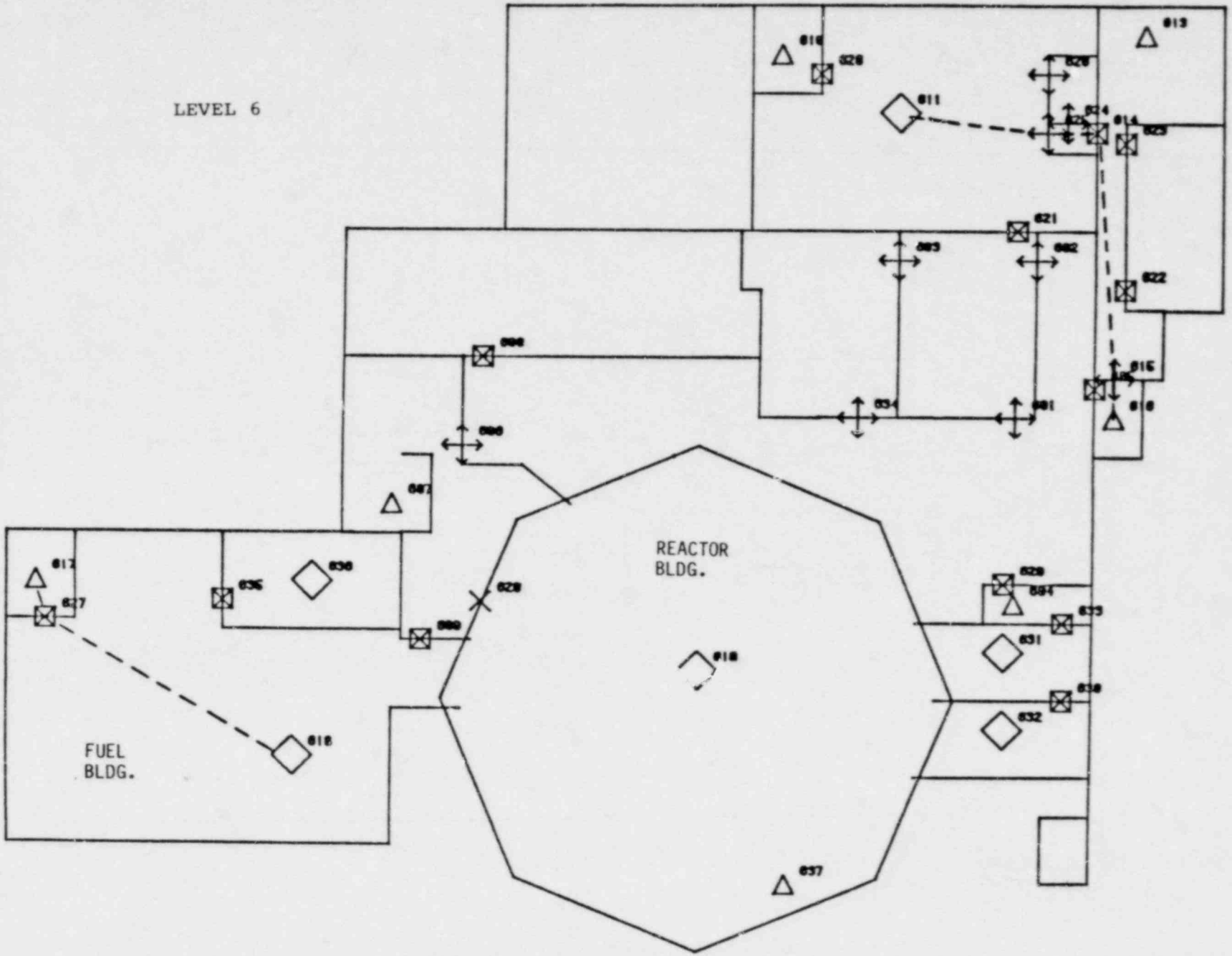

Figure 7. Continued

level 6, the adversary force splits. One adversary travels to the target to perform the sabotage, while the other two remain behind to ambush responding guards.

In Scenario B, two adversaries penetrate the fence at the north side of the facility, run to the control building, penetrate the exterior door, then disable two Type II targets in series to accomplish the sabotage. A third adversary takes cover outside the facility near the guard station and fires upon the guards as they respond to alarms triggered by the main adversary force.

In Scenario C, one adversary acts as a diversion to ensure that the main adversary force can enter the turbine building without being detected by the guard force. Once in the turbine building, the main force (two adversaries) travels to a stairwell, climbs the stairwell to level 6, and attempts to take over the vital area in which sabotage can be initiated.

Guard Response Procedures -- A guard response submodel was developed in SNAP for each of the individual adversary attack scenarios. This guard submodel was not general in nature, but rather was specific to each of the adversary attack alternatives (in contrast to the application of SNAP to the fuel cycle facility, in which a general guard submodel was used; see Subsection 2.1.3). This approach was felt to more efficiently utilize model development resources. While specific to individual attack scenarios, the guard response procedure models include all aspects of the response. Incorporated within the model were guard deployment strategies, communications, response to diversionary activities by the adversary, sensor assessment, and similar important guard activities.

System Performance -- A total of 16 cases were run for the three adversary attack scenarios, incorporating a number of sensitivities not included in the base case scenarios. The probability of system win for each of the three base case scenarios is as follows:

1. For Scenario A, .03.
2. For Scenario B, .32.
3. For Scenario C, .00.

Through the sensitivity analysis, an upgraded system was found to be considerably better. The best probability of system win for each of the three scenarios is as follows:

1. For Scenario A, .87.
2. For Scenario B, .94.
3. For Scenario C, .89.

The evaluation of the system using SNAP showed that the base case safeguards system performance was unacceptable, but if fairly moderate upgrades are made for the facility, safeguards system performance could be improved to a significantly higher level.

Observations -- The following observations were made regarding the use of SNAP for reactor facility analysis:

1. The application of SNAP to a reactor facility provided specific scenario analysis of a large complex facility and was accomplished within reasonable resources. This was made possible by interfacing the output of SAFE, which provided a manageable set of critical adversary paths, with SNAP. This interface served to minimize analyst effort in generating a reasonable set of adversary attack scenarios.
2. Highly detailed scenario-specific models of guard response procedures and response attack actions in engagement tactics were successfully modeled using SNAP.
3. SNAP is a highly flexible tool, which provides the capability for modeling all aspects of the reactor facility.
4. SNAP is a useful tool for evaluating base case performances as well as upgrades to safeguards systems.
5. The scenario-specific results of the analysis using SNAP provided valuable insights to the safeguards performance contribution of proposed upgrades.
6. The output of the SAFE/SNAP analysis may be fed back to SAFE to successfully close the global/scenario loop.
7. Overall, resource requirements for the analysis were quite reasonable for the level of detail selected in the model. This application should provide recommendations concerning design/modeling detail important for subsequent studies.

3. MODEL UTILITY

In this section, the overall utility of the SAFE, FESEM, ISEM, and SNAP safeguards evaluation models is discussed. Some pros and cons are summarized for each of the models. General input requirements and output capabilities are described, and resource requirements (both analyst and computing) for the different models are specified. General discussions on the effectiveness of the models for solving safeguards problems and their applicability to the NRC's regulatory activities conclude the section.

3.1 MODEL PROS AND CONS

Some pros and cons on the use of each of the four models (SAFE, FESEM, ISEM, and SNAP) for safeguards system evaluation are listed below.

3.1.1 SAFE Pros and Cons

PROS

- SAFE provides an effective and efficient technique for the evaluation of complex facilities (such as the reactor facility presented in this report).
- SAFE provides an effective technique for generating worst-case scenarios which are excellent candidates for more detailed evaluation using scenario evaluation methods.

CONS

- SAFE is not well-suited for modeling scenarios in detail. It lacks the ability to consider detailed tactics for guards and adversaries.
- A method as sophisticated as SAFE may not be required to evaluate very simple facilities. It may be sufficient to apply a scenario technique for a set of scenarios that appear to be worst case.
- SAFE could be improved to enhance the representation and evaluation of theft problems.

3.1.2 FESEM Pros and Cons

PROS

- FESEM is an easy model to learn to use.
- FESEM is an easy model to apply. It provides for interactive input and has simple input requirements.
- With FESEM, a broad variety of adversary scenarios can be considered in a single simulation (parameters such as the number of adversaries, weapon type, etc. can be allowed to vary).

CONS

- FESEM provides a relatively low level of detail for scenario modeling.
- FESEM has limited capability for defining response procedures. Multiple response forces can be specified, but only an overall response time can be specified for each force.
- FESEM uses a simple neutralization model.
- FESEM is oriented toward solving outsider problems (although insiders can be considered).
- With FESEM, a particular path must be input.

3.1.3 ISEM Pros and Cons

PROS

- ISEM is fairly easy to learn to use.
- ISEM is easy to apply. It provides for interactive input and has fairly simple input requirements.
- ISEM provides some flexibility for defining guard procedures. Guards can respond from different locations to other locations based on different alarms and can be redirected to a limited extent.
- Built-in analytical models for different types of sensors can be used with ISEM so that detection probabilities are generated internally based on specified adversary characteristics (e.g., metal, SNM detectors).

CONS

- ISEM provides only a moderate level of detail for modeling scenarios.

- ISEM is oriented toward consideration of insider problems. This is reflected in the fact that the neutralization phase is constrained to a single active adversary.
- With ISEM, a scenario or path must be input.

3.1.4 SNAP Pros and Cons

PROS

- SNAP is a network modeling language used for constructing safeguards models which provides the analyst with a very flexible tool for building scenario models; that is, an infinite variety of scenarios can be modeled, scenarios can be modeled to virtually any desired level of detail, and adversary and guard procedures can be modeled in detail.

CONS

- SNAP is more difficult to learn to use than the other scenario models.
- SNAP is also more difficult to apply.* In the case of SNAP, the user must actually build the safeguards model (whereas, with FESEM and ISEM, the model already exists and only specific safeguards data inputs are required).
- With SNAP, a scenario or path must be input.

3.2 MODEL INPUTS AND OUTPUTS

Model inputs and outputs for SAFE, FESEM, ISEM, and SNAP are presented below. A brief description of how inputs are supplied and what kind of inputs are required is followed by a description of what kind of outputs are provided for each model.

3.2.1 SAFE Inputs and Outputs

Inputs -- The representation of a facility is input by a digitizing process within SAFE. Barriers such as fences and walls are digitized as lines, and access or penetration points, stairwells, and targets are digitized as nodes.

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*Current SNAP graphical input/output developments may make SNAP both easier to learn to use and to apply.

All other input data are supplied interactively. Nodes in the facility are characterized by a time delay and a probability of detection. The data characterize the performance of components in the facility and specify sabotage times for targets.

For pathfinding, inputs such as which nodes to use as adversary start nodes and terminal nodes must be supplied. Response times are necessary for the generation of minimum interruption paths as well as the calculation of interruption measures along particular paths.

Use of the EASI Graphics model within SAFE requires little more than the selection of a path and the specification of options. Use of the neutralization model, BATLE, requires the specification of a number of engagement parameters which characterize the site and the combatants.

Outputs -- Facility drawings can be generated which illustrate the representation of the facility. In the adversary path analysis phase, worst-case paths based on the particular pathfinding option chosen are output; other outputs characterizing worst-case paths are also available. Interruption, neutralization, and system win measures are output for path evaluation.

The EASI Graphics model allows the generation of two- or three-dimensional plots which show the probability of interruption or the probability of system win as a function of one or two variables for a particular path.

BATLE outputs include a number of statistics and reports which provide neutralization measures, a time history of the engagement, and probability densities for the number of guards and adversaries.

3.2.2 FESEM Inputs and Outputs

Inputs -- Inputs to FESEM can be provided one of two ways: (1) inputs can be provided directly as a data set which consists of a set of GASP IV data (FESEM uses the GASP IV simulation language) and other input data or (2) the data file can be created by entering the data interactively.

Inputs include certain user-specified options such as the number of runs in the simulation, a set of site attributes, barrier attributes

for each barrier along the path to be considered including the distance to the next barrier, adversary attributes, and the specification of response forces and their attributes.

Outputs -- FESEM outputs include a table of collected statistics, a series of summaries that presents a number of results including the probability of defender success and attacker success, and histograms selected by the user. Also available are event-sequence traces and a time for battles plot showing the attrition of both defender force size and adversary force size.

3.2.3 ISEM Inputs and Outputs

Inputs -- Inputs to ISEM can be provided in either of two ways: (1) inputs can be provided directly as a data set which includes a set of GASP IV data (ISEM uses the GASP IV simulation language) and other input data or (2) the data set can be constructed by entering the data interactively.

The facility is represented by a set of areas, portals, and barriers for which certain attributes must be specified (this includes the specification of sensors). The adversary path to be considered is defined as a particular sequence of these facility entities. Attributes which define the adversary threat, as well as attributes for guard respose forces, must be input. Actions to be taken by response guards based on different types of alarms are specified, and response times are supplied accordingly. Certain user options must also be specified.

Outputs -- ISEM outputs include a summary of the input data, a summary of certain statistics including the probability of system win, and a number of histograms. Event sequence traces for particular runs are also available.

3.2.4 SNAP Inputs and Outputs

Inputs -- Input to SNAP is provided as a set of SNAP data statements. SNAP supplies a set of symbols and rules for combining these symbols in order to design safeguards models. These symbols can then be directly translated into SNAP input statements.

SNAP models consist of three submodels: the facility, adversary, and guard submodels. The facility submodel represents the facility as a set of spaces, barriers, and targets--all of which may have associated sensors. The adversary submodel defines the adversary attributes as well as the movement of the adversary force through the facility and the adversary decision logic. The guard submodel defines the guards' attributes, operating policies, and movement throughout the facility.

Outputs -- SNAP outputs include echo reports of input data, a set of general system performance statistics, a set of histograms, and other facility statistics. Event traces for particular runs are also available.

Developments -- Certain SNAP capabilities are currently being developed that will enhance the input of data and the output capabilities of SNAP. An interactive graphic input capability is being developed to assist the user in designing SNAP models. An interface is being constructed between SAFE and SNAP that will allow automatic generation of skeletal SNAP models using the facility representation and output provided by SAFE. (This capability facilitates the construction of SNAP models when SAFE and SNAP are used together for facility analysis.) A graphic output capability which provides graphic event traces is also under development. (This capability would allow visual observation of a scenario run as it progresses.)

3.3 MODEL RESOURCE REQUIREMENTS

Some of the resources required by the SAFE, FESEM, ISEM, and SNAP models are listed in the following subsections. Computing and analyst resource requirements are discussed.

3.3.1 Computing Resources

Certain computer resource requirements for the models discussed are summarized in Table 13. All resources are based on current implementations of the models. Equipment resources generally characterize the type of computing equipment that is required. Only SAFE requires special equipment other than a main computer and a terminal for model use. Language/software entries specify what languages and software the models use for implementation. Memory requirements provide an estimate of the amount of computer memory required to use the models. Central processing unit (CPU) time entries provide an estimate of computing times required for running the models (machine-dependent).

Table 13

Computer Resource Requirements

Resource	SAFE	FESEM	ISEM	SNAP
Equipment	Digitizing tablet[a] Tektronix 4050 Series Terminal[a] Modem Hardcopy Computer	Computer Terminal[b]	Computer Terminal[b]	Computer Terminal[b]
Language(s)/ Software	TEK 4050 Series BASIC (digitizing program) TEK PLOT10/Advanced Graphics FORTRAN NOS Operating System GCS or DISSPLA	GASP IV FORTRAN	GASP IV FORTRAN	FORTRAN
Memory (octal words)	~100K (application dependent)	100K	105K	~100K (application dependent)
CPU Time (CDC 6600)	10 seconds to 10 minutes (based on a single run through the SAFE analysis procedure; varies with options specified and problem complexity)	18 to 30 seconds (100 runs)	6 to 8 seconds (100 runs)	10 to 100 seconds (100 runs) (large variation due to flexibility in model design complexity)

[a]For facility representation.

[b]Standard computer terminal for input and output--may require communications device (e.g., modem, acoustic coupler, etc.) and hardcopy output device if one is not built in.

NOTE: Based on current model implementations

3.3.2 Analyst Resources

Analyst time requirements for learning to use and applying the models discussed are summarized in Table 14. Time to learn refers to the time needed for the analyst to become familiar with how to use the model. Facility characterization represents time spent gathering layout drawings and facility information from which model inputs can be specified. In order to evaluate specific existing sites, a site visit may be necessary for the gathering and/or verification of data. Characterization time is somewhat constant with regard to which or how many models are applied to the facility; however, it can vary a great deal depending on the availability of the data and the complexity of the facility being analyzed. It will also vary depending on the level of detail required for the analysis.

Estimates for the time required to apply the models to a facility are also specified. Application times can vary based on the complexity of the facility and the extent of the analysis performed. For FESEM, ISEM, and SNAP, estimates are supplied for a single-scenario application as well as for the total application.*

3.4 GENERAL

The general utility of the models, SAFE, SNAP, FESEM, and ISEM, for the evaluation of a PPS is illustrated in Table 15. SAFE is an efficient and effective method for the global evaluation of facilities; however, it is ineffective for the consideration of detail in specific scenarios. SNAP, FESEM, and ISEM are useful for the evaluation of specific scenarios, but they are very inefficient for global evaluation of facilities other than very simple ones since a broad range of paths and scenarios must be evaluated or bounded.

Table 16 illustrates the usefulness of the models discussed for considering specific types of threats. It should be noted that a well-defined method for global evaluation of the insider problem is lacking and that SNAP is the only one of the four models which can be used effectively to consider both outsiders and insiders.

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*Total application, for these models, assumes the evaluation of some reasonable set of selected scenarios.

Table 14

Analyst Time Requirements
(all times are in man-periods)[a]

	SAFE	FESEM	ISEM	SNAP
Time to Learn	1 to 2 weeks	1 to 2 days	1 to 3 days	1 to 2 weeks
Time for Facility Characterization	1 to 6 months	1 to 6 months	1 to 6 months	1 to 6 months
Time to Apply[b]	Facility representation --2 days to 2 weeks Analysis • Base case--1 to 2 days • Other--a few days to 4 weeks Total application--1 week to 2 months	For a scenario: Data input--a few hours Analysis • Base case--a few hours • Other--a few hours to 2 days Total--1 to 3 days Total application--1 day to 1 week	For a scenario: Data input--a few hours Analysis • Base case--a few hours • Other--a few days Total--1 to 5 days Total application--1 day to 2 weeks	For a scenario Model design/input--a few days to 1 month Analysis • Base case--1 day to 1 week • Other--a few days to a few months Total--1 week to a few months Total application--1 week to 6 months

[a]Additional manpower does not necessarily result in a proportional reduction of time.

[b]Times vary according to problem complexity and extent of analysis.

Table 15

General Model Utility

Model(s)	Application: Global Evaluation	Application: Scenario Evaluation
SAFE	X	Area of Ineffectiveness
SNAP FESEM ISEM	Area of Inefficiency	X

Table 16

Model Utility--Threat

Model	Threat: Outsider	Threat: Insider
SAFE	X	some
SNAP	X	X
FESEM	X	some
ISEM	some	X

Table 17 illustrates techniques for generating scenarios for detailed evaluation by scenario models. For very simple facilities, it may be sufficient to use an expert to identify a reasonable set of scenarios that appear to be representative of the worst cases. However, for a more complex facility, an expert may be ineffective since so many paths and scenarios are possible. SAFE provides a technique which can reduce the large number of possible paths in the facility to a more manageable set of worst-case paths, which can be considered for scenario-specific analysis. For simple facilities, the time required to apply SAFE may not warrant its use for scenario generation.

3.5 UTILITY TO NRC

The NRC has the responsibility of performing regulatory activities in the nuclear industry as codified in 10 CFR Parts 0 to 199. Among its responsibilities is the responsibility to ascertain that nuclear

Table 17

Scenario Generation

	Technique	
Facility	Expert	SAFE
Simple	X	Area of Inefficiency
Complex	Area of Ineffectiveness	X

facilities are well-protected. NRC activities in regard to this task include the processes of rulemaking (performed on a generic basis) as well as licensing and evaluation, assessment, and inspection (performed on a site-specific basis). An overview illustrating the roles which these activities play in the overall design and analysis of a PPS is presented in Figure 8.

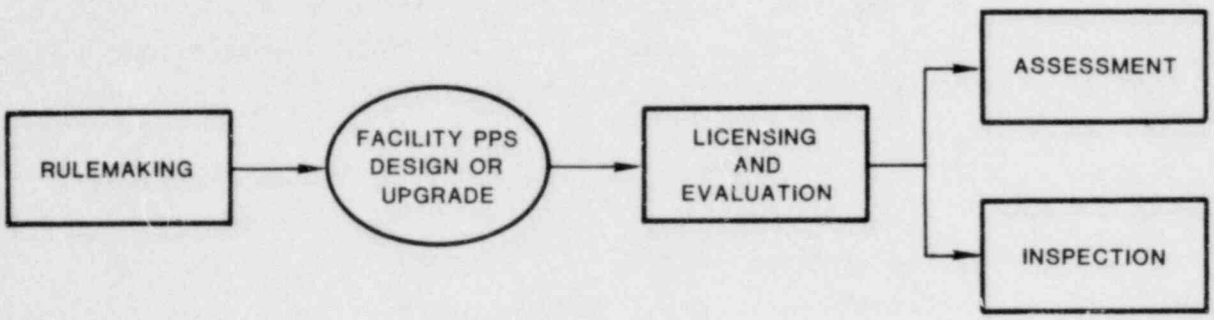

Figure 8. Systematic Design and Analysis of a PPS

At present, the performance of these regulatory activities continues to rely, to a considerable extent, on implicit professional judgments. There is no systematic way of ensuring uniform consideration of threats during safeguards design or evaluation, nor is there a systematic way of evaluating the adequacy of the assumptions and considerations used. Supplementing professional judgment with the use of methods such as those discussed by this report can result in more systematic approach.

Rulemaking is the process of specifying rules and requirements for PPSs. This activity is performed on a generic basis; that is, rules

are specified for all facilities in general. These rules provide guidelines for the design or upgrade of facilities. Although the models in this report require a specific site representation for analysis, their application to a number of sites or different designs can provide excellent insights into general characteristics which are important for adequate PPSs. Also, these models can provide a basis for establishing certain acceptance criteria for the evaluation process. It should be noted that these models could also be useful to industry during the design stage of nuclear facilities to compare the relative performance of different designs or to successively upgrade designs until satisfactory performance levels are achieved.

Licensing and evaluation is the process of comprehensively checking and reviewing a proposed PPS design or upgrade and finally approving or disapproving this design. The evaluation should consider the general threat specified by the NRC and the wide range of conditions which may occur at the proposed site. Such an evaluation may require several weeks. The evaluation provides a basis for licensing or not licensing the facility. Any of the models discussed can be useful in the evaluation process. SAFE would be particularly useful for a global evaluation of the proposed design, and the scenario models (SNAP, FESEM, and ISEM) can provide insights into the performance of the safeguards system against specific scenarios.

Assessment involves a field examination of a PPS to determine if vulnerabilities exist for specific threat scenarios and specific conditions or if other weaknesses exist. The examination is conducted "through the eyes of the adversary" and includes pre-assessment studies of the site layout and site safeguards. The preparatory process is performed within a medium time frame, perhaps on the order of 10 to 15 days, followed by a 5- to 10-day period for the field assessment. A facility could be judged inadequate on the basis of such an assessment. Although all the models discussed can be useful for assessment, the time constraint may preclude the use of SAFE and SNAP. SAFE and SNAP could be applied over such a medium time frame if the facility is simple or simple scenarios are considered or if these models have previously been applied to the facility for evaluation, in which case some of the modeling effort may be saved. However, the simpler models may be more useful. In addition to FESEM and ISEM, two models used within SAFE to evaluate performance along specific adversary paths (EASI and BATLE) are also available and would be very useful for assessments.

Inspection involves an operational check and review of the PPS to verify compliance with an approved security plan. This process is performed in conjunction with a site visit and might require 2 to 4 days. Some of the simpler safeguards models might be used to consider certain scenarios under the current operating conditions at the site. In particular, EASI and BATLE may be very useful since they are very easy to use.

Table 18 summarizes which particular evaluation models might be used to support each of the activities discussed.

Table 18

Utility of Evaluation Models to NRC Regulatory Activities

	Activity			
Model	Rulemaking	Licensing and Evaluation	Assessment	Inspection
SAFE	+	X	✓	✓
SNAP	+	X	✓	✓
FESEM	+	X	X	✓
ISEM	+	X	X	✓
EASI	+	X	X	X
BATLE	+	X	X	X

LEGEND:
X indicates areas of direct utility
+ indicates indirect use to provide insights
✓ indicates borderline utility

3.5.1 Classification

When computer models are applied to specific sites for evaluation, the input and output data may contain classified information. Certain input data characterizing a specific facility and model outputs indicating specific vulnerabilities in a facility are currently considered to be classified information.

The model inputs and outputs for SNAP, FESEM, and ISEM are very difficult to associate with a specific site. On the other hand, SAFE outputs include a facility layout that could be associated with a

specific site. Thus, access to a complete set of SAFE inputs and outputs can be very informative. Ongoing developments for SAFE include an effort to disassociate SAFE analysis results from the facility layout representation in order to make it difficult to connect results with a specific site.

A new safeguards information rule currently being implemented would protect all sensitive safeguards information but would not classify this information. Access would be limited to authorized persons having a need to know. The use of safeguards models on computers would be limited to use on a computer inside a protected area with hardwire lines to terminals. Dial-up access could be used only if transmission across telecommunications lines is protected. Any future use of safeguards models for analysis should adhere to the guidelines of this new safeguards information rule.

4. RECOMMENDATIONS

Previous sections of this report have described applications of the safeguards evaluation models, SAFE, SNAP, FESEM, and ISEM; the strengths and weaknesses of these models have been identified and their utility discussed. This section provides some recommendations on the use of these models for the evaluation of PPSs and on their use by the NRC.

4.1 GENERAL

Facilities can be characterized as simple or complex. Simple facilities are facilities which have simple layouts and a small number of targets; adversary paths for these targets can be identified by inspection. Complex facilities have complicated layouts (perhaps many levels) and a large number of targets; numerous adversary paths for these targets are possible.

For simple facilities, an approach that uses an expert to select a set of adversary paths or scenarios for evaluation with scenario-specific techniques may be sufficient. The analyst may then apply the scenario technique of his choice in order to perform such evaluations. In addition to FESEM, ISEM, and SNAP, the models used internally in SAFE to evaluate specific adversary paths (EASI and BATLE) are also available. The use of EASI and BATLE would be preferable to the use of FESEM or ISEM since EASI and BATLE are very easy to use; also, they are analytic models and therefore more efficient.

For complex facilities, a more structured approach is necessary. SAFE can be used to provide global effectiveness measures and a set of worst-case adversary paths which can, in turn, be considered in more detail with scenario techniques, if desired.

In terms of choosing a scenario technique to evaluate specific scenarios, SNAP is highly recommended. The overall flexibility of SNAP

for consideration of different types of threat and detailed scenarios, including detailed adversary and guard tactics, makes it the preferred scenario model.

4.2 A COMBINED SAFE/SNAP ANALYSIS APPROACH

A combined SAFE/SNAP approach[13] provides a methodology sufficiently broad in scope to encompass the global as well as the scenario aspects of the problem of evaluating PPSs. A conceptual outline of the combined SAFE/SNAP methodology is illustrated in Figure 9.

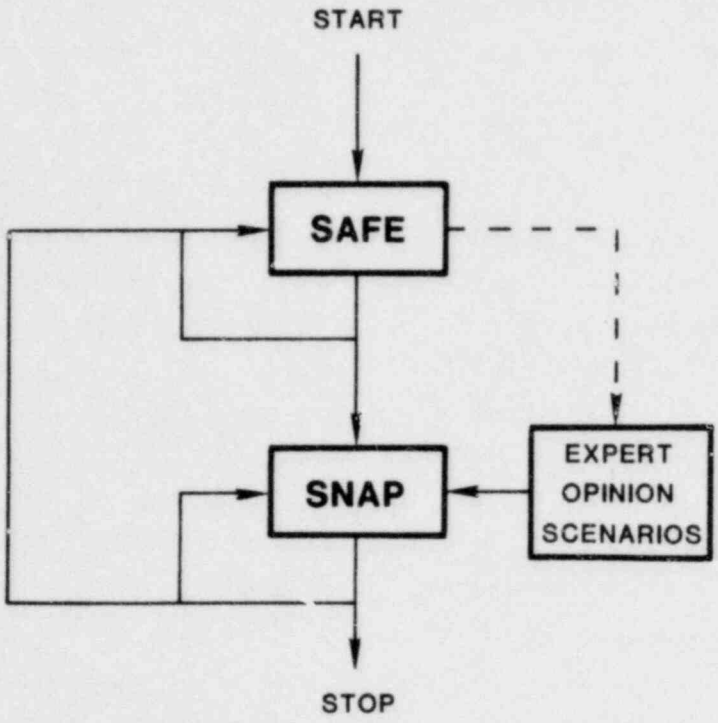

Figure 9. Conceptual Outline of SAFE/SNAP Methodology

Initially, SAFE would be applied to the facility. SAFE would then produce global performance measures for the facility and a corresponding set of worst-case paths. Iterations of SAFE can be applied to the facility to consider sensitivities to certain parameters and to consider the effect of upgrades to the facility. If SAFE results show very weak performance, the application of SNAP may not be necessary.

The critical paths that are output from SAFE are excellent candidates for evaluation with SNAP, which can more thoroughly represent detailed tactics. The particular set of paths to be evaluated using

SNAP provides a basis for constraining areas in the facility that must be modeled for SNAP analysis. With SNAP, guard tactics such as patrols and response to alarms can be modeled in detail, and these tactics can be "played against" specific adversary scenarios. Iterations of SNAP can be used to study sensitivities to certain parameters, to consider upgrades to the facility, and to consider changes in adversary or guard tactics.

Expert opinion may be used to supplement the set of worst-case paths identified by SAFE and to generate scenarios to be considered using SNAP. SAFE results may also help provide insights to the expert in the generation of scenarios.

An advantage of the combined approach is that SNAP can provide feedback to SAFE. Response and engagement statistics generated by SNAP may provide insights into characteristics such as response delays, arrival times for guards, and locations at which engagements are most likely to occur. SNAP results also provide a basis for comparison with SAFE results, which should strengthen confidence in the results of both analyses.

4.2.1 SAFE/SNAP Developments

The combined SAFE/SNAP approach will be enhanced by future developments, as discussed in Subsection 3.2.4. Graphics input/output capabilities will enhance the input/output capabilities of SNAP, and a physical interface between SAFE and SNAP will allow the automatic construction of skeletal SNAP models based on the worst-case paths output by SAFE.

4.3 USE BY NRC

The NRC is involved in safeguards regulatory activities which include rulemaking, licensing and evaluation, assessment, and inspection. Methods such as those described in this report can be used to supplement current procedures.

Of the methods discussed in this report, SAFE and SNAP are recommended, particularly for use in the evaluation phase. SAFE and SNAP can also be used for assessment if time permits. When quick results are required, particularly in inspection, EASI and BATLE (models used

internally by SAFE for evaluation) are recommended. Recommendations for NRC use of evaluation models are summarized in Table 19.

Table 19

Recommendations for NRC Use

Rulemaking	Licensing and Evaluation	Assessment	Inspection
All methods can provide insights	Combined SAFE/SNAP	If time permits, SAFE/SNAP; otherwise EASI/BATLE	EASI/BATLE

4.4 CONCLUSION

Each of the four evaluation models discussed in this report (SAFE, SNAP, FESEM, and ISEM) has certain strengths and weaknesses. SAFE is very useful for global evaluation of complex facilities. SNAP, FESEM, and ISEM are scenario methods which allow consideration of specific scenarios. Of the scenario techniques, SNAP provides the most power and flexibility for evaluating detailed scenarios, although it also requires more analyst resources.

A combined SAFE/SNAP approach for the evaluation of complex facilities is suggested. Such an approach is both global- and scenario-based and thus strives toward a "complete" evaluation. It provides an efficient and effective evaluation scheme which allows a quick study of both the global and scenario aspects of evaluating safeguards systems.

5. REFERENCES

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[13] D. Engi, L. D. Chapman, and F. H. Grant, A Combined Approach to Safeguards Evaluation, SAND80-0529, NUREG/CR-1591 (Albuquerque: Sandia Laboratories, August 1980).*

*Available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and/or the National Technical Information Service, Springfield, VA 22161.

**Available for purchase from the National Technical Information Service, Springfield, VA 22161.

APPENDIX A

SAFE Analysis of the Reactor Facility

A.1 FACILITY CHARACTERIZATION, BASE DATA, AND ASSUMPTIONS

The reactor facility includes

- 9 Levels:
  - ground level (level 2)
  - 2 underground levels (levels 0 and 1)
  - 6 aboveground levels (levels 3 through 8)
- 32 Targets:
  - 5 Type I
  - 27 Type II

Digitized layout drawings for each level of the facility are shown in Figure A-1. Definitions for the node symbols used in the drawings are provided in Table A-1. Base case assumptions for the guard force at the reactor facility are listed in Table A-2.

The Type I and Type II targets (vital areas) in the facility are listed in Tables A-3 and A-4, respectively. Vital areas for such facilities are identified by means of fault tree/vital area analysis techniques. The doors which provide access to containment were included in the analysis in order to consider the possibility that guards are not able to follow the adversary into containment and to consider how well access to the containment area can be prevented. Target sabotage times and response times for each of the targets are included in Tables A-3 and A-4.

Sabotage time ranges are based on expert opinion and the assumption of a knowledgeable adversary. The means of the ranges are used for the base case sabotage times. Response times were calculated based on anticipated travel times for the guards from certain start locations to the target areas.

LEVEL 2
(Ground Level)

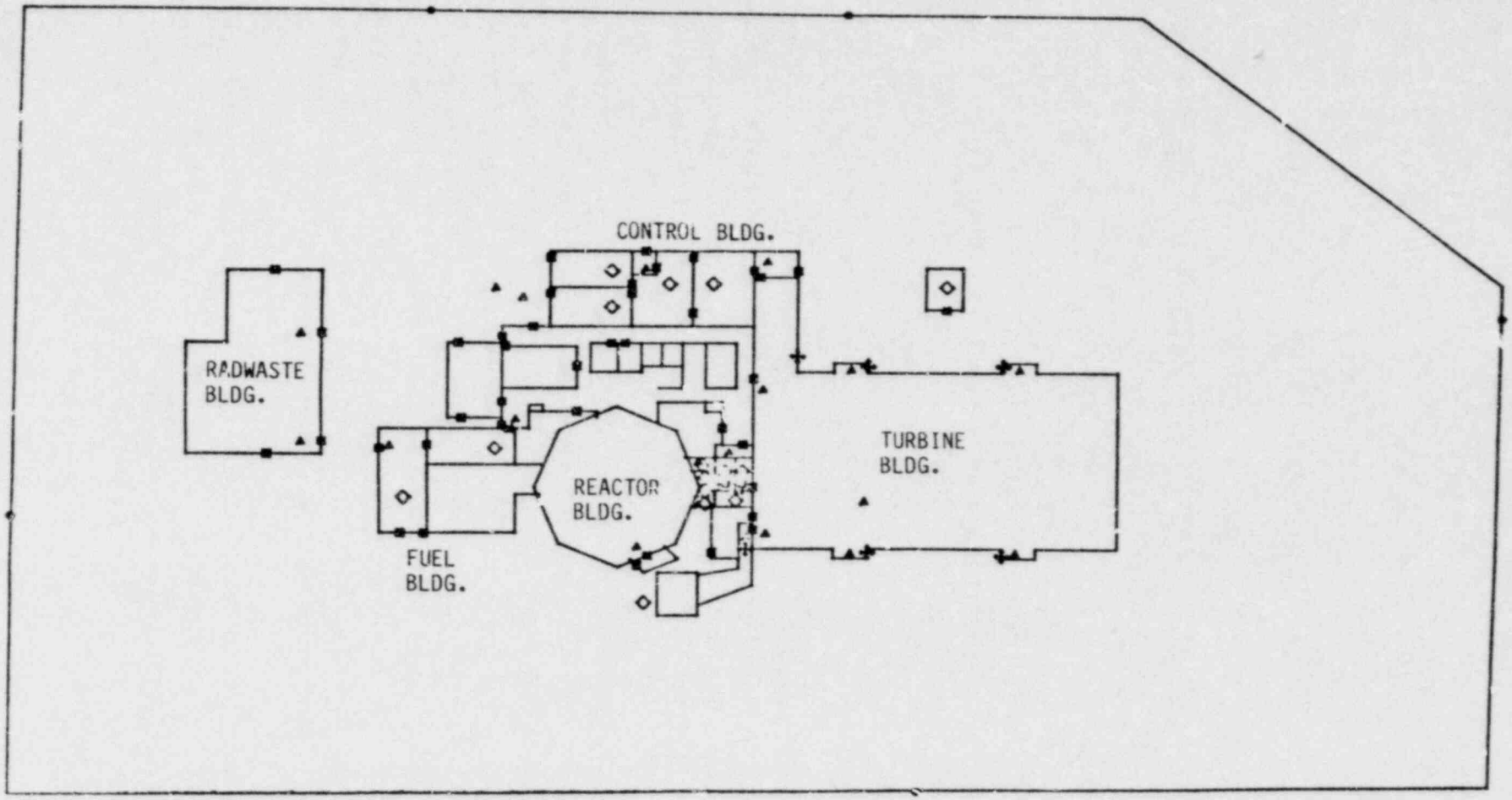
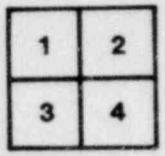


Figure A-1. Facility Layout Drawings

LEVEL 2 (Ground Level)

Quarter 1

Quarters Labeled:



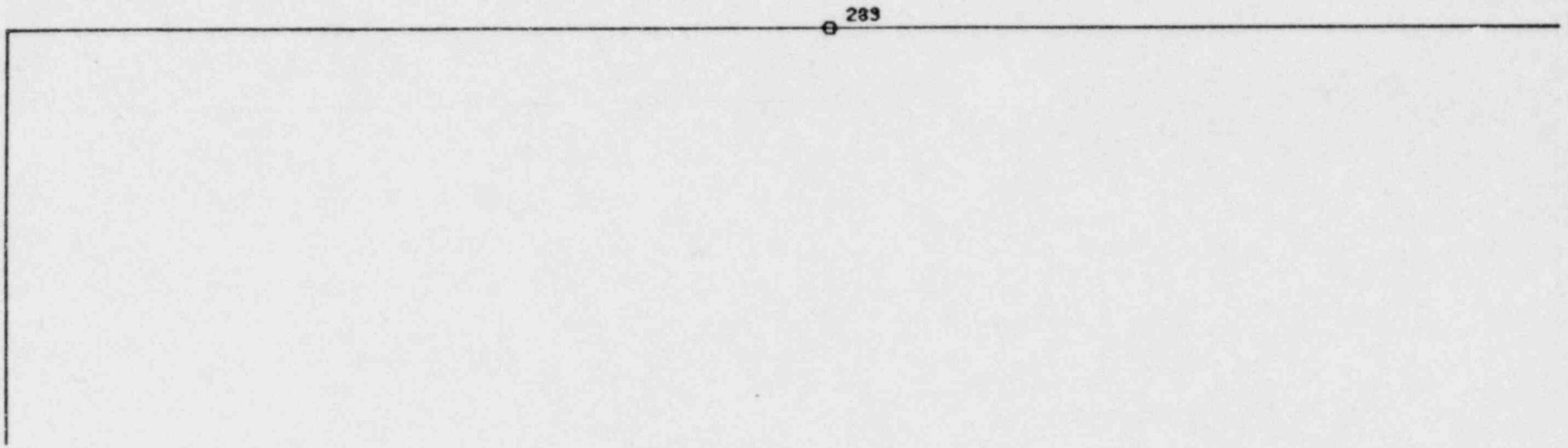


Figure A-1. Continued

LEVEL 2
Quarter 2

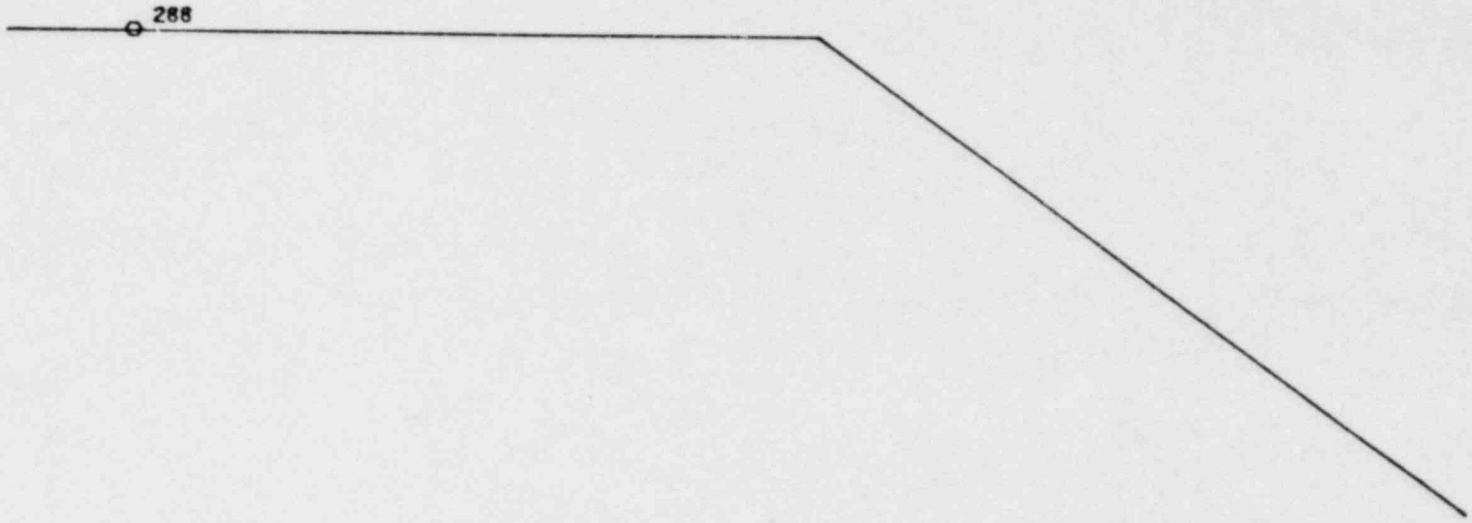
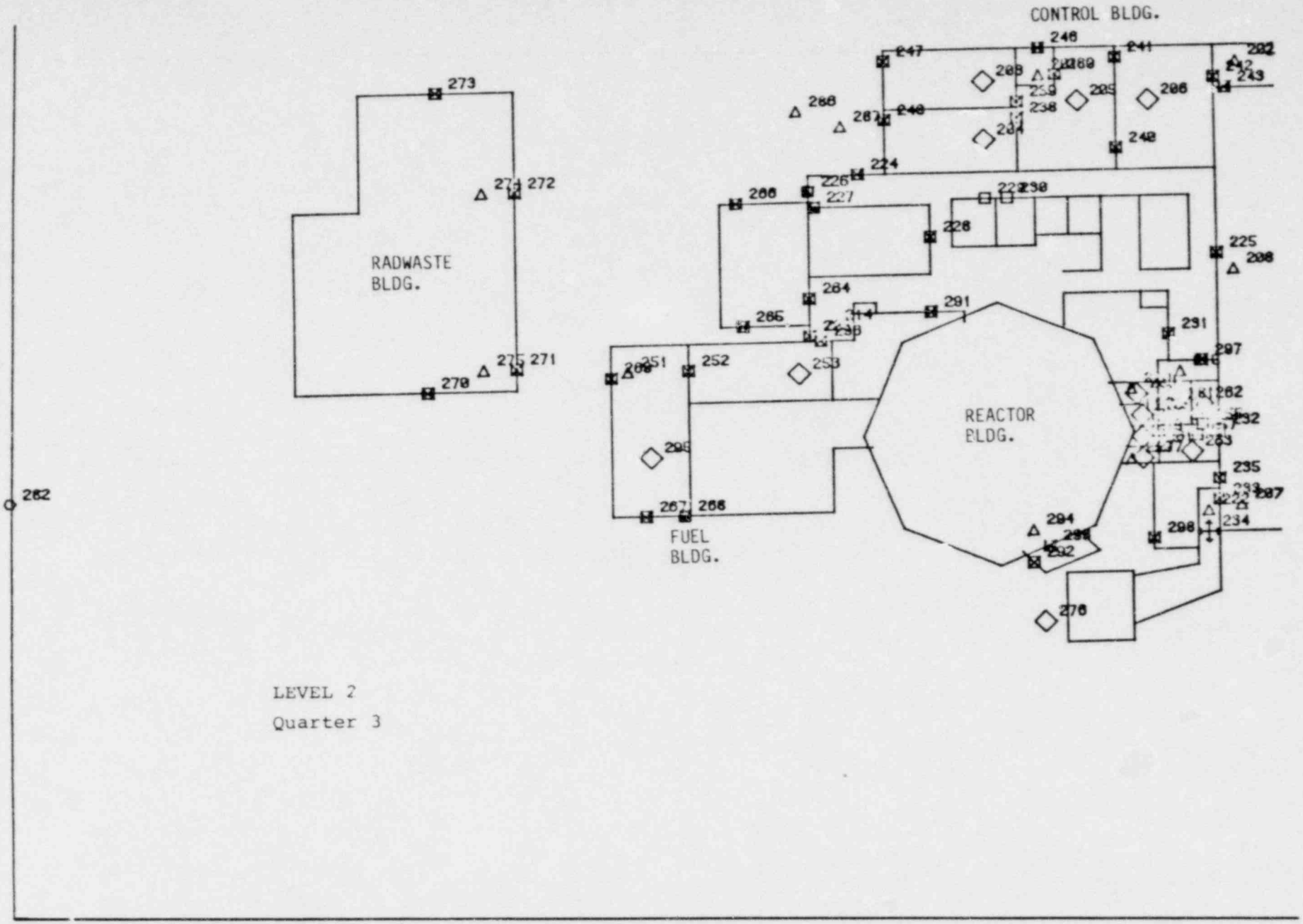


Figure A-1. Continued



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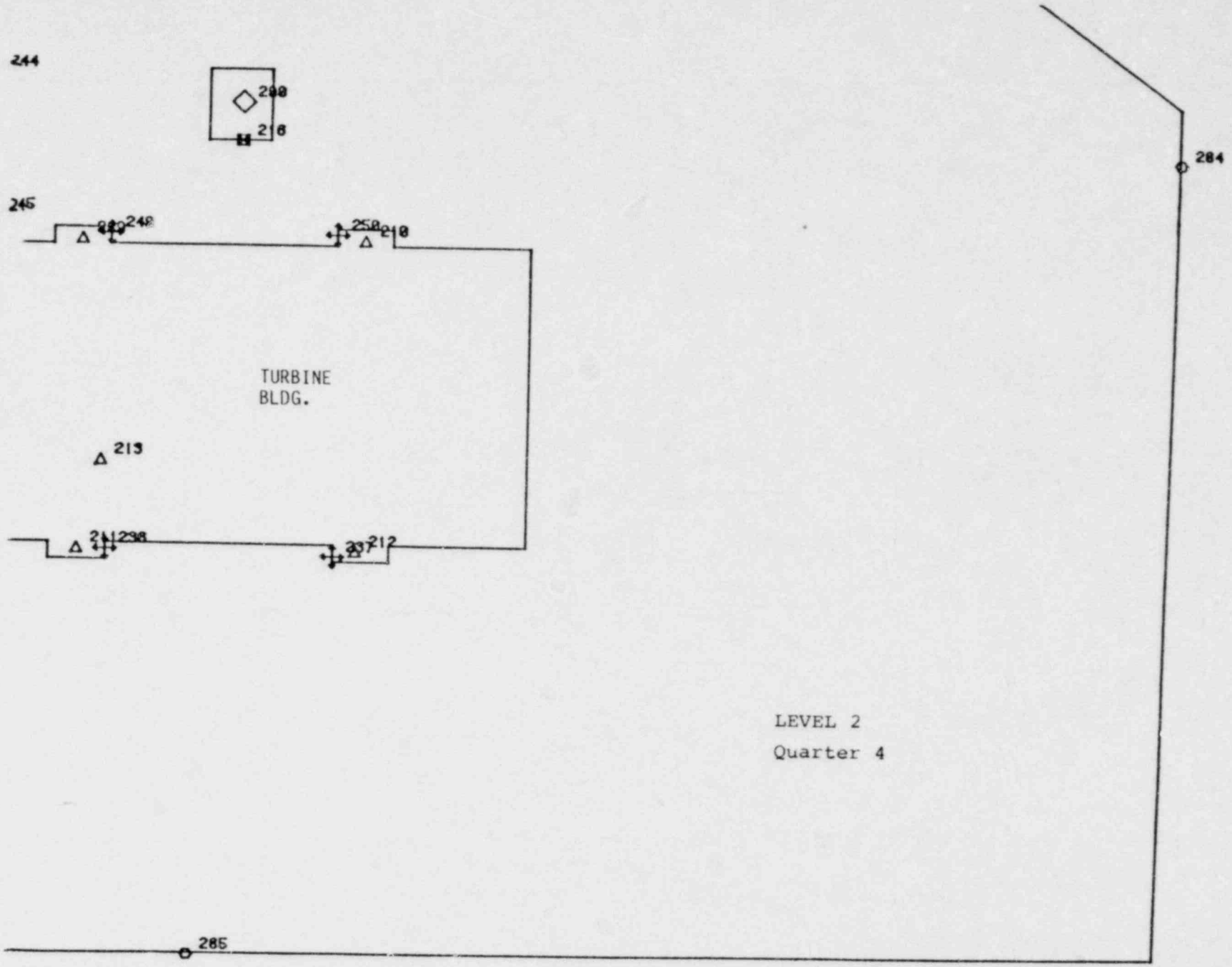
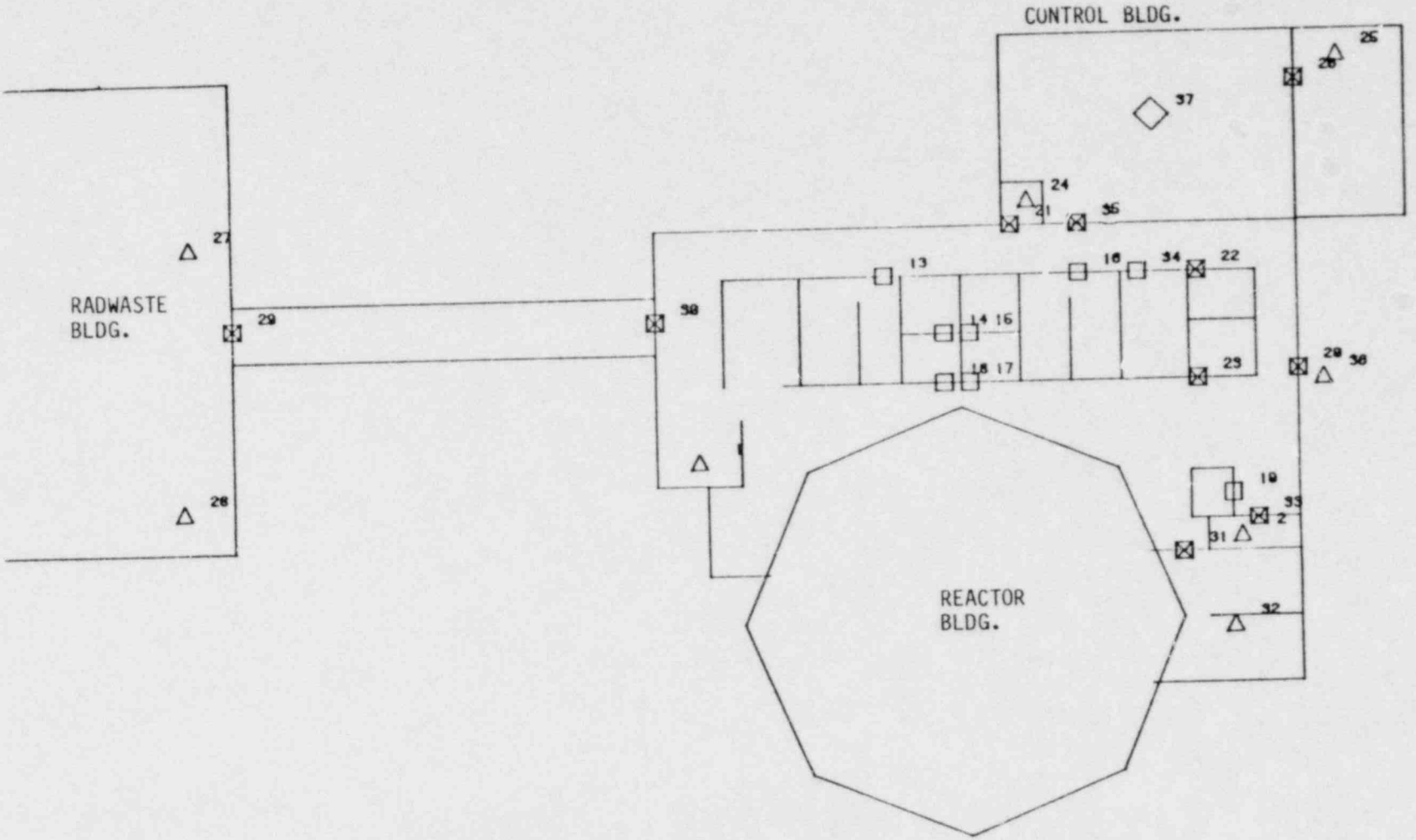


Figure A-1. Continued

LEVEL 0



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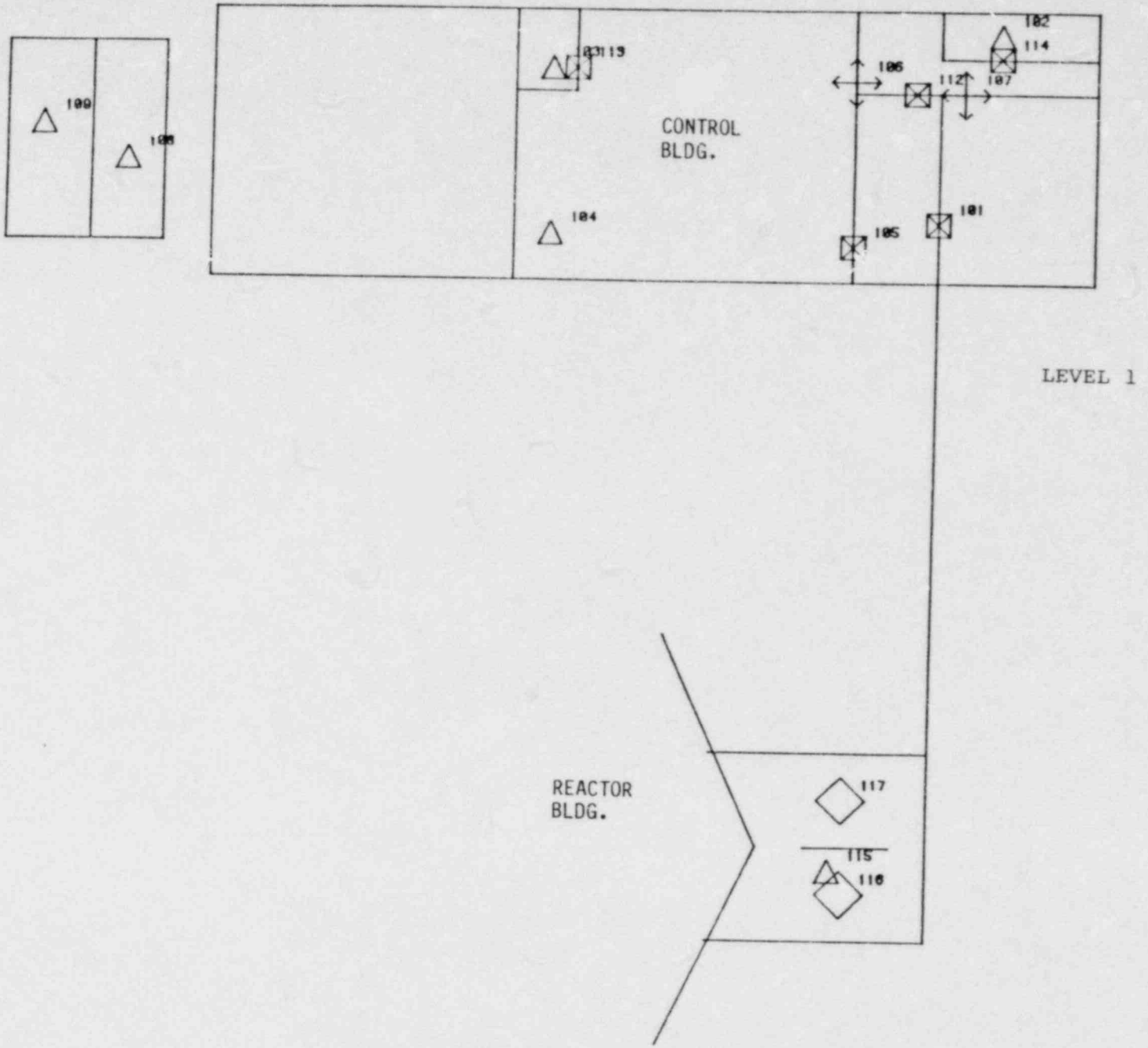


Figure A-1. Continued

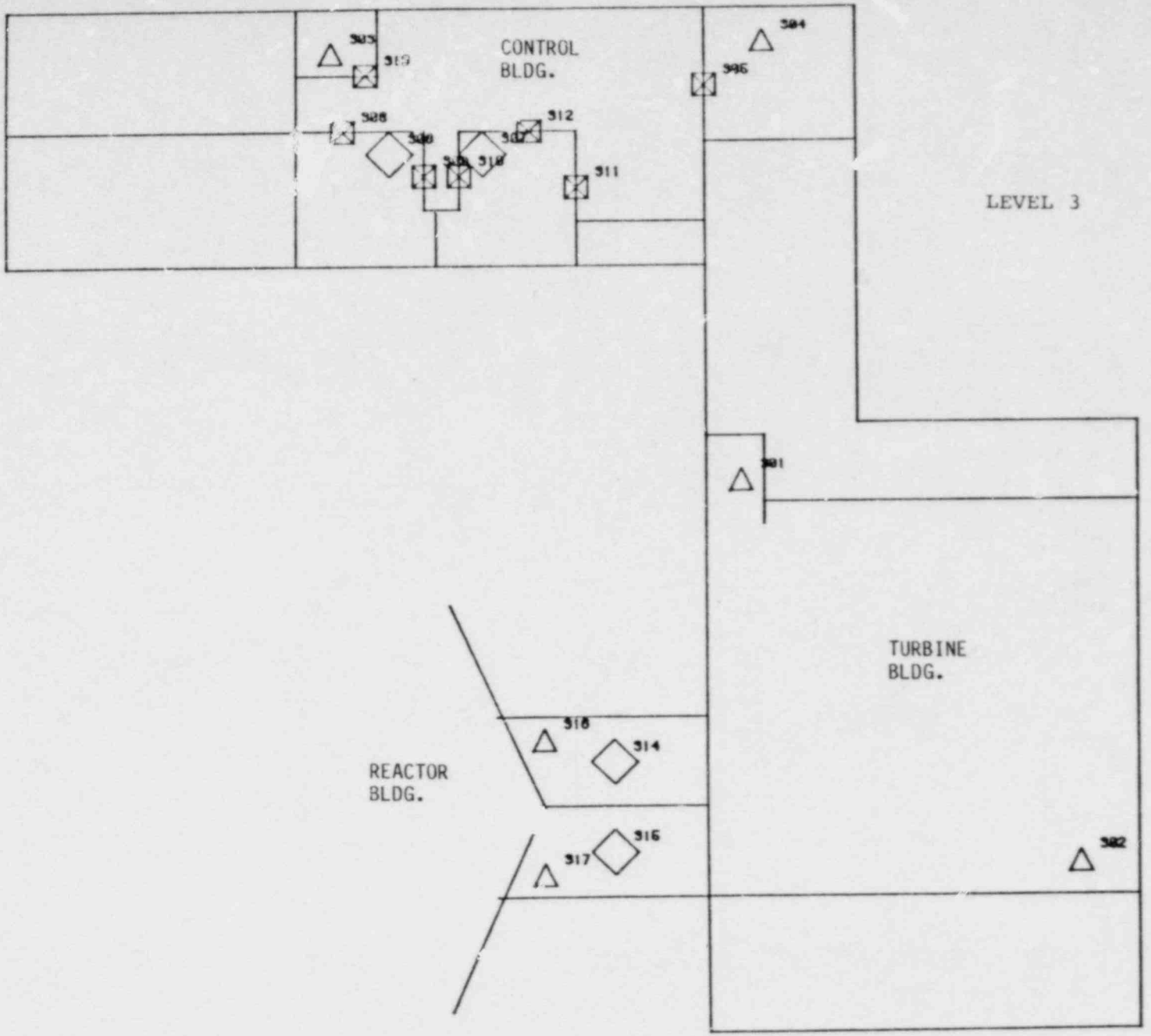


Figure A-1. Continued

LEVEL 4

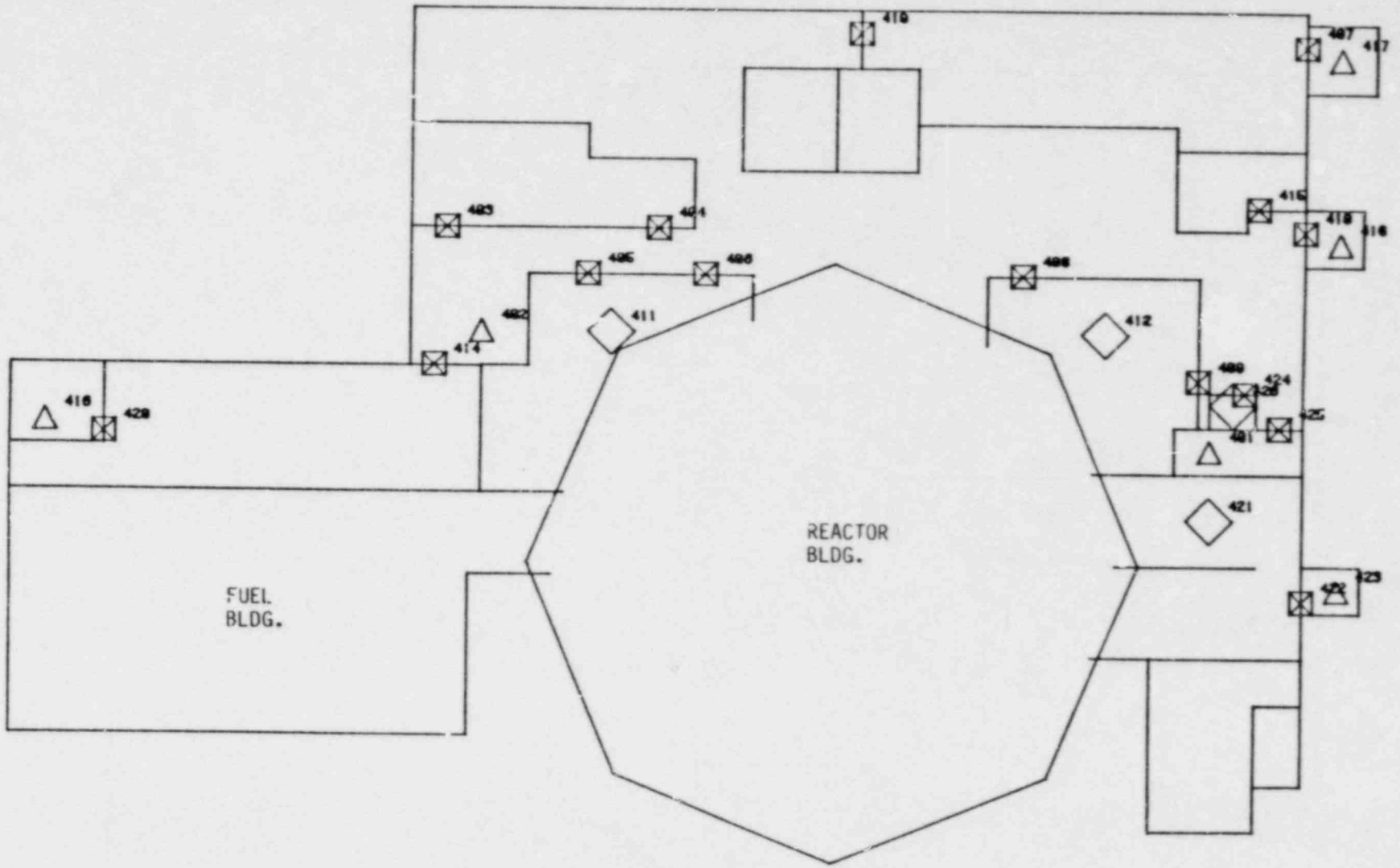


Figure A-1. Continued

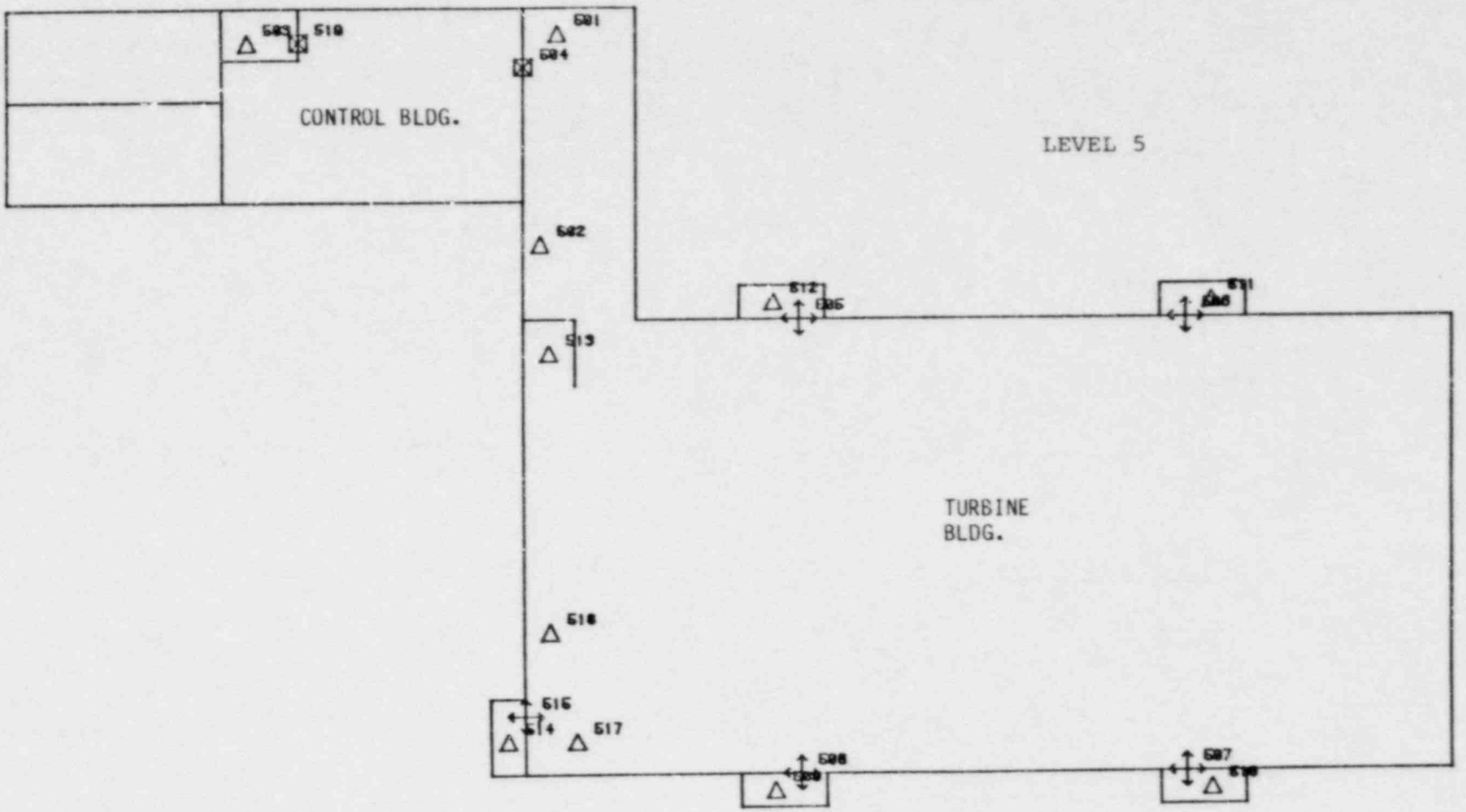


Figure A-1. Continued

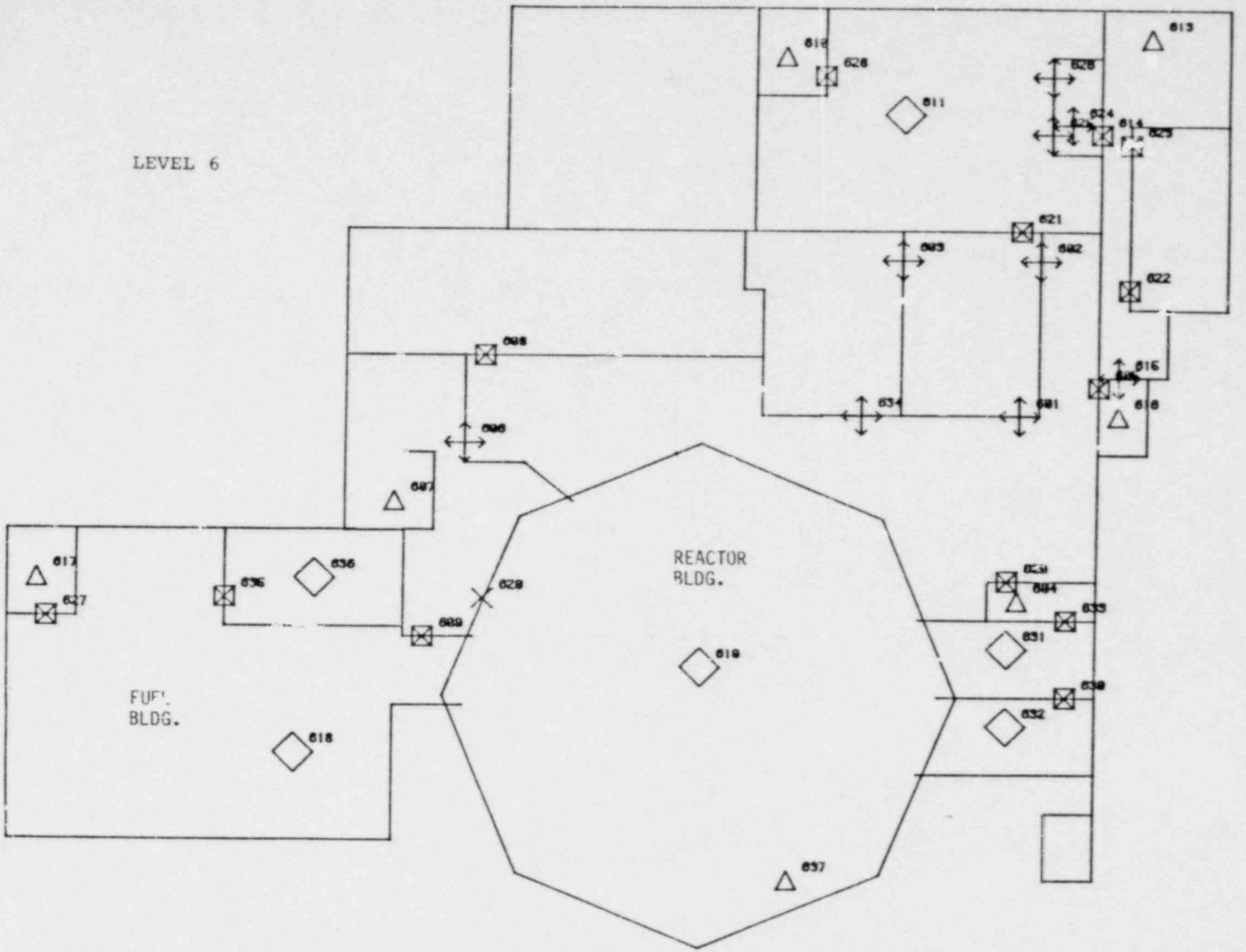


Figure A-1. Continued

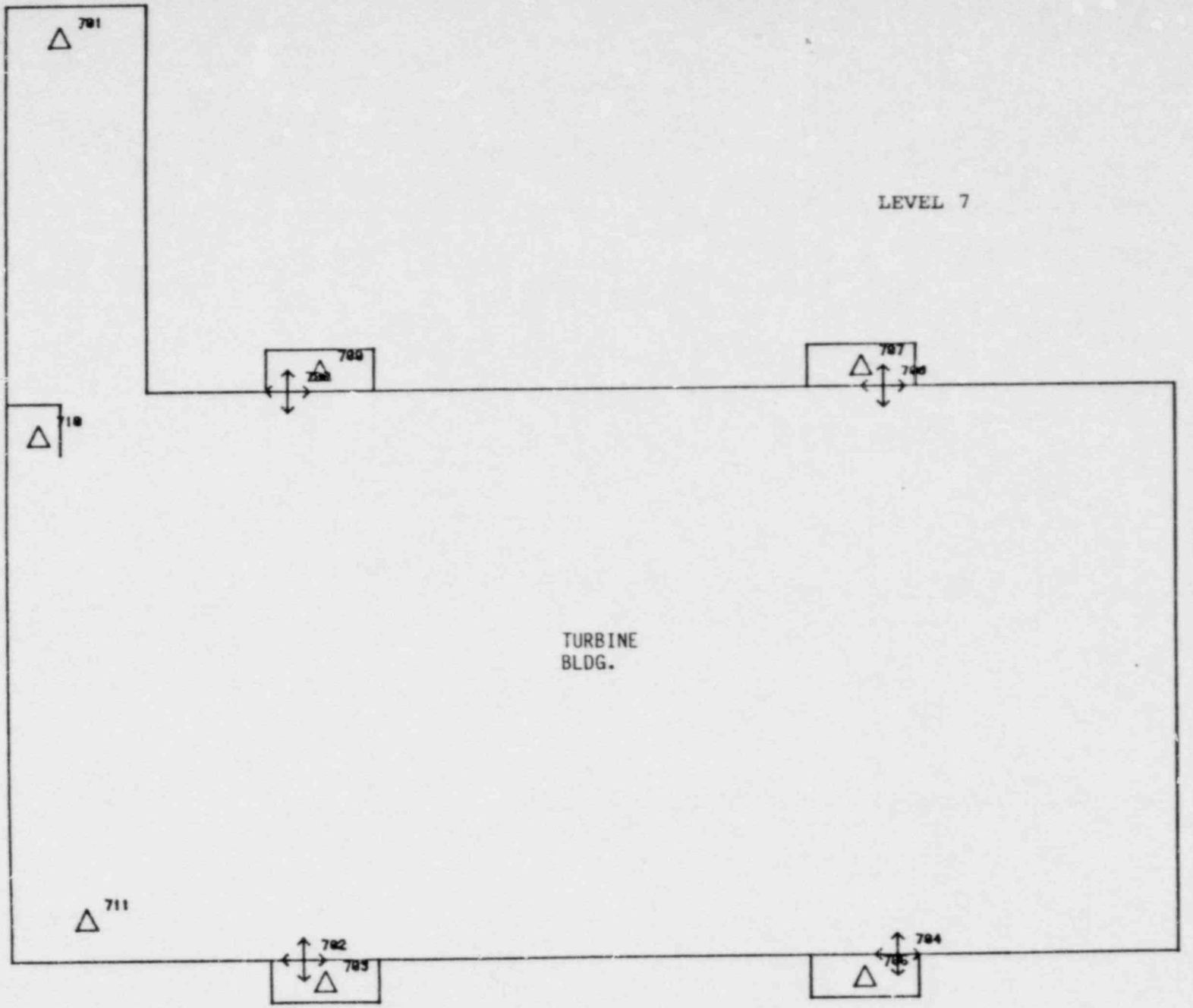


Figure A-1. Continued

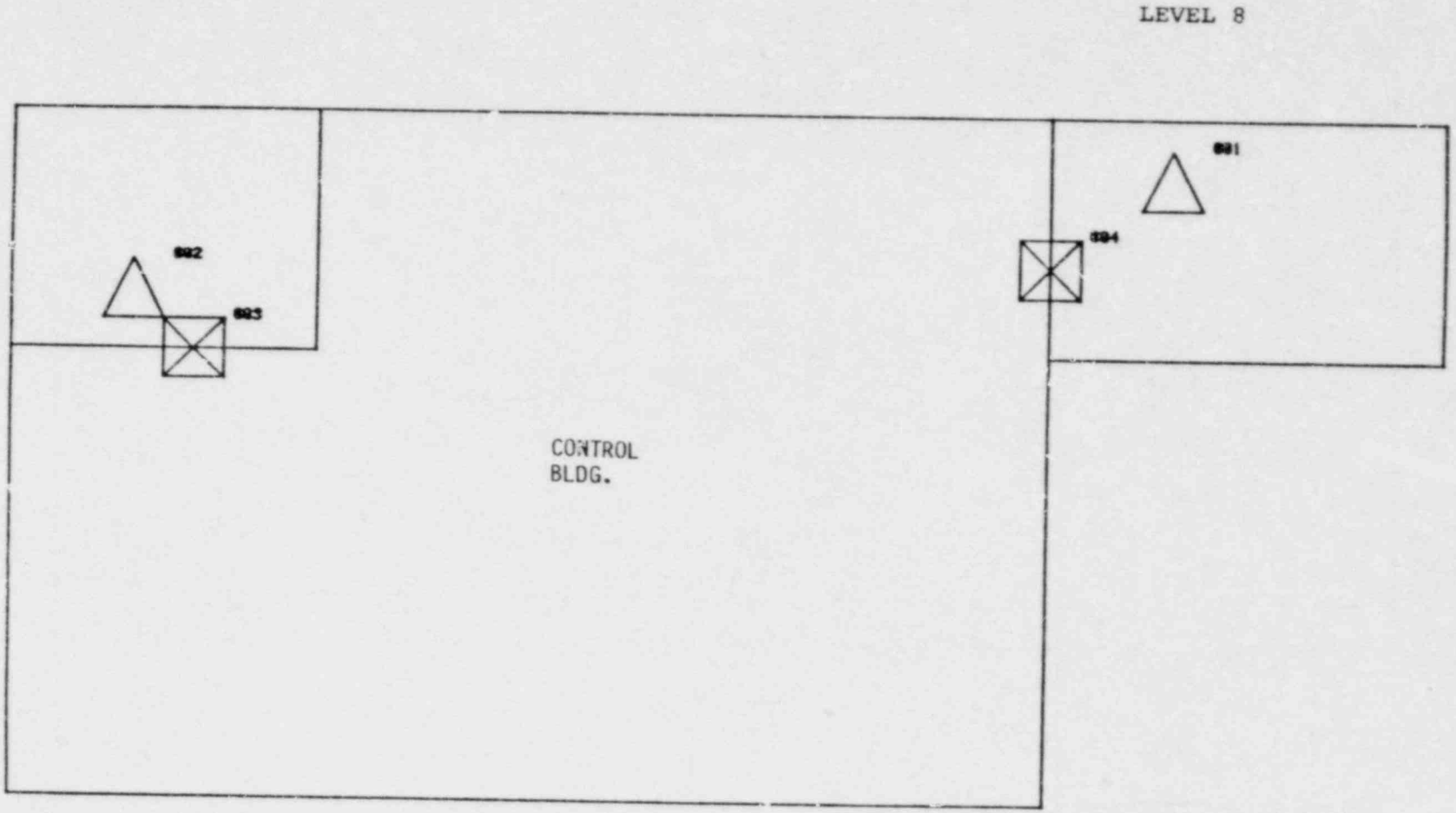


Figure A-1. Continued

Table A-1

Node Symbol Definitions

Node Symbol	Definition
○	Fence node
▩	Vehicle roll-up door
□	Watertight door
×	Containment airlock door
✣	Standard, unlocked door or personnel portal
⊠	Locked door or containment hatch
△	Stairwell
◇	Target

Table A-2

Response Assumptions

Guard station at fence node 284

- All guards stationed here

Roving patrol guard

- Two 1/2-hour patrols each 8-hour shift
- Patrols fence area

Initial response is from roving guard (if on patrol)

Response times are based on minimum travel times from guard positions to targets

- Times are optimistic for guards

Table A-3

Type I Vital Areas (5)

Vital Area Location	Target Node Label	Sabotage Task Time (minutes) Min.	Mean	Max.	Response Time (minutes)
Level 2	293				2.5
	295	2.0	3.5	5.0	3.0
Level 4	426	10.0	20.0	30.0	2.8
Level 6	611	10.0	20.0	30.0	3.2
	618	2.0	3.5	5.0	3.9
	619	5.0	7.5	10.0	6.9
	620				3.7

Table A-4

Type II Vital Areas (27)

Vital Area Location	Target Node Label	Sabotage Task Time (minutes) Min.	Mean	Max.	Response Time (minutes)
Level 0	37	1.0	2.0	3.0	2.8
Level 1	116	1.0	2.0	3.0	3.2
	117	1.0	2.0	3.0	3.3
Level 2	203	1.0	2.0	3.0	2.6
	204	1.0	2.0	3.0	2.6
	205	2.0	3.5	5.0	2.4
	206	2.0	3.5	5.0	2.2
	253	1.0	2.0	3.0	2.8
	262	1.0	2.0	3.0	2.4
	263	1.0	2.0	3.0	2.4
	276	2.0	3.5	5.0	2.3
	277	1.0	2.0	3.0	2.5
	278	1.0	2.0	3.0	2.4
	279	1.0	2.0	3.0	2.5
	280	1.0	2.0	3.0	2.6
	281	1.0	2.0	3.0	2.4
	290	1.0	2.0	3.0	1.5

Table A-4 (Continued)

Vital Area Location	Target Node Label	Sabotage Task Time (minutes)			Response Time (minutes)
		Min.	Mean	Max.	
Level 3	306	2.0	3.5	5.0	2.8
	307	2.0	3.5	5.0	2.7
	314	1.0	2.0	3.0	3.1
	315	1.0	2.0	3.0	3.0
Level 4	411	5.0	7.5	10.0	3.1
	412	5.0	7.5	10.0	2.8
	421	1.0	2.0	3.0	3.2
Level 6	631	5.0	7.5	10.0	3.4
	632	5.0	7.5	10.0	3.5
	636	5.0	7.5	10.0	4.2

A list of combinations of Type II targets which can be attacked by the adversary to achieve sabotage are listed in Table A-5. Combinations are generated by the same fault tree/vital area analysis discussed above.

Table A-5
Type II Vital Area Combinations

Doubles

307-306	262-306	206-203	631-632
203-307	262-203	206-421	412-411
205-307	262-205	205-206	276-636
204-306	276-290	263-206	618-636
204-203	276- 37	116-117	253-636
205-204	206-306	314-315	

Triples

281-307-306	281-304-306	281-262-421
281-421-307	281-421-204	281-262-263
281-263-307	281-263-204	
281-307-306	281-262-306	

Quads

280-279-278-277

NOTE: Combinations are in terms of node labels.

Base case data which characterize the performance of components in the facility are listed in Table A-6. The adversary equipment assumed is also noted.

A.2 GLOBAL INTERRUPTION STUDIES

Global interruption results were generated for each of the following cases:

1. Base case
2. No fence detection
3. Response times increased 1 minute
4. No fence and no exterior building door detection

Table A-6

Component Performance

Component Description	Task Time (minutes)	Detection Probability
Fence		
Chain-link, barbed wire, detection system	0.1	.90
Roll-up doors locked, alarmed	0.8	.95
Watertight doors locked, alarmed	0.8	.90
Containment airlock door	5.0	.90
Standard pedestrian door		
Unlocked, unalarmed	0.05	.01
Locked, unalarmed	0.2	.05
Locked, alarmed	0.2	.90, .95
Personnel portals	0.05	.90
Steel-plate door locked, alarmed	1.0	.95
Containment hatch locked, unalarmed	2.0	.05

NOTE: Adversary equipment includes gloves, pry bar, and explosives.

5. Zero sabotage times
6. a. Minimum sabotage times
   b. Maximum sabotage times
7. All exterior building doors hardened (to 1-minute doors) and alarmed, plus
   a. Base case,
   b. No fence detection, or
   c. Zero sabotage times.

These sensitivity analyses were performed to consider the sensitivity of the evaluation results to various parameters:

- Case 2 considers sensitivity to the fence sensor.
- Case 3 considers delays in guard response.
- Case 4 considers sensitivity to the outer two sensors and provides insights into the insider problem (adversary is inside building undetected).

- Case 5 considers how well access to target areas can be prevented and provides insights into whether an engagement is most likely to occur when the adversaries arrive at the target area or before.
- Cases 6a and 6b consider sensitivities to the target sabotage times.
- Cases 7a, b, and c consider the effect of a design upgrade for the facility.

The global results generated for each facility target (Type I and Type II) for each of the cases considered are presented in Table A-7. Note that the results are for individual targets and do not consider combinations.

Composite interruption measures for combinations of targets were generated using a MAX formula, which takes the maximum of the interruption measures for each of the individual targets that make up a combination as the composite measure. This formula is used on the basis that the facility safeguards system should be able to protect a combination of targets at least as well as it is able to protect any one of its constituent targets.

The worst-case targets and combinations for each global interruption case are summarized in Table A-8. Base case results are fairly good, although other cases indicate possible vulnerabilities. The design upgrade does not result in significant changes in global results, although performance does improve for some targets.

Certain targets and combinations appear consistently as worst cases. In particular, Type I target 618 shows up consistently as a worst-case target, as do Type II combinations 203-204, 116-117, and 276-37. These targets and/or combinations are excellent candidates for further study.

A.3 EASI GRAPHICS STUDIES

The paths chosen for study using EASI Graphics are illustrated in Figure A-2. They include a path to target 618, paths to targets 203 and 204, and a path to target 611. Paths to targets 618, 203, and 204 were chosen since these targets consistently showed up as worst-case paths in the global interruption analysis. The path to target 611 was

Table A-7

Global Interruption Results

- TYPE I TARGETS

Target Location	Node Label	Probability of Interruption (Cases 1, 2, and 3) Base Case	No Fence Detection	Response Times Increased 1 minute
Level 2	293	.90	.21	.67
	295	1.00	---	---
Level 4	426	1.00	1.00	1.00
Level 6	611	.99	.95	.99
	618	.95	.73	.77
	619	.98	.91	.96
	620	.99	.92	.95

- TYPE II TARGETS

Level 0	37	.89	.17	.50
Level 1	116	.88	.28	.59
	117	.88	.27	.58
Level 2	203	.88	.23	.47
	204	.88	.23	.48
	205	.99	.94	.89
	206	.99	.90	.96

Table A-7 (Continued)

- TYPE II TARGETS (Continued)

Target Location	Node Label	Probability of Interruption (Cases 1, 2, and 3) Base Case	No Fence Detection	Response Times Increased 1 minute
	253	.81	.21	.39
	262	.97	.72	.86
	263	.97	.72	.86
	276	.89	.00	.78
	277	.99	.93	.94
	278	.97	.74	.87
	279	.99	.93	.94
	280	1.00	.98	.98
	281	.97	.74	.87
	290	.97	.78	.80
Level 3	306	.99	.89	.91
	307	.99	.90	.95
	314	1.00	.97	.97
	315	.99	.90	.93
Level 4	411	1.00	.99	1.00
	412	1.00	1.00	1.00
	421	.81	.08	.44
Level 6	631	1.00	1.00	1.00
	632	1.00	1.00	1.00
	636	1.00	.99	.99

Table A-7 (Continued)

- TYPE I TARGETS

Target Location	Node Label	Probability of Interruption (Cases 4, 5, 6a, and 6b) No Fence, Ext. Door Detection	Zero Sabotage Times	Minimum Sabotage Times	Maximum Sabotage Times
Level 2	293	.00	.90	.90	.90
Level 4	426	.95	.12	1.00	1.00
Level 6	611	.95	.08	.99	.99
	618	.38	.05	.68	.99
	619	.04	---	.93	.99
	620	.00	.99	.99	.99

- TYPE II TARGETS

Level 0	37	.15	.06	.50	.96
Level 1	116	.12	.16	.62	.97
	117	.11	.16	.62	.96
Level 2	203	.00	.04	.47	.96
	204	.00	.04	.47	.97
	205	.82	.02	.87	1.00
	206	.90	.03	.93	.99
	253	.13	.03	.36	.96

Table A-7 (Continued)

- TYPE II TARGETS (Continued)

Target Location	Node Label	Probability of Interruption (Cases 4, 5, 6a, and 6b) No Fence, Ext. Door Detection	Zero Sabotage Times	Minimum Sabotage Times	Maximum Sabotage Times
	262	.72	.64	.89	.99
	263	.72	.64	.89	.99
	276	.00	.01	.74	.90
	277	.93	.87	.96	1.00
	278	.74	.67	.90	.99
	279	.93	.87	.96	1.00
	280	.98	.94	.99	1.00
	281	.74	.66	.90	.99
	290	.00	.21	.87	.99
Level 3	306	.85	.06	.93	1.00
	307	.89	.08	.93	1.00
	314	.97	.92	.98	1.00
	315	.90	.84	.95	1.00
Level 4	411	.94	.12	1.00	1.00
	412	.94	.15	1.00	1.00
	421	.07	.06	.43	.92
Level 6	631	.99	.19	1.00	1.00
	632	1.00	.26	1.00	1.00
	636	.97	.05	.99	1.00

Table A-7 (Continued)

- TYPE I TARGETS

Target Location	Node Label	Probability of Interruption (Cases 7a, 7b, and 7c)		
			All Exterior Bldg. Doors Hardened and Alarmed, plus	
		Base Case	No Fence Detection	Zero Sabotage Times
Level 2	293	.90	.21	.90
Level 4	426	1.00	1.00	.60
Level 6	611	1.00	1.00	.39
	618	.97	.77	.21
	619	.98	.91	---
	620	.99	.92	.99

- TYPE II TARGETS

Level 0	37	.95	.60	.38
Level 1	116	.96	.70	.60
	117	.96	.69	.60
Level 2	203	.88	.23	.09
	204	.89	.23	.12
	205	.99	.95	.25
	206	1.00	.97	.37
	253	.90	.21	.25
	262	1.00	.97	.90
	263	1.00	.97	.90
	276	.89	.00	.01

Table A-7 (Continued)

- TYPE II TARGETS (Continued)

Target Location	Node Label	Probability of Interruption (Cases 7a, 7b, and 7c)		
		All Exterior Bldg. Doors Hardened and Alarmed, plus		
		Base Case	No Fence Detection	Zero Sabotage Times
	277	1.00	.99	.97
	278	1.00	.97	.90
	279	1.00	.99	.97
	280	1.00	1.00	.99
	281	1.00	.97	.90
	290	.98	.83	.82
Level 3	306	.99	.95	.39
	307	.99	.96	.47
	314	1.00	1.00	.99
	315	1.00	.99	.96
Level 4	411	1.00	.99	.47
	412	1.00	1.00	.66
	421	.95	.59	.41
Level 6	631	1.00	1.00	.64
	632	1.00	1.00	.70
	636	1.00	.99	.20

Table A-8

Worst Case Targets and Combinations

	Type I Target (PI)	Type II Combination (PI)*
Base case	618 (.95)	203-204 (.88) 116-117 (.88) 276- 37 (.89)
No fence detection	618 (.73)	276- 37 (.17) 203-204 (.23) 116-117 (.28)
Response times increased 1 minute	618 (.77)	203-204 (.48) 116-117 (.59) 276- 37 (.78)
No fence, ext. door detection	619 (.04) 618 (.38)	203-204 (.00) 276-290 (.00) 116-117 (.12) 276- 37 (.15)
Zero sabotage times	618 (.05) 611 (.08) 426 (.12)	205-206 (.03) 203-204 (.04) (Many others <.10)
Minimum sabotage times	611 (.68)	203-204 (.47) 116-117 (.62) 276- 37 (.74)
Maximum sabotage times	(All ≥ .99)	276- 37 (.96) 203-204 (.97) 116-117 (.97)

All Exterior Bldg. Doors Hardened and Alarmed

Plus	Type I Target (PI)	Type II Combination (PI)
Base case	618 (.97)	203-204 (.89) 276- 37 (.95) 116-117 (.96)
No fence detection	618 (.77)	203-204 (.23) 276- 37 (.60) 116-117 (.70)
Zero sabotage times	618 (.21) 611 (.39)	203-204 (.12) 276-636 (.20) (Many others <.50)

*The formula used for finding the probability of interruption (PI) of a combination of targets was the maximum of the PIs of the targets which belong to the combination.

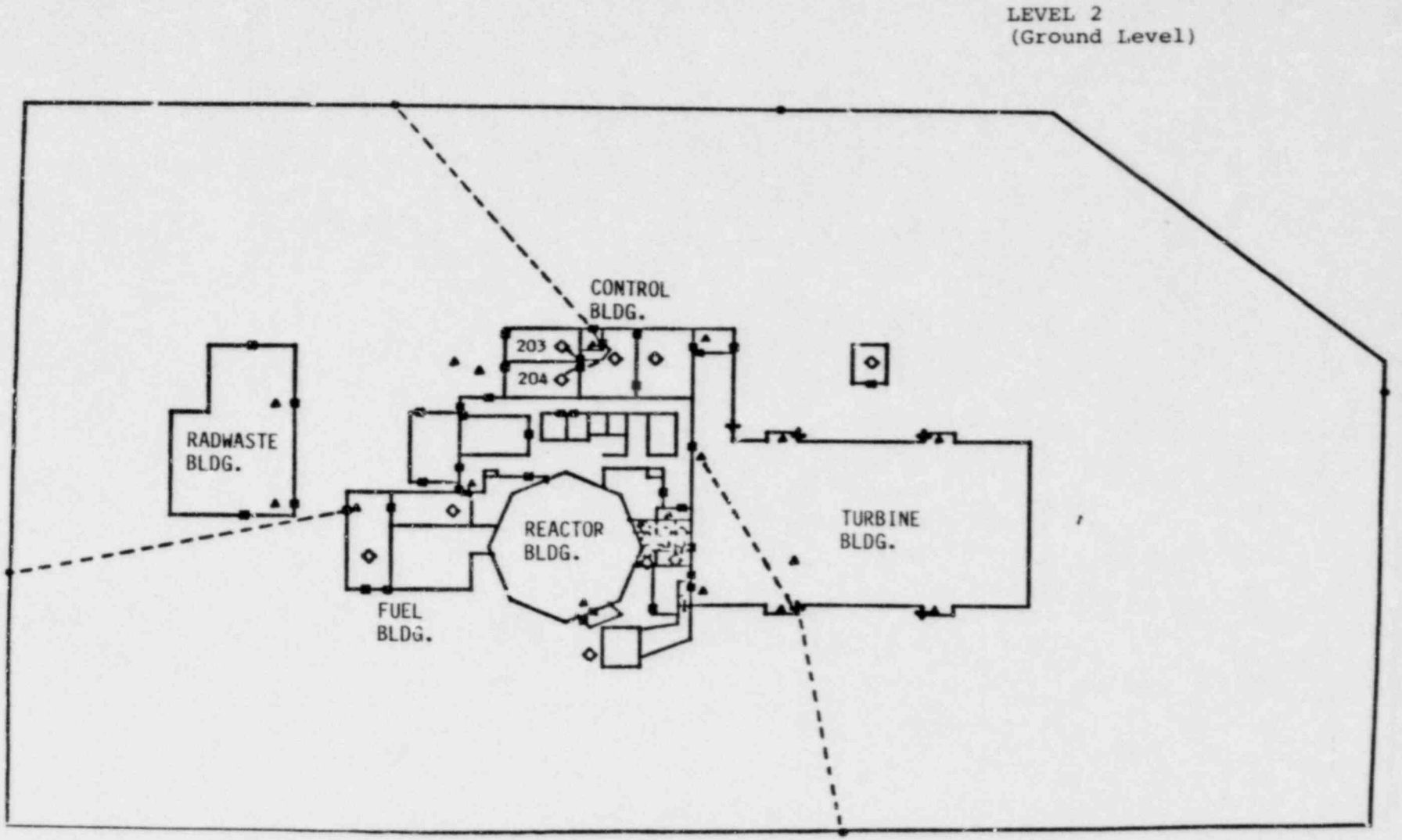


Figure A-2. Paths Analyzed Using EASI Graphics

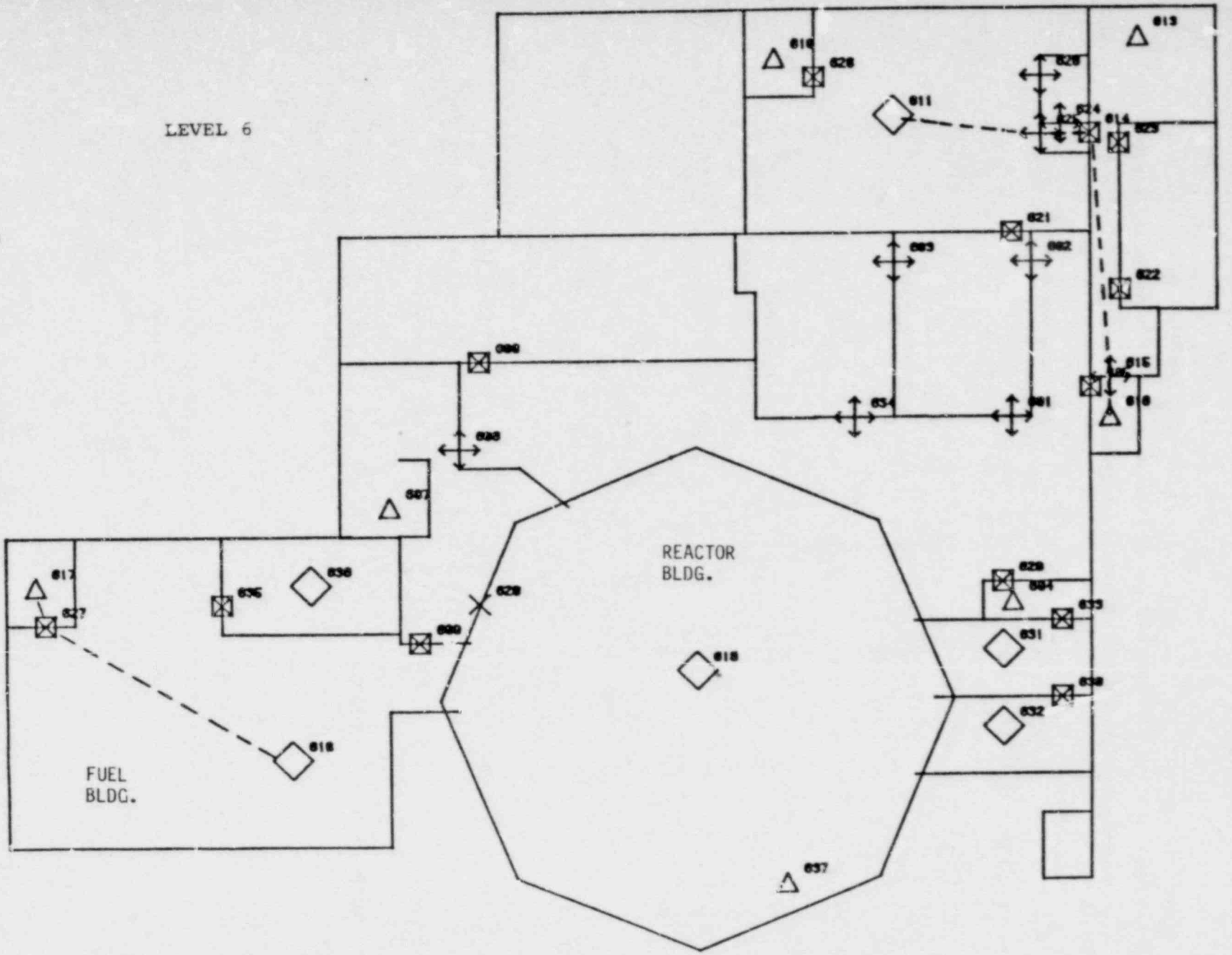


Figure A-2. Continued

considered since target 611 showed up as a worst-case when only access to the target areas is considered (Zero Sabotage Times case).

Base case data for the path to target 618 are listed in Table A-9. Plots generated for this path (Plots 1 through 8) are provided in Figure A-3.

Table A-9

Base Data for Path 282-269-251-617-627-618

Response Time	3.90
Standard Deviation	.78
Probability of Communication	1.00

	Task	Mean	Std. Dev.	Prob. Det.
Fence	1	.10	.02	0.00
	2	.95	.19	.90
Exterior door	3	.20	.04	0.00
	4	.03	.01	.95
Stairs (Level 2)	5	.01	.00	0.00
↕	6	.83	.17	0.00
Stairs (Level 6)	7	.01	.00	.00
	8	.04	.01	0.00
Door	9	.20	.04	.00
	10	.25	.05	.95
Target	11	3.50	.70	.00

Base case data for the paths to targets 203 and 204 (these paths are virtually identical) are listed in Table A-10. Plots generated for these paths (Plots 1 through 9) are provided in Figure A-4.

Base case data for the path to target 611 are listed in Table A-11. Plots generated for this path (Plots 1 through 7) are provided in Figure A-5.

A.4 NEUTRALIZATION STUDIES

Two generic engagements were modeled: One was modeled to represent an engagement outside the buildings (in an open area), and the other was modeled to represent an engagement inside the buildings (in a more confined area).

Base case engagement parameters are listed in Table A-12 for both the outside and inside cases. Three adversaries are assumed. The adversaries are first engaged by an initial response force (one guard in

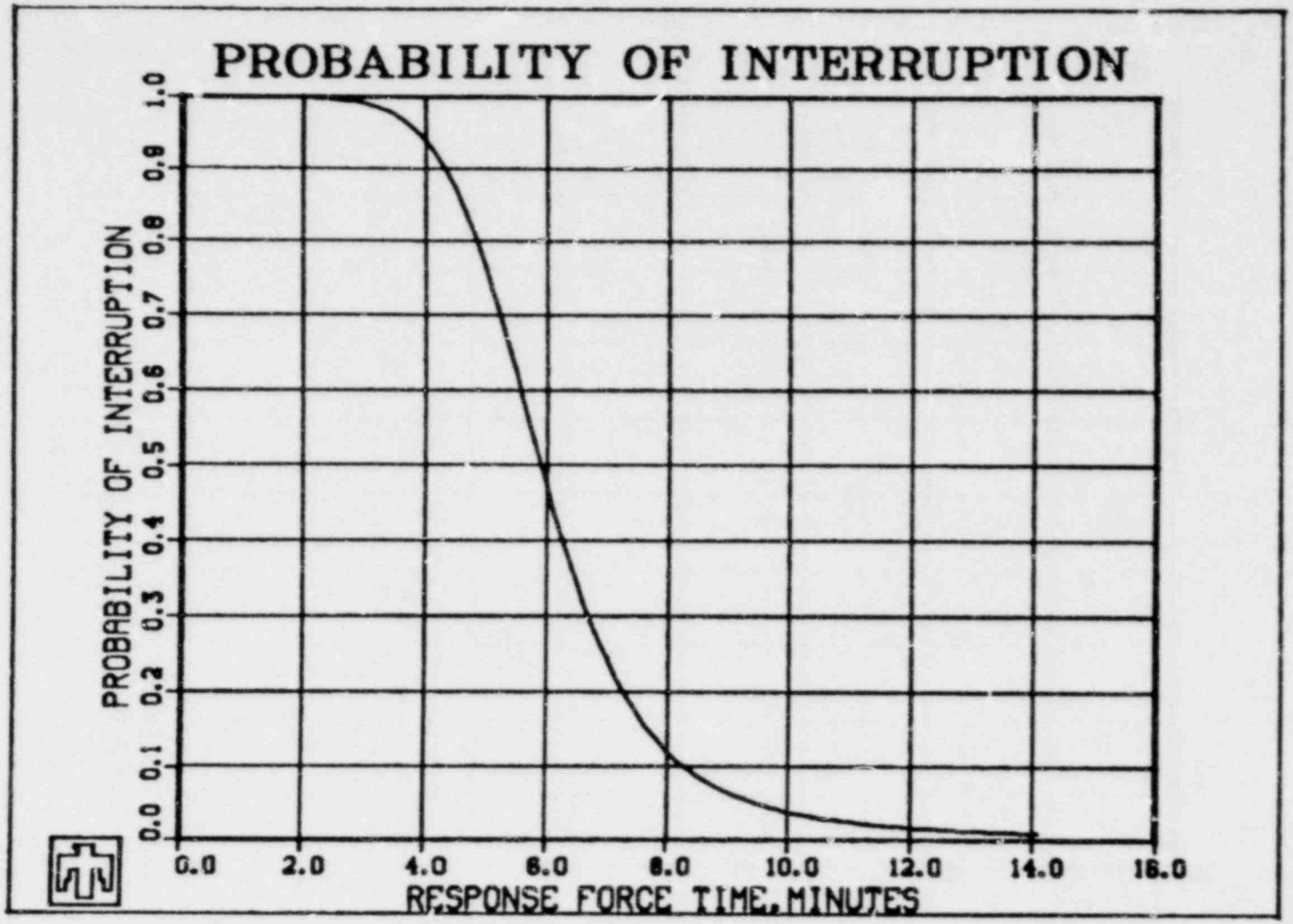


Figure A-3. Plots of Path to Target 618.
Plot 1--Interruption vs. Response Time (base value = 3.90 minutes)

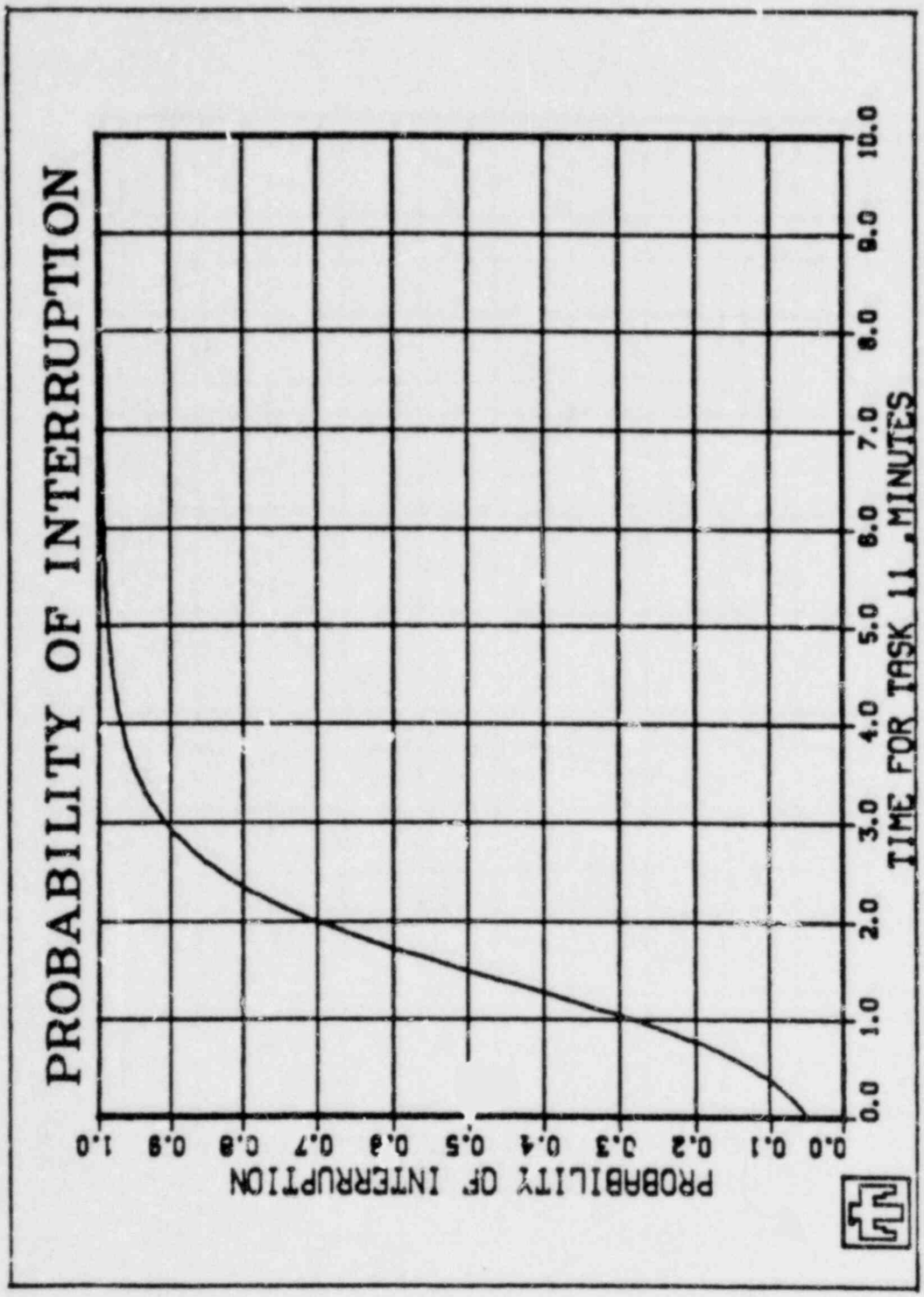


Figure A-3. Continued
Plot 2--Interruption vs. Time for Task 11 (target sabotage time, base value = 3.50 minutes)

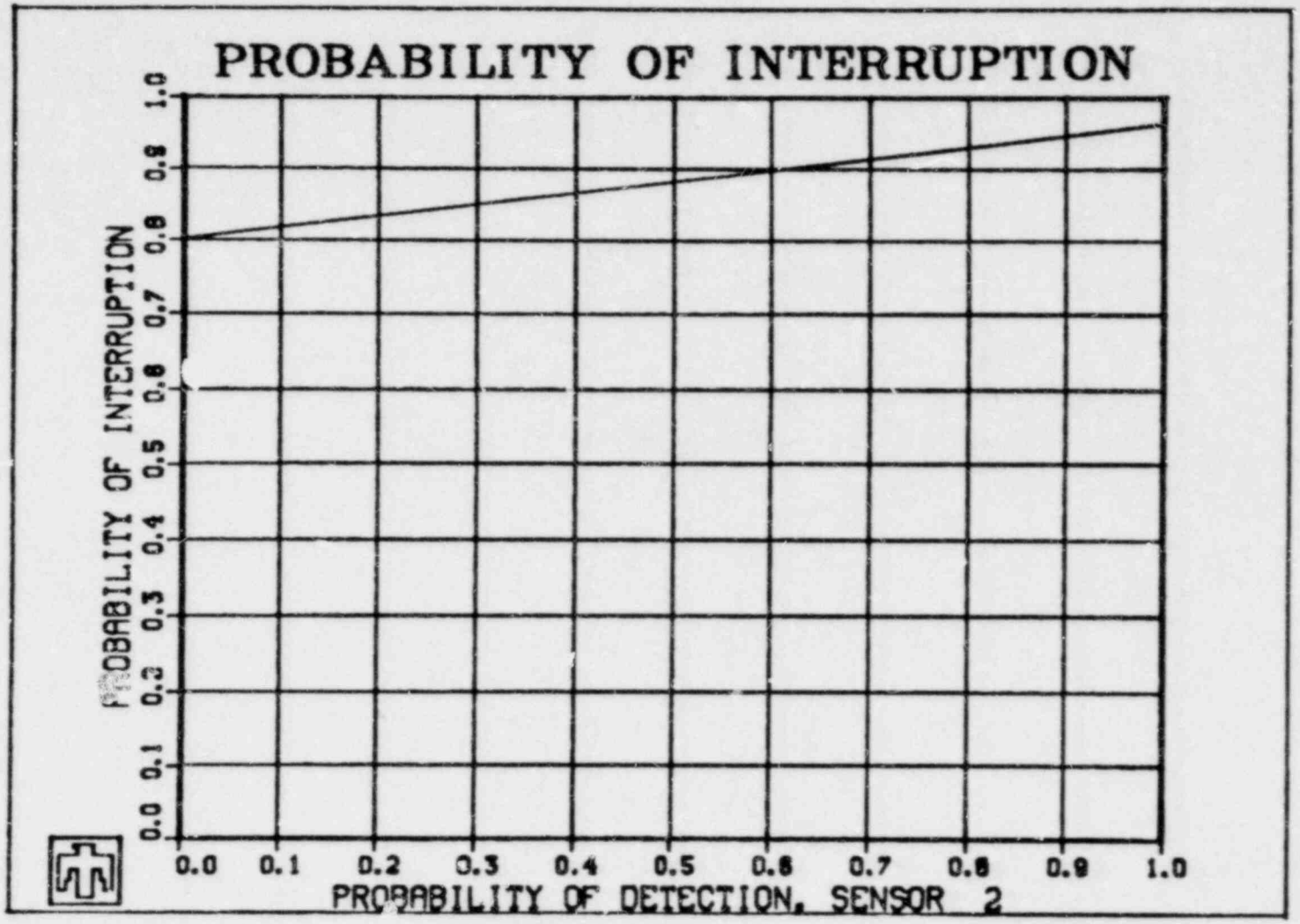


Figure A-3. Continued
Plot 3--Interruption vs. Sensor 2 Detection (fence sensor, base value = .90)

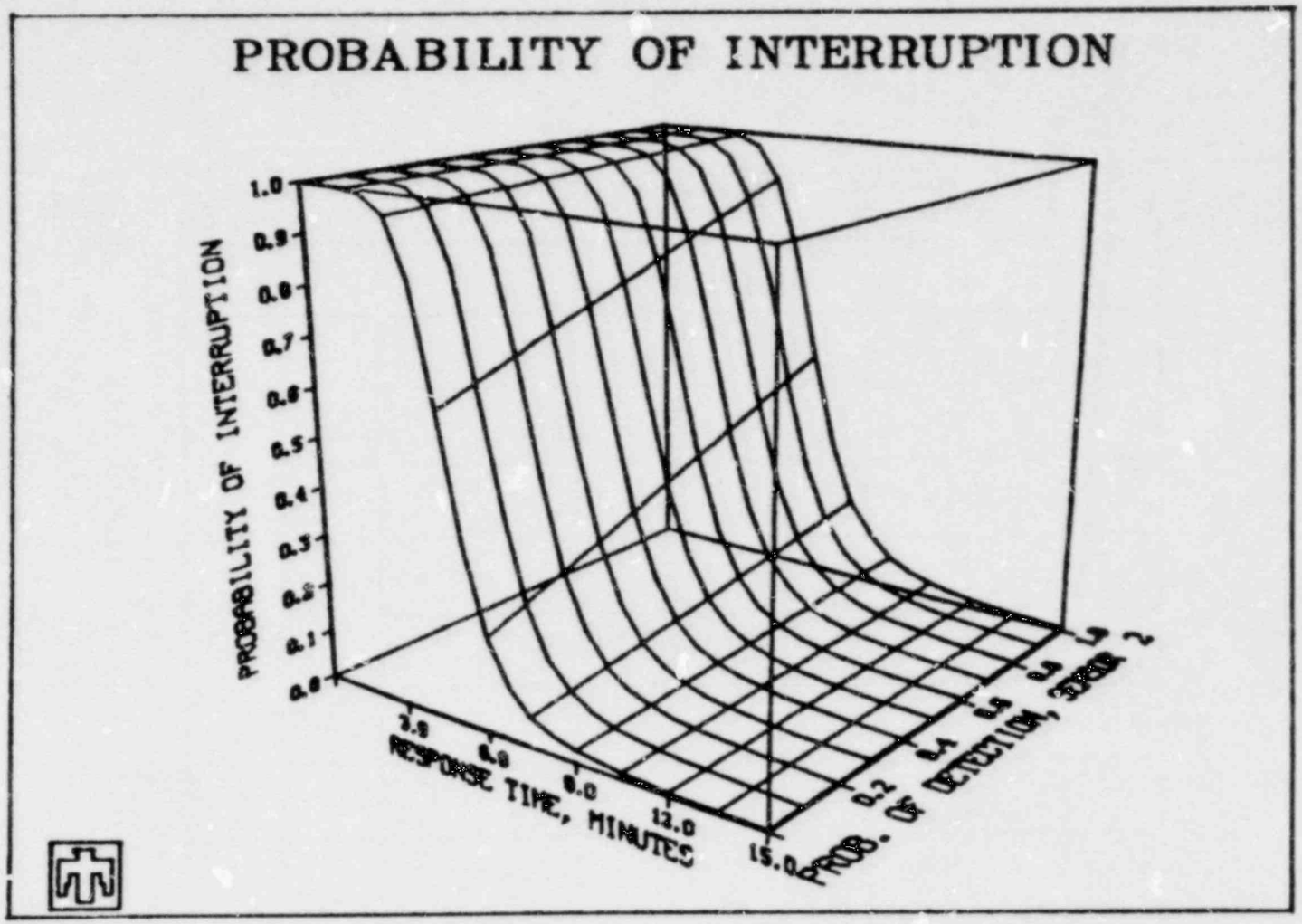


Figure A-3. Continued
Plot 4--Interruption vs. Response Time (base value = 3.90 minutes) and Sensor 2 Detection (fence sensor, base value = .90)

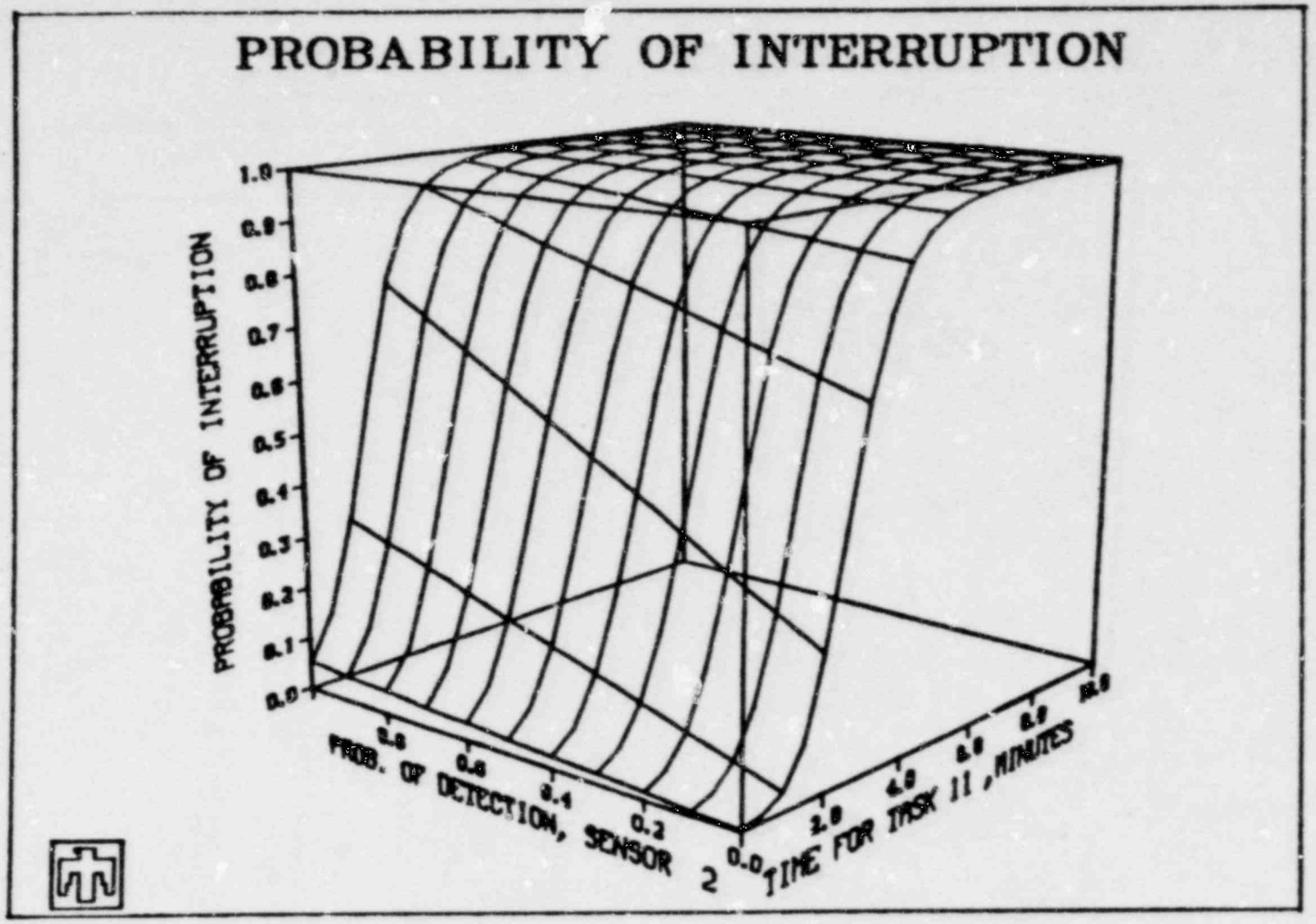


Figure A-3. Continued
Plot 5--Interruption vs. Sensor 2 Detection (fence sensor, base value = .90) and Time for Task 11 (target sabotage time, base value = 3.50 minutes)

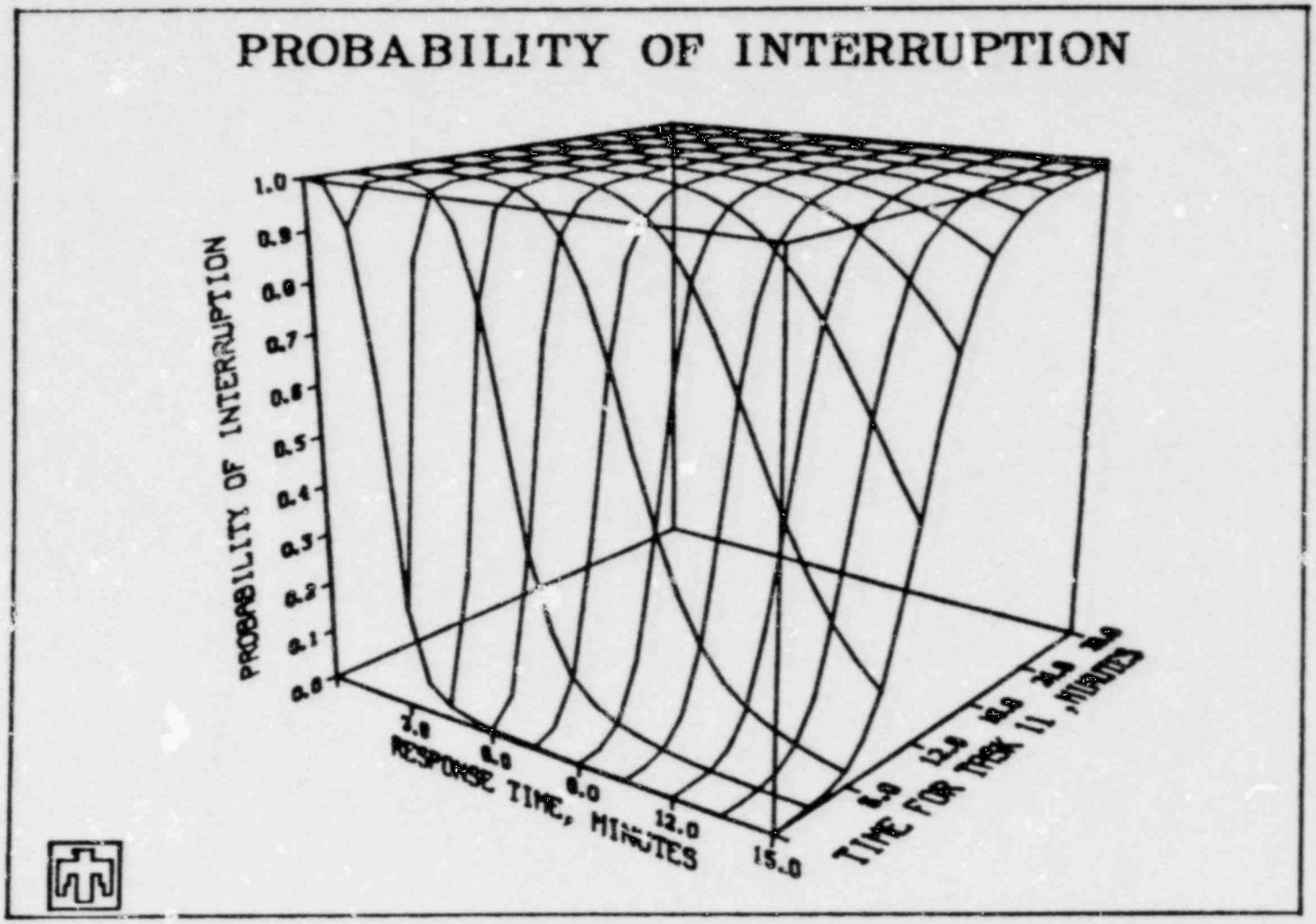


Figure A-3. Continued
Plot 6--Interruption vs. Response Time (base value = 3.90 minutes) and Time for Task 11 (target sabotage time, base value = 3.50 minutes)

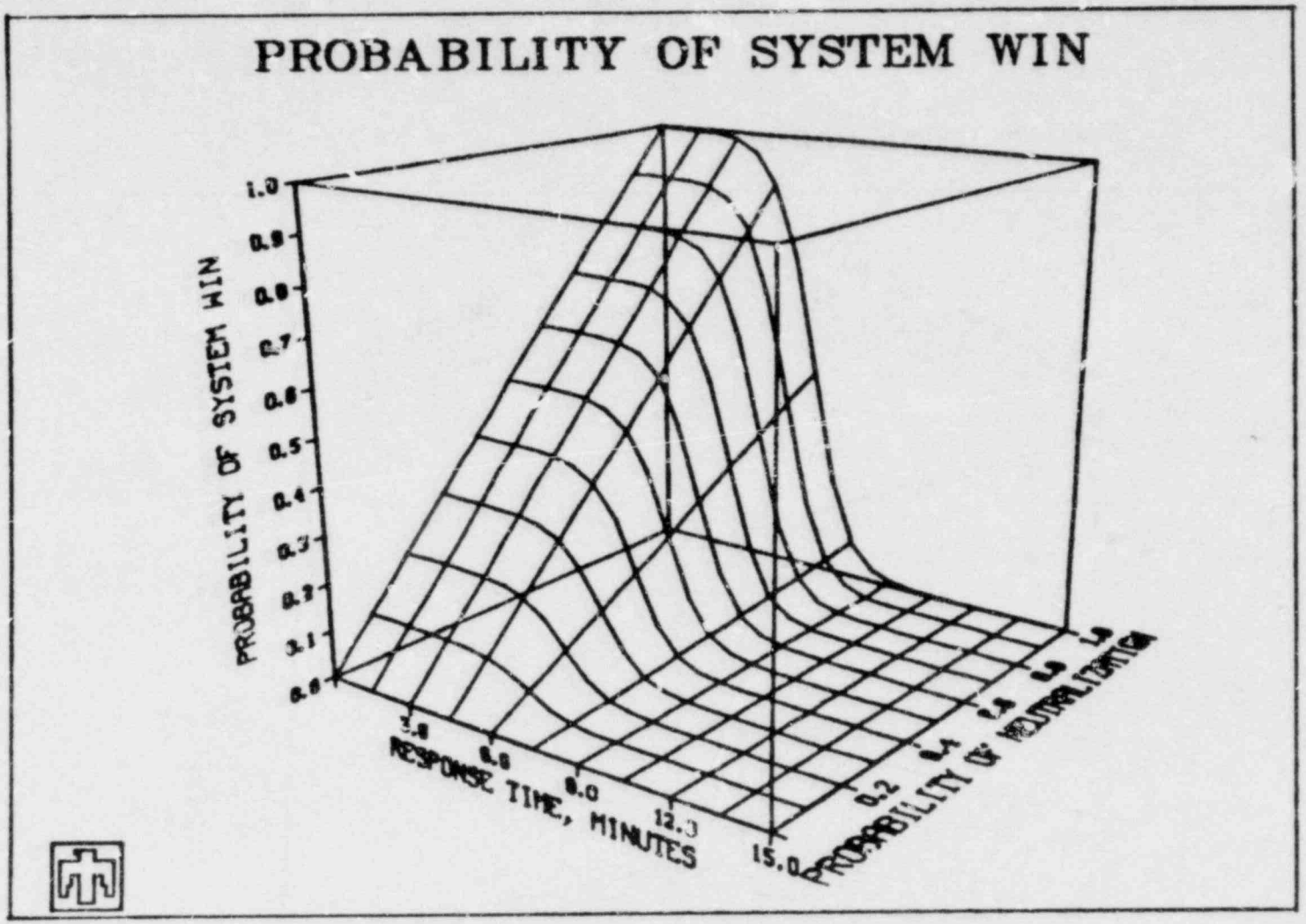
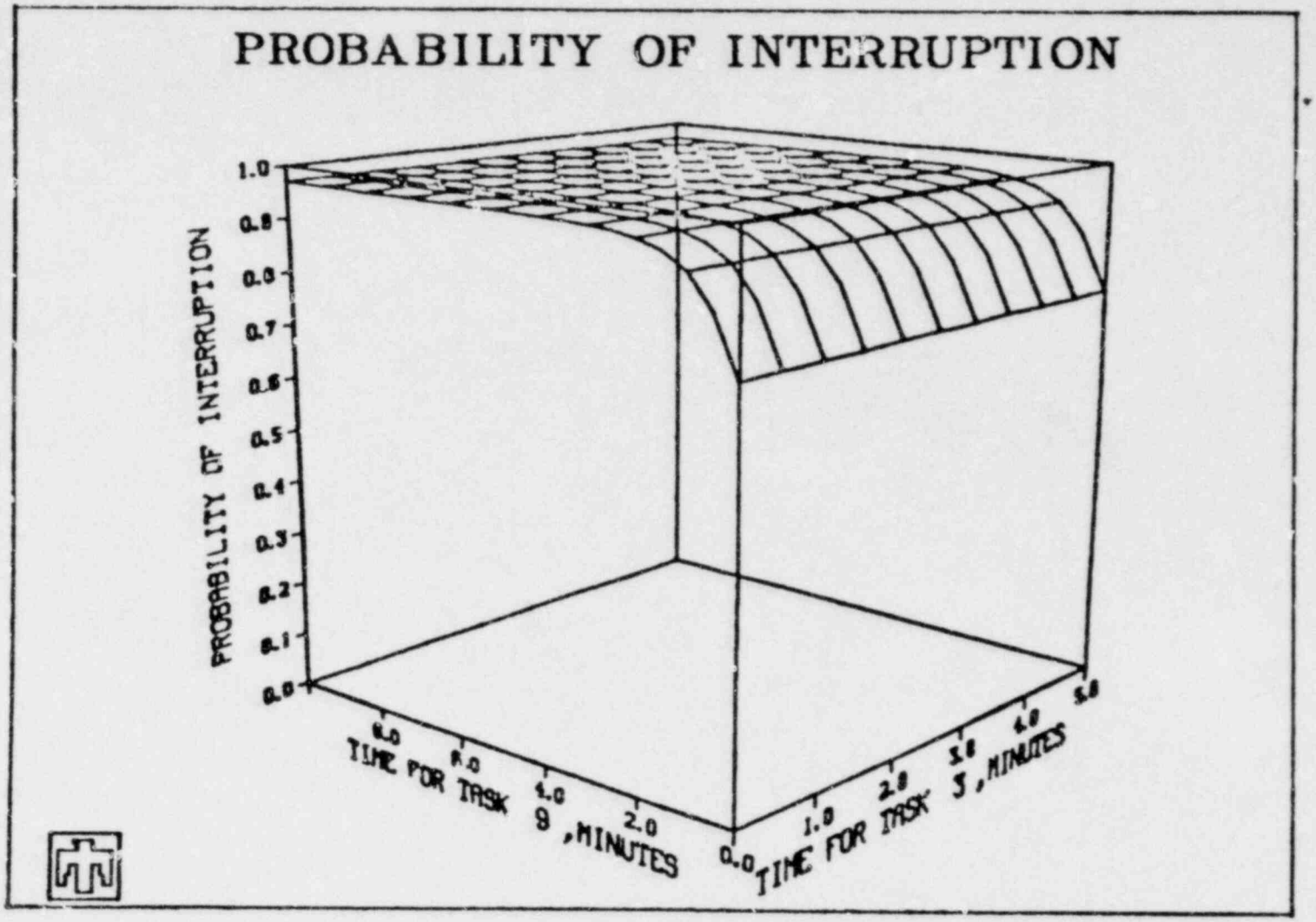


Figure A-3. Continued
Plot 7--System Win vs. Response Time (base value = 3.90 minutes) and Neutralization



NOTE: ASSUMES NO FENCE DETECTION (SENSOR 2 PROB. DET. = 0)

Figure A-3. Continued
Plot 8--Interruption vs. Time for Task 9 (interior door, base value = 0.20 minute) and Time for Task 3 (exterior door, base value = 0.20 minute)

Table A-10

Base Data for Path 283-246-289-239-203
or Path 283-246-289-238-204

Response Time	2.60
Standard Deviation	.52
Probability of Communication	1.00

	Task	Mean	Std. Dev.	Prob. Det.
Fence	1	.10	.02	0.00
	2	.83	.17	.90
Exterior Door	3	.20	.04	0.00
	4	.05	.01	.95
Door	5	.20	.04	.00
	6	.12	.02	.95
Door	7	.20	.04	.00
	8	.06	.01	.90
Target	9	2.00	.40	0.00

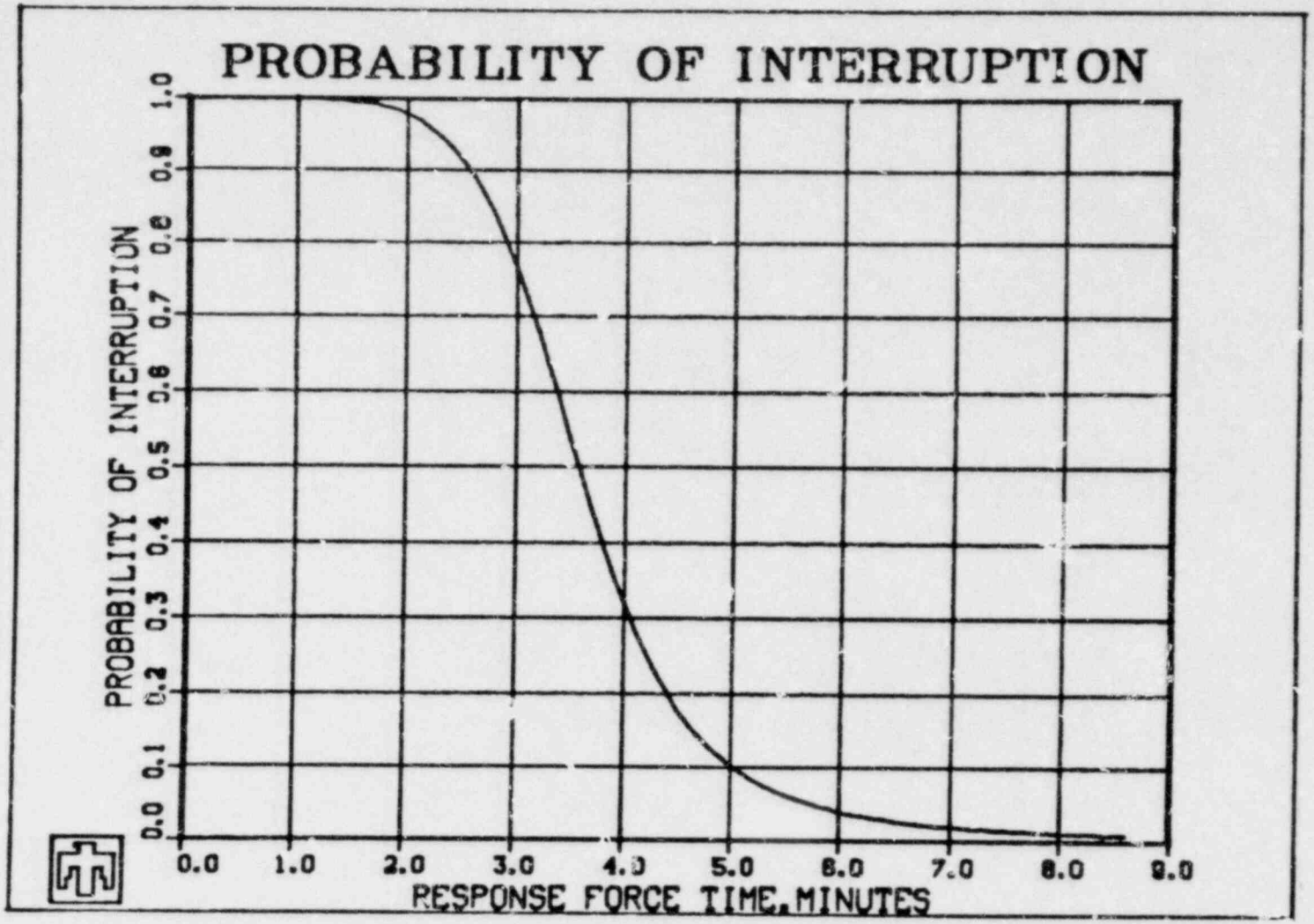


Figure A-4. Plots for Paths to Targets 203 and 204
Plot 1--Interruption vs. Response Time (base value = 2.60 minutes)

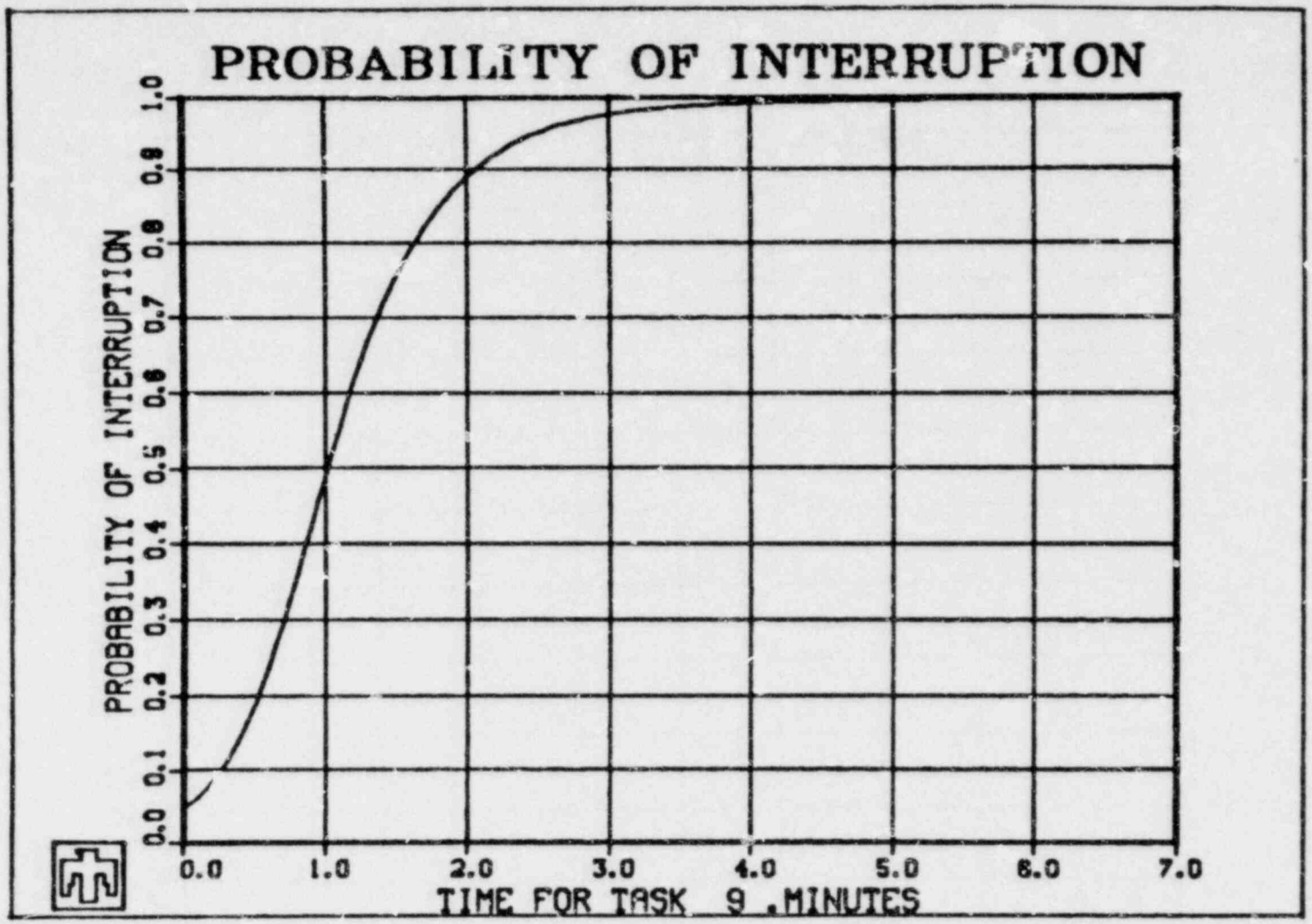


Figure A-4. Continued
Plot 2--Interruption vs. Time for Task 9 (target sabotage time, base value = 2.00 minutes)

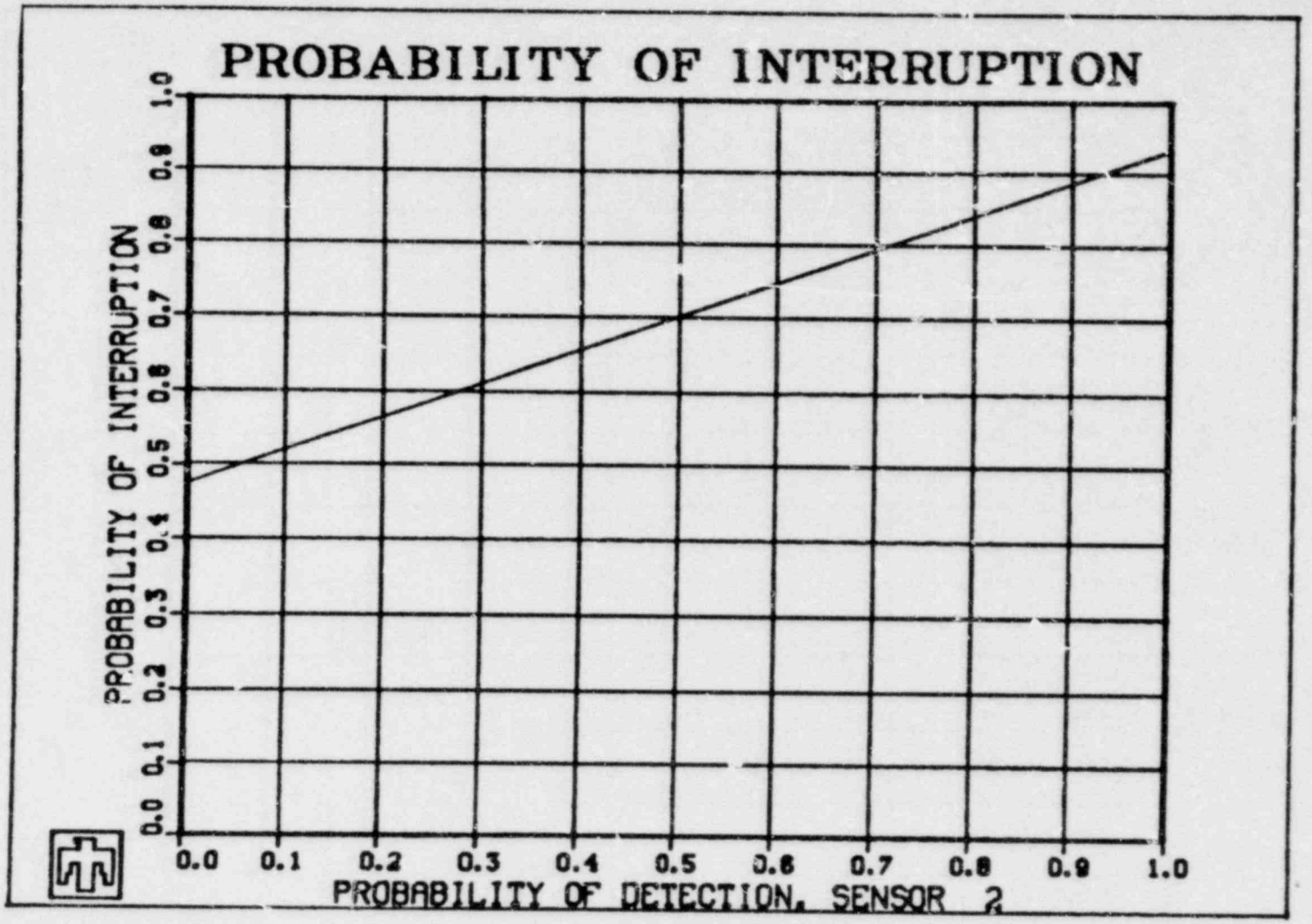


Figure A-4. Continued
Plot 3--Interruption vs. Sensor 2 Detection (fence sensor, base value = .90)

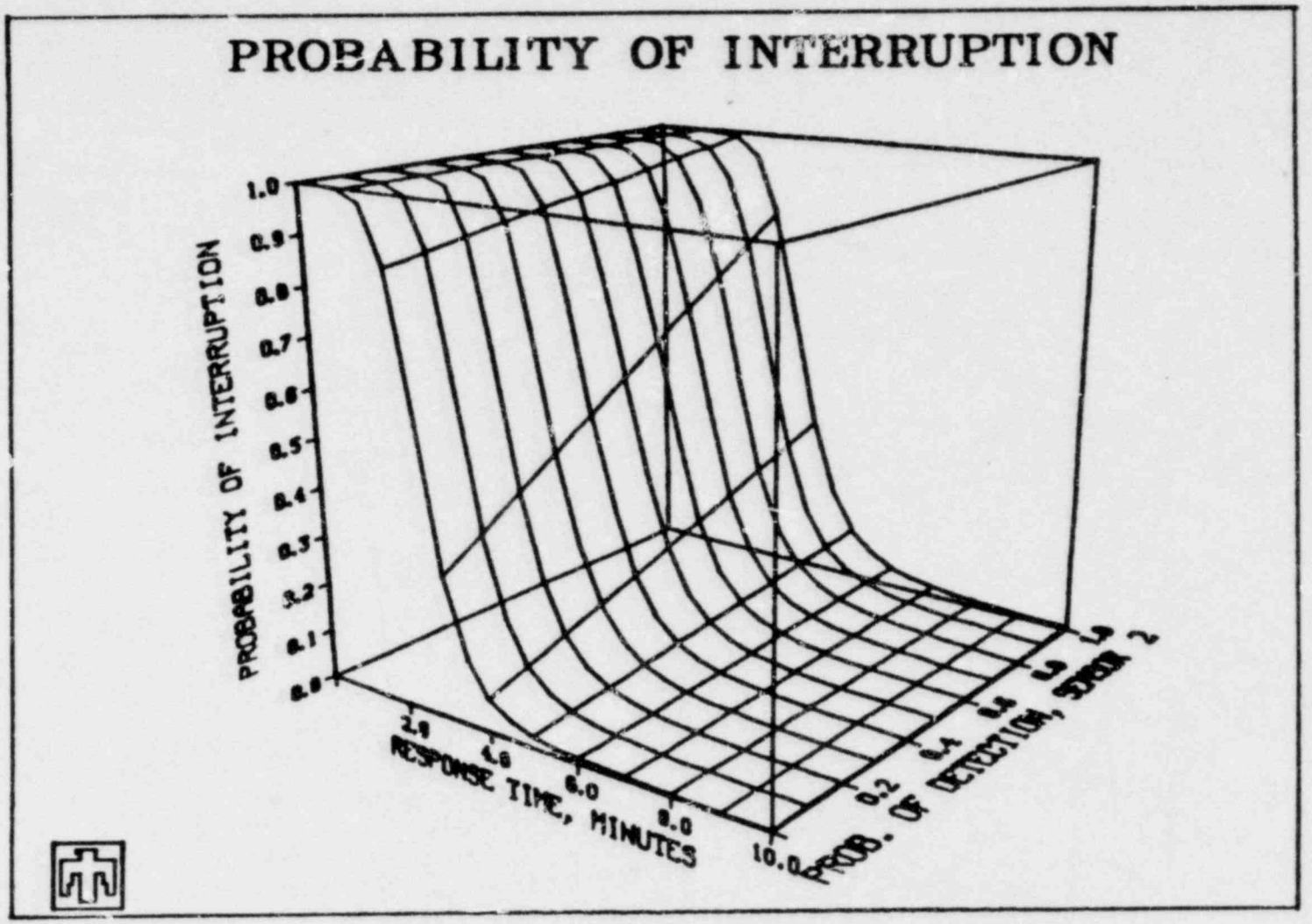


Figure A-4. Continued
Plot 4--Interruption vs. Response Time (base value = 2.60 minutes) and Sensor 2 Detection (fence sensor, base value = .90)

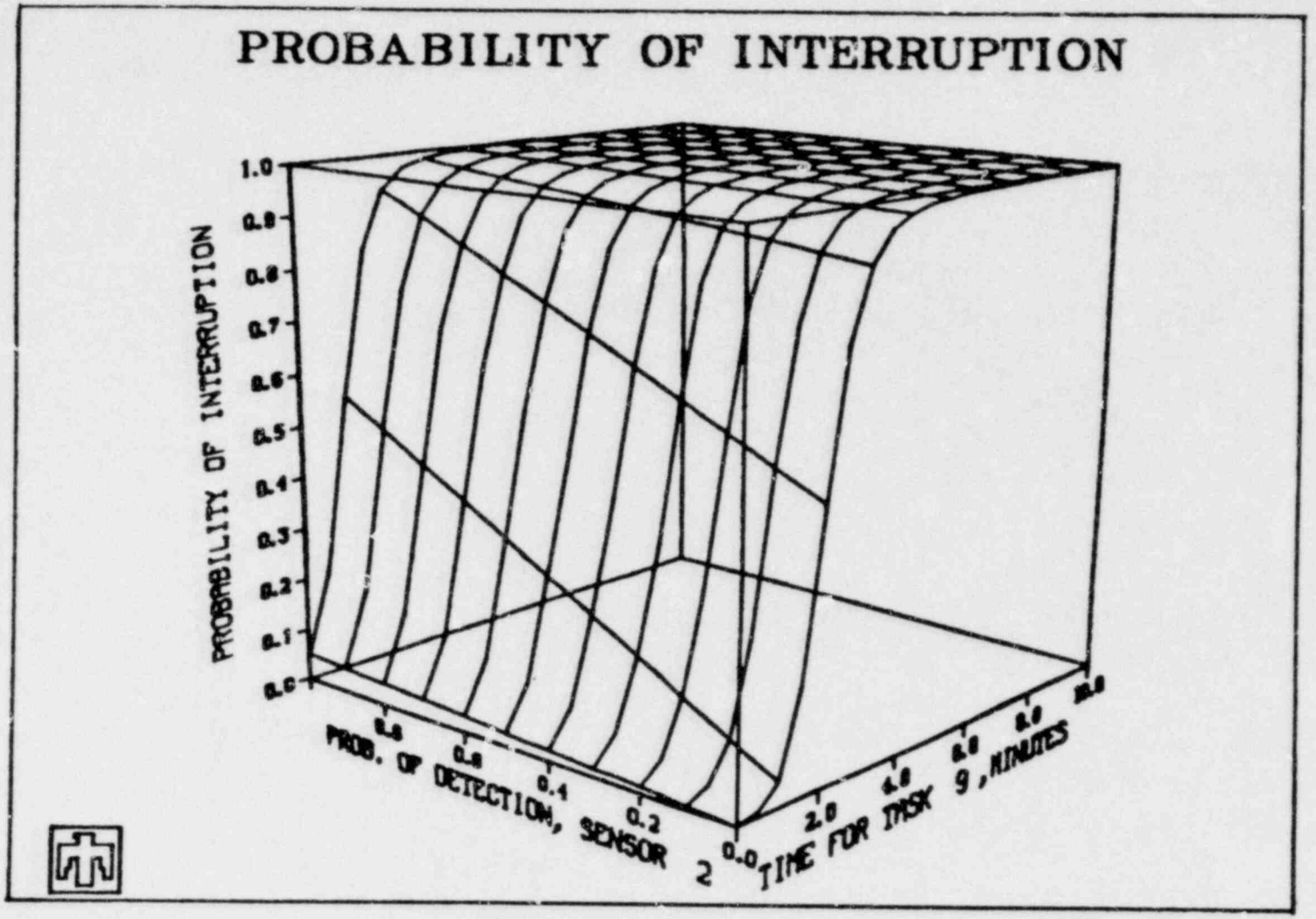


Figure A-4. Continued
Plot 5--Interruption vs. Sensor 2 Detection (fence sensor, base value = .90) and Time for Task 9 (target sabotage time, base value = 2.0 minutes)

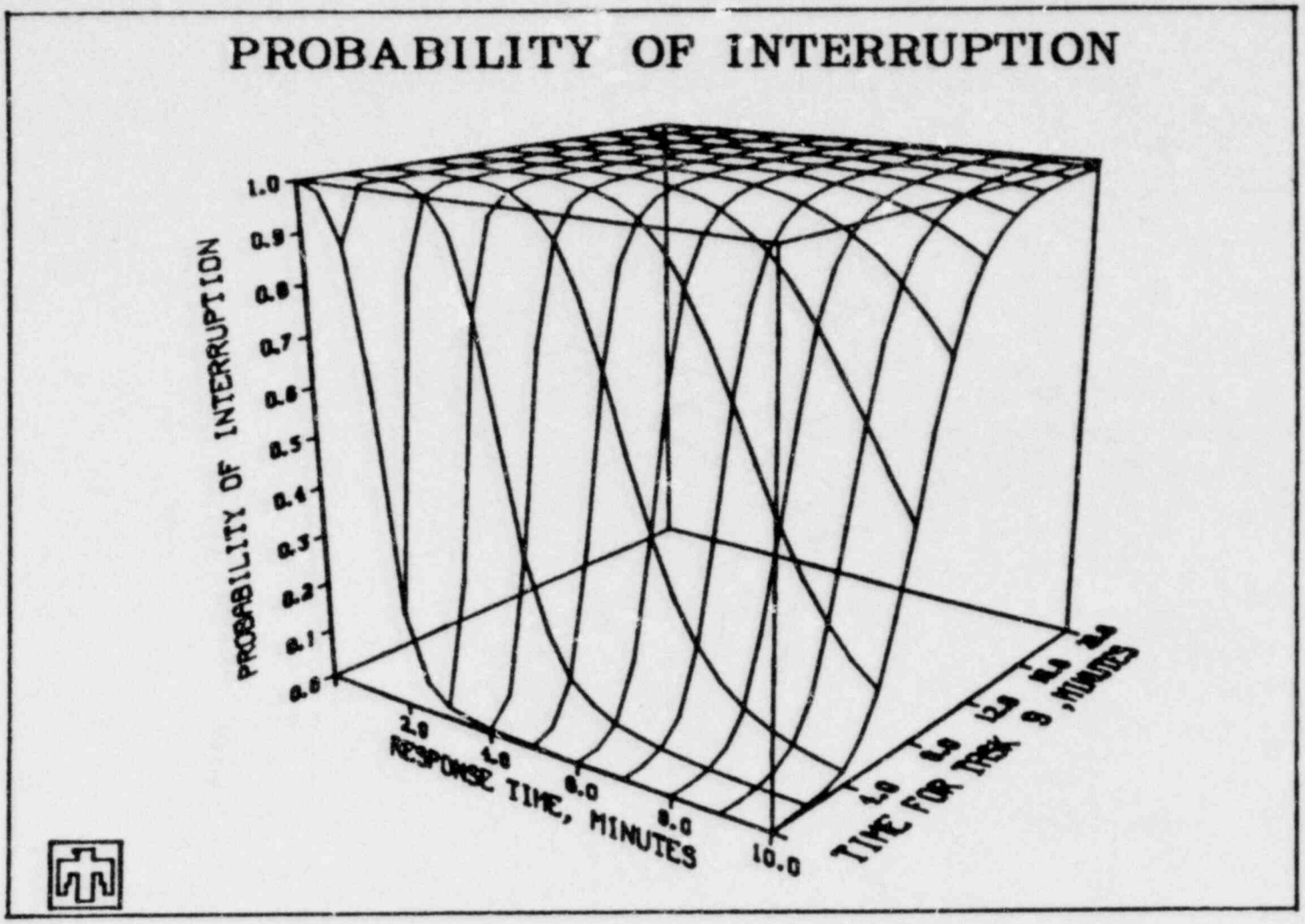


Figure A-4. Continued
Plot 6--Interruption vs. Response Time (base value = 2.60 minutes) and Time for Task 9 (target sabotage time, base value = 2.00 minutes)

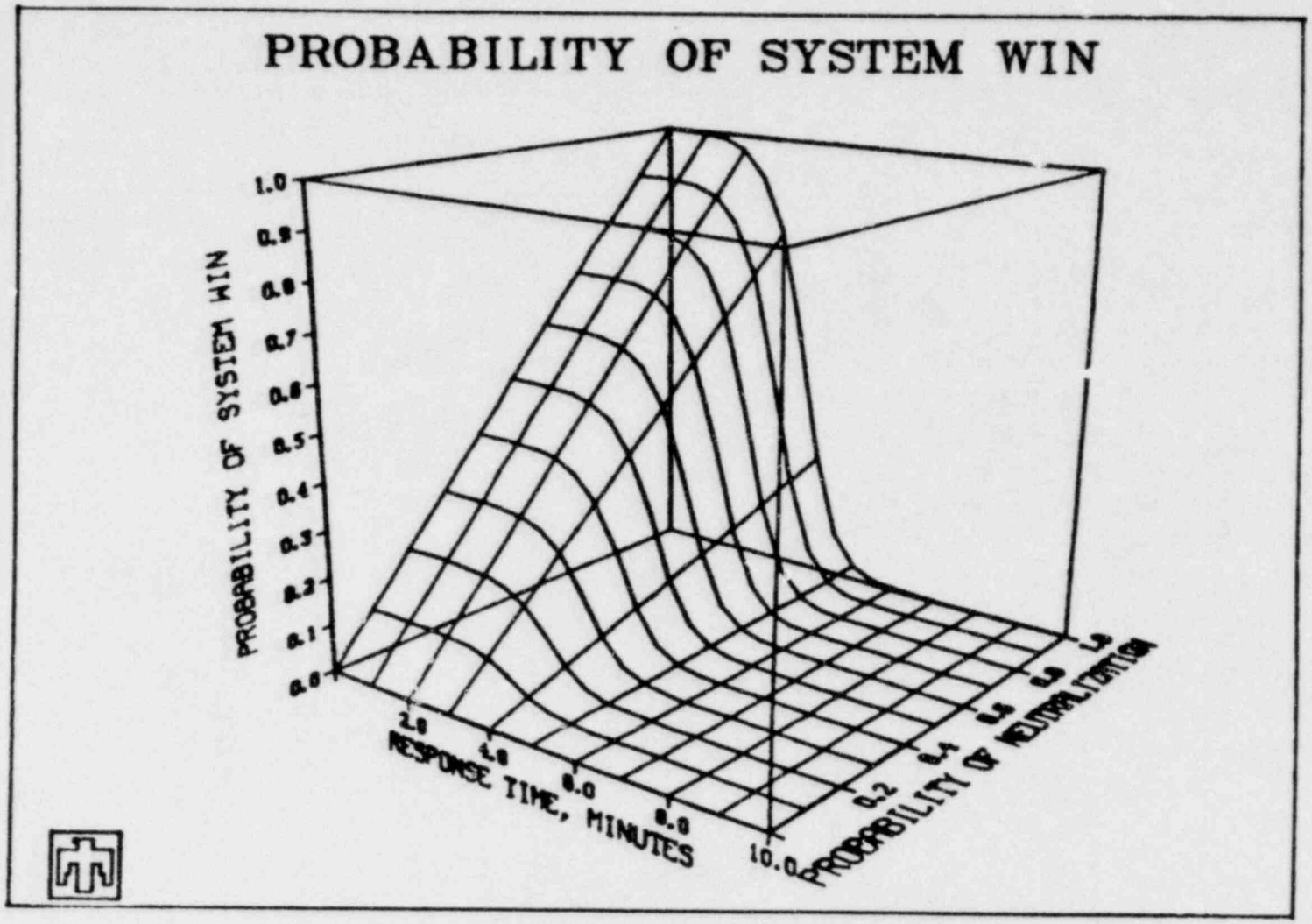
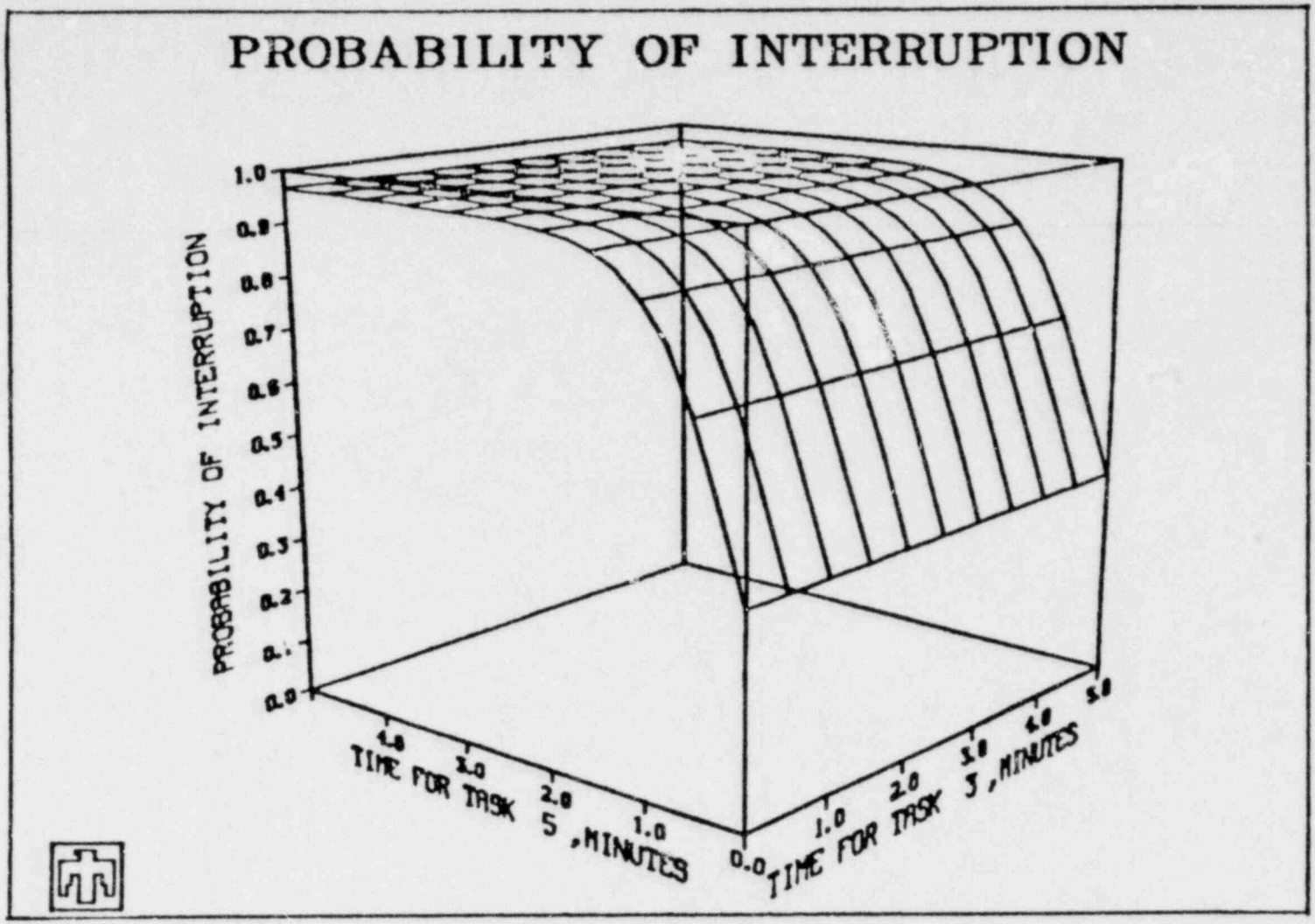
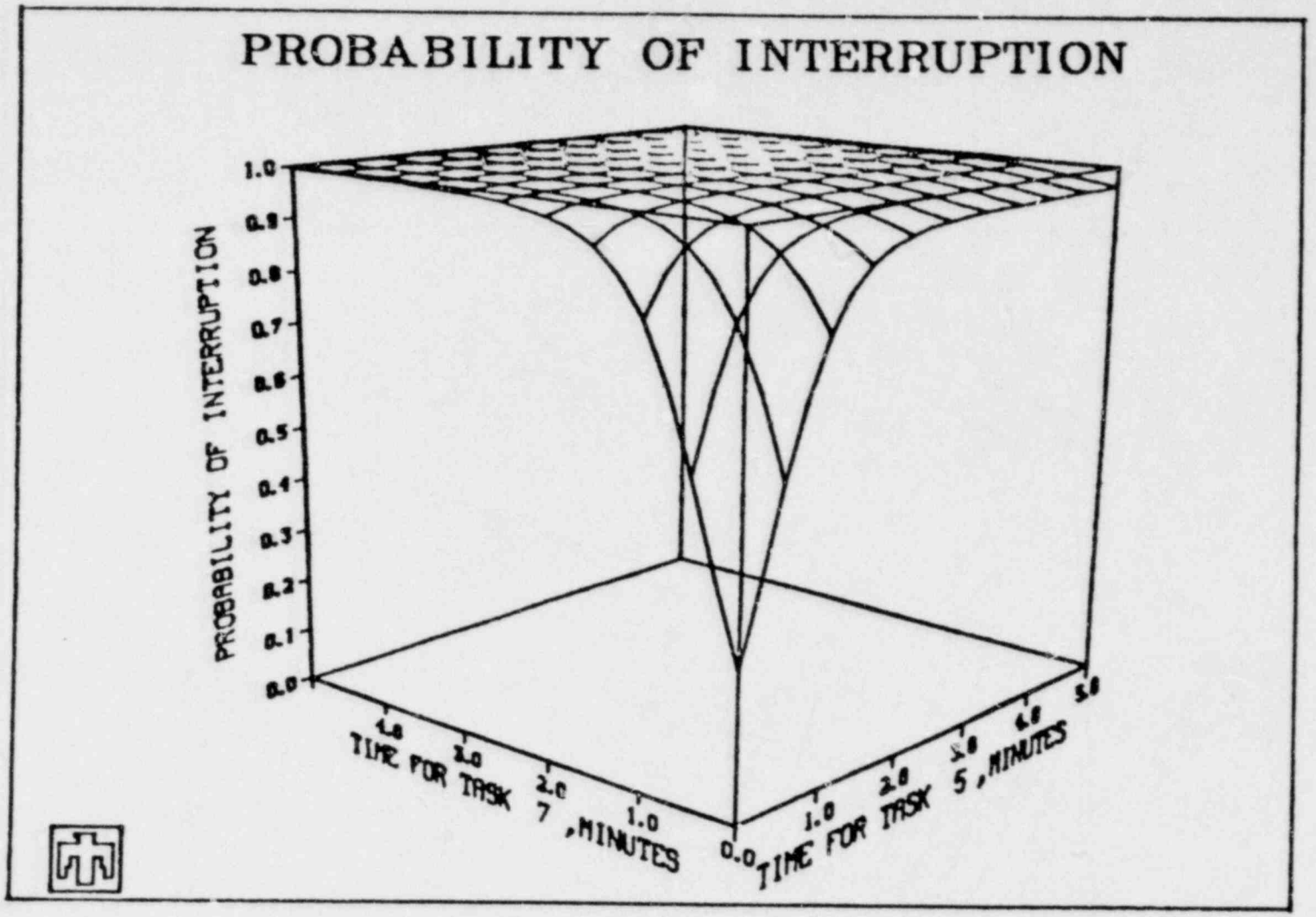


Figure A-4. Continued
Plot 7--System Win vs. Response Time (base value = 2.60 minutes) and Neutralization



NOTE: ASSUMES NO DETECTION AT FENCE (SENSOR 2 PROB. DET. =0)

Figure A-4. Continued
Plot 8--Interruption vs. Time for Task 5 (interior door, base value = 0.20 minute) and Time for Task 3 (exterior door, base value = 0.20 minute)



NOTE: ASSUMES NO DETECTION AT FENCE (SENSOR 2 PROB. DET. = 0)

Figure A-4. Continued
Plot 9--Interruption vs. Time for Task 7 (interior door, base value = 0.20 minute) and Time for Task 5 (interior door, base value = 0.20 minute)

Table A-11

Base Data for Path 285-236-208-616-615-614-625-611

Response Time	3.20
Standard Deviation	.64
Probability of Communication	1.00

	Task	Mean	Std. Dev.	Prob. Det.
Fence	1	.10	.02	0.00
	2	.64	.13	.90
Exterior Door	3	.05	.01	0.00
	4	.50	.10	.01
Stairs (Level 2)	5	.01	.00	.00
↕	6	.92	.18	0.00
Stairs (Level 6)	7	.01	.00	.00
	8	.03	.01	0.00
Door	9	.05	.01	.00
	10	.21	.04	.01
Door	11	.20	.04	.00
	12	.04	.01	.95
Door	13	.05	.01	.00
	14	.13	.03	.01
Target	15	20.00	4.00	.00

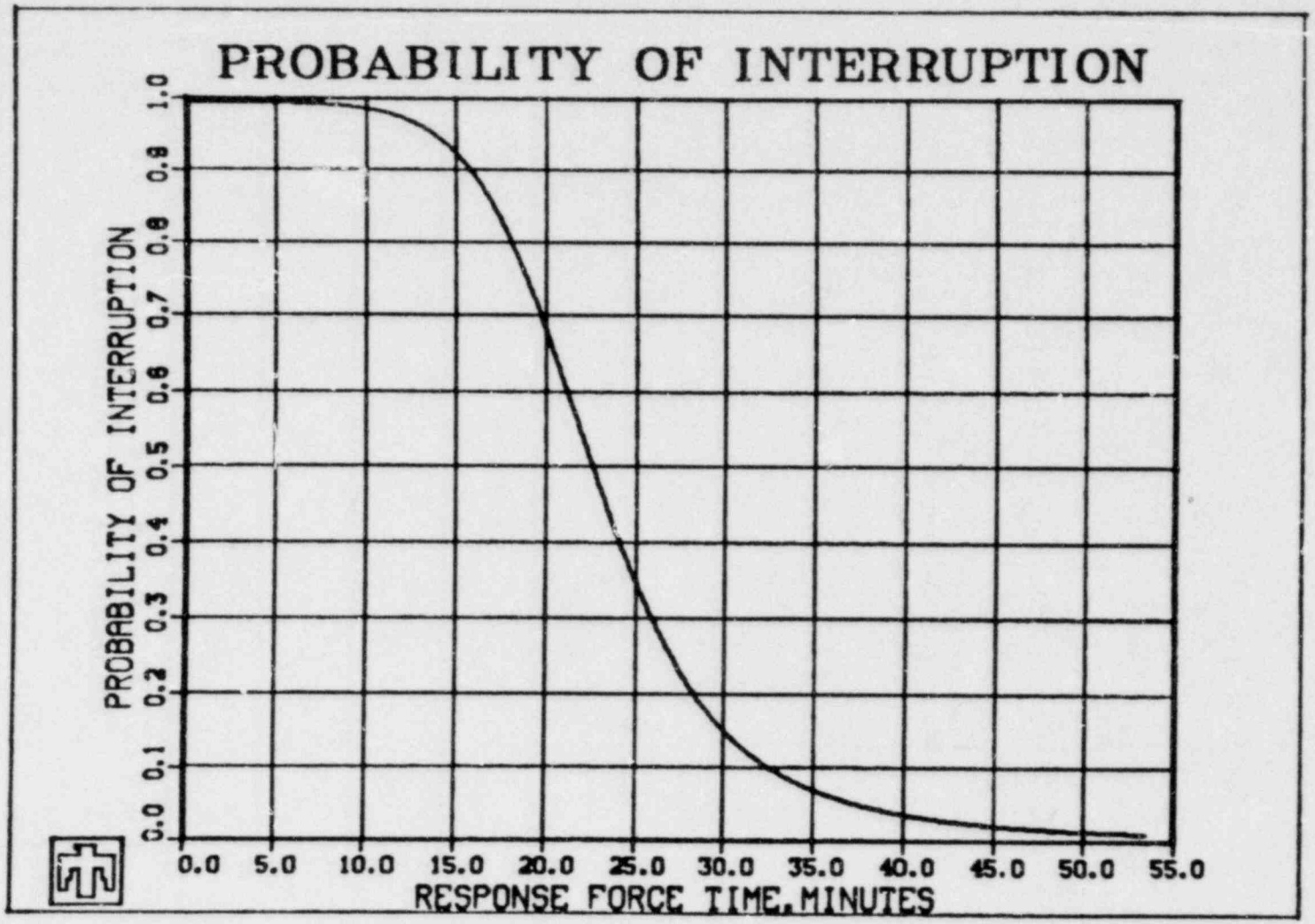


Figure A-5. Plots for Path to Target 611.
Plot 1--Interruption vs. Response Time (base value = 3.20 minutes)

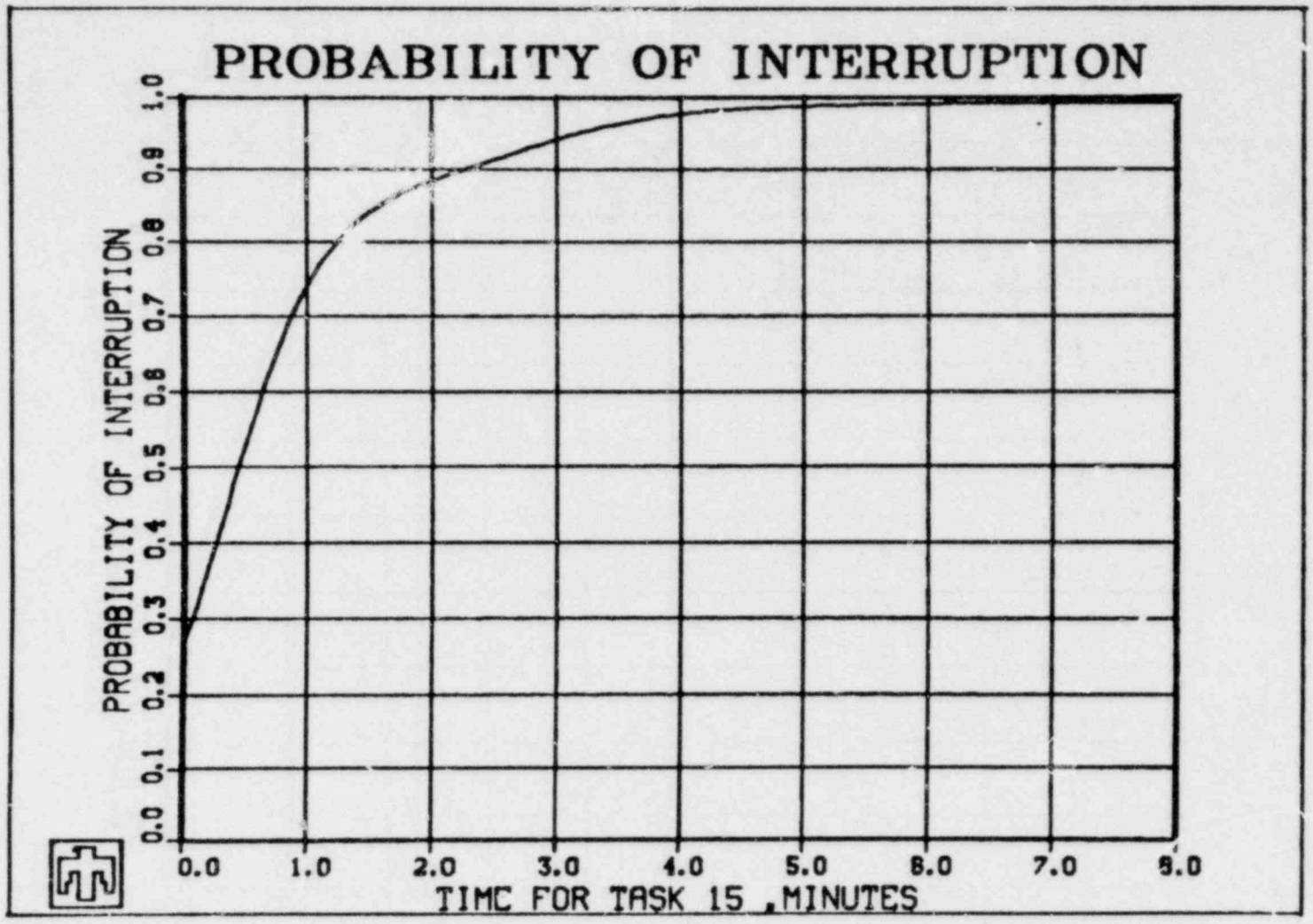


Figure A-5. Continued
Plot 2--Interruption vs. Time for Task 15 (target sabotage time, base value = 20.00 minutes)

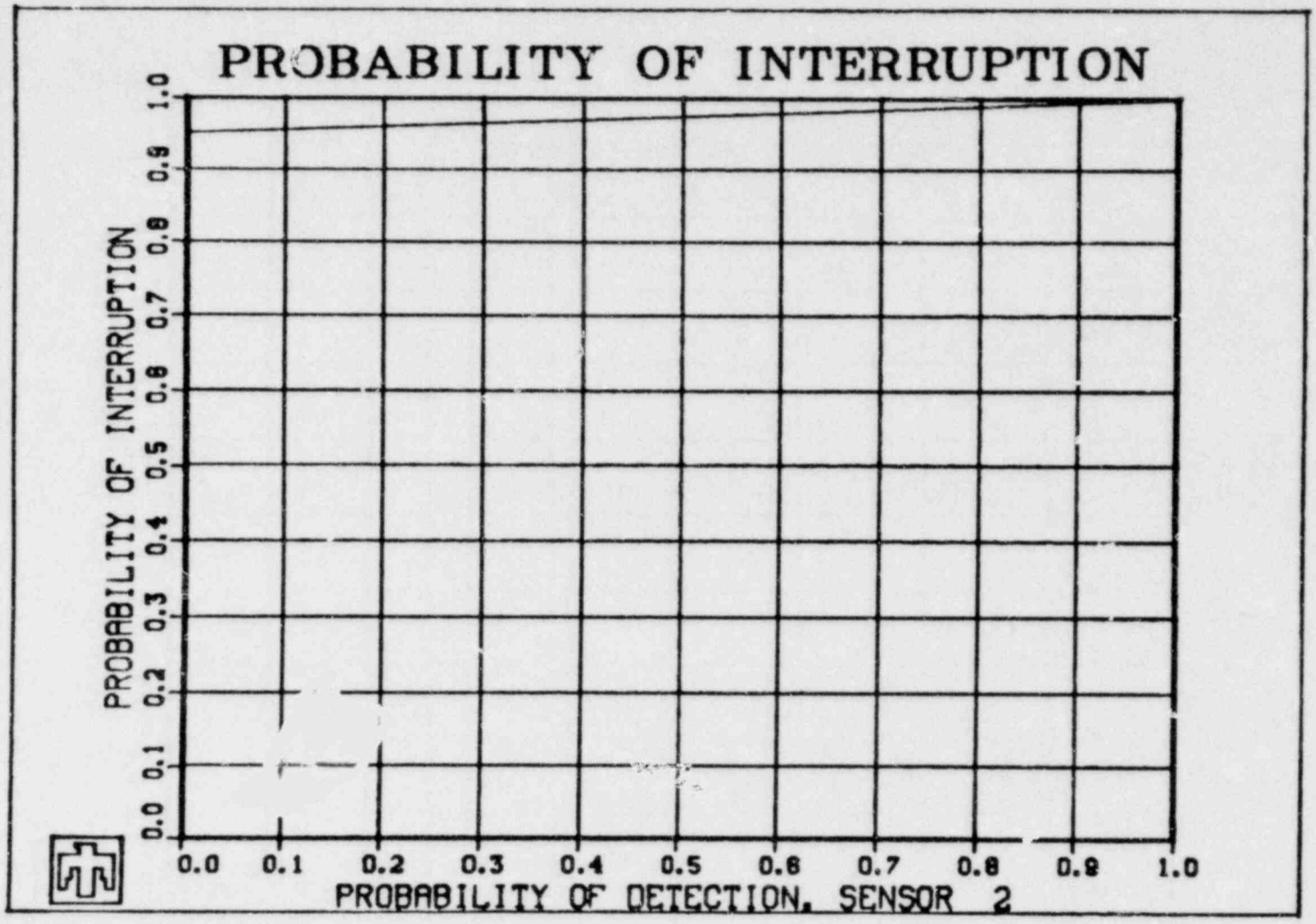


Figure A-5. Continued
Plot 3--Interruption vs. Sensor 2 Detection (fence sensor, base value = .90)

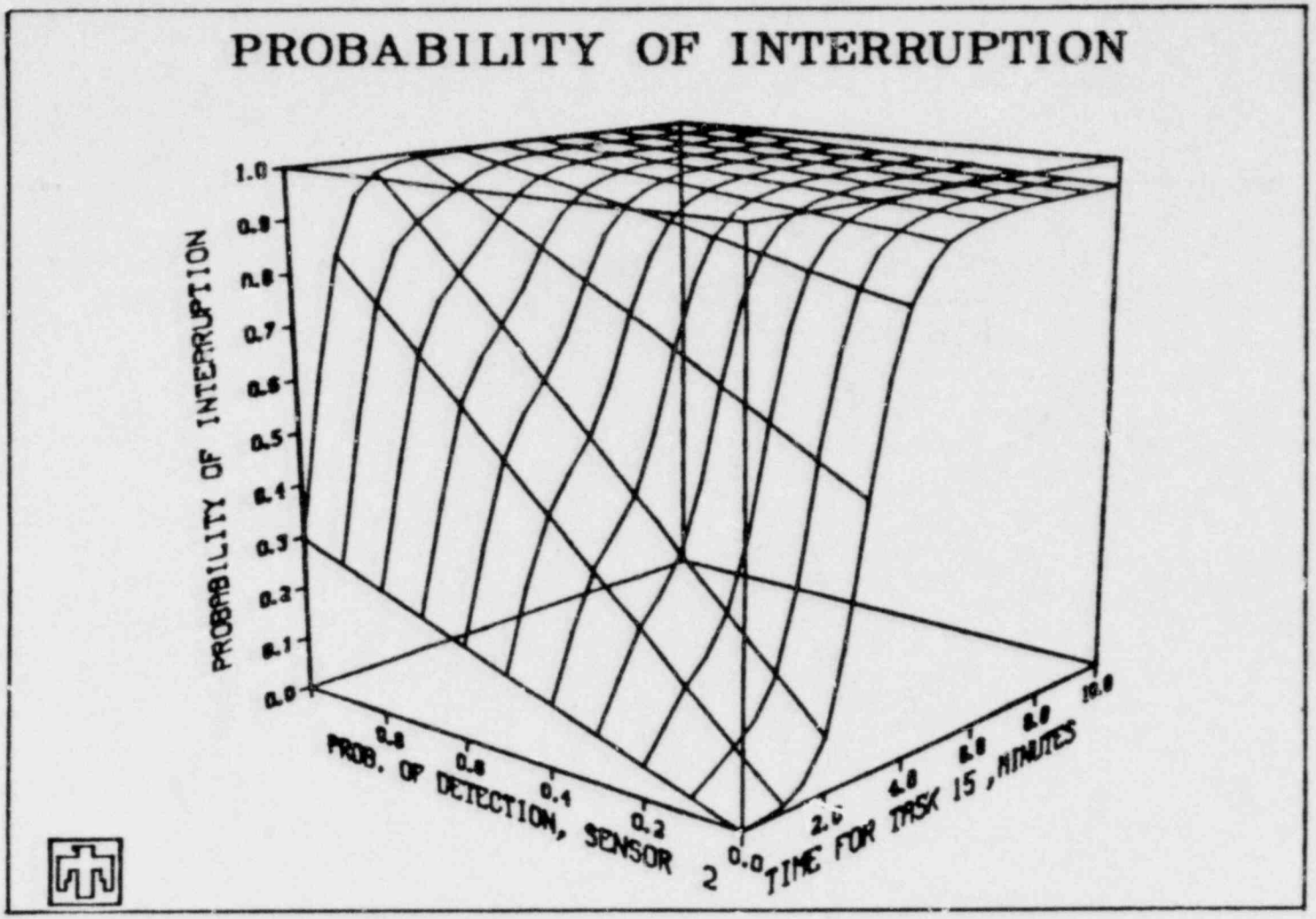


Figure A-5. Continued
Plot 4--Interruption vs. Sensor 2 Detection (fence sensor, base value = .90) and Time for Task 15 (target sabotage time, base value = 20.00 minutes)

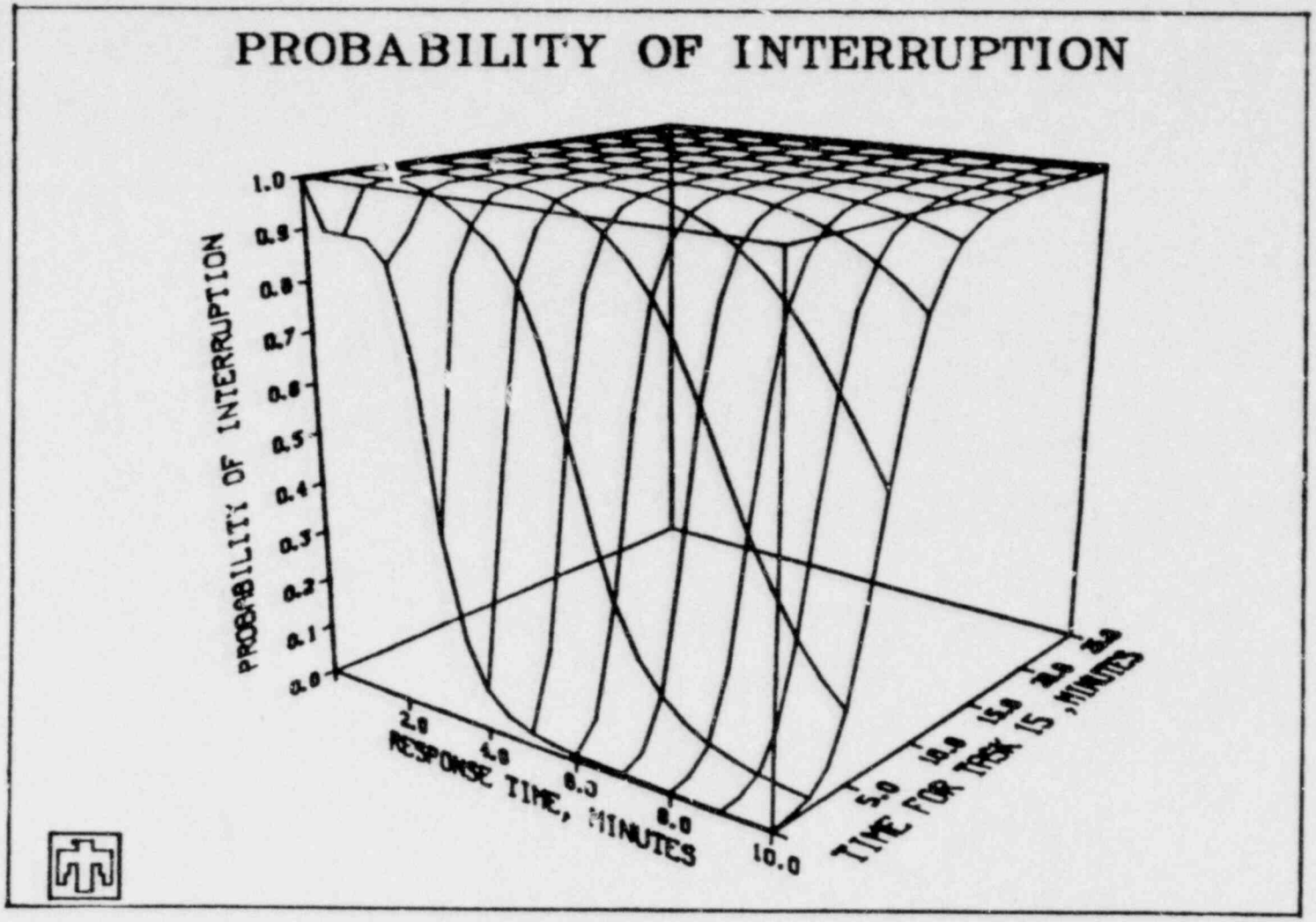


Figure A-5. Continued
Plot 5--Interruption vs. Response Time (base value = 3.20 minutes) and Time for Task 15 (target sabotage time, base value = 20.00 minutes)

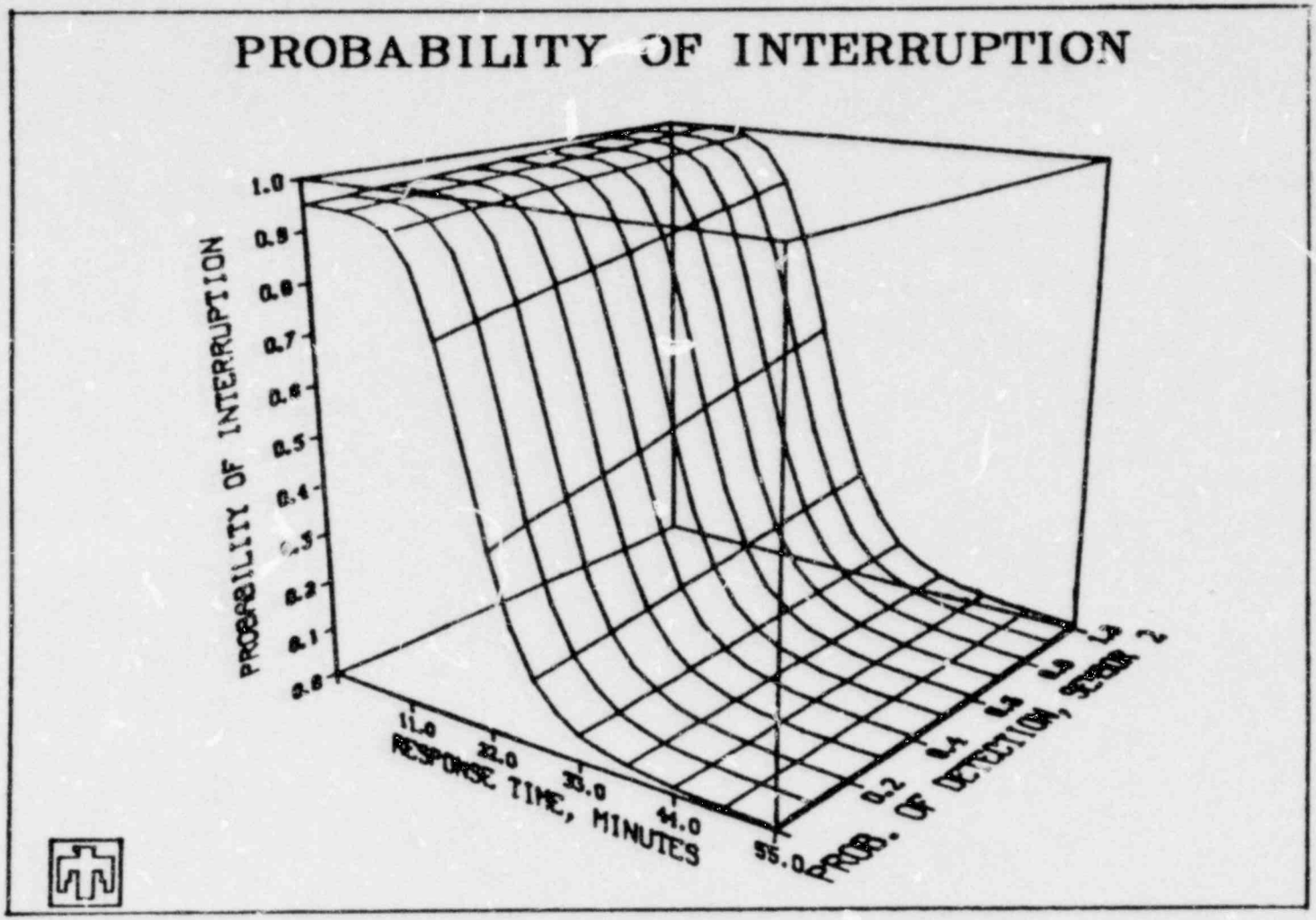
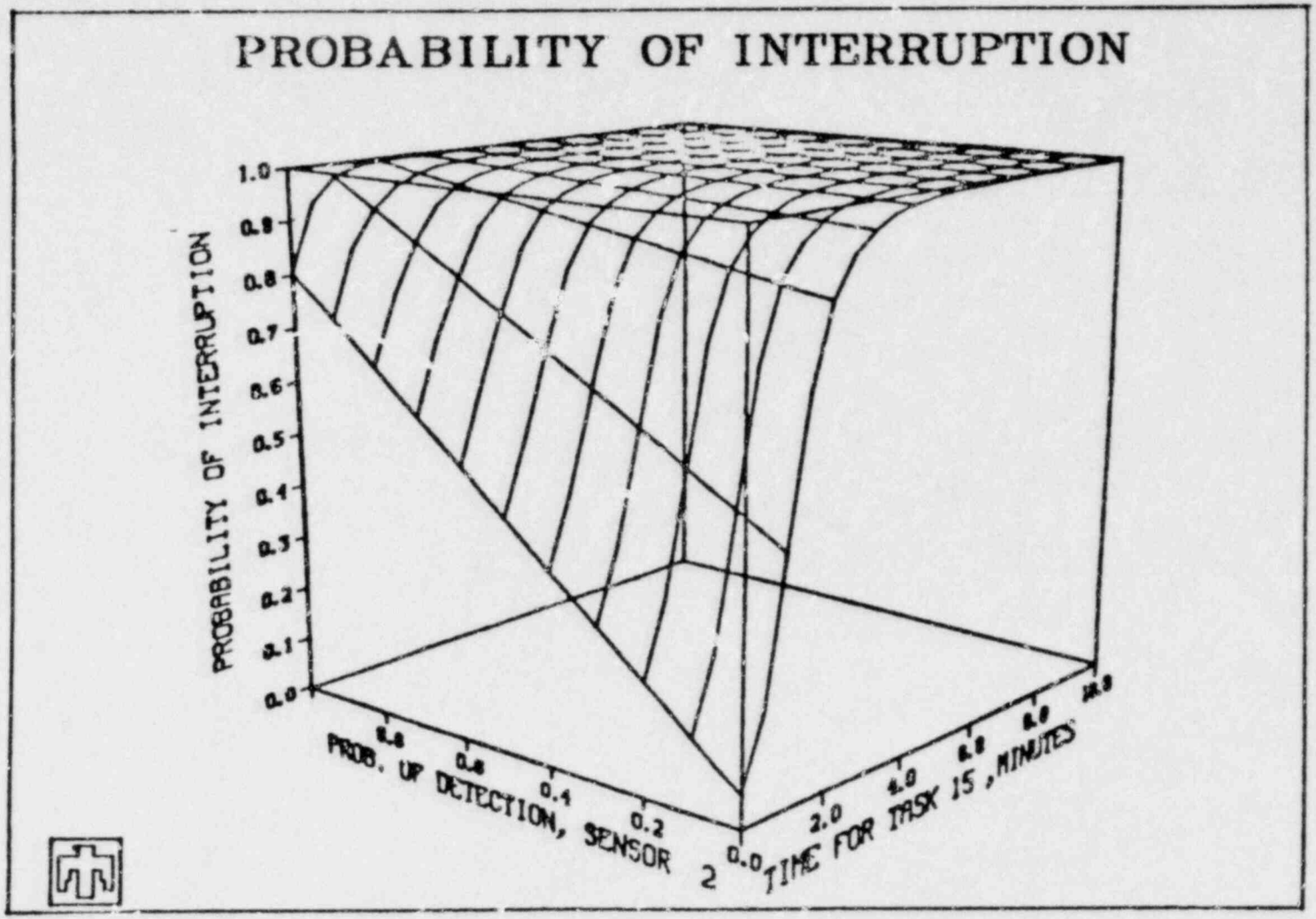


Figure A-5. Continued
Plot 6--Interruption vs. Response Time (base value = 3.20 minutes) and Sensor 2 Detection (fence sensor, base value = .90)



NOTE: ASSUME EXT. DR. HARDENED, ALARMED (TASK 3 MEAN TIME = 1., SENSOR 4 PROB. DET. = .95)

Figure A-5. Continued
Plot 7--Interruption vs. Sensor 2 Detection (fence sensor, base value = .90) and Time for Task 15 (target sabotage time, base value = 20.00 minutes)

Table A-12

Engagement Parameters

- Three adversaries
- Adversaries initially engaged by initial response force, secondary response force arrives later
- Adversaries have automatic weapons
- Initial response force has handguns; secondary force has shotguns

Other Parameters	Outside		Inside	
	Guards	Adversaries	Guards	Adversaries
Posture	Crouch	Stand/then crouch after 3 seconds	Crouch	Crouch
Firing exposure	60%	90%/then 60% after 3 seconds	50%	50%
Reloading exposure	1%	90%/then 1% after 3 seconds	10%	10%
Delay	50% to 0 when sec. force arrives	0	50% to 0 when sec. ce arrives	0
Proficiency (0 is average)	0	10% (more recent training)	0	10% (more recent training)
Degradation due to posture	10%	25%/then 10% after 3 seconds	10%	10%
Degradation due to illumination	0	0	0	0
Tactics	Defensive	Assault	Defensive	Assault
Range	25 meters		10 meters	

the base case) with a secondary force (four guards in the base case) arriving later. Runs included the base case and cases that considered an increase in the number of guards and an upgrade in the weapons used by the guards. Each case was considered with a number of different arrival times (ranging up to 2 minutes) for the secondary guard force.

The results of these neutralization studies are tabulated in Table A-13 and plotted in Figure A-6. The overall probability of neutralization and the likelihood that the initial response force survives are good only for the case in which the guards are increased and the guards' weapons are upgraded (assuming realistic secondary force arrival times greater than 30 seconds). Note that these results represent the probability of neutralization prior to completion of sabotage only if the adversary is neutralized before sabotage can be completed; thus, secondary force arrival time and total engagement time can be critical.

Table A-13

Probability of Neutralization

Outside-- Number of Guards in Initial, Secondary Response Forces	Probability of Neutralization: Arrival Time of Secondary Response Force (seconds)					
	0	10	20	30	60	120
1, 4	0.36	0.30	0.27	0.26	0.25	0.25
2, 5	0.67	0.61	0.55	0.51	0.48	0.48
2, 5 Plus semiautomatic weapons	1.00	0.99	0.98	0.98	0.98	0.98

Inside-- Number of Guards in Initial, Secondary Response Forces	Arrival Time of Secondary Response Force (seconds)					
	0	10	20	30	60	120
1, 4	0.60	0.49	0.47	0.47	0.47	0.47
2, 5	0.86	0.75	0.70	0.69	0.69	0.69
2, 5 Plus semiautomatic weapons	1.00	0.99	0.99	0.99	0.99	0.99

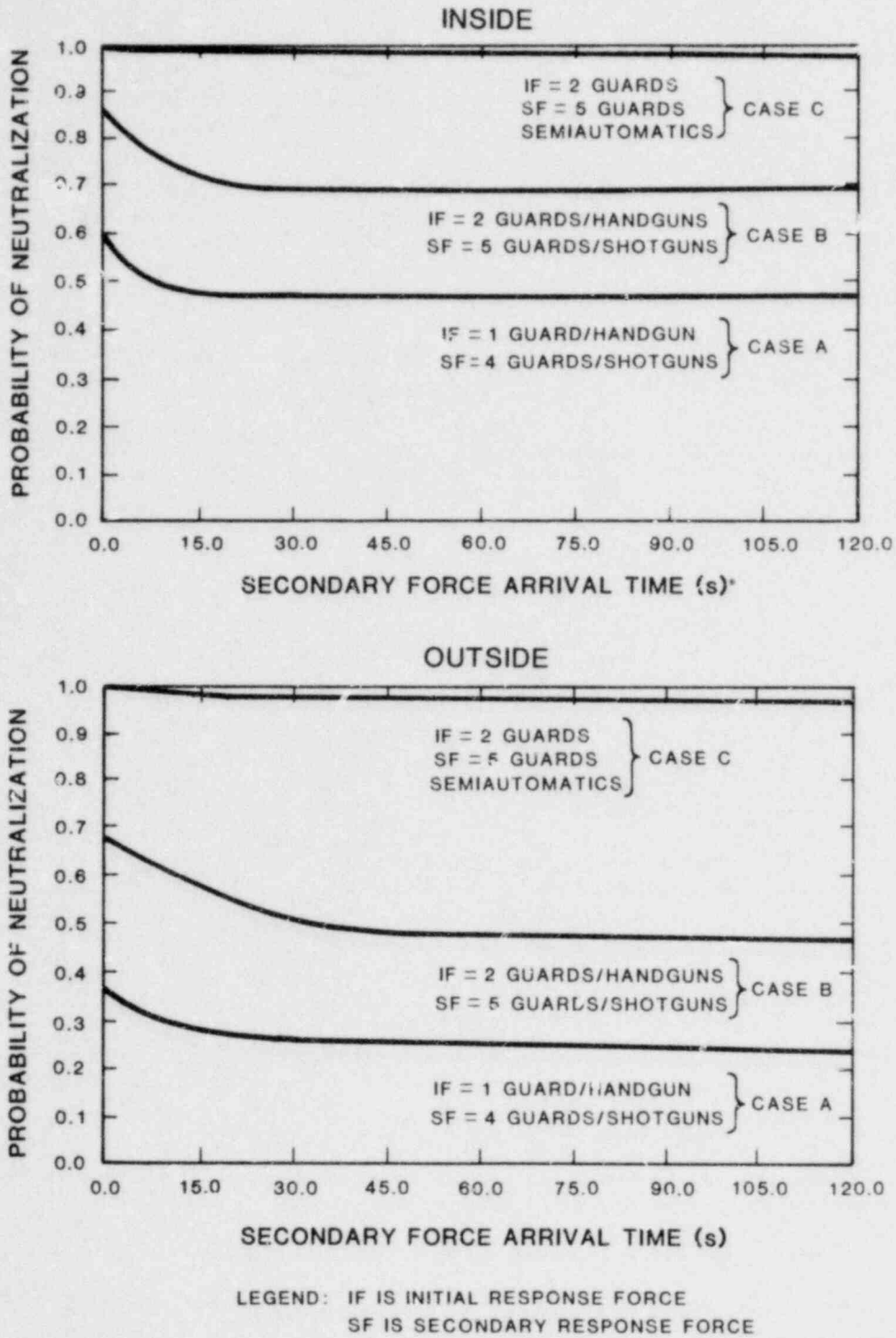


Figure A-6. Plots of Results for Inside and Outside Engagements

APPENDIX B

FESEM Analysis of the Reactor Facility

This appendix presents the applications of FESEM to a set of scenarios for the reactor facility.

B.1 ADVERSARY PATHS CONSIDERED

The paths chosen for FESEM analysis were suggested by the SAFE global interruption analysis of the reactor facility. The following paths were considered:*

To target 618
282-269-251-617-627-618

To targets 203, 204
283-246-289-239-203
283-246-289-238-204
283-246-289-239-203-239-238-204**

The paths to targets 618 and 203 and 204 are illustrated in Figure B-1.

B.2 ASSUMPTIONS AND DATA

Base case assumptions for the FESEM analysis are listed in Table B-1. Assumptions include three adversaries and five guards. Guards are grouped into two response forces: Force 1 (one guard in the base case) and Force 2 (four guards in the base case).

---

*Paths are described in terms of the node labels used on the SAFE digitized facility layout drawings (see Appendix A).

**This path considers targets 203 and 204 in series. Data for exit through door 239 after leaving 203 were set to reflect free access for the adversary since the door was penetrated on entry.

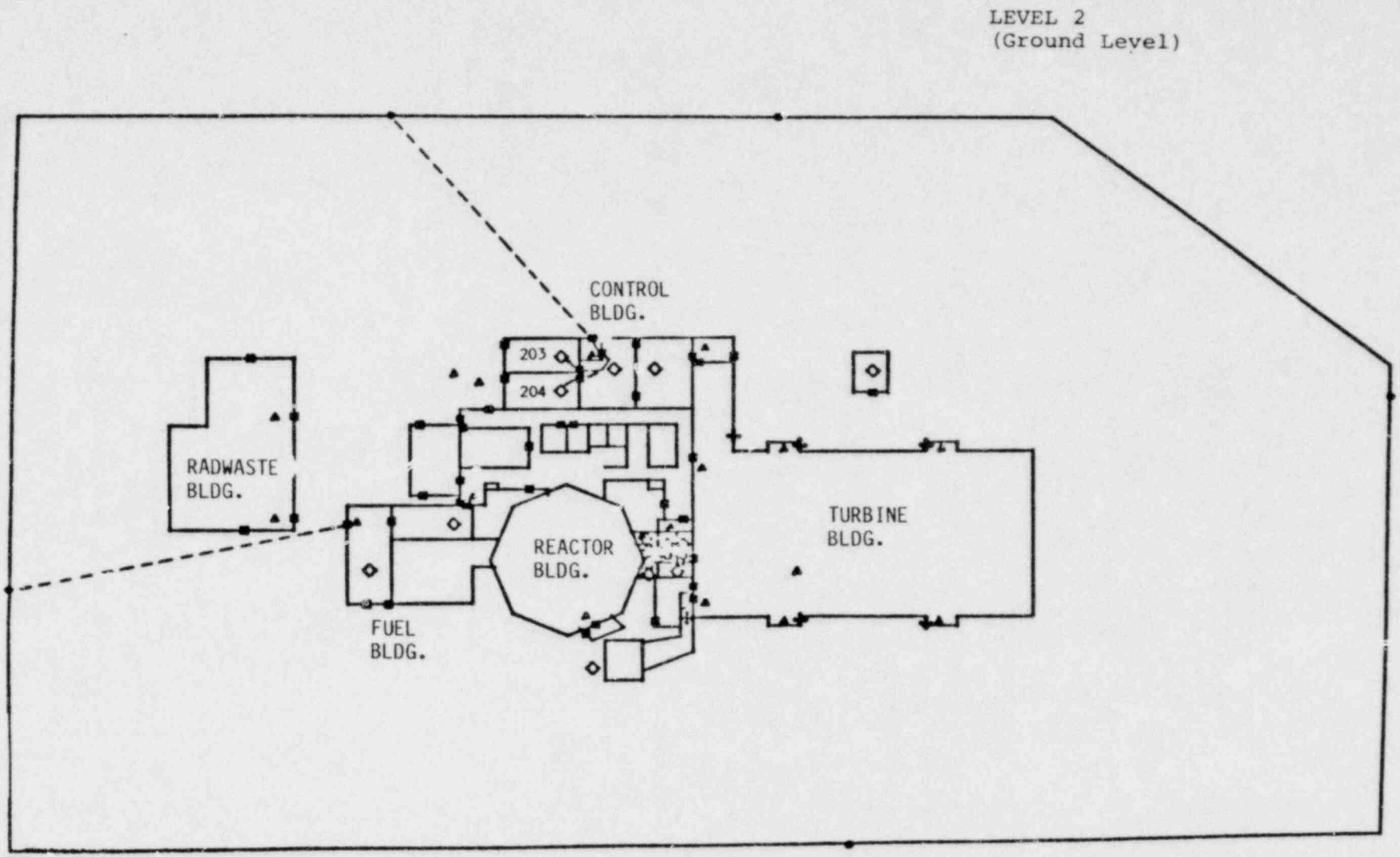


Figure B-1. Paths Analyzed Using FESEM

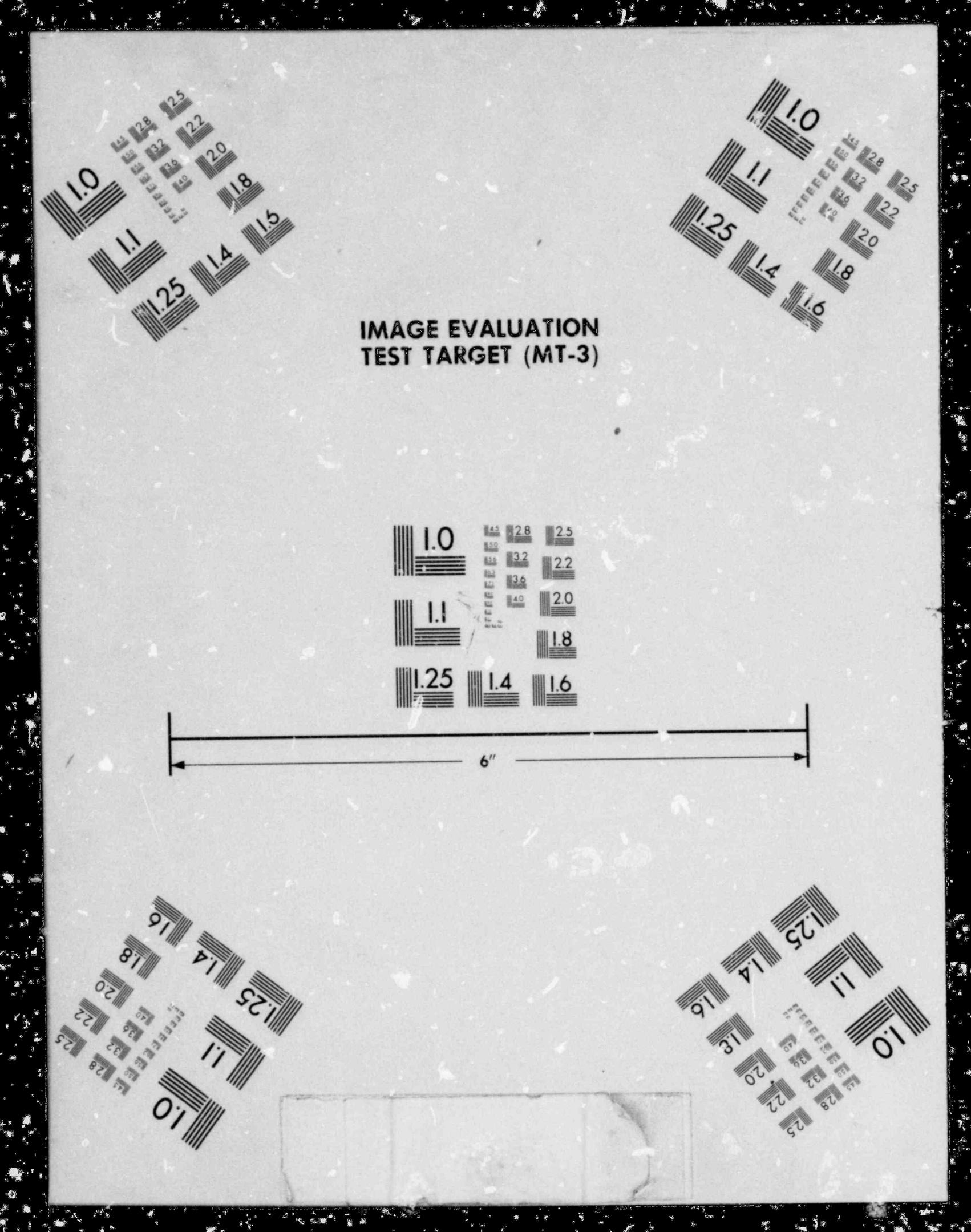
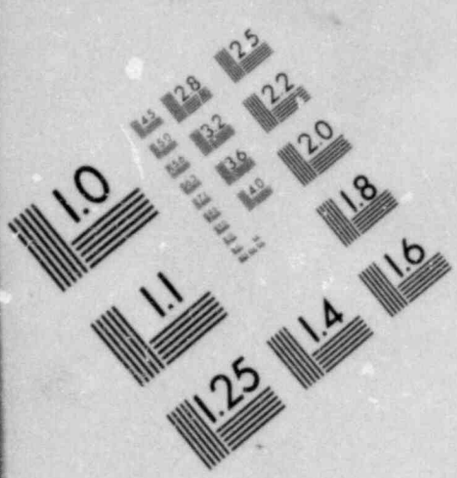


IMAGE EVALUATION
TEST TARGET (MT-3)
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6"



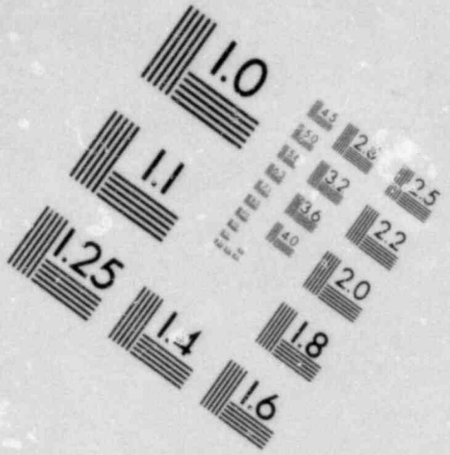
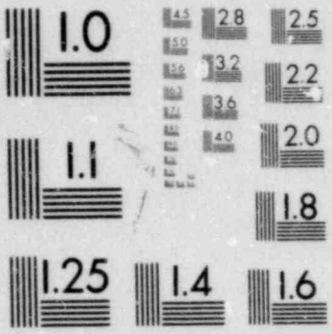
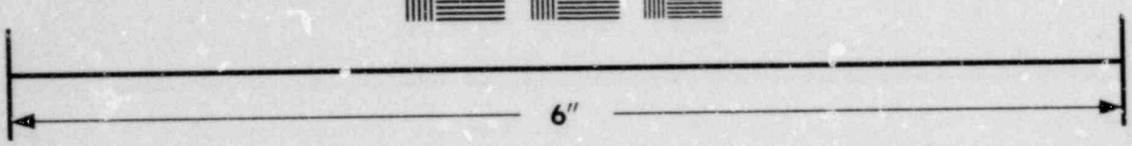
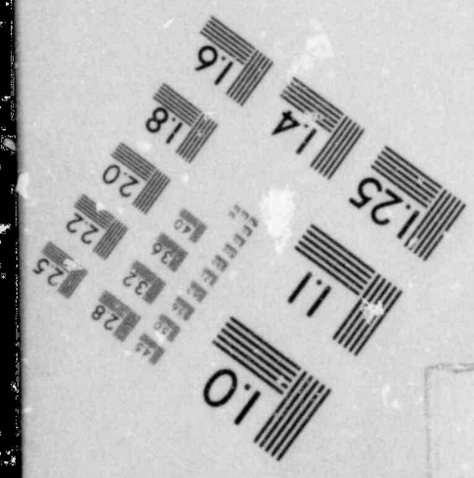
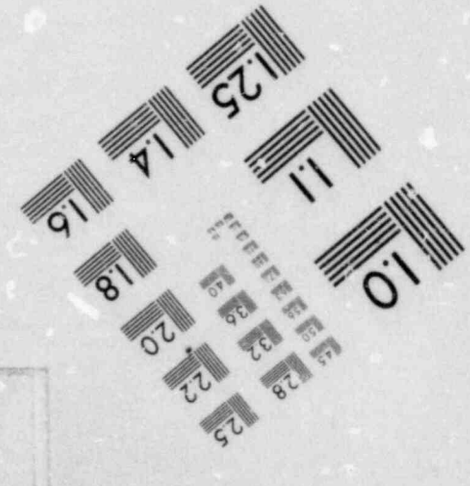


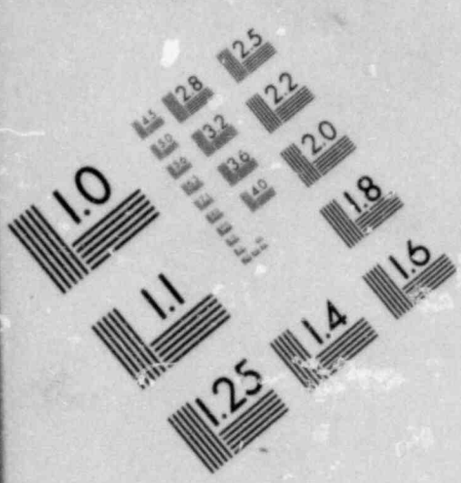
IMAGE EVALUATION
TEST TARGET (MT-3)











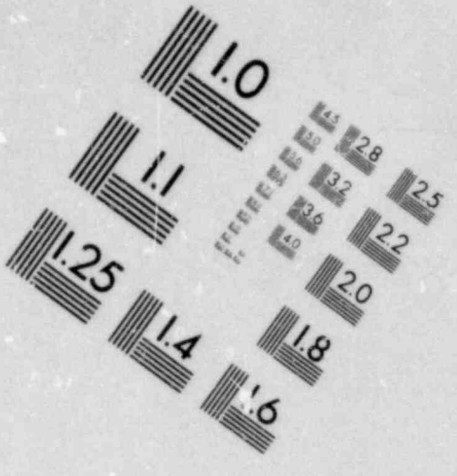
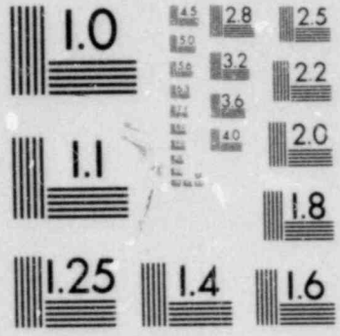
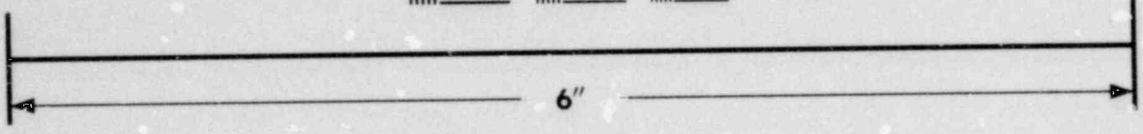
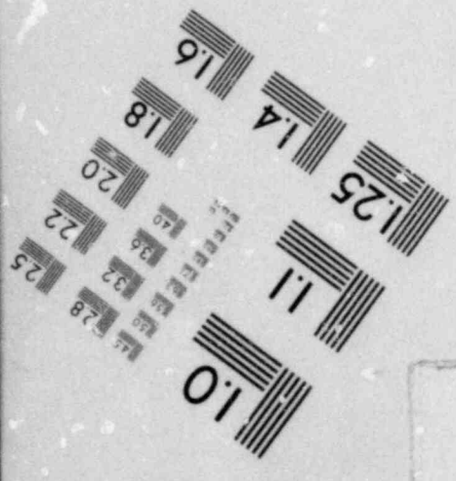
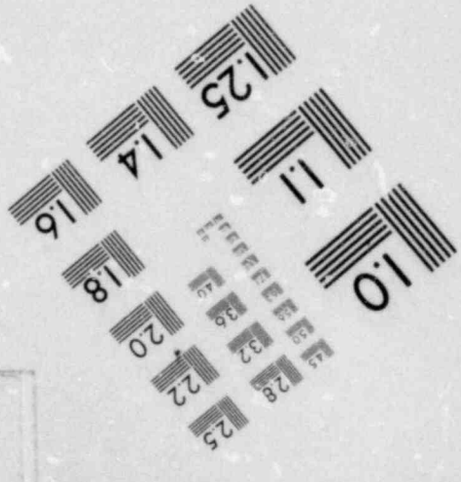


IMAGE EVALUATION
TEST TARGET (MT-3)









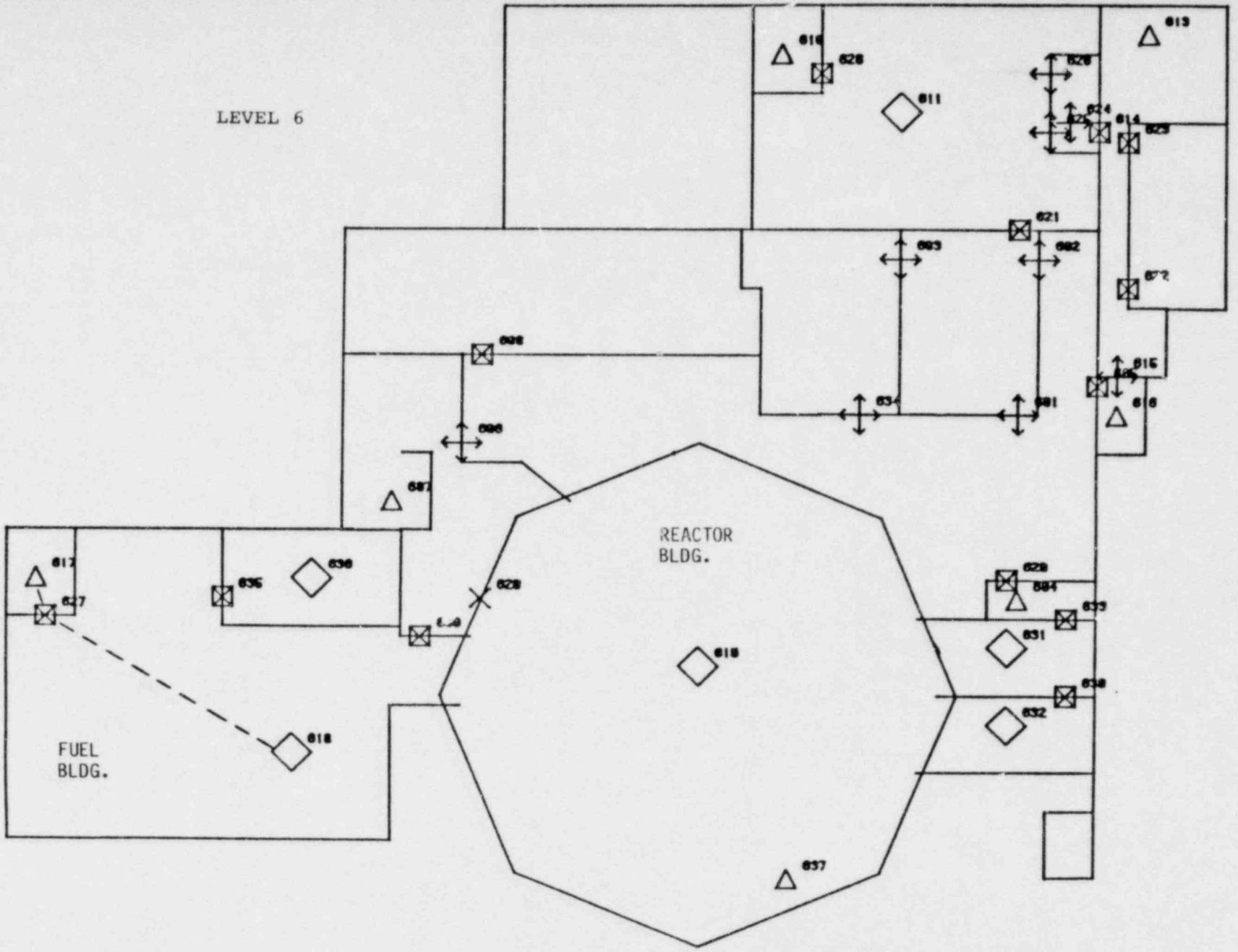


Figure B-1. Continued

Table B-1

Base Case Assumptions for FESEM Analysis

Outsider Sabotage

Adversary Characteristics

- Three adversaries
- High dedication
- On foot (average, 4 mi/h)
- Automatic weapons
- Tools with high explosives

Guard Characteristics

- Two on-site response forces (Force 1 = one guard, Force 2 = four guards)
- Medium dedication
- One guard needed to engage adversaries
- Probability of communicating external attack = 1.0
- Automatics (implicitly assumed by FESEM)

Adversary Path Data

- Data used for barrier time delays, alarm probabilities, and area crossing distances reflect the base case data specified in the SAFE analysis.

Guard response data are listed in Table B-2. Times are based on an initial response by Force 1 and a later arrival by Force 2. Times for Force 1 are specified for two cases: one in which the force is on patrol and another in which it is not.

Table B-2

Guard Response Times

	Guard Response Times (minutes)		
	Response Force 1		Response
Target	On Patrol	No Patrol	Force 2*
618	2.5	3.9	4.9
203	2.0	2.6	3.6
204	2.0	2.6	3.6

*Response times for Force 2 assume 1 minute to alert Force 2 to respond.

B.3 ANALYSIS RESULTS

Results of the FESEM analysis included cases that consider a "patrol" versus "no patrol" and cases in which additional guards and an upgraded exterior building door were considered. Results are summarized in Table B-3.

Table B-3

FESEM Results

Target	Special Case	Probability of Interruption*	Probability of Defenders' Success
618	Patrol	1.00	.01
618	No patrol	.97	.00
618	No patrol Force 1 = 2 guards Force 2 = 5 guards	.97	.31
618	Patrol Force 1 = 2 guards Force 2 = 5 guards 1-minute exterior building door	1.00	.79
203,204	Patrol	.98	.01
203,204	No patrol	.92	.00
203,204	Patrol Force 1 = 2 guards Force 2 = 5 guards 1-minute exterior building door	.98	.75
203→204 (in series)	No patrol	1.00	.88
203→204 (in series)	Patrol Force 1 = 2 guards Force 2 = 5 guards 1-minute exterior building door	1.00	1.00

*Not a direct output of FESEM.

B.4 EXAMPLE OUTPUT

An example FESEM output for the first case listed in the FESEM results (Table B-3) is provided in Figure B-2. The user should refer to the Users Guide for Evaluating Alternative Fixed-Site Physical Protection Systems Using "FESEM," SAND77-1367, for a detailed description of the outputs.

```
1
 GEN,DWSASSER,2,10,22,1980,1000,8,Y,N,N,U,N*
 STAT,14,0,15,3*
 LIM,26,6,30,25,6,3000,0,10,2*
 COL,1,NOATRS,2,WPNTS,3,REBPS,4,MOAS,5,OSAS,6,TYPAS,7,STEB,8,NOATRT,9,WPNTT,
 10,REBPT,11,MOAT,12,OSAT,13,TYPAT,14,TIMEBAT*
 HIS,1,NGATRST,30,,1*          NO.GEN.ATTACKS---TOTAL,SAB.,THEFT
 HIS,2,NOWINDST,30,,1*         NO.WINS BY DEF.,SABOTAGE THEFT
 HIS,3,MOAFSTAR,20,,1*         MOBILITY OF ATTACKER---SAB.,THEFT,ALL RUNS
 HIS,4,ATFAR,18,,1*            ALARM LOCATION FOR ALL RUNS
 HIS,5,OSA,6,,1*               DED.AND SOPH.OF ATTACKER ALL RUNS
 HIS,6,TOATSTT,15,,1*          TYPE OF ATTACK SUCCESS---GEN.,SAB.,THEFT
 HIS,7,TIMEFBAT,35,,2*         TIME FOR BATTLES
 HIS,8,SITEGDEL,30,,5*         SITE AND GUARD DELAY
 HIS,9,NUMBAT,12,,1*           NUMBER OF BATTLES
 HIS,10,NUMRFA,12,,1*          NO.OF RESPONSE FORCE ARRIVALS
 HIS,11,TIMFSAB,30,,6*         TIME FOR SABOTAGE
 HIS,12,TIMFTHF,30,,6*         TIME FOR THEFT
 HIS,13,GTOABFS,40,,1*         GEN.TYPE OF ATTACK BY FORCE SIZE
 HIS,14,TOASBFS,40,,1*         TYPE OF ATTACK SUCCESS BY FORCE SIZE
 HIS,15,NBPBBAT,15,,1*         NO.BARRIERS PENETRATED BEFORE BAT.STARTS
 PLO,1,TIME,3,2,0,1*
 VARPLT,1,1,A,ATTRPOP,1,1,0,20,2,D,DEFRPOP,1,1,0,20*
 PLO,2,ATRPOP,7,4,2,,25*
 VARPLT,2,1,S,SABLOS,1,1,0,1,2,T,THFLOS,1,1,0,1*
 VARPLT,2,3,D,DEFSUC,1,1,0,1,4,A,ATRSUC,1,1,0,1*
 PLO,3,ATRPOP,9,4,2,,25*
 VARPLT,3,1,U,SABLWI,1,1,0,1,2,V,SABLWOI,1,1,0,1*
 VARPLT,3,3,W,THFLWI,1,1,0,1,4,X,THFLWOI,1,1,0,1*
 PRI,1,LVF,1,2,LVF,1,3,LVF,1,4,LVF,1*
 CON,5,-1,,1,,1,,1,,1,1*
 PAR,1,1000,1000,1000*         SURVEILLANCE ALARM TIME(MINUTES)
 PAR,2,3,2,5*                  THEFT COMPLETION TIME(MINUTES)
 PAR,3,3.5,1.75,5.25*          SABOTAGE COMPLETION TIME(MINUTES).LT. 3MEN
 PAR,4,3,2,5*                  SABOTAGE COMPLETION TIME(MINUTES).GE.3 MEN
 PAR,5,2.5,1.25,3.75*          ON-SITE FORCE 1 RESPONSE TIME(MINUTES)
 PAR,6,4.9,2.45,7.35*          ON-SITE FORCE 2 RESPONSE TIME(MINUTES)
 PAR,15,2,1,4*                 LANDING TIME FOR AIR ATTACKS(MINUTES)
 PAR,16,1.8,1,3*               AIR SURVEILLANCE ALARM TIME(MINUTES)
 PAR,17,0,0,0*                 ON-SITE FORCE ALERT DELAY(MINUTES)
 PAR,18,0,0,0*                 OFF-SITE FORCE ALERT DELAY(MINUTES)
 PAR,19,,5,,2,1*               BUILDING EXIT DELAY FOR THIEF-GUARD CONFRONTATION
 INI,0,N,Y,,,Y*
 FIN*
1
```

Figure B-2. Example of FESEM Output for Path to Target 618 (Patrol)

USER SPECIFIED OPTIONS

NRBO = 20 NOSUM = 1 NPFEO = 0 NAONSR = 1 KFATRA = 0 SWTEXT = 0
SWTINT = 0 MNOHIS = 0 IDYN = 1

SITE SPECIFIED CHARACTERISTICS

NUMBER OF BARRIERS	NO. OF RESPONSE FORCES ON-SITE	OFF-SITE	GUARD D/S	AIR ATTACKS BEG. AT BAR.
5.00	2.00	0.00	2.00	0.00

SURV. DET. PROB. FOR AIR ATTACKS	SURV. BEGINS AT BARRIER NO.	MUSTER FORCE SIZE
0.00	1.00	1.00

SPEED ON FOOT(MPH) MODE	MIN	MAX	SPEED WITH VEHICLE(MPH) MODE	MIN	MAX
4.00	3.00	5.00	15.00	10.00	20.00

RESPONSE FORCE SPECIFICATIONS

ON-SITE RESPONSE FORCE NUMBER	NUMBER OF MEN	RESPONSE TIME	COMMUNICATION PROBABILITY EXTERNAL	INTERNAL
1	1.00	2.50	1.00	.60
2	4.00	4.30	1.00	.60

BARRIER SPECIFICATIONS

BARRIER NUMBER	DISTANCE TO NEXT BARRIER	BARRIER DELAY ON FOOT,NO HE MODE	MIN	MAX
1.00	333.00	.10	.05	.15
2.00	10.50	.20	.10	.30
3.00	291.00	.01	.01	.02
4.00	14.00	.01	.01	.02
5.00	0.00	.20	.10	.30

Figure B-2. Continued

BARRIER NUMBER	BARRIER DELAY WITH VEHICLE, NO HE		
	MODE	MIN	MAX
1.00	.10	.05	.20
2.00	0.00	0.00	0.00
3.00	3.00	2.00	5.00
4.00	3.00	2.00	5.00
5.00	10.00	7.00	15.00

BARRIER NUMBER	BARRIER DELAY WITH HE		
	MODE	MIN	MAX
1.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00
3.00	0.00	0.00	0.00
4.00	.50	.20	1.00
5.00	5.00	2.00	10.00

BARRIER NUMBER	ALARM PROBABILITY		ASSESSMENT DELAY		
	EXTERNAL	INTERNAL	MODE	MIN	MAX
1.00	.90	0.00	0.00	0.00	0.00
2.00	.95	.10	0.00	0.00	0.00
3.00	0.00	0.00	0.00	0.00	0.00
4.00	0.00	.50	0.00	0.00	0.00
5.00	.95	0.00	0.00	0.00	0.00

BARRIER NUMBER	ATTACKERS USE HE	PROB. OF HE DETECTION	TIME TO IMPLANT, DETONATE HE		
			MODE	MIN	MAX
1.00	0.00	0.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.00	0.00	0.00
4.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00	0.00

BARRIER NUMBER	ACTIVATED BARRIER	TIME TO ACTIVATE BARRIER		
		MODE	MIN	MAX
1.00	0.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.00	0.00
4.00	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00

Figure B-2. Continued

ATTACKER ATTRIBUTE LIMITS

ATTRIBUTE NUMBER	LOWER LIMIT	UPPER LIMIT
1.0	3.0	3.0
2.0	2.0	2.0
3.0	2.0	2.0
4.0	1.0	1.0
5.0	3.0	3.0
6.0	2.0	2.0

GASP SUMMARY REPORT

SIMULATION PROJECT NUMBER 2 BY DWSASSER

DATE 10/ 22/ 1980 RUN NUMBER 1000 OF 1000

CURRENT TIME = .887E+01

0 **STATISTICS FOR VARIABLES BASED ON OBSERVATION**

	MEAN	STD DEV	CV	MINIMUM	MAXIMUM	OBS
NOATRS	.300E+01	0.	0.	.300E+01	.300E+01	988
WPNTS	.200E+01	0.	0.	.200E+01	.200E+01	988
RFBPS	.200E+01	0.	0.	.200E+01	.200E+01	988
MOAS	.100E+01	0.	0.	.100E+01	.100E+01	988
DSAS	.300E+01	0.	0.	.300E+01	.300E+01	988
TYPAS	.200E+01	0.	0.	.200E+01	.200E+01	988
STEB	.445E+01	.112E+01	.252E+00	.141E+01	.718E+01	987
NOAT?			NO VALUES RECORDED			
WPNT.			NO VALUES RECORDED			
RFBP			NO VALUES RECORDED			
MOAT			NO VALUES RECORDED			
DSAT			NO VALUES RECORDED			
TY?AT			NO VALUES RECORDED			
TIMEBAT	.196E+01	.193E+01	.984E+00	.111E+00	.106E+02	1784

1

SUMMARIZED RESULTS BY ATTACK FORCE SIZE (PROBABILITY)

NO. OF ATTACKERS	SABOTAGE GENERATION	THEFT GENERATION	SABOTAGE LOSSES	THEFT LOSSES	DEFENDERS SUCCESS	ATTACKERS SUCCESS
3	1.000	0.000	.988	0.000	.012	.988

Figure B-2. Continued

SUMMARIZED TOTALS FROM ALL RUNS (PROBABILITY)

SABOTAGE GENERATION	THEFT GENERATION	SABOTAGE LOSSES	THEFT LOSSES	DEFENDERS SUCCESS	ATTACKERS SUCCESS
1.0000	0.0000	.9880	0.0000	.0120	.9880

MOBILITY SUMMARY FOR ALL RUNS (PROBABILITY)

MOBILITY FOR SAB. LOSSES			MOBILITY FOR THEFT LOSSES		
FOOT	LAND	AIR	FOOT	LAND	AIR
.9880	0.0000	0.0000	0.0000	0.0000	0.0000

TYPE OF ATTACK SUMMARY (PROBABILITY)

SABOTAGE LOSSES		THEFT LOSSES	
WITH INSIDER ASSISTANCE	WITHOUT INSIDE ASSISTANCE	WITH INSIDER ASSISTANCE	WITHOUT INSIDE ASSISTANCE
0.0000	.9880	0.0000	0.0000

SUMMARIZED ATTACK LOSSES BY FORCE SIZE (PROBABILITY)

NO. OF ATTACKERS	SAB. LOSSES WITH INSIDE ASST.	SAB. LOSSES WITHOUT INSIDE ASST.	THEFT LOSSES WITH INSIDE ASST.	THEFT LOSSES WITHOUT INSIDE ASST.
3	0.0000	.9880	0.0000	0.0000

C C

TABLE NUMBER 2
RUN NUMBER 1000

ATTPOP	SABLOS	THELOS	DEFSUC	ATTSUC
.3000E+01	.9880E+00	0.	.1200E-01	.9880E+00
MINIMUM	.9880E+00	0.	.1200E-01	.9880E+00
MAXIMUM	.9880E+00	0.	.1200E-01	.9880E+00

Figure B-2. Continued

```
                              **PLOT NUMBER  2**
                                RUN NUMBER   1000

                                        SCALES OF PLOT
S=SABLOS          0.                        .500E+00                    .100E+01
T=THELOS          0.                        .500E+00                    .100E+01
D=DEFSUC          0.                        .500E+00                    .100E+01
A=ATRSUC          0.                        .500E+00                    .100E+01
  ATROOP          0   10   20   30   40   50   60   70   80   90  100
   .3000E+01      TO                     +                          S+
  ATROOP          0   10   20   30        50   60   70   80   90  100


   OUTPUT  CONSISTS  OF      1 POINT SETS (      4 POINTS)


                              **TABLE NUMBER  3**
                                RUN NUMBER   1000

  ATROOP       SABLWI        SABLWOI       THELWI       THELWOI
 .3000E+01  0.           .9880E+00  0.           0.

   MINIMUM  0.           .9880E+00  0.           0.
   MAXIMUM  0.           .9880E+00  0.           0.


                              **PLOT NUMBER  3**
                                RUN NUMBER   1000

                                        SCALES OF PLOT
U=SABLWI          0.                        .500E+00                    .100E+01
V=SABLWOI         0.                        .500E+00                    .100E+01
W=THELWI          0.                        .500E+00                    .100E+01
X=THELWOI         0.                        .500E+00                    .100E+01
  ATROOP          0   10   20   30   40   50   60   70   80   90  100
   .3000E+01      U                      +                          V+
  ATROOP          0   10   20   30   40   50   60   70   80   90  100


   OUTPUT  CONSISTS  OF      1 POINT SETS (      4 POINTS)
```

Figure B-2. Continued

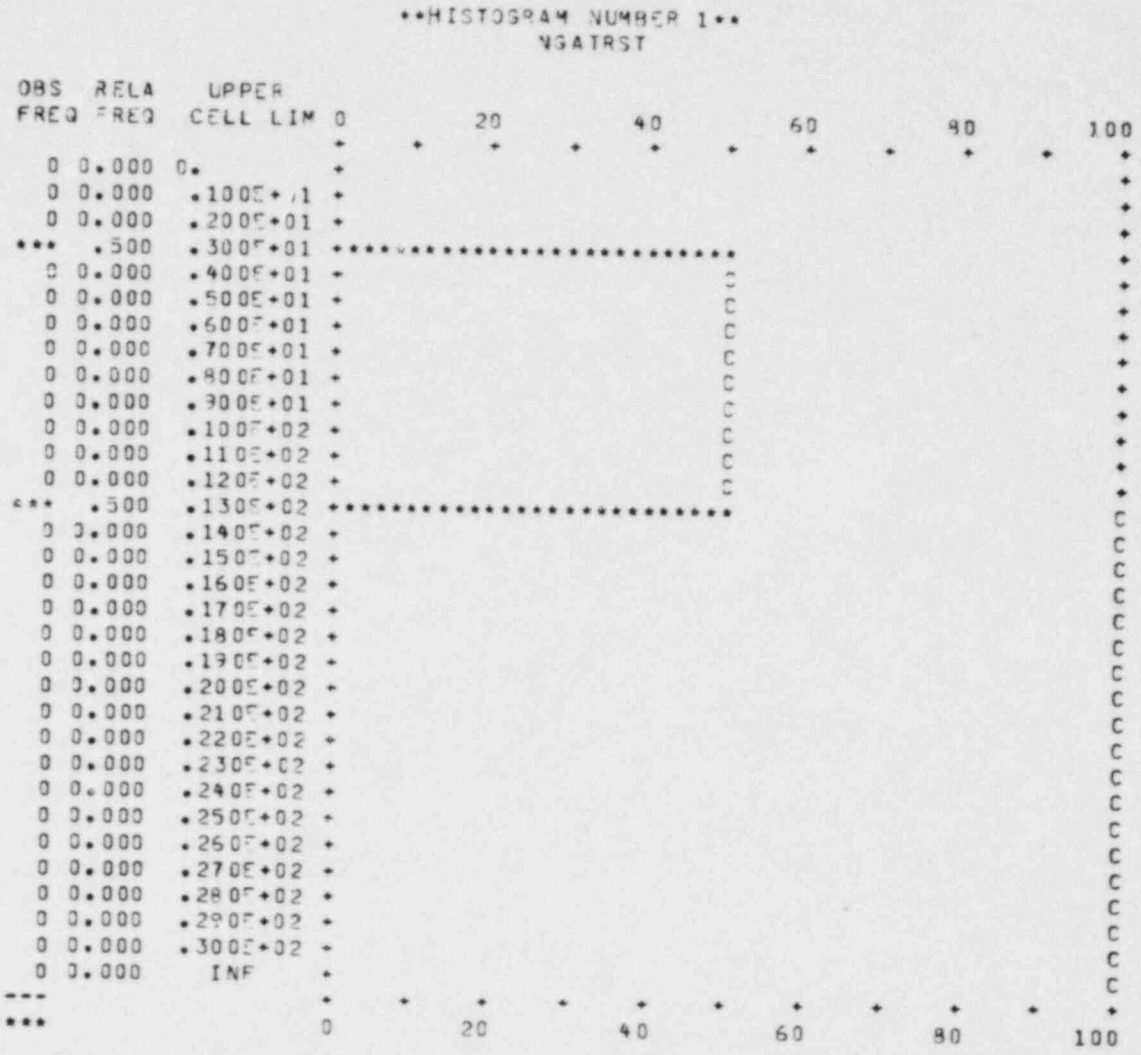


Figure B-2. Continued

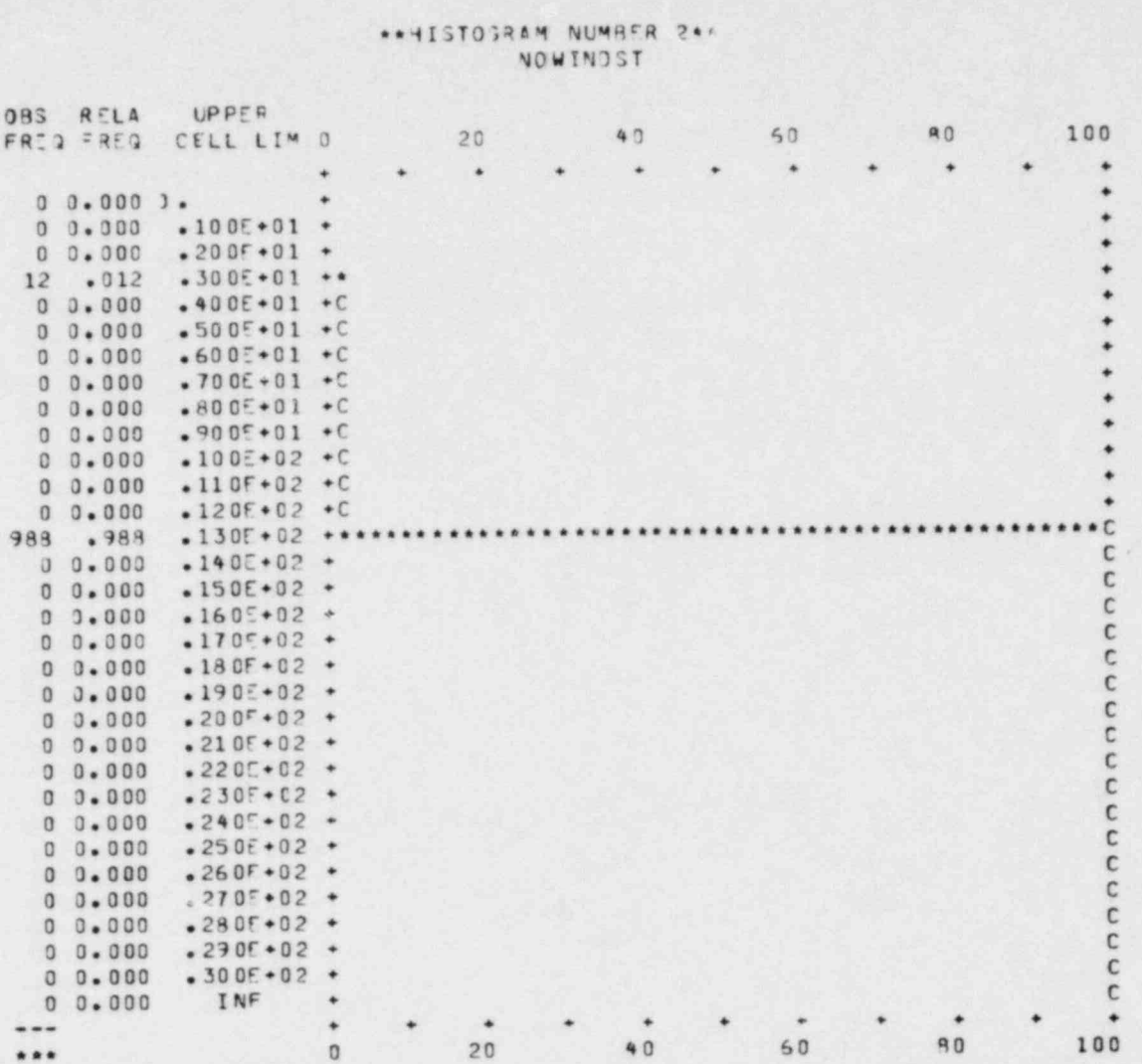


Figure B-2. Continued

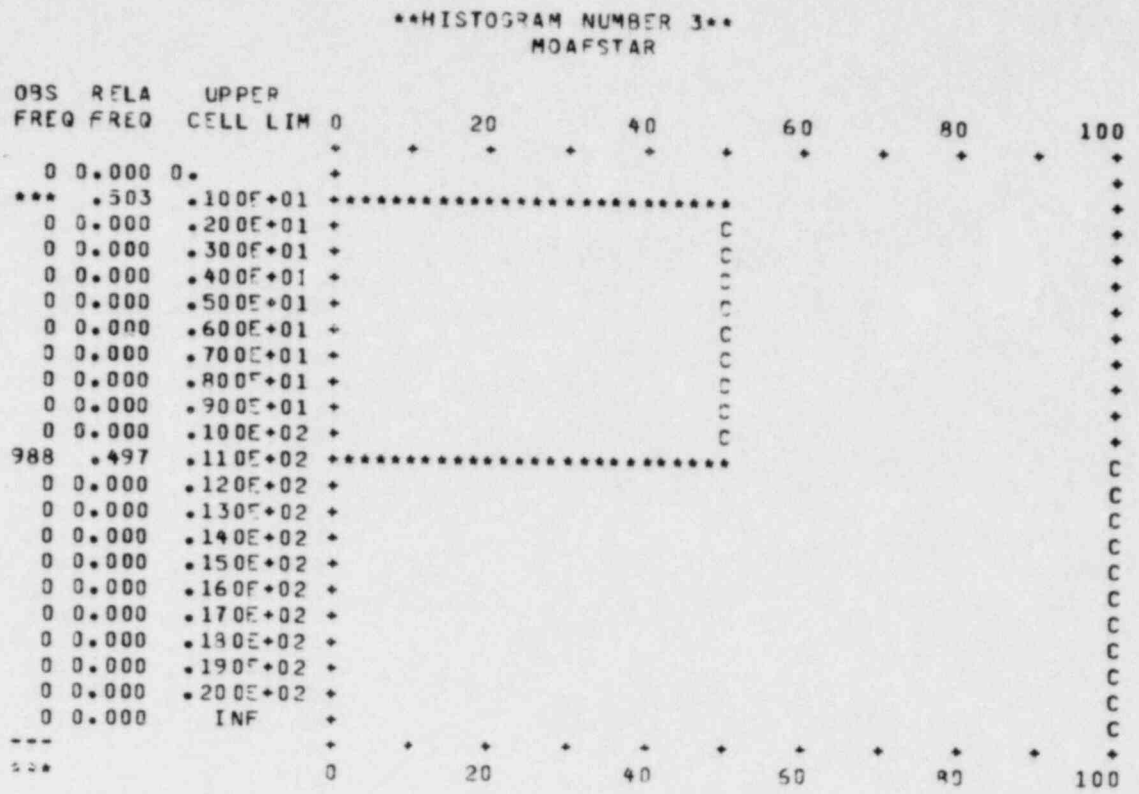
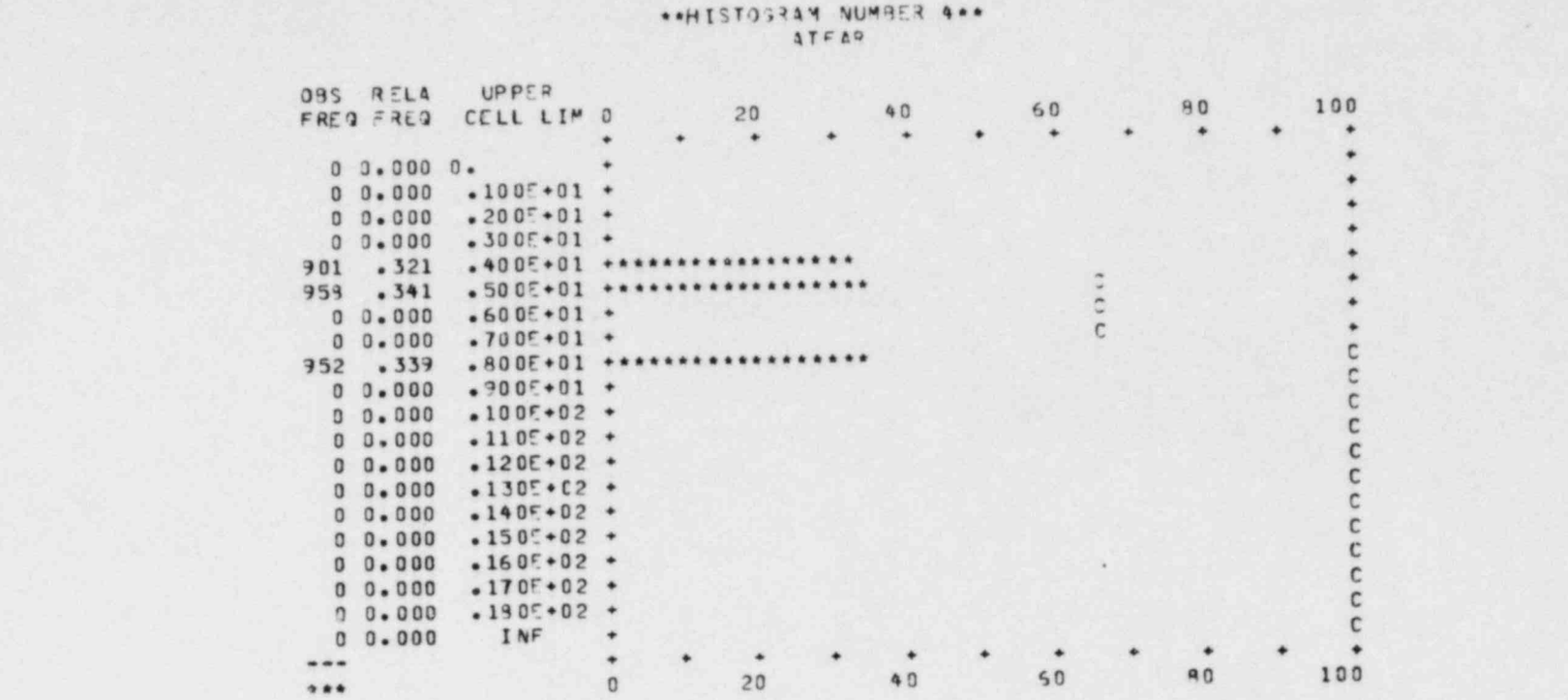


Figure B-2. Continued



CELLS 1,2,3 REPRESENT SURVEILLANCE, AIR SURVEILLANCE AND HE ALARM,RESP.

CELLS 4,5,... REPRESENT BARRIER NUMBER PLUS 3

Figure B-2. Continued

HISTOGRAM NUMBER 5
OSA

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	0.	
0	0.000	.100E+01	
0	0.000	.200E+01	
***	1.000	.300E+01	**********
0	0.000	.400E+01	C
0	0.000	.500E+01	C
0	0.000	.600E+01	C
0	0.000	INF	C

***			0 20 40 60 80 100

HISTOGRAM NUMBER 6
TOATSTT

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	0.	
0	0.000	.100E+01	
***	.503	.200E+01	**********
0	0.000	.300E+01	C
0	0.000	.400E+01	C
0	0.000	.500E+01	C
0	0.000	.600E+01	C
0	0.000	.700E+01	C
0	0.000	.800E+01	C
0	0.000	.900E+01	C
0	0.000	.100E+02	C
0	0.000	.110E 02	C
988	.497	.120E+02	**********
0	0.000	.130E+02	C
0	0.000	.140E+02	C
0	0.000	.150E+02	C
0	0.000	INF	C

***			0 20 40 60 80 100

Figure B-2. Continued

```
                    **HISTOGRAM NUMBER 7**
                          TIMEFBAT

OBS   RELA    UPPER
FREQ  FREQ    CELL LIM  0        20        40        60        80       100
                        +    +    +    +    +    +    +    +    +    +    +
   0 0.000 ).           +                                                  +
***   .562   .200E+01   +******************************                   +
464   .260   .400E+01   +**************                          C         +
270   .151   .600E+01   +*********                                       C+
 43   .024   .800E+01   +**                                              C
  3   .002   .100E+02   +                                               C
  1   .001   .120E+02   +                                               C
  0 0.000    .140E+02   +                                               C
  0 0.000    .160E+02   +                                               C
  0 0.000    .180E+02   +                                               C
  0 0.000    .200E+02   +                                               C
  0 0.000    .220E+02   +                                               C
  0 0.000    .240E+02   +                                               C
  0 0.000    .260E+02   +                                               C
  0 0.000    .280E+02   +                                               C
  0 0.000    .300E+02   +                                               C
  0 0.000    .320E+02   +                                               C
  0 0.000    .340E+02   +                                               C
  0 0.000    .360E+02   +                                               C
  0 0.000    .380E+02   +                                               C
  0 0.000    .400E+02   +                                               C
  0 0.000    .420E+02   +                                               C
  0 0.000    .440E+02   +                                               C
  0 0.000    .460E+02   +                                               C
  0 0.000    .480E+02   +                                               C
  0 0.000    .500E+02   +                                               C
  0 0.000    .520E+02   +                                               C
  0 0.000    .540E+02   +                                               C
  0 0.000    .560E+02   +                                               C
  0 0.000    .580E+02   +                                               C
  0 0.000    .600E+02   +                                               C
  0 0.000    .620E+02   +                                               C
  0 0.000    .640E+02   +                                               C
  0 0.000    .660E+02   +                                               C
  0 0.000    .680E+02   +                                               C
  0 0.000    .700E+02   +                                               C
  0 0.000      INF      +                                               C
---                     +    +    +    +    +    +    +    +    +    +    +
***                     0        20        40        60        80       100
```

Figure B-2. Continued

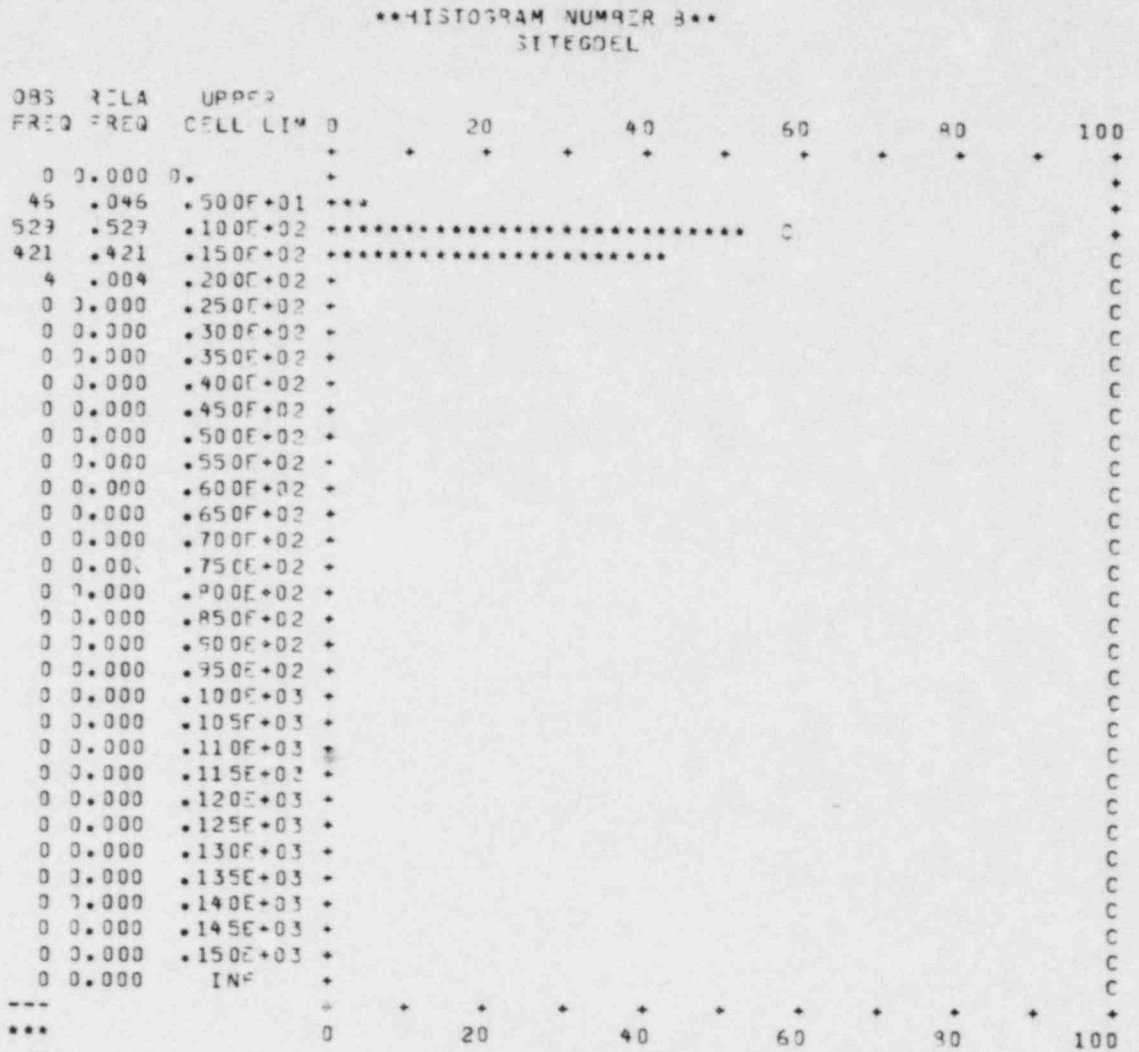


Figure B-2. Continued

HISTOGRAM NUMBER 9
NUMBAT

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
3	.003	0.	+
210	.210	.100E+01	**********C
787	.787	.200E+01	**********C
0	0.000	.300E+01	+
0	0.000	.400E+01	+
0	0.000	.500E+01	+
0	0.000	.600E+01	+
0	0.000	.700E+01	+
0	0.000	.800E+01	+
0	0.000	.900E+01	+
0	0.000	.100E+02	+
0	0.000	.110E+02	+
0	0.000	.120E+02	+
0	0.000	INF	+
---			+
***			0 20 40 60 80 100

HISTOGRAM NUMBER10
NUMBER

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
3	.003	0.	+
189	.189	.100E+01	*********C
808	.808	.200E+01	**********C
0	0.000	.300E+01	+
0	0.000	.400E+01	+
0	0.000	.500E+01	+
0	0.000	.600E+01	+
0	0.000	.700E+01	+
0	0.000	.800E+01	+
0	0.000	.900E+01	+
0	0.000	.100E+02	+
0	0.000	.110E+02	+
0	0.000	.120E+02	+
0	0.000	INF	+
---			+
***			0 20 40 60 80 100

Figure B-2. Continued

HISTOGRAM NUMBER11
TIMESAR

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	).	+
141	.143	.600E+01	+*******
735	.745	.120E+02	+**********C
111	.112	.180E+02	+*******C
0	0.000	.240E+02	+C
0	0.000	.300E+02	+C
0	0.000	.360E+02	+C
0	0.000	.420E+02	+C
0	0.000	.480E+02	+C
0	0.000	.540E+02	+C
0	0.000	.600E+02	+C
0	0.000	.660E+02	+C
0	0.000	.720E+02	+C
0	0.000	.780E+02	+C
0	0.000	.840E+02	+C
0	0.000	.900E+02	+C
0	0.000	.960E+02	+C
0	0.000	.102E+03	+C
0	0.000	.108E+03	+C
0	0.000	.114E+03	+C
0	0.000	.120E+03	+C
0	0.000	.126E+03	+C
0	0.000	.132E+03	+C
0	0.000	.138E+03	+C
0	0.000	.144E+03	+C
0	0.000	.150E+03	+C
0	0.000	.156E+03	+C
0	0.000	.162E+03	+C
0	0.000	.168E+03	+C
0	0.000	.174E+03	+C
0	0.000	.180E+03	+C
0	0.000	INF	+C
---			+ + + + + + + + + + + +
988			0 20 40 60 80 100

Figure B-2. Continued

HISTOGRAM NUMBER12
TIMETHF

OBS FREQ	RELA FREQ	UPPER CELL LIM	0	20	40	60	80	100
			+	+	+	+	+	+

NO VALUES RECORDED.

Figure B-2. Continued

```
                         **HISTOGRAM NUMBER13**
                                GTOABES

OBS  RELA    UPPER
FREQ FREQ   CELL LIM 0        20        40        60        80       100
                     +    +    +    +    +    +    +    +    +    +    +
   0 0.000  0.       +                                                 +
   0 0.000  .100E+01 +                                                 +
   0 0.000  .200E+01 +                                                 +
   0 0.000  .300E+01 +                                                 +
   0 0.000  .400E+01 +                                                 +
   0 0.000  .500E+01 +                                                 +
   0 0.000  .600E+01 +                                                 +
   0 0.000  .700E+01 +                                                 +
   0 0.000  .800E+01 +                                                 +
   0 0.000  .900E+01 +                                                 +
   0 0.000  .100E+02 +                                                 +
   0 0.000  .110E+02 +                                                 +
   0 0.000  .120E+02 +                                                 +
 *** 1.000  .130E+02 +**************************************************
   0 0.000  .140E+02 +                                                 C
   0 0.000  .150E+02 +                                                 C
   0 0.000  .160E+02 +                                                 C
   0 0.000  .170E+02 +                                                 C
   0 0.000  .180E+02 +                                                 C
   0 0.000  .190E+02 +                                                 C
   0 0.000  .200E+02 +                                                 C
   0 0.000  .210E+02 +                                                 C
   0 0.000  .220E+02 +                                                 C
   0 0.000  .230E+02 +                                                 C
   0 0.000  .240E+02 +                                                 C
   0 0.000  .250E+02 +                                                 C
   0 0.000  .260E+02 +                                                 C
   0 0.000  .270E+02 +                                                 C
   0 0.000  .280E+02 +                                                 C
   0 0.000  .290E+02 +                                                 C
   0 0.000  .300E+02 +                                                 C
   0 0.000  .310E+02 +                                                 C
   0 0.000  .320E+02 +                                                 C
   0 0.000  .330E+02 +                                                 C
   0 0.000  .340E+02 +                                                 C
   0 0.000  .350E+02 +                                                 C
   0 0.000  .360E+02 +                                                 C
   0 0.000  .370E+02 +                                                 C
   0 0.000  .380E+02 +                                                 C
   0 0.000  .390E+02 +                                                 C
   0 0.000  .400E+02 +                                                 C
   0 0.000    INF    +                                                 C
 ---                 +    +    +    +    +    +    +    +    +    +    +
 ***                 0        20        40        60        80       100
```

Figure B-2. Continued

HISTOGRAM NUMBER14
TOASBFS

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	.	
0	0.000	.100E+01	
0	0.000	.200E+01	
0	0.000	.300E+01	
0	0.000	.400E+01	
0	0.000	.500E+01	
0	0.000	.600E+01	
0	0.000	.700E+01	
0	0.000	.800E+01	
0	0.000	.900E+01	
0	0.000	.100E+02	
0	0.000	.110E+02	
0	0.000	.120E+02	
988	1.000	.130E+02	**********
0	0.000	.140E+02	C
0	0.000	.150E+02	C
0	0.000	.160E+02	C
0	0.000	.170E+02	C
0	0.000	.180E+02	C
0	0.000	.190E+02	C
0	0.000	.200E+02	C
0	0.000	.210E+02	C
0	0.000	.220E+02	C
0	0.000	.230E+02	C
0	0.000	.240E+02	C
0	0.000	.250E+02	C
0	0.000	.260E+02	C
0	0.000	.270E+02	C
0	0.000	.280E+02	C
0	0.000	.290E+02	C
0	0.000	.300E+02	C
0	0.000	.310E+02	C
0	0.000	.320E+02	C
0	0.000	.330E+02	C
0	0.000	.340E+02	C
0	0.000	.350E+02	C
0	0.000	.360E+02	C
0	0.000	.370E+02	C
0	0.000	.380E+02	C
0	0.000	.390E+02	C
0	0.000	.400E+02	C
0	0.000	INF	
988			0 20 40 60 80 100

Figure B-2. Continued

HISTOGRAM NUMBER15
NBPBBAT

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
			+ + + + + + + + + + +
0	0.000	0.	+
1	.001	.100E+01	+
1	.001	.200E+01	+
180	.101	.300E+01	+******
144	.081	.400E+01	+*****C
***	.817	.500E+01	+**********C
0	0.000	.600E+01	+C
0	0.000	.700E+01	+C
0	0.000	.800E+01	+C
0	0.000	.900E+01	+C
0	0.000	.100E+02	+C
0	0.000	.110E+02	+C
0	0.000	.120E+02	+C
0	0.000	.130E+02	+C
0	0.000	.140E+02	+C
0	0.000	.150E+02	+C
0	0.000	INF	+C
---			+ + + + + + + + + + +
***			0 20 40 60 80 100

Figure B-2. Continued

APPENDIX C

ISEM Analysis of the Reactor Facility

This appendix presents the application of ISEM to an insider scenario for the reactor facility.

C.1 PATH DESCRIPTION

The path chosen for ISEM analysis is the following:*

To target 618
Path: 284-269-251-617-627-618
(284 is the access portal at the security building)

The path to target 618 is illustrated in Figure C-1. The path was chosen so that it passed through normal personnel access points.

C.2 ASSUMPTIONS AND DATA

Base case assumptions for the adversary and guards are listed in Table C-1. A single insider is assumed to be attempting to gain access to the facility via the normal personnel entry-control system.

Adversary path data are summarized in Table C-2. Sensors assumed along the path are listed. Detection probabilities associated with portals 284 and 269 are based almost entirely on detection of the concealed handgun by the metal detectors since plastic explosives are very difficult to detect.

Guard response data are summarized in Table C-3. Response procedures and assessment times based on different alarms that may occur are specified, and response times for guards from locations they may be at to locations they may respond to are also listed.

---

*The path is described in terms of the node labels used on the SAFE digitized facility layout drawings (see Appendix A).

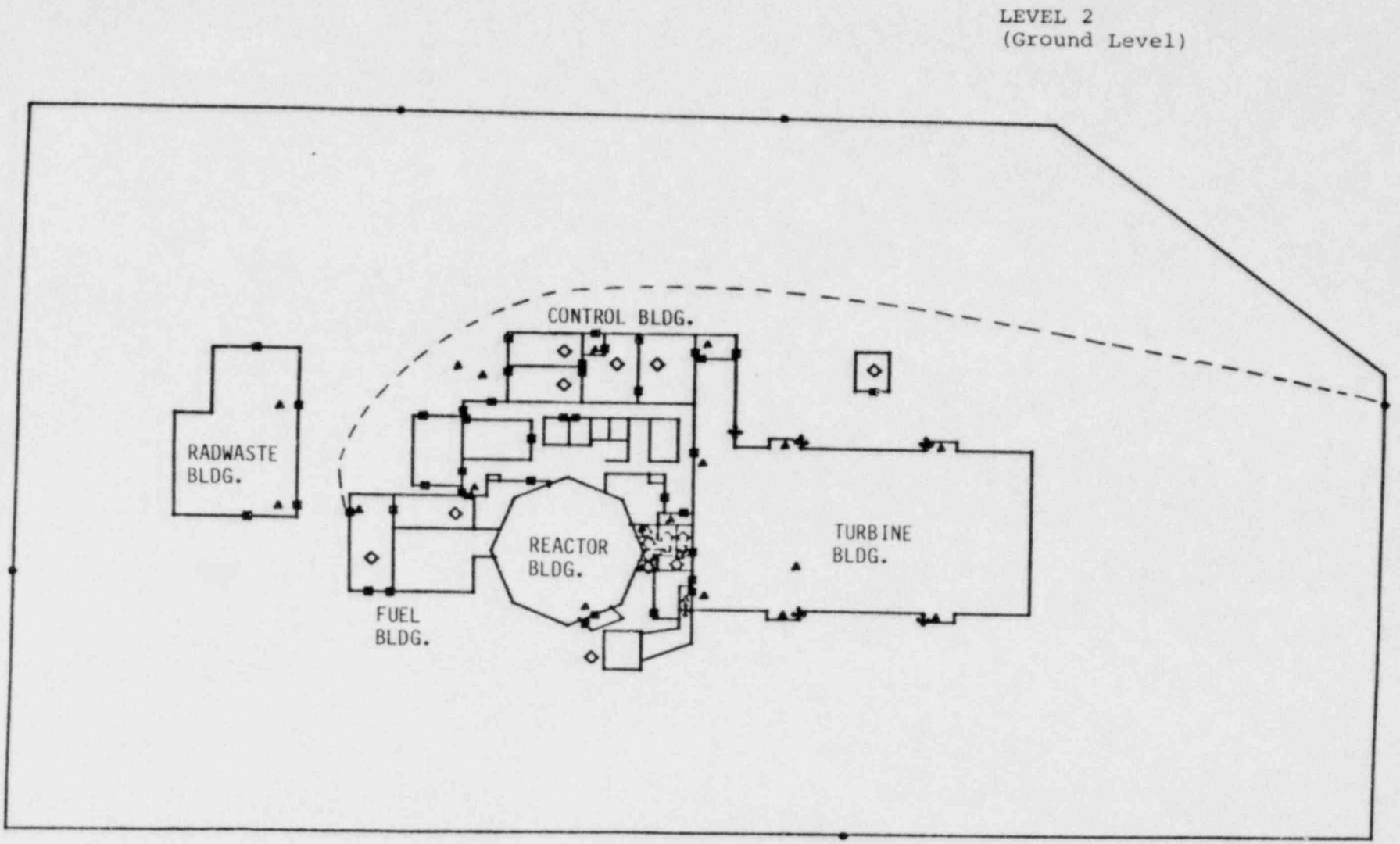


Figure C-1. Path Analyzed Using ISEM

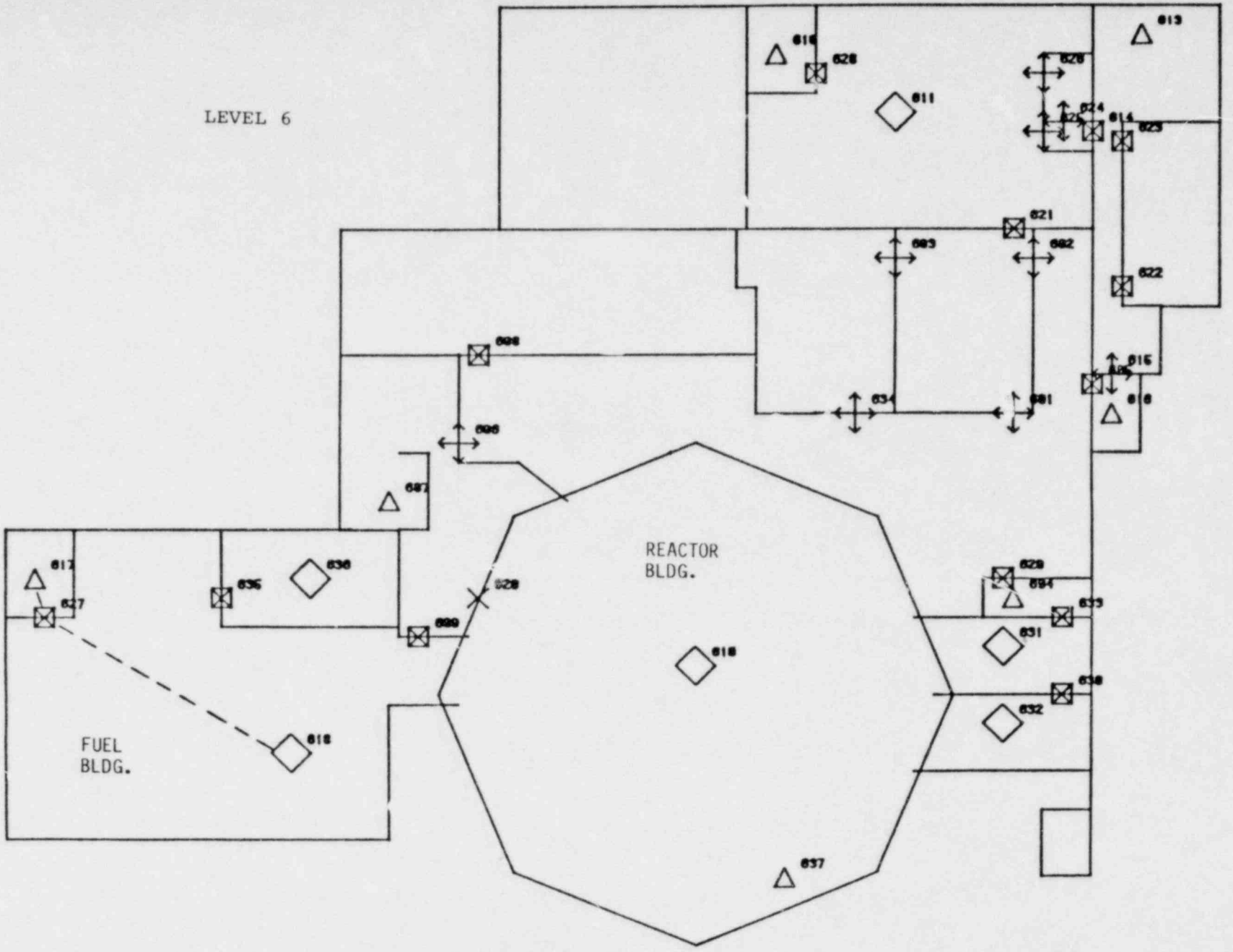


Figure C-1. Continued

Table C-1

Base Case Assumptions for ISEM Analysis

Adversary Characteristics

- Single insider
- Handgun (concealed)
- High competency level
- Plastic explosives (concealed)

Guard Characteristics

- Five response guards
  (One on patrol; four stationed in the security building)
- High competency level
- Shotguns

Table C-2

Adversary Path Data*

Path Location	Sensor	Time Delay (minutes)	Detection Probability
Portal 284	Metal, explosives detectors	0.1	0.1
Portal 269	Metal, explosives detectors	0.1	0.1
Portal 627	None	0.1	0.0
Target area	CCTV	--	0.2

*Path data assume that the adversary is using the normal personnel access system to gain entry. (Note: The access system was conceived in order to illustrate the example). Other data, such as area crossing times and the time to sabotage target, reflect base case data specified in the SAFE analysis.

Table C-3

Guard Response Data

Alarm	No. of Guards Responding	From	To	Assessment Time (minutes)
At portal 284	1	Security bldg.	Portal 284	0.1
At portal 269	1	Patrol	Portal 269	0.1
CCTV detection at target area	All	Anywhere	Target area	0.5
Battle	All	Anywhere	Target area	--

	Response Times Mean (min, max)		
From \ To	Portal 284 (minutes)	Portal 269 (minutes)	Target Area (minutes)
Security building	0.15(0.1,0.2)	--	4.0(3.9,4.1)
Patrol	--	1.5(0.0,3.0)	2.5(1.0,4.0)
Portal 284	--	--	4.0
Portal 269	--	--	1.0

A second case, which assumes a search at the security building entrance portal with two guards present, was considered. A detection probability of .95 was assumed for the search.

C.3 ANALYSIS RESULTS

The base case scenario and a case which assumed a search at portal 284 were evaluated. The results are presented in Table C-4.

Table C-4

ISEM Results

Case	Probability of Interruption*	Probability of System Win
Base case	.06	.03
Search at entrance portal	.95	.95

*Not a direct output of ISEM

C.4 EXAMPLE OUTPUT

An example ISEM output for the base case insider scenario presented in this appendix is provided in Figure C-2. The user should refer to the Insider Safeguards Effectiveness Model (ISEM) Users Guide, SAND77-0043, for a detailed description of the outputs.

```
GEN,BOOZER D D,1,2,20,1976, 500,8,Y,N,N,N,N*
LIM,6,1,250,16,26,4500*
COL,1,SYSWIN,2,TOTTIM,3,TIMWIN,4,TIMLOS,5,ENGTIM,6,BATTIM,7,TIMABGL,
8,GUARDK,9,INCIP,10,NALARM,11,TFBEB,12,TBEBGW,13,PGWGB,14,NABB,
15,NENGAG,16,NGRODE,17,NGRDAR,18,TIMBBAT,19,TIMTFA,20,TIMTAL,21,GRDATIM,
22,PIMTIMNB*
HIS,1,SYSWIN,7,-1,.5,2,TOTTIM,20,,,.4,3,TIMWIN,20,,,.4,4,TIMLOS,20,,,.4,
5,NENGAG,,,,,6,NUMGRDK,,,,7,NGRODE,,,,8,NGRDAR,,,,9,ENGTIM,30,,,.1*
HIS,10,TIMTFA,20,,,.4,11,TIMTAL,20,,,.4,12,NUMGRD,5,,,13,GRDATIM,20,,,.4*
HIS,14,UNTAMALM,34,,,15,TAMALARM,34,,*
PRI,1,LVF,2,2,LVF,1,3,LVF,1,8,LVF,1,4,LVF,1,7,LVF,1,11,LVF,16*
PRI,12,LVF,16,13,LVF,16,14,LVF,16,15,LVF,16,16,LVF,16,17,LVF,16*
PRI,18,LVF,16,19,LVF,16,20,LVF,16,21,LVF,16,22,LVF,16,23,LVF,16*
PRI,24,LVF,16,25,LVF,16*
PRI,1,LVF,2*
INI,0*
 FIN*
```

.....FACILITY DESCRIPTION.....

STEALTH

NUMBER OF AREAS 4 ..FILE 2..

AREA NUM	CROSS TIME	AREA TYPE	NC AUT EMP	MIN NO EMP	AREA M**2	NC OF AREA SENSORS	-LIST-				NO OF LOCAL SENSORS	-LIST-				
1.00	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	3.75	0.00	0.00	0.00	0.00	1.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	0.00	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

NUMBER OF PORTALS 4 ..FILE 3..

PORTAL NUM	PORTAL DELAY	PORTAL TYPE	PROB GD SOS ALARM	NO OF ENTRY SENSORS	-LIST-				NO OF EXIT SENSORS	-LIST-				
1.00	.10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00
2.00	.10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00	0.00	0.00	0.00
3.00	.10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

NUMBER OF BARRIERS 0 ..FILE 8..

Figure C-2. Example of ISEM Output for the Base Case Insider Scenario

NUMBER OF SENSORS 3 ..FILE 4..

SENSOR NUM	SENSOR CLASS	SENSOR TYPE	SENSOR LOCAT TYPE	SENSOR LOCAT NUM	ALARM LOGIC LOCAT TYPE	ALARM LOGIC ENTITY NUM	NC OF ALARM LOCAT	NC 1 ALARM LOCAT TYPE	NC 1 ALARM LOCAT NUM	NO 2 ALARM LOCAT TYPE	NO 2 ALARM LOCAT NUM	NO 3 ALARM LOCAT TYPE	NO 3 ALARM LOCAT NUM	DELAY	RESP TYPE
1.00	1.00	5.00	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
2.00	1.00	5.00	1.00	2.00	0.00	0.00	1.00	1.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00
3.00	2.00	1.00	2.00	3.00	0.00	0.00	1.00	2.00	3.00	0.00	0.00	0.00	0.00	0.00	3.00

NUMBER OF SENSORS 3 ..FILE 7..

SENSOR NUM	---SNM SENSORS ONLY--- INTEG TIME	EFFECT AREA	THRHD STDDEV	BKGD COUNT INTEN	NC 2 ALARM LOGIC LOCAT TYPE	NO 2 ALARM LOGIC LOCAT NUM	LOGIC1 DEFEAT PROB	ALARM1 ASSESS TIME	ALARM1 DEFEAT PROB	ALARM2 ASSESS TIME	ALARM2 DEFEAT PROB	ALARM3 ASSESS TIME	ALARM3 DEFEAT PROB	LOGIC2 DEFEAT PROB	ALARM PROB
1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.10	0.00	0.00	0.00	0.00	0.00	0.00	.10
2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.10	0.00	0.00	0.00	0.00	0.00	0.00	.10
3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.50	0.00	0.00	0.00	0.00	0.00	0.00	.20

.....THREAT DESCRIPTION.....

NUMBER OF EMPLOYEE INSIDERS 1 ..FILE 5..

INSDER NUM									SAME	EXPE	NO AUT ACC AR	-AUTHORIZED AREAS-			
1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

.....PATH DESCRIPTION.....

NUMBER OF FACILITY ENTITIES IN EXIT PATH 7

ENTITY NUMBER	ENTITY TYPE	NUMBER ENTITY TYPE	CUMULATIVE AVERAGE PATH TIME NO BARRIERS INSTALLED	ALL BARRIERS INSTALLED
1	PORTAL	1	.10	.10
2	AREA	1	3.25	3.25
3	PORTAL	2	3.35	3.35
4	AREA	2	4.27	4.27
5	PORTAL	3	4.37	4.37
6	AREA	3	8.12	8.12
7	PORTAL	4	8.12	8.12

Figure C-2. Continued

.....GUARD RESPONSE DESCRIPTION.....

RESPONSE FILE 11

--RESPONSE AREA LIST--

1	2	3	4	5	6	7	8	9	10	11	12	13	14	NO OF RESP AREAS	RESP TYPE
4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00
1.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00
1.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	9.00

GUARD RESPONSE FILE 12

NUMBER OF GUARDS RESPONDING FROM AREA 1 TO PORTAL NUMBER..

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	RESP TYPE
0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00

GUARD RESPONSE FILE 15

NUMBER OF GUARDS RESPONDING FROM AREA 4 TO PORTAL NUMBER..

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	RESP TYPE
1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00

GUARD RESPONSE TIME RANGE FROM AREAS (LISTED CONSECUTIVELY) TO PORTALS..

	1	2	3	4
1	-1.00	0.00	-1.00	1.00
	-1.00	3.00	-1.00	4.00
2	-1.00	-1.00	-1.00	-1.00
	-1.00	-1.00	-1.00	-1.00
3	-1.00	-1.00	-1.00	-1.00
	-1.00	-1.00	-1.00	-1.00
4	.10	-1.00	-1.00	3.90
	.20	-1.00	-1.00	4.10

Figure C-2. Continued

```
                                                    1     2     3     4
RESPONSE TIMES TO BATTLE FROM PORTALS..          4.00  1.00-1.00  0.00
RESPONSE TIMES TO BATTLE FROM RESPONSE AREAS.. 2.50-1.00-1.00  4.00
NUMBER OF RESPONSE GUARDS IN RESPONSE AREAS..    1     0     0     4
TOTAL NUMBER OF RESPONSE GUARDS =   5
PROBABILITY GUARD SOUNDS BATTLE ALARM UPON ARRIVING AT BATTLE =1.00
GUARD(S) WEAPON LEVEL     = 2.0       INSIDER WEAPON LEVEL      = 1.0
GUARD(S) COMPETENCE LEVEL = 3.0       INSIDER COMPETENCE LEVEL = 3.0

.......OUTPUT REQUESTED.......

EVENT SEQUENCE ON FIRST 10 RUNS

COLLECT VARIABLES DEFINED IN SUMMARY

COLLECTION STATISTICS IN SUMMARY

HISTOGRAM VARIABLES DEFINED IN SUMMARY

HISTOGRAMS PLOTTED IN SUMMARY

.......RANDOM SEED.......
          1119
```

Figure C-2. Continued

RUN 1

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.08					
PORTAL 2	2.94					
AREA 2	3.04					
PORTAL 3	3.93					
AREA 3	4.03					
PORTAL 4	8.11					
SEQEND	8.11					
INSIDER(S) WIN						

RUN 2

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
		ALARM(1)	.00			
AREA 1	.11					
		ACTION(1)	.14			
				ARRPCR 1	.26	
PORTAL 2	3.53					
AREA 2	3.63					
PORTAL 3	4.61					
AREA 3	4.72					
		ALARM(3)	5.72			
		ACTION(3)	6.43			
				ARRPCR 4	8.34	
PORTAL 4	8.66					
				ARRBAT	8.66	
		ALARM-BAT	8.66			
		ACTION(9)	8.66			
				ENGAGE	8.66	BEGIN 1
				GKILL	8.67	END
SEQEND	8.67					
INSIDER(S) WIN						

Figure C-2. Continued

RUN 3

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.10					
PORTAL 2	3.49					
		ALARM(2)	3.49			
		ACTION(2)	3.58			
AREA 2	3.60					
				ARRPOR 2	4.42	
PORTAL 3	4.66					
AREA 3	4.76					
PORTAL 4	8.38					
SEQEND	8.38					
INSIDER(S) WIN						

RUN 4

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.10					
PORTAL 2	3.14					
AREA 2	3.24					
PORTAL 3	4.22					
AREA 3	4.32					
PORTAL 4	8.05					
SEQEND	8.05					
INSIDER(S) WIN						

Figure C-2. Continued

RUN 5

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.11					
PORTAL 2	3.16					
AREA 2	3.26					
PORTAL 3	4.14					
AREA 3	4.25					
		ALARM(3)	6.74			
		ACTION(3)	7.13			
PORTAL 4	8.07					
SEQEND	8.07					
INSIDER(S) WIN						

RUN 6

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.09					
PORTAL 2	3.14					
AREA 2	3.25					
PORTAL 3	4.17					
AREA 3	4.28					
PORTAL 4	8.07					
SEQEND	8.07					
INSIDER(S) WIN						

Figure C-2. Continued

RUN 7

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.10					
PORTAL 2	3.38					
		ALARM(2)	3.38			
		ACTION(2)	3.48			
AREA 2	3.49					
PORTAL 3	4.40					
AREA 3	4.49					
				ARRPCR 2	6.11	
PORTAL 4	8.63					
SEQEND	8.63					
INSIDER(S) WIN						

RUN 8

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.10					
PORTAL 2	2.78					
		ALARM(2)	2.78			
		ACTION(2)	2.88			
AREA 2	2.89					
				ARRPCR 2	3.61	
PORTAL 3	3.96					
AREA 3	4.06					
PORTAL 4	7.90					
SEQEND	7.90					
INSIDER(S) WIN						

Figure C-2. Continued

RUN 9

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.11					
PORTAL 2	3.17					
AREA 2	3.28					
PORTAL 3	4.20					
AREA 3	4.30					
PORTAL 4	8.36					
SEQEND	8.36					
INSIDER(S)	WIN					

RUN 10

INSIDER EVENT	TIME	ALARM EVENT	TIME	GUARD EVENT	TIME	BATTLE ENGAG GDS
START	0.00					
PORTAL 1	0.00					
AREA 1	.10					
PORTAL 2	3.42					
AREA 2	3.52					
PORTAL 3	4.46					
AREA 3	4.55					
PORTAL 4	8.01					
SEQEND	8.01					
INSIDER(S)	WIN					

Figure C-2. Continued

COLLECT VARIABLE DEFINITIONS

VARIABLE	DEFINITION
SYSWIN	MEAN IS ESTIMATE OF PROBABILITY THE SYSTEM WINS
TOTTIM	TOTAL TIME TO OUTCOME ON EACH RUN
TIMWIN	TIME TO OUTCOME WHEN SYSTEM WINS
TIMLOS	TIME TO OUTCOME WHEN SYSTEM LOSES
ENGTIM	TIME FOR EACH ENGAGEMENT (MULTIPLE ENGAGEMENTS ON A GIVEN RUN E POSSIBLE)
BATTIM	ACCUMULATED ENGAGEMENT TIME FOR EACH RUN
TIMABGL	TIME AFTER BEGINNING OF FIRST ENGAGEMENT TO OUTCOME GIVEN THE GUARDS LOSE
GUARDK	NUMBER OF GUARDS KILLED PER RUN GIVEN GUARDS WERE KILLED
INCIP	OBS COLUMN GIVES NUMBER OF RUNS INSIDER WAS CAUGHT IN A PORTAL
NALARM	TOTAL NUMBER OF ALARMS INCLUDING FIRST BATTLE ALARM PER RUN
TFEEB	TIME FORM BEGINNING TO END OF BATTLE
TBEBGW	TIME FROM BEGINNING TO END OF BATTLE GIVEN GUARDS WIN
PGWGB	PROBABILITY THAT GUARDS WIN GIVEN A BATTLE
NABB	NUMBER OF ALARMS BEFORE BATTLE BEGINS
NENGAG	NUMBER OF ENGAGEMENTS ON EACH RUN
NGRDDE	NUMBER OF GUARDS DEPLOYED
NGRDAR	NUMBER OF GUARDS ARRIVING AT BATTLE
TIMBBAT	TIME TO BEGINNING OF BATTLE

Figure C-2. Continued

TIMTFA	TIME TO FIRST ALARM
TIMTAL	TIME TO ALL ALARMS (ONLY FIRST BATTLE ALARM IS CONSIDERED)
GRDATIM	TIME TO ALL GUARD ARRIVALS AT BATTLE
PTHTIMNB	PATH TIME WHEN THERE IS NO BATTLE

HISTOGRAM VARIABLE DEFINITIONS

NUMBER	VARIABLE	DEFINITION
1	SYSWIN	COMPARISON OF WINS AND LOSSES
2	TOTTIM	TOTAL TIME TO OUTCOME ON EACH RUN
3	TIMWIN	TIME TO OUTCOME WHEN SYSTEM WINS
4	TIMLOS	TIME TO OUTCOME WHEN SYSTEM LOSES
5	NENGAG	NUMBER OF ENGAGEMENTS ON EACH RUN
6	NUMGRDK	NUMBER OF GUARDS KILLED PER RUN GIVEN GUARDS WERE KILLED
7	NGRDDE	NUMBER OF GUARDS DEPLOYED
8	NGRDAR	NUMBER OF GUARDS ARRIVING AT BATTLE
9	ENGTIM	TIME FOR EACH ENGAGEMENT (MULTI EGMTS VALID)
10	TIMTFA	TIME TO FIRST ALARM
11	TIMTAL	TIME TO ALL ALARMS (ONLY FIRST BATTLE ALARM IS CONSIDERED)
12	NUMGRD	NUMBER OF GUARDS ARRIVING AT BATTLE DURING EACH ENGAGEMENT
13	GRDATIM	TIME TO ALL GUARD ARRIVALS AT BATTLE
14	UNTAMALM	SENSOR ALARMS WITH NO TAMPERING
15	TAMALARM	SENSOR ALARMS WITH TAMPERING

Figure C-2. Continued

GASP SUMMARY REPORT

SIMULATION PROJECT NUMBER 1 BY BCOZER C D

DATE 2/ 20/ 1976 RUN NUMBER 500 OF 500

CURRENT TIME = 0.

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN	STD DEV	CV	MINIMUM	MAXIMUM	OBS
SYS*1N	.280E-01	.165E+00	.590E+01	0.	.100E+01	500
TOTTIM	.816E+01	.389E+00	.477E-01	.707E+01	.912E+01	500
TIMWIN	.846E+01	.375E+00	.443E-01	.780E+01	.904E+01	14
TIMLOS	.815E+01	.387E+00	.474E-01	.707E+01	.912E+01	486
ENGTIM	.146E+00	.160E+00	.110E+01	.746E-02	.718E+00	28
BATTIM	.146E+00	.160E+00	.110E+01	.746E-02	.718E+00	28
TIMABGL	.939E-01	.867E-01	.923E+00	.746E-02	.249E+00	14
GUARDK	.100E+01	0.	0.	.100E+01	.100E+01	14
INCIP			NO VALUES RECORDED			
NALARM	.514E+00	.715E+00	.139E+01	0.	.300E+01	500
TFBEB	.146E+00	.160E+00	.110E+01	.746E-02	.718E+00	28
TBEBGW	.198E+00	.200E+00	.101E+01	.289E-01	.718E+00	14
PGWGB	.500E+00	.509E+00	.102E+01	0.	.100E+01	28
NABB	.214E+01	.356E+00	.166E+00	.200E+01	.300E+01	28
NENGAG	.100E+01	0.	0.	.100E+01	.100E+01	28
NGRDUE	.327E+01	.198E+01	.606E+00	.100E+01	.500E+01	181
NGRDAR	.100E+01	0.	0.	.100E+01	.100E+01	28
TIMBBAT	.831E+01	.377E+00	.454E-01	.733E+01	.890E+01	28
TIMTFA	.396E+01	.266E+01	.673E+00	.228E-11	.859E+01	197
TIMTAL	.469E+01	.278E+01	.593E+00	.228E-11	.890E+01	257
GRDATIM	.831E+01	.377E+00	.454E-01	.733E+01	.890E+01	28
PTHTIMNB	.814E+01	.383E+00	.471E-01	.707E+01	.905E+01	472

Figure C-2. Continued

HISTOGRAM NUMBER 1
SYSWIN

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	-.100E+01	+
0	0.000	-.500E+00	+
486	.972	0.	+**********
0	0.000	.500E+00	+ C
14	.028	.100E+01	+* C
0	0.000	.150E+01	+ C
0	0.000	.200E+01	+ C
0	0.000	.250E+01	+ C
0	0.000	INF	+ C
---			+
500			0 20 40 60 80 100

HISTOGRAM NUMBER 2
TOTTIM

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	0.	+
0	0.000	.400E+00	+
0	0.000	.800E+00	+
0	0.000	.120E+01	+
0	0.000	.160E+01	+
0	0.000	.200E+01	+
0	0.000	.240E+01	+
0	0.000	.280E+01	+
0	0.000	.320E+01	+
0	0.000	.360E+01	+
0	0.000	.400E+01	+
0	0.000	.440E+01	+
0	0.000	.480E+01	+
0	0.000	.520E+01	+
0	0.000	.560E+01	+
0	0.000	.600E+01	+
0	0.000	.640E+01	+
0	0.000	.680E+01	+
2	.004	.720E+01	+
35	.070	.760E+01	+***C
135	.270	.800E+01	+********** C
328	.656	INF	+********** C
---			+
500			0 20 40 60 80 100

Figure C-2. Continued

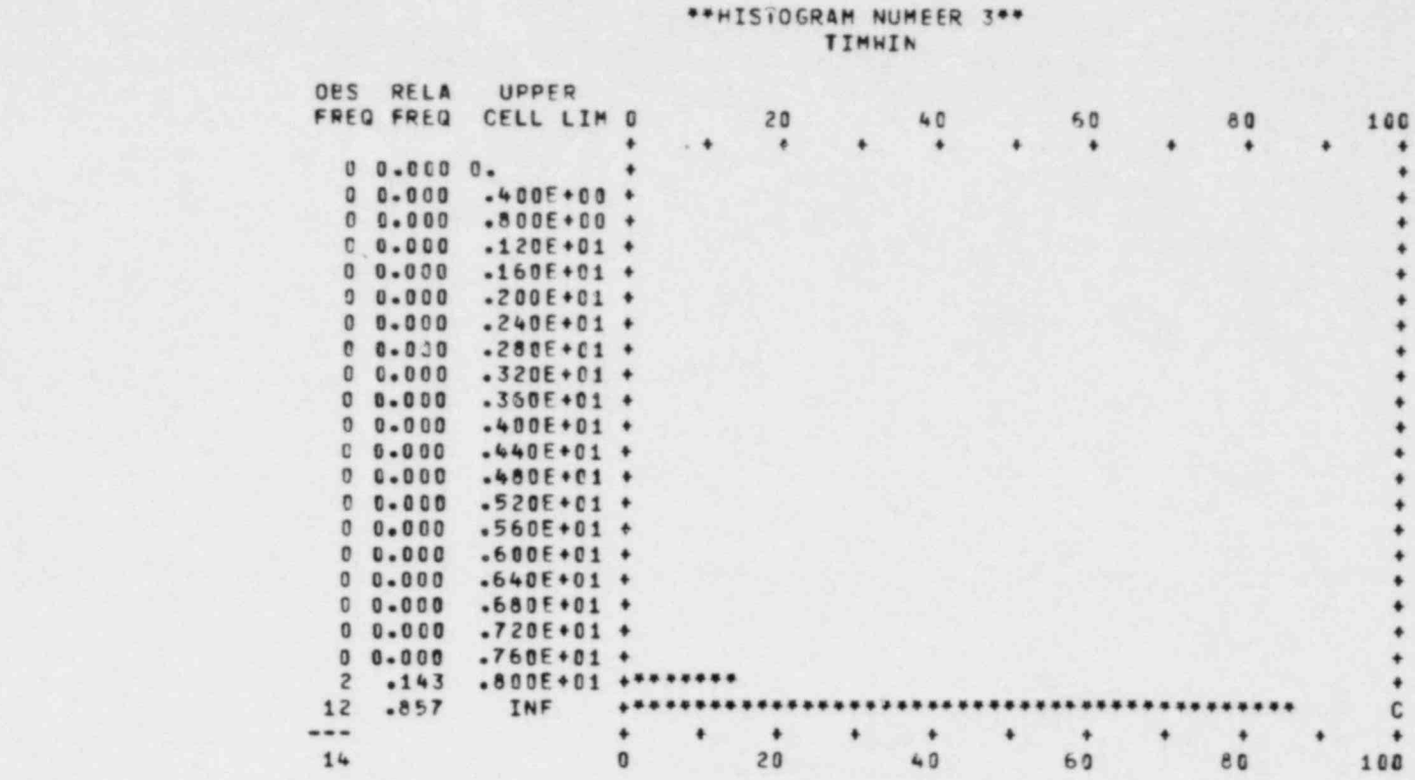


Figure C-2. Continued

HISTOGRAM NUMBER 4
TIMES

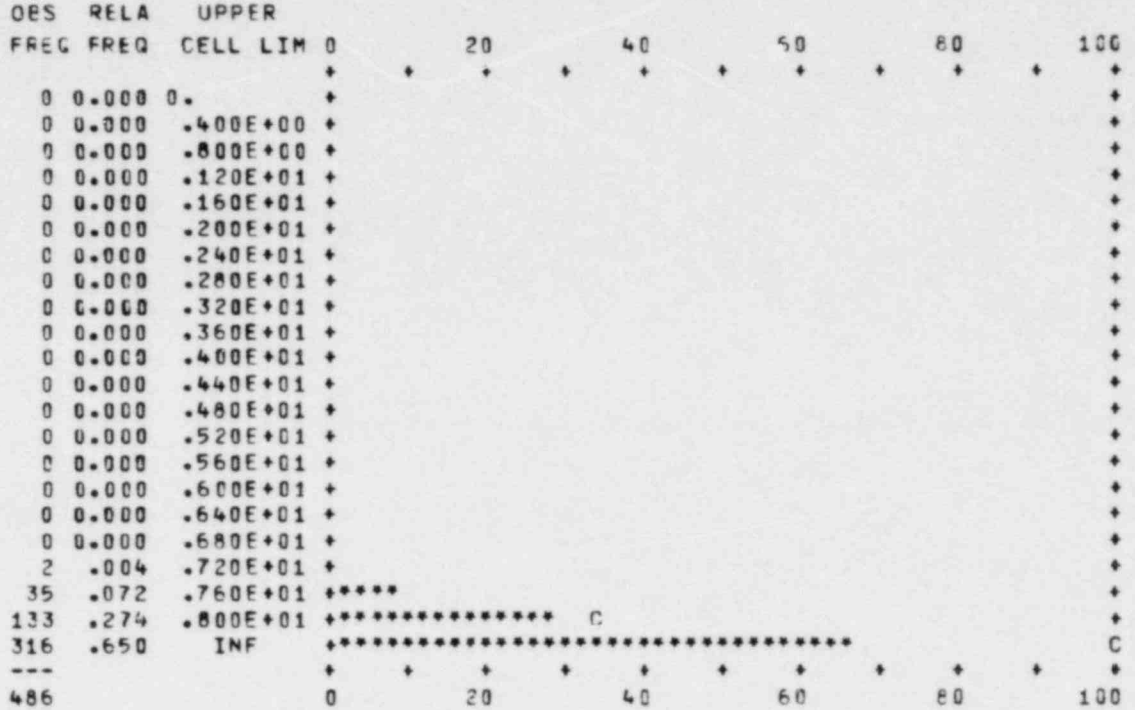
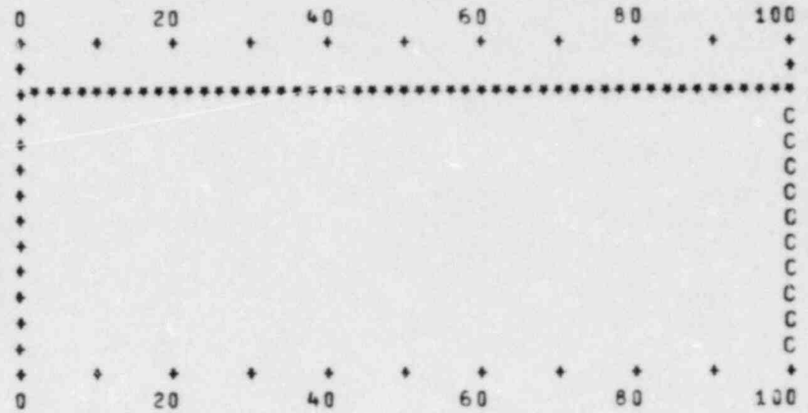


Figure C-2. Continued

HISTOGRAM NUMBER 5
NENGAG

OBS FREQ	RELA FREQ	UPPER CELL LIM
0	0.000	0.
28	1.000	.100E+01
0	0.000	.200E+01
0	0.000	.300E+01
0	0.000	.400E+01
0	0.000	.500E+01
0	0.000	.600E+01
0	0.000	.700E+01
0	0.000	.800E+01
0	0.000	.900E+01
0	0.000	.100E+02
0	0.000	INF
28		



HISTOGRAM NUMBER 6
NUMGROK

OBS FREQ	RELA FREQ	UPPER CELL LIM
0	0.000	0.
14	1.000	.100E+01
0	0.000	.200E+01
0	0.000	.300E+01
0	0.000	.400E+01
0	0.000	.500E+01
0	0.000	.600E+01
0	0.000	.700E+01
0	0.000	.800E+01
0	0.000	.900E+01
0	0.000	.100E+02
0	0.000	INF
14		

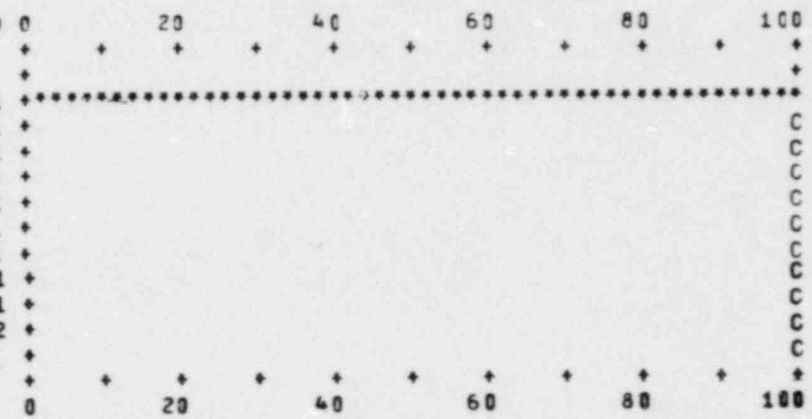


Figure C-2 Continued

HISTOGRAM NUMBER 7
NGRDDE

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	0.	
77	.425	.100E+01	**********
2	.011	.200E+01	** C
0	0.000	.300E+01	C
0	0.000	.400E+01	C
102	.564	.500E+01	********** C
0	0.000	.600E+01	C
0	0.000	.700E+01	C
0	0.000	.800E+01	C
0	0.000	.900E+01	C
0	0.000	.100E+02	C
0	0.000	INF	C

181			0 20 40 60 80 100

HISTOGRAM NUMBER 8
NGRDAR

OBS FREQ	RELA FREQ	UPPER CELL LIM	0 20 40 60 80 100
0	0.000	0.	
28	1.000	.100E+01	**********
0	0.000	.200E+01	C
0	0.000	.300E+01	C
0	0.000	.400E+01	C
0	0.000	.500E+01	C
0	0.000	.600E+01	C
0	0.000	.700E+01	C
0	0.000	.800E+01	C
0	0.000	.900E+01	C
0	0.000	.100E+02	C
0	0.000	INF	C

28			0 20 40 60 80 100

Figure C-2. Continued

HISTOGRAM NUMEER 9
ENGTIM

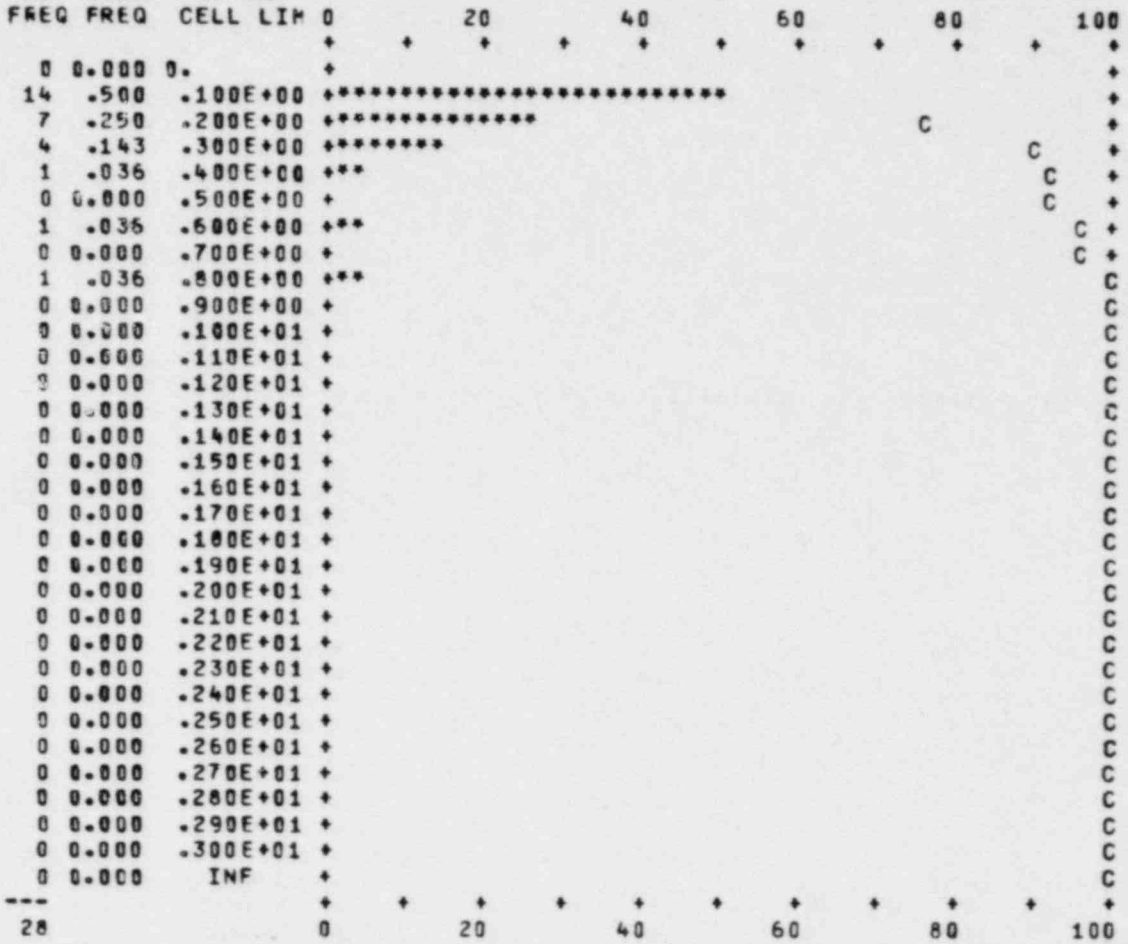


Figure C-2. Continued

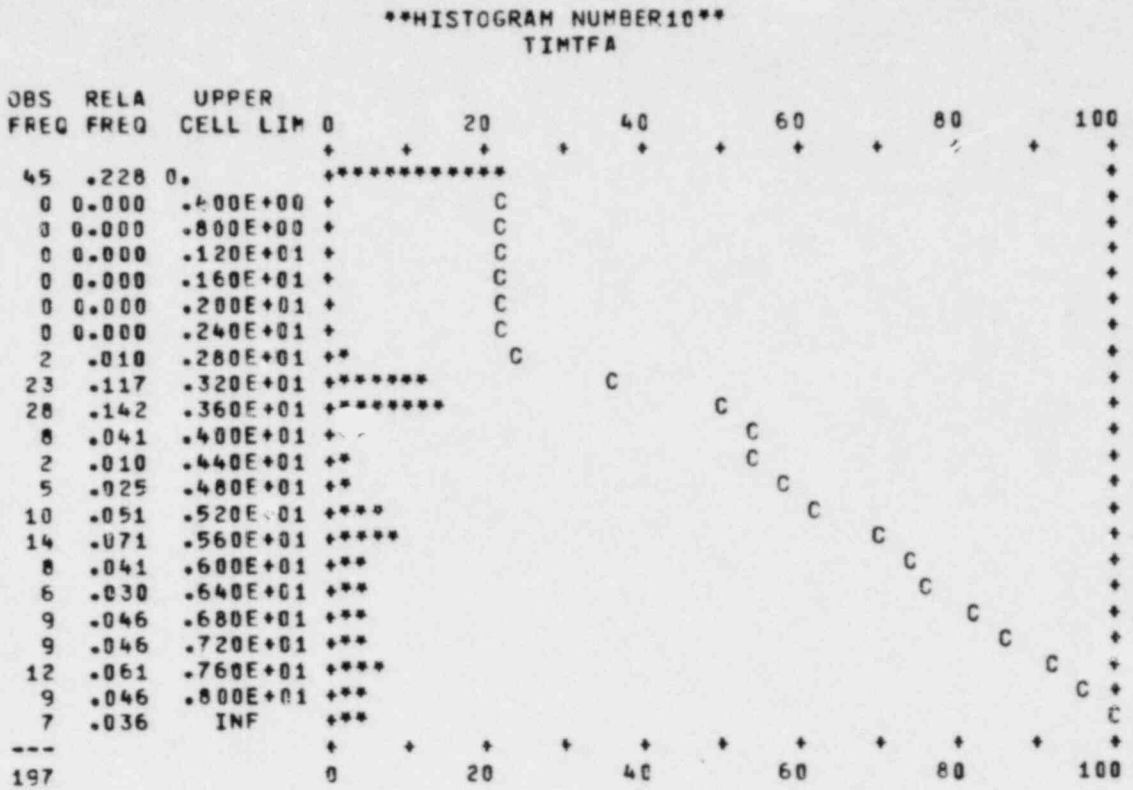


Figure C-2. Continued

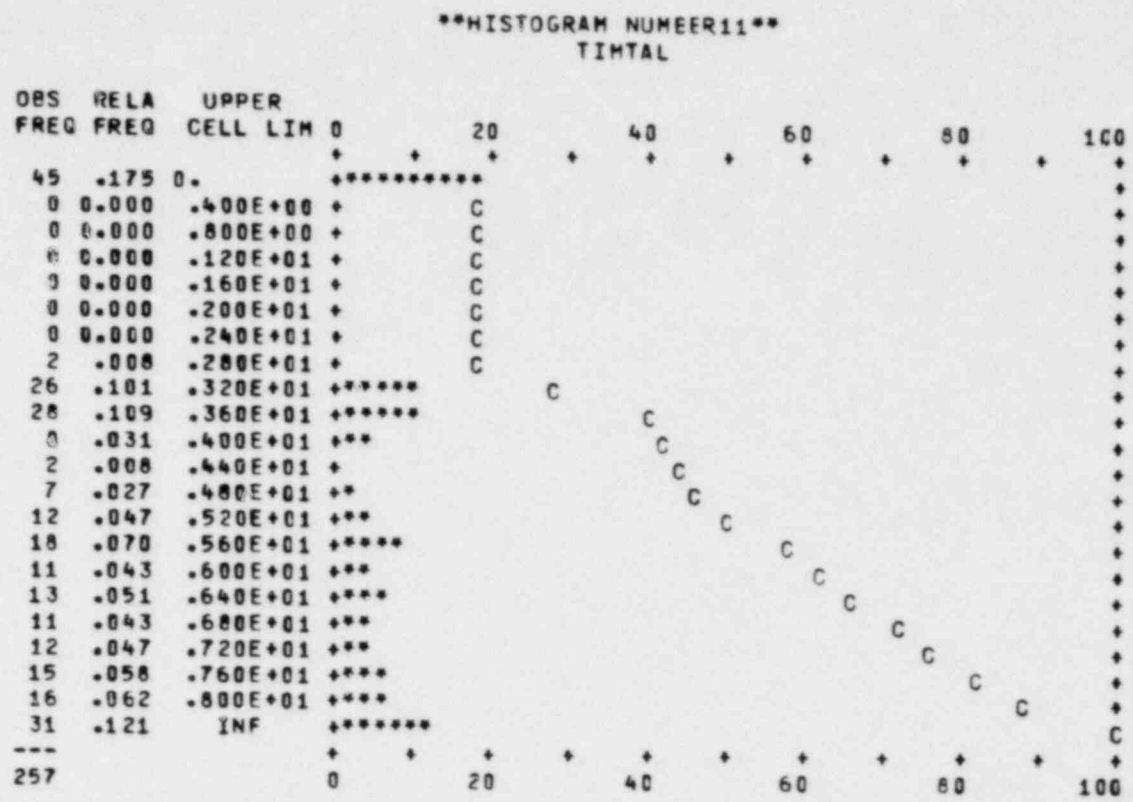
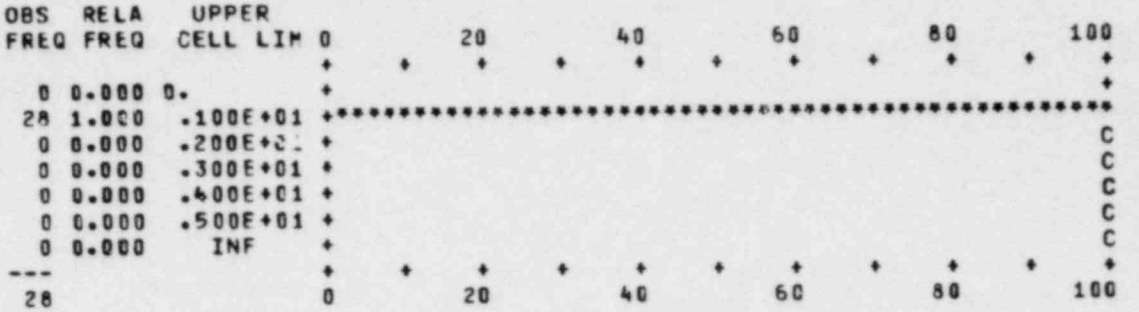


Figure C-2. Continued

HISTOGRAM NUMBER12
NUMGRD



HISTOGRAM NUMBER13
GRDATIP

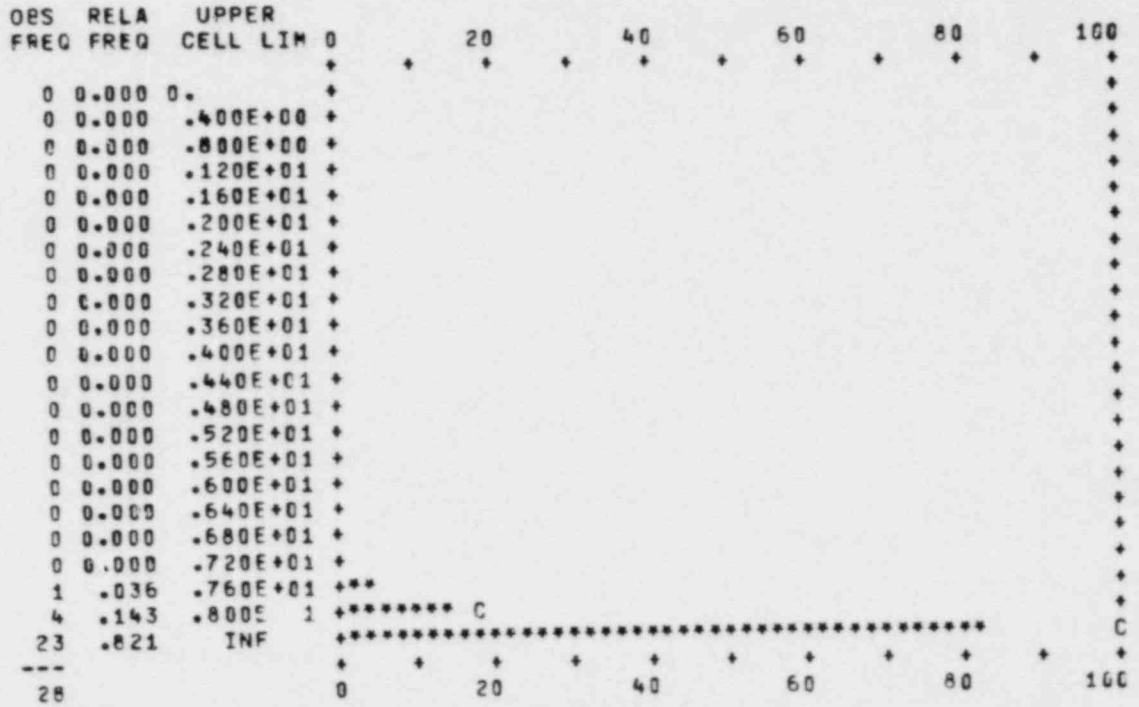


Figure C-2. Continued

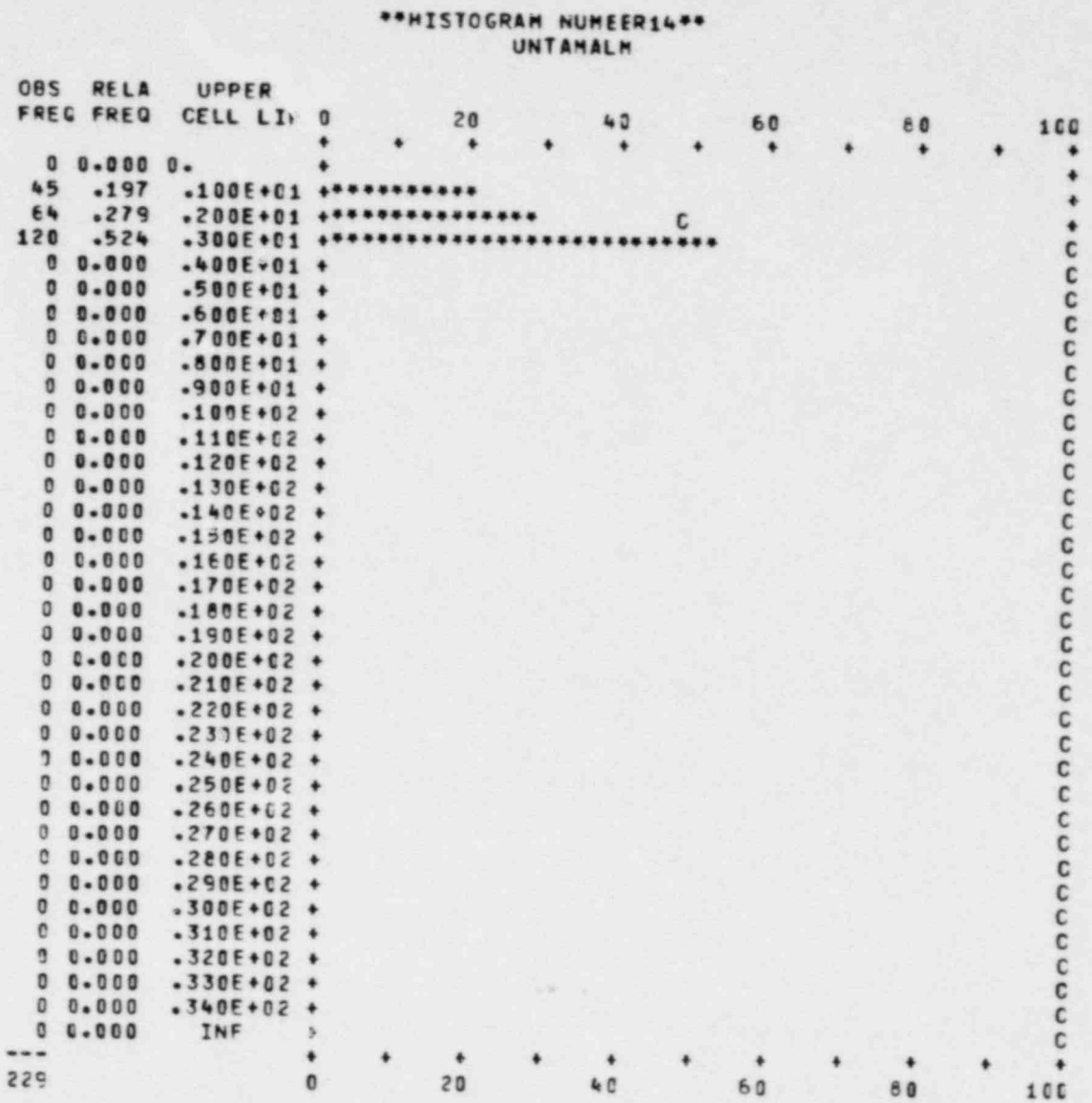


Figure C-2. Continued

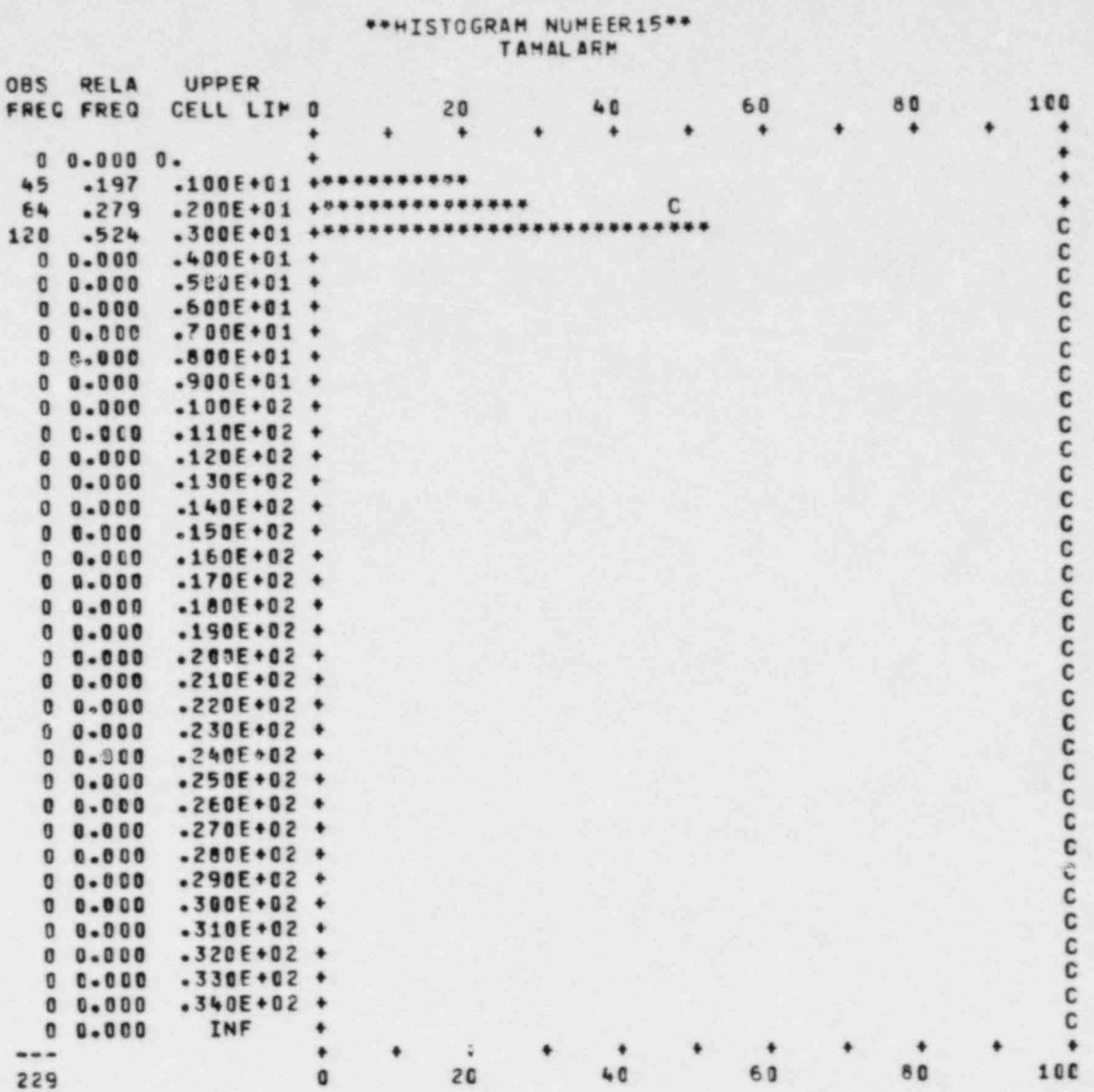


Figure C-2. Continued

APPENDIX D

SNAP Analysis of the Reactor Facility

This appendix presents the application of SNAP, using three selected scenarios, to a generic reactor facility.

D.1 GENERAL PROCEDURES AND ASSUMPTIONS USED IN MODEL FORMULATION

The safeguards system for a generic nuclear reactor facility was evaluated by testing its performance using SNAP models of three adversary attack scenarios. The general procedures and assumptions used in formulating these SNAP models are discussed in this section, while individual scenario details and results are discussed later in this appendix. Four major tasks must be accomplished to build any SNAP model. These are

1. Select scenarios,
2. Build facility submodel,
3. Build adversary submodel, and
4. Build guard submodel.

These tasks are discussed in the following subsections.

D.1.1 Scenario Selection

Scenario selection is one of the most important tasks in the SNAP analysis of the nuclear reactor facility. Due to resource constraints, only a few of the thousands of possible adversary scenarios can be selected for detailed SNAP scenario-specific analysis. The ones that are selected must provide a good test of the safeguards system.

The scenarios are selected only after a complete global SAFE analysis of the baseline safeguards system has been performed. The SAFE analysis looks at all feasible adversary paths to facility targets and selects the ones which have the lowest probability of being interrupted by the responding guard force. To get a more complete assessment of the most vulnerable adversary paths, SAFE is run several times with

different guard response times, different target sabotage times, and with and without detection at the fence surrounding the facility.

A set of vulnerable adversary attack scenarios is selected using these SAFE runs. Then the analyst chooses from among the more vulnerable scenarios, as assessed by the SAFE analysis. In this analysis, three SNAP scenarios were selected and expert opinion was solicited from Sandia National Laboratories and NRC personnel to determine if the selected scenarios were acceptable or if other scenarios were overlooked. The result was that the adversary attack paths output by SAFE were accepted without modification.

The first scenario, Scenario A, was selected because, in the base case, the no-fence detection case, and the reinforcement response case, the adversary path for this scenario had the lowest or one of the lowest interruption probabilities of all Type I targets.

Scenario B was selected because it was one of the two more vulnerable scenarios for Type II targets. From the standpoint of the adversary, the selected scenario was believed to be more favorable because fewer doors, stairwells, and facility operating spaces need to be traversed to accomplish the objective.

In Scenario C, the target is the area on level 6 from which sabotage actions can be controlled. This scenario was selected because it appears vulnerable to an attack using diversionary tactics for this generic reactor facility. (This scenario was discovered in a SAFE no-fence detection analysis.)

D.1.2 Facility Submodel

The facility submodel represents the physical attributes of the nuclear reactor facility. These include locations in the facility (targets, barriers, doors, fences), sensors (door alarms), and monitors of sensor activity. The goal of the facility submodel is to represent the attributes of the nuclear reactor facility to the required level of detail while keeping computer and analyst resources to a minimum. To do this, a modified grid technique developed in previous SNAP applications was used. Figure D-1 shows the ground level of the facility with the grid superimposed. Locations, barriers, targets, and sensors are indexed according to their position in the grid.

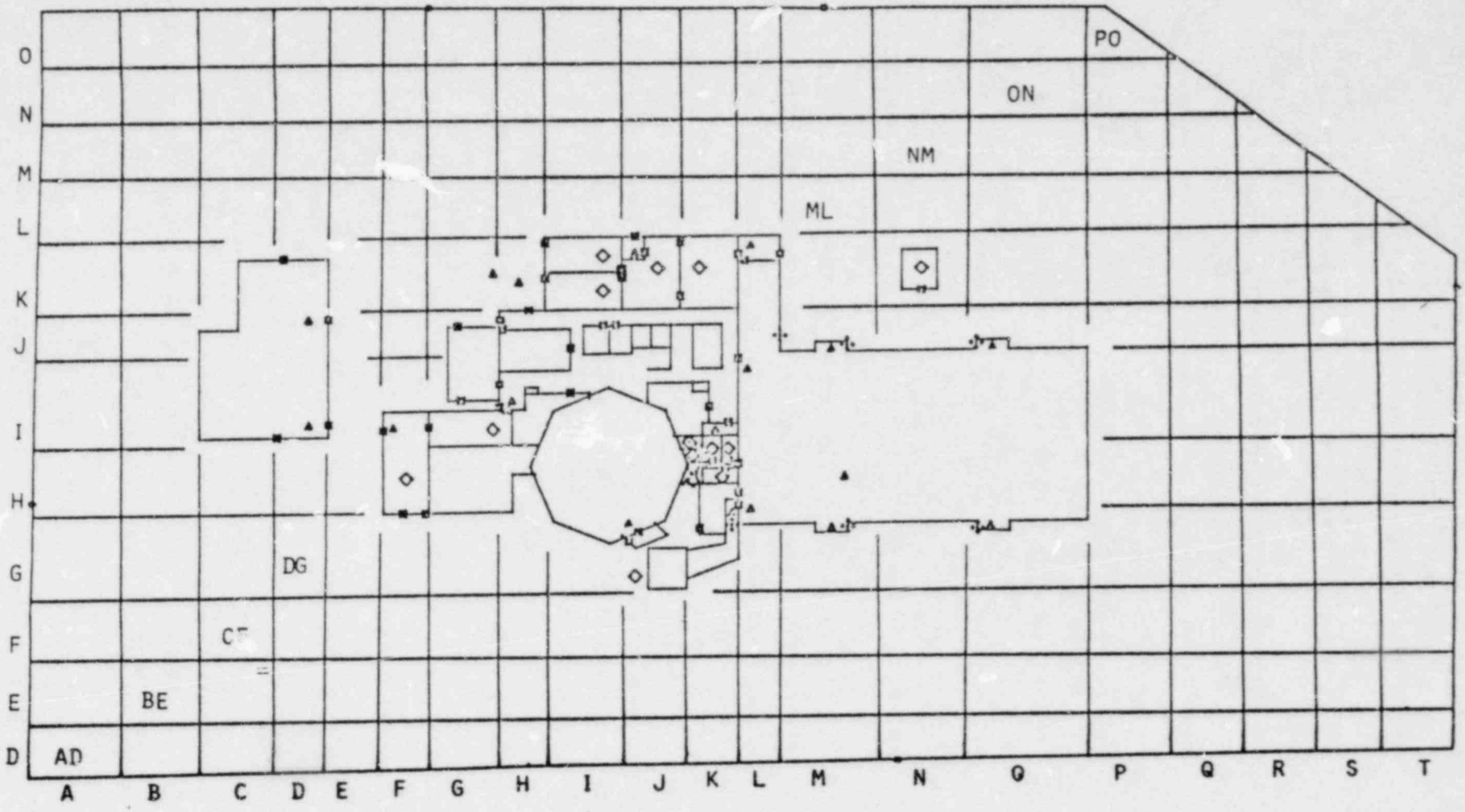


Figure D-1. Facility Diagram, Level 2, with Grid Locations

The grid sections and the corresponding facility locations they represent are approximately 20 meters wide. This is larger than the 5-meter grids used in previous models. The large size of the nuclear reactor facility required that the larger grids be used to reduce computer and analyst resources required for the analysis. In areas where engagements are likely to occur inside the buildings, the grids were subdivided into 5-meter grids to provide greater detail. Thus, in engagement areas in the building, the grid sizes were similar to previous models.

In the SNAP model of each scenario, only those facility spaces that are occupied by guards or adversaries are included in the facility submodel. This greatly reduces the effort required to build a SNAP facility submodel. Figure D-2 shows the grid locations that were needed on level 2 of the facility for Scenario A. The SAFE analysis greatly aids the building of the facility submodels by helping the analyst define the adversary paths early in the project. Once the adversary paths are set, the portions of the facility that need to be included in the SNAP facility submodel can be defined and the unneeded portions eliminated. Thus, in addition to providing global analysis performance measures and aiding selection of SNAP adversary paths, SAFE significantly reduces the resources required to build SNAP facility submodels.

D.1.3 Adversary Submodel

The adversary submodel defines the adversary decision logic and movement through the facility. In the three scenarios developed for the analysis of the nuclear reactor facility, the goal of the adversaries is sabotage. Their attack plans do not give any consideration to escape from the facility once the sabotage has been performed. No insiders were included in this application, although they could have been, as was demonstrated in previous modeling efforts.

The basic tactic of the adversaries is to use an attack path that gives them the highest probability of completing their sabotage before the guard force can detect and respond to the attack. Once the attack plan has been selected and the attack begun, the decisions of the adversaries are quite simple. The adversaries proceed along the attack path essentially racing the guards. The adversaries try to accomplish their objective (e.g., penetrate a fence, cross field to a building, penetrate a building exterior door, travel to the target, and sabotage the target)

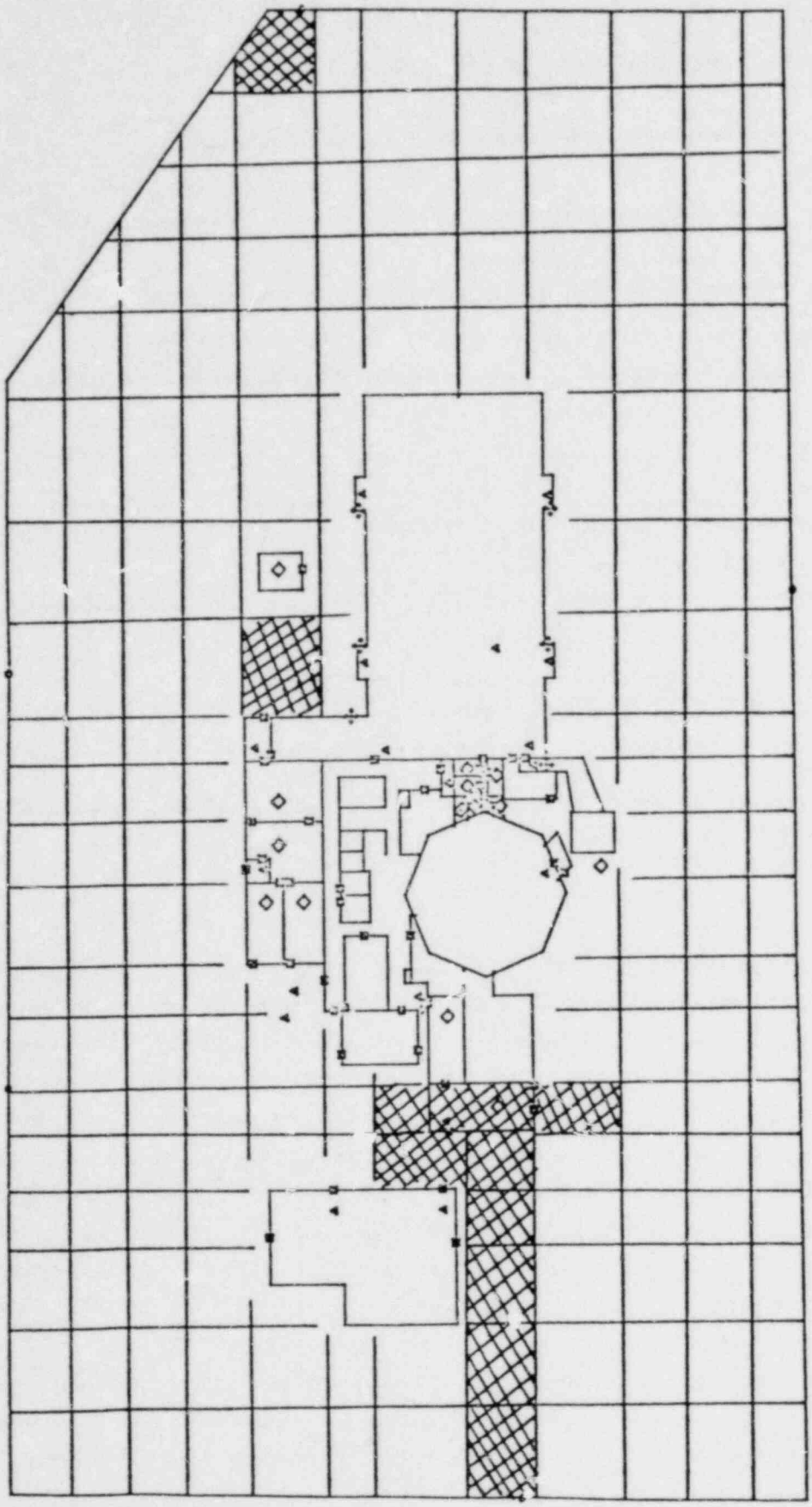


Figure D-2. Facility Diagram, Level 2, Showing Grid Locations Used for Scenario A

before the guards can stop them. Other adversary tactics modeled include a diversionary force and an adversary providing cover fire to delay guards as they leave the guard station to respond to an alarm.

The general characteristics of the adversary force in each of the scenarios are listed below:

1. The adversary force consists of three adversaries,
2. All are armed with automatic weapons,
3. The adversaries are very knowledgeable about the facility layout, guard procedures, and sabotage methods,
4. If a guard patrol is in progress, the adversaries wait until it has ended before starting their attack,
5. They are well-equipped to penetrate facility barriers in an expedient manner,
6. Their rate of travel in the field between the fence and the buildings is 300 m/min (10 mi/h),
7. Their rate of travel in the building is 117 m/min (4 mi/h),
8. Twelve seconds is required for an adversary to penetrate a locked, alarmed door with a crowbar, and
9. Sixty seconds is required for an adversary using explosives to penetrate a hardened, locked, alarmed door.

A detailed discussion of the adversary attack scenarios is provided in Subsection D.2.

D.1.4 Guard Submodel

The guard submodel defines the operating policies of the guards. It includes a representation of the guard decision logic as well as the physical movement of the guards through the facility. Because the SNAP guard submodels developed for this analysis are scenario-specific, only those decisions and movements which might occur in response to one specific adversary attack scenario are modeled in each guard submodel. Thus, three guard submodels were developed in this project, one for each adversary scenario. The specified guard decisions and movements modeled in each guard submodel, however, are based upon general guard operating policies, which are consistent for all scenarios.

Because the generic reactor facility used for this analysis does not actually exist, a realistic safeguards system had to be assumed. The safeguards system assumed for this analysis should not be construed as representing a specific nuclear reactor facility. The analysis

evaluates the base case safeguards systems developed for the facility and investigates several upgrades to the system that can improve system performance. The base case guard procedure and assumptions are discussed in the following paragraphs. Proposed upgrades to the safeguards system will be discussed in a later section.

The general procedure of the guard force is to send one response guard to respond to all fence, building, exterior door, and most building interior door alarms. For interior door alarms near a Type I target, two response guards are sent. The response force travels to the area in which the alarm was triggered. Despite the occurrence of many false alarms during normal operations, the response force proceeds with caution to reduce the chance that they will be surprised by an adversary force. If a second alarm is triggered near the first alarm (for example, a fence alarm, followed by a building exterior door alarm near that section of the fence), the guards will investigate the alarm which is closer to vital areas. Once the adversary is sighted (visually or by CCTV) or the response force determines that a barrier has been penetrated, the presence of an adversary is viewed as confirmed. The response force then radios the PAS monitor who, in turn, sends all available response guards to neutralize the adversary force.

If the adversary has not been sighted, then the guards may not know which path the adversary has taken. When the guard force has no information about the adversary path, it spends an average of 1 minute assessing in which direction the adversary went, then continues chasing the adversary. When the guard force is within range, it challenges the adversary. An engagement begins when the adversary force fires at the guard force and the guards return the fire. Guard forces do not wait for reinforcements to start an engagement. They engage the adversary at the earliest possible opportunity.

The following additional assumptions have been made about the guard procedures at the proposed generic nuclear reactor facility:

- There are five guards available to respond to alarms and one guard permanently located in the PAS to communicate with the response guards,
- All response guards are armed with shotguns,
- All guards are located at the guard station except for two 1/2-hour patrols per shift,

- The guard station is located at the fence on the east side of the facility (Figure D-3),
- Guards travel at 117 m/min (fast walk, 4 mi/h),
- The local law enforcement agency (LLEA) is summoned upon confirmation of adversary presence and arrives 15 minutes later,
- The PAS guard is queued to CCTV monitors in the building interior near targets when nearby door alarms are triggered. The PAS guard has a 30% probability of confirming the adversary presence an average of 30 seccnds after the door alarm is triggered.

Assumptions and procedures which are common to all three scenarios modeled for the generic nuclear reactor facility have been described. Subsection D.2 discusses the specific actions, movements, and tactics of tne guard and adversary forces in each scenario and the resulting safeguards system performance.

D.2 DESCRIPTION OF ADVERSARY SCENARIOS AND SAFEGUARDS PERFORMANCE

Each of the following subsections discusses one of the three adversary attack scenarios selected and the specific guard response to that attack plan. The ability of the baseline and various upgraded safeguards systems to neutralize the attack is also assessed.

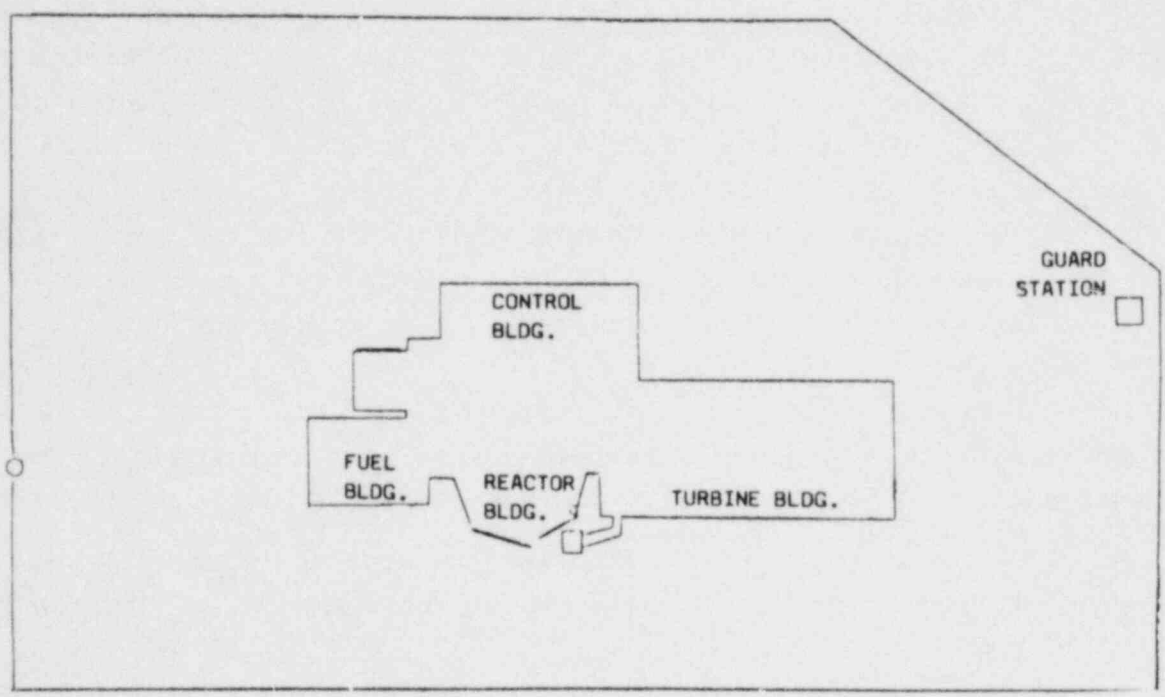


Figure D-3. Facility Diagram, Level 2, Location of Guard Station

The scenario discussions that follow are not discussions of actual model runs. The descriptions are of typical adversary attacks and guard responses. Some possible variations due to random occurrences are discussed. Task times reported in the descriptions are averages which are subject to random variation.

D.2.1 Scenario A

Description (Base Case Safeguards) -- Level 6 of the fuel building contains the target of the adversaries in Scenario A. This is a Type I target, i.e., one which requires sabotage at only one location to cause a significant radiological release. The time required for the adversaries to sabotage the target once they reach it ranges from 2.5 to 4.5 minutes with an average of 3.5 minutes.

A force of three adversaries begins the scenario by penetrating (in 0.1 minute) the facility perimeter fence at the southwest portion of the facility (Figure D-4). If the fence alarm is triggered, one response guard will be dispatched to investigate the alarm. This guard will arrive at the southwest corner of the fuel building at facility grid location FHC3 an average of 3.0 minutes after he is dispatched.

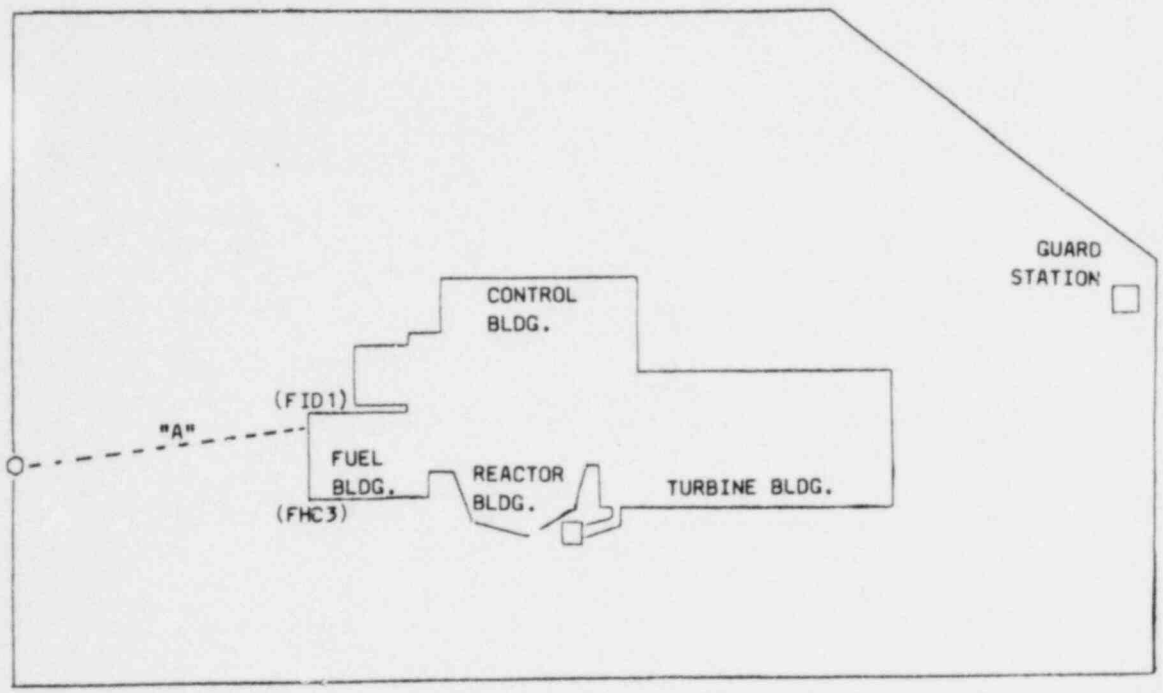


Figure D-4. Adversary Scenario A, Level 2

After penetrating the fence, the adversary force runs across an open field to a door (FID1) at the northwest corner of the fuel building. The adversary crosses the field in 0.55 minute at a rate of 300 m/min (10 mi/h). He requires 0.2 minute to penetrate this locked alarmed door with a crowbar. Next, the adversary force locates and climbs a nearby stairwell which takes the force to level 6. This series of tasks requires an average of 0.93 minute. On level 6 (Figure D-5), the adversary travels to locked, alarmed door UTD1 (0.08 minute), penetrates it with a crowbar (0.2 minute), and travels to grid location USR2 (0.16 minute). At this location, the adversaries divide up, one adversary moving on to sabotage the target and the remaining adversaries taking cover at URR4 (very close to USR2) to ambush the responding guards when they come through door UTD1. When the adversaries divide forces, an average of 2.2 minutes has elapsed. Thus, by the time the adversaries have reached this position on level 6, the first response guard has not yet reached the southwest corner of the fuel building and the guard force has not yet confirmed that an adversary force is present. After the adversaries divide, one adversary travels to the target (0.4 minute) and performs the sabotage (3.5 minutes).

The guard who was dispatched to investigate the fence alarm arrives at the southwest corner of the fuel building 3.0 minutes after the adversary attack began. (If the fence was not triggered and the guard was dispatched in response to one of the building door alarms, the response guard will arrive more than 3 minutes after the attack begins.)

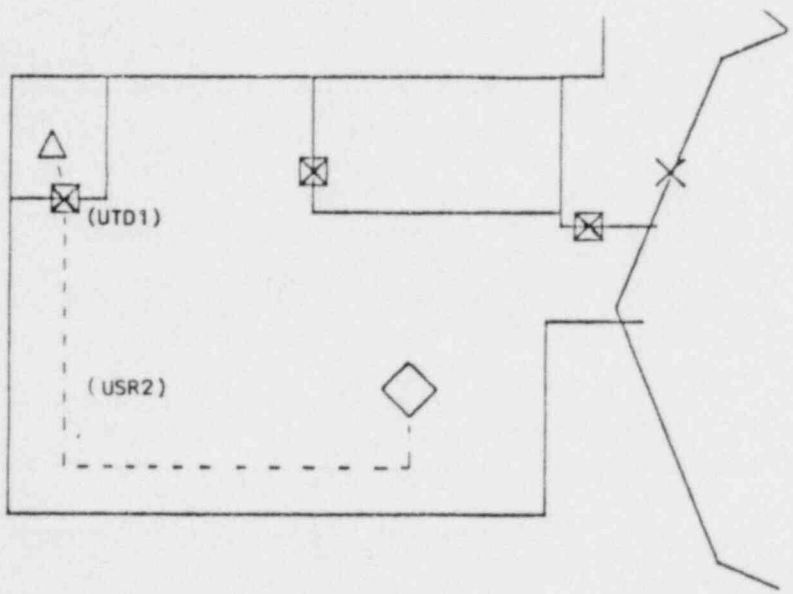


Figure D-5. Adversary Scenario A, Level 6

When the guard arrives, an average of 1 minute is required to assess the adversary path unless either of the two building doors alarms (probabilities .90 and .95) has been triggered. If either alarm was triggered, the guard proceeds to check out the alarm and no assessment time is required.

The guard proceeds to the fuel building door FIDl (0.17 minute) and finds that it has been penetrated. He then radios the PAS guard, confirming the adversary presence. All available response guards are sent to respond to the confirmed adversary presence.

After radioing for reinforcements, the first response guard must assess the adversary path if the door alarm on level 6 has not been triggered. The first response guard then proceeds up the stairwell to door UTDl on level 6. When the guard passes through the door, he is ambushed by the two adversaries who are at location URR4. The force of four reinforcement guards does not arrive at door UTDl until over 7 minutes has elapsed from the time the adversaries began their attack.

Results (Base Case) -- The preceding description of the guard response showed that, on the average, more than 7 minutes is required to get reinforcement guards to door UTDl on level 6. After they arrive there, they must defeat the adversary cover force at location URR4 on level 6, then travel to the target and neutralize the adversary force before the adversaries' goal of sabotage is completed. However, less than 6.5 minutes (average) is required for the adversaries to complete the sabotage from the start of the attack. Thus, the base case results, which show that the adversaries have a 97% success rate, are not surprising.

The general performance statistics (Figure D-6) show that the initial response guard engages the adversaries in 98% of the trials. The response guards are able to defeat the adversaries (before the sabotage is complete) at URR4 only 9 times in 100 model trials. In three of those trials, the guards are able to neutralize the adversaries before the sabotage is complete. Thus, the probability that the safeguards system can defeat the adversaries is .03. The average time required for the first response guard to engage the adversaries is 4.6 minutes and the average time for the adversaries to complete sabotage is 6.3 minutes (the attack begins at time 1.0).

GENERAL SYSTEM PERFORMANCE STATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	1.500	1.142	.011	0.000	5.000	100
NO. ADVER CSLTY	.280	.668	.007	0.000	3.000	100
DEG OBJ SATISFD	.979	.171	.002	0.000	1.000	100
TIME FOR ENG	.358	.325	.003	.000	1.423	105
TOTAL ENG TIME	.376	.387	.004	0.000	1.845	100
NO. ENG/RUN	1.050	.520	.005	0.000	3.000	100
TIME PET ENT/ENG	4.554	.526	.005	3.520	6.449	98
SIMULATION TIME	7.374	.599	.006	6.278	8.733	100
SIM TIME/AD SUC	7.347	.580	.006	6.278	8.587	97
SIM TIME/AD FAIL	8.259	.598	.189	7.587	8.733	3

AVG NUMBER OF ENGAGEMENTS PER RUN	1.05
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.09
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.96
PROBABILITY SYSTEM WINS	.03
PROBABILITY AN INTERRUPT OCCURS	.98

Figure D-6. General Performance Statistics for the Base Case Safeguards System, Scenario A

Because the performance of the baseline safeguards system was so poor, several upgrades to the system are proposed to improve safeguards system performance.

Proposed Safeguards Upgrades -- Several upgrades have been proposed to improve the performance of the safeguards system. These proposed upgrades are essentially divided into two categories: (1) upgrades that increase the probability that the guard forces can respond in time to intercept the adversary force and (2) upgrades that increase the probability that guard forces will win engagements against the adversary force once the guards have responded.

Four upgrades have been suggested that would increase the probability that a guard force will respond in time to intercept the adversary force:

1. Addition of a second guard station at the southwest corner of the building and transferral of the existing guard station from the fence to the northeast portion of the building (Figure D-7),

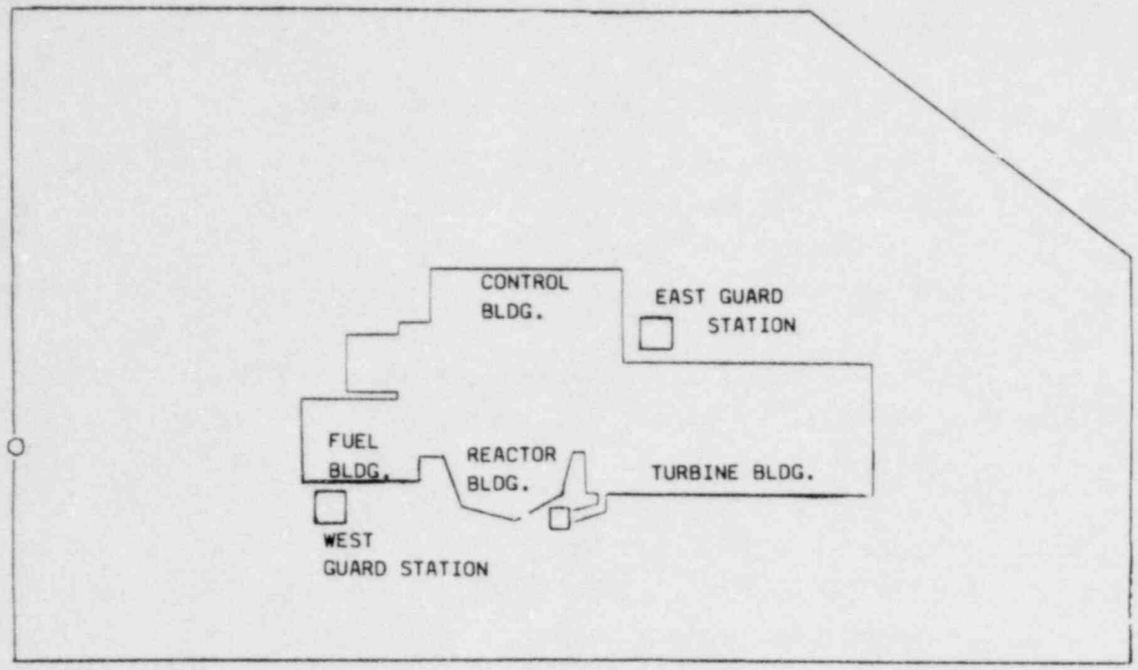


Figure D-7. Location of Guard Stations for Upgraded Two Guard-Station Configuration

2. Addition of a CCTV in the fence area to confirm adversary presence. The PAS guard would be queued to the fence area CCTV by fence alarms in a manner similar to that used for the CCTV in the building interior,
3. Addition of one response guard on level 6 to protect Type I targets located there, and
4. Hardening selected facility doors to increase adversary task times and allow the guard force more time to respond. Also, hardening, locking, and alarming selected unlocked, unalarmed doors.

Examination of the guard response for the base case safeguards system clearly shows the need for these upgrades. When the adversary target is in the southwest portion of the building, the first response guard takes more than 3 minutes to get to the exterior door penetrated by the adversaries. After the adversary presence is confirmed, another 3 minutes is required for guard reinforcements to arrive. By the time these reinforcements engage the adversaries at the target, the sabotage will most likely have been completed.

Two upgrades that would increase the probability that the guard force will win engagements against the adversary force are

1. Changing the guard weapon from shotguns to automatic weapons and
2. Increasing the number of response guards from 5 to 7.

The need for these or alternative methods to improve the probability that guards will win engagements is shown in later sections, which describe scenarios in which the guards are able to respond in time to engage the adversary forces but too often lose the engagements.

The contribution that the preceding upgrades and combinations of these upgrades can make to safeguards performance for Scenario A is evaluated in the next subsection.

Results (Upgraded Safeguards Systems) -- Several different levels of upgrades to the baseline safeguards system are evaluated, and their contribution to improved safeguards performance is analyzed. Table D-1 shows the results of six different cases that were run for the safeguards system of Scenario A. Case 1 (described previously) is the baseline case with no safeguards upgrades. Case 6 tests model sensitivity and will be discussed later in this subsection. Cases 2 through 5 are evaluations of various levels of system upgrades. The safeguards upgrades tested for Scenario A are

- Case 2 -- Improved probability that guards will respond in a timely fashion by hardening of the facility doors, addition of a second guard station, and addition of CCTV in the fence area,
- Case 3 -- Improved probability that guards will win engagements by upgrading of their weapons to automatics and by addition of two response guards,
- Case 4 -- Combination of the upgrades for Cases 2 and 3, and
- Case 5 -- Addition of a guard on level 6 to the safeguards upgrades for Case 4.

Safeguards improvements which either assure timely guard reinforcement response (Case 2) or increase engagement effectiveness (Case 3) do not greatly increase safeguards effectiveness. In Case 2, the reinforcements arrive in time but have a low probability of neutralizing the adversaries. In Case 3, the guards are better equipped to win engagements but cannot defeat the adversaries consistently because the guard reinforcements do not arrive in time. In Case 2, an average of 0.61

Table D-1

Scenario A Results

Case Number	Interruption Upgrades: Harden Doors	Two Guard Stations	CCTV Fence Area	Level 6 Response Guard	Neutralization Upgrades: Automatics	2 Additional Response Guards	Guard Posture	P(System Win)
1								.03
2	X	X	X					.12
3					X	X		.14
4	X	X	X		X	X		.59
5	X	X	X	X	X	X		.70
6	X	X	X	X	X	X	X	.87

adversaries are neutralized per trial, while 4.5 guards are neutralized on the average (general performance statistics are included in the appendix for each scenario). The probability that the safeguards system successfully defeats the adversaries is .12 in Case 2 and .14 in Case 3.

In Case 4, upgrades to ensure timely response of guards and upgrades to increase the probability of guards winning engagements are included. The Case 4 upgrades are a combination of the upgrades for Cases 2 and 3. These upgrades include hardening of facility doors, addition of a second guard station, moving the existing guard station closer to the facility, addition of CCTV in the fence area, upgrading guard weapons to automatics, and the addition of two response guards.

The hardening of one facility exterior door (FID1) and one facility interior door (UTD1) in Case 4 slows down the adversaries' progress to the target. They have to use explosives instead of crowbars to penetrate these doors. This increases their task time from 12 seconds to 60 seconds. Meanwhile, the guard initial and reinforcement response is much quicker with the new guard station configuration. After the first alarm is triggered, the initial response guard is able to get in a position to confirm the adversary presence and engage the adversary in 0.6 minute. The PAS dispatches all available reinforcements after receiving confirmation of an adversary presence from the first response guard. The two available reinforcement guards at the west guard station arrive at the southwest corner of the fuel building 0.6 minute after they are dispatched. The four available reinforcement guards at the east guard station arrive at the northwest corner of the fuel building 2.0 minutes after they are dispatched. Either of these reinforcement forces may reach the fuel building in time to engage the adversaries before the adversaries enter the building. The guards from the west station, however, have a higher probability of doing so because of their shorter response time.

If the adversaries are able to neutralize the first response guard quickly, they may be able to enter the building. In this case, the guard reinforcements will engage the adversaries at some point in the building interior.

The probability of system win in Case 4 is .59. This is much improved over the first three cases, but a little disappointing considering all the safeguards improvements that have been added.

In Case 5, all safeguards upgrades for Case 4 are included plus an additional guard is stationed on level 6 of the facility. This increases the probability of system win to .70.

In Cases 4 and 5, significant improvements are made to the safeguards system, yet the probability of system win increased only to .70 in Case 5. Investigation of model results shows that due to the quick guard response and the hardened facility doors, the guards are often able to engage the adversaries before they enter the building. However, the guards too often lose this engagement.

The conditions assumed for this engagement are that the adversaries are lying prone in the open field between the building and the fence with 80% of their bodies exposed to fire while the guards are firing at the adversaries from a standing position behind the corner of the fuel building with 60% exposure.

In Case 6, the model sensitivity to these engagement conditions was tested. The model was run with the upgraded safeguards system of Case 6 but with the guard posture changed from standing to prone when the guards engage the adversary in the open field before the adversary enters the building. The result was a substantial increase in the probability of system win to .87. The reason for this substantial change in system performance is that a guard in a standing posture presents a much larger target (his head and torso) than a guard in prone posture (head only). Because the guards in a standing posture are larger targets, they are eliminated much more quickly and the system performance is much poorer. Due to this change in guard posture, guard casualties dropped by more than 25% and adversary casualties rose by approximately 20% in Case 6.

In summary, the baseline safeguards system performance for Scenario A is unacceptable with only a .03 probability of success. To significantly improve safeguards performance, upgrades to assure more timely guard response and upgrades to increase the probability that guards win engagements are necessary. Additionally, safeguards performance is very sensitive to guard posture during engagement when the adversary is

engaged prior to entering the building. The best-case upgraded safeguards system performance for the six cases of Scenario A is a .87 probability of system win for Case 6.

The following sections will describe and analyze the safeguards performance for Scenario B.

D.2.2 Scenario B

Description (Base Case Safeguards) -- Two vital components in adjacent rooms on level 2 (ground level of the facility) are the targets of the adversaries in Scenario B. These are Type II targets. Both of the targets must be disabled to sabotage the facility. The time required to sabotage each of these targets once they are reached ranges from 1.5 to 2.5 minutes with an average of 2.0 minutes.

Two adversaries penetrate the fence (0.1 minute) at the north of the facility to begin the attack (Figure D-8) for Scenario B. When the fence alarm is triggered (probability .90), a response guard is dispatched from the guard station. This guard is immediately engaged by an adversary outside the fence, 20 meters from the guard station. The purpose of this adversary is to provide cover fire at the guard station which will delay guard response and neutralize responding guards.

An average of 30 seconds after the first response guard is engaged by the adversary at the guard station, two response guards with semi-automatics join the engagement to neutralize the adversary. If the first response guard does not neutralize the adversary at the guard station and respond to the alarm, a second guard will attempt to respond to the alarm. Because this guard is aware of the adversary location, he is able to get past the cover fire 80% of the time to respond to the alarm; 20% of the time this guard is neutralized. (These secondary response guards neutralized by the adversary at the guard station are not included in neutralization statistics reported by SNAP.) If this second response guard is neutralized, a third guard will attempt to respond an average of 30 seconds later with an 80% chance of success. If the third guard is neutralized, one of the two guards who are engaging the adversary at the guard station will respond after the adversary at the guard station is neutralized.

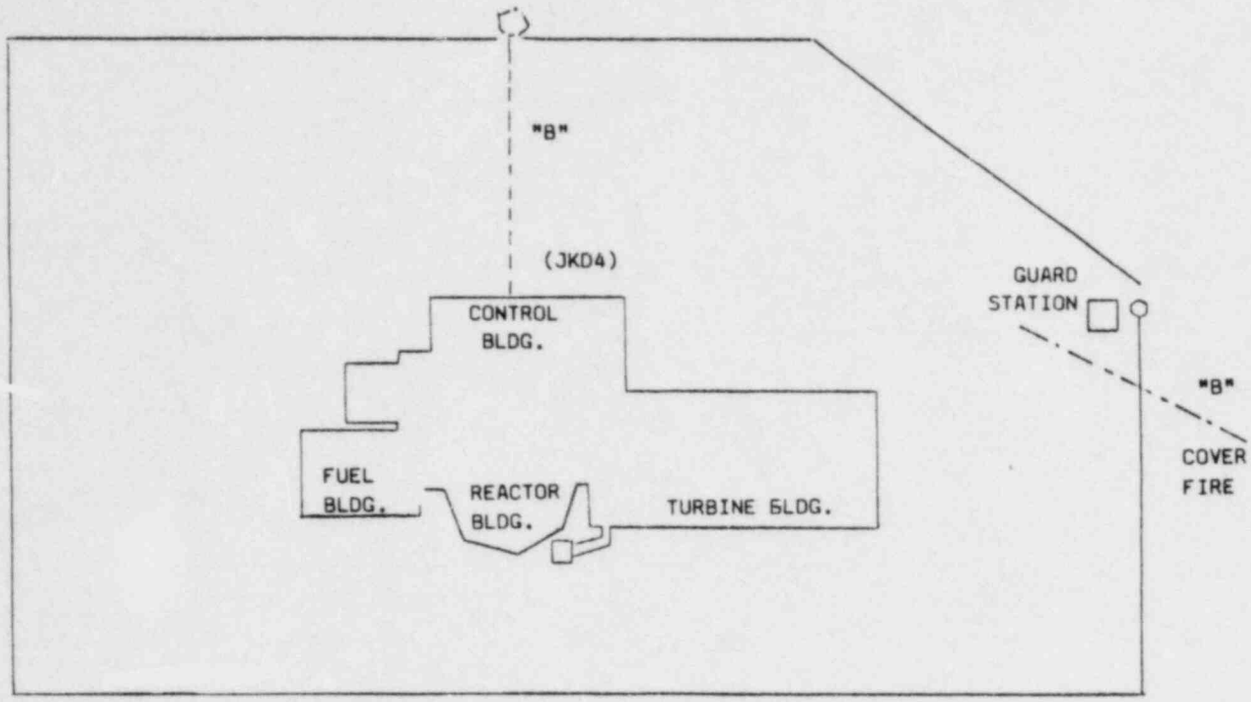


Figure D-8. Adversary Scenario B, Level 2

While the guards are dealing with the adversary cover fire at the guard station, the main adversary force is proceeding toward the target. After penetrating the fence, the adversary runs 80 meters across the field (0.3 minute). The adversary then penetrates door JKD4 in 0.2 minute using a crowbar. Next, the adversary finds door JKD3 (0.1 minute) and penetrates it (Figure D-9) using a crowbar (0.2 minute).

The adversary force then proceeds (0.2 minute) to door JKD2, which is penetrated in 0.2 minute. The adversary force travels to location IKR3 to perform the sabotage of the first target. The base case results show that the adversary always gets to this position because of the long guard response time (2.0 minutes from the guard station to the northeast corner of the control building) and because of the delay caused by the adversary cover fire at the guard station.

After the sabotage of the first target, the adversary force exits the room (0.3 minute) and penetrates the door (JKD1) leading to the second target. Again, the door is penetrated in 0.2 minute with a crowbar. The adversary force travels to the target area (IKR1) in 0.1 minute and sabotages the target.

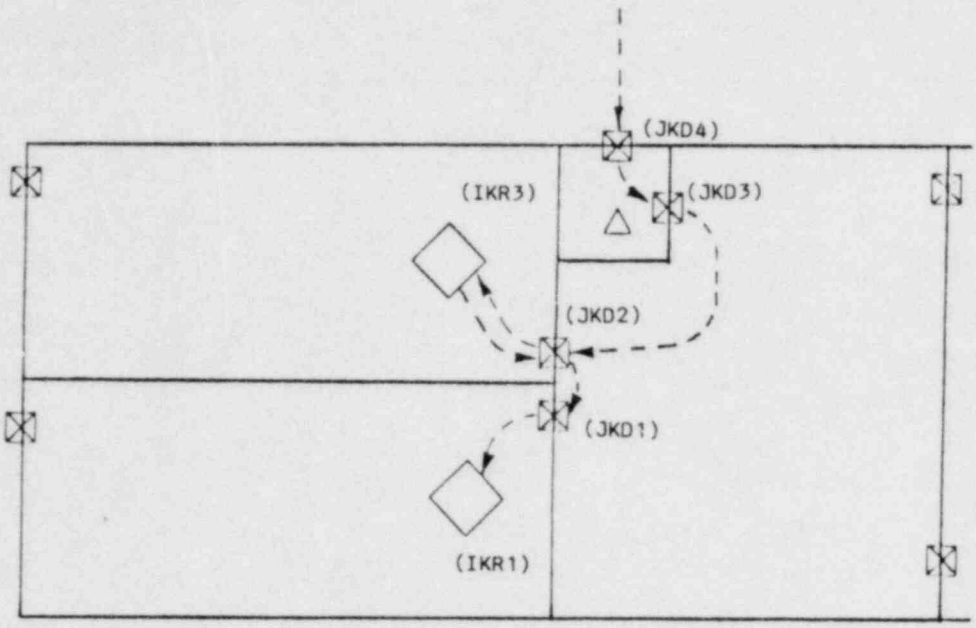


Figure D-9. Adversary Scenario B, Level 2

After a response guard gets past the adversary cover fire at the guard station, he requires 2.0 minutes to get to the northeast corner of the control building. If any of the door alarms have been triggered by the adversary, the guard will proceed to the door JKD4 (0.6 minute) to inspect the triggered alarm (if the triggered alarm was not for door JKD4, the guard enters the building through JKD4 to inspect the triggered alarm). If no alarm has been triggered, an average of 1 minute is required for the guard to assess the adversary path before proceeding to door JKD4. After inspecting the door and finding that it has been penetrated, the response guard radios the PAS guard confirming the adversary presence. The PAS guard in turn dispatches reinforcements.

If the adversary providing cover fire at the guard station has not been eliminated, one reinforcement guard will be sent if available. At most, one guard will be available because, of the four remaining response guards, one was engaged by the adversary during a response attempt and two additional guards joined the engagement to return the adversary fire. The remaining guard will not be available if neutralized in an earlier response attempt. When the adversary at the guard station is eliminated, all available response guards are dispatched.

These reinforcement guards perform the same tasks as the first response guard except that they do not have to assess the adversary attack path. No assessment is required because the first response guard has made the assessment and radioed back to the PAS guard.

After sending for reinforcements, the first response guard travels to the target area (0.4 minute), sees that door JKD2 (Figure D-9) has been penetrated, and gets into position to engage the adversary at or near the target. The exact location of the engagement varies from run to run due to random variation of guard and adversary task times. By the time the reinforcements get to the target area, the adversary may have completed sabotage of the first target and penetrated door JKD1 leading to the second target. If so, because two adjacent doors have been penetrated, the guards will have to guess at which of the two targets the adversaries are. If they guess wrong, they are delayed 30 seconds in their pursuit.

Results (Baseline Safeguards System) -- The result of the SNAP model of Scenario B is that the safeguards system is successful only 32% of the time. In this scenario, guard response time is not a problem because the adversaries have to disable two targets in series before their objective is accomplished. The guards have enough time to respond.

The most significant problem in this scenario is that the guard casualty rate is too high; more than 3.4 guards are neutralized per model run while only 1.5 adversaries are neutralized. The high number of guards neutralized is due in part to the adversary ambushing the guards at the guard station plus the more powerful weapon type of the adversaries.

Results (Upgraded Safeguards Systems) -- As in Scenario A, the baseline safeguards system performance was unacceptable for Scenario B. Consequently, several upgraded safeguards systems are evaluated for Scenario B. Table D-2 lists the upgrades included in each of the six cases. Case 1, the base case, was discussed in the preceding subsection.

In Case 2, the guard weapon type is upgraded to automatic weapons and two additional response guards are added. This increases the probability of system win to .57. Because of the safeguards upgrades, the number of adversary casualties increases by more than 25%, while guard

Table D-2

Scenario B Results

	Interruption Upgrades			Neutralization Upgrades			Adversary Upgrades		
Case Number	Harden Doors	Two Guard Stations	CCTV Fence Area	Automatics	Two Additional Guards	Guard Posture	Parallel Tasks	One Additional Adversary	P(System Win)
1									.32
2				X	X				.57
3	X	X	X	X	X				.69
4	X	X	X	X	X	X			.94
5				X	X		X	X	.05
6	X	X	X	X	X		X	X	.58

casualties increase by just 5%. System performance has been increased significantly, but the number of guard casualties is still unacceptably high due in part to the adversary cover fire at the guard station.

Case 3 includes the safeguards of Case 2. In addition, a guard station is added at the southwest corner of the fuel building, the existing station is moved away from the fence to a position close to the building, CCTV is added in the fence area and two facility doors (JKK4 and JKD3) are hardened. These facility upgrades eliminate the adversary tactic of ambushing the guards at the guard station and significantly improve guard response so that the guards engage the adversary much earlier in their attack. The result of this scenario is an improved probability of system win (.69) but with a very high guard casualty rate.

Because of the quick response of the guards in Case 3, they are often able to engage the adversary with the initial response guard and one group of three reinforcement guards before the adversary force can penetrate the hardened exterior door. The model results show that, as in Scenario A, the adversaries win this type of engagement too often.

Again, the conditions assumed for this engagement are that the adversaries are lying prone in the open field between the building and the fence with 80% of their bodies exposed to fire, while the guards are firing at the adversaries from a standing position behind the corner of the control building where they have 60% exposure.

In Case 4, the model sensitivity to these engagement conditions was tested. The model was run with the upgraded safeguards system of Case 3 but with the guard posture changed from standing to prone when the guard engages the adversary in the open field before the adversary enters the building. The result was a substantial increase in the probability of system win to .94. Guard casualties dropped by nearly 40% and adversary casualties rose by nearly 30% in Case 4. As in Scenario A, the ability of the guards to win engagements when the adversary force is encountered outside the building is critical.

In Cases 5 and 6, the sensitivity of the upgraded safeguards systems of Cases 2 and 3, respectively, to an upgraded adversary force was tested. The adversary force was upgraded by adding one additional adversary and by changing the adversary tactic from disabling the two

targets in series, to disabling them in parallel. This new tactic decreased, by more than 2 minutes, the time required for the adversary to complete the facility sabotage.

The safeguards system of Case 2 (automatics, two additional guards) was very sensitive to the upgraded adversary capabilities. The probability of system win dropped from .57 to .05 from Case 2 to Case 5. The safeguards system of Case 3 with more safeguards upgrades (automatics, two additional guards, hardened facility doors, two guard stations, CCTV in the fence area) experienced only a small decrease in performance when the adversary capabilities were increased. The probability of system win was .69 for Case 3 and .58 for Case 6. Thus, SNAP demonstrates that the safeguards systems of Cases 2 and 3, which have comparable performance against the baseline adversary force, have very different performance against a stronger adversary force.

In summary, the baseline safeguards system performance for Scenario B is unacceptable with just a .32 probability of success. Safeguards performance can be greatly improved by the addition of several upgrades. The best case performance was observed in Case 4 with a .94 probability of success for the safeguards system. Cases 5 and 6 demonstrated that increasing the adversary capability above the baseline assumptions may greatly degrade the performance of a given safeguards system while degrading the performance of an upgraded system very little.

D.2.3 Scenario C

Description (Base Case Safeguards) -- The target of the adversaries in Scenario C is a room on level 6. Adversary success for this scenario is achieved when the adversaries gain access to the vital area because after the adversaries gain access it would be very difficult for the on-site guards to neutralize them during the sabotage events which can be remotely initiated from this area.

Scenario C begins when three adversaries penetrate the fence (0.10 minute) south of the facility (Figure D-10). The adversaries run 60 meters across the field (0.2 minute) to facility location KGF1. Two adversaries continue to run across the field (0.2 minute) to the unlocked unalarmed door, MGD1. The third adversary remains at location KGF1 to provide diversionary cover fire.

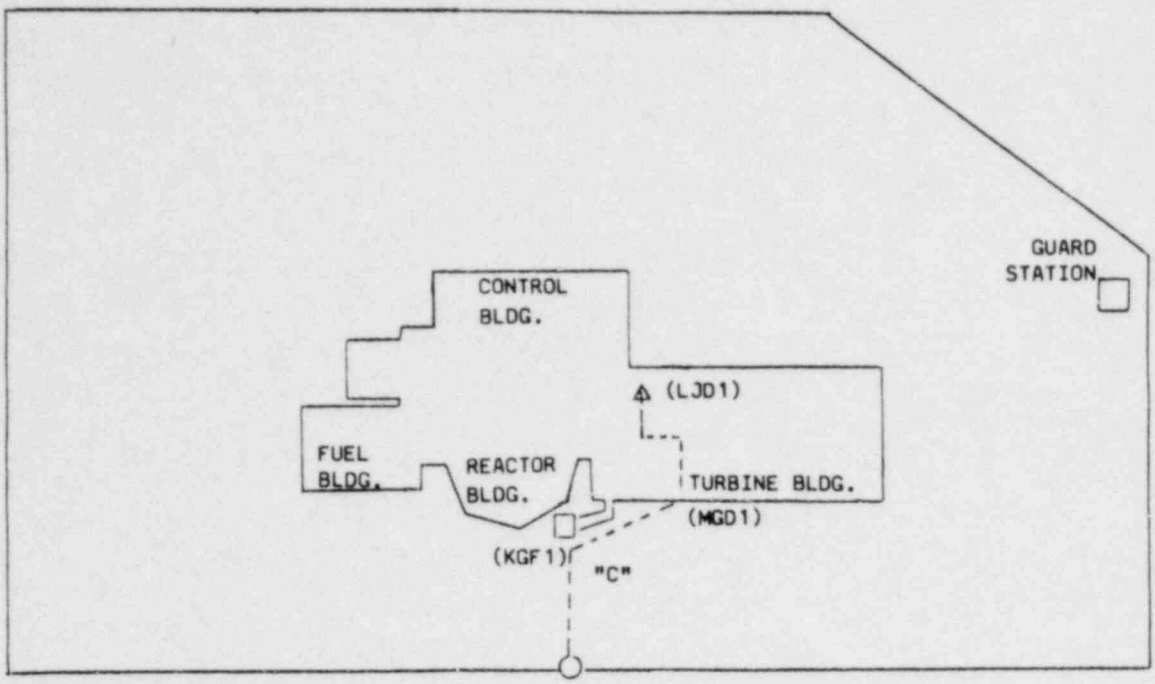


Figure D-10. Adversary Scenario C, Level 2

The purpose of the diversionary cover fire is to divert the guards force's attention from the main adversary force. Because no door alarms will be encountered by the main adversary force until they are on level 6 and because the guards are busy with the diversionary force, the main adversary force will be only seconds away from accomplishing their objective before the guards are aware of their presence.

After the main adversary force runs across the field to door MGD1 at the south of the turbine building, they enter the unlocked door (0.05 minute), travel through the turbine building to a stairwell which leads to the sixth floor (0.5 minute), ascend the stairwell (0.9 minute), enter the unlocked, unalarmed door ZUD1 (0.05 minute) on level 6 (Figure D-11), and travel to the locked, alarmed door ZXD1 (0.2 minute). The average cumulative time for the adversary to reach this point from the start of the attack is just over 2.2 minutes. Because of the diversionary force, the guards are not yet aware of the presence of this force (without the diversion, the fence would have been inspected and the presence of this main force confirmed). The attack scenario is completed when the main force penetrates door ZXD1 (0.2 minute) with a crowbar and gains access to the vital area. The door alarm is triggered (probability .95) but too late for any guard response.

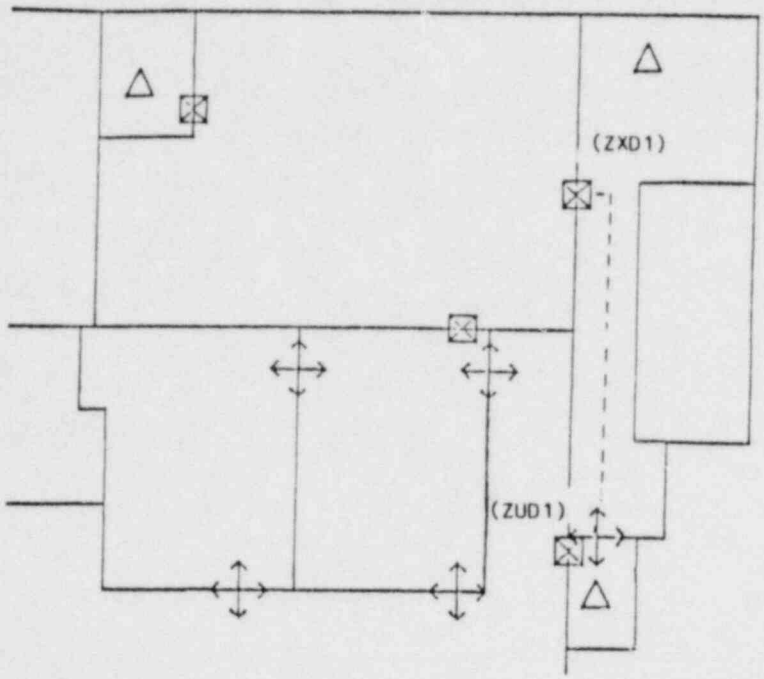


Figure D-11. Adversary Scenario C, Level 6

One guard is dispatched to investigate when the fence alarm is triggered. This guard travels to door MGD1 (2.0 minutes). At this time, the adversary at KGF1 engages the guard with diversionary cover fire. The guard radios the PAS guard confirming an adversary presence. The PAS, in turn, sends all available reinforcements to engage the adversary. However, the main adversary force is already inside the building and, by the time the guard force detects the main adversary force, there is insufficient time to respond.

Results (Base Case) -- Once again in Scenario C, the baseline safeguards system performance is unacceptable. This time the safeguards system was never successful (100 trials) in neutralizing the adversaries before they could accomplish their objective. The reason for the poor performance is that the combination of the long guard response time and the adversary diversionary tactics allow the main adversary force to get to the vital area door (12 seconds away from their objective) before the guard force is even aware of their presence.

Results (Upgraded Safeguards System) -- Safeguards upgrades are necessary for Scenario C to speed up guard response, to slow down the main adversary force, and to detect the movement of the main adversary force in the turbine building. These upgrades are necessary so that the

guard force can detect the main adversary force and have time to respond before it gains access to the vital area. Table D-3 lists the upgrades and results for each of the six cases for Scenario C. Case 1, the base case, was discussed in the preceding subsection.

In Case 2, five upgrades are added to the base case safeguards system. These upgrades are

1. Hardening, locking, and alarming the turbine building exterior doors and the interior doors which provide access to stairwells,
2. Addition of a second guard station and relocation of the existing station closer to the building,
3. Addition of CCTV in the fence area,
4. Upgrading the guard weapons to automatics, and
5. Addition of two guards to the response force.

As a result of these upgrades, the safeguards performance improved significantly. In Case 2, the probability of safeguards success is .89. In this case, the main adversary force is delayed by two hardened doors in the turbine building (MGD1 and LJD1). These doors, which are unlocked in the base case safeguards system, now require 1.0 minute to penetrate instead of 0.05 minute. In addition, when the doors are penetrated, alarms are triggered (probability .95). Thus, the guard force is aware of the main adversary force well before they reach the control room. With the upgraded guard station configuration, the guards are able to respond more quickly to intercept the main adversary force. With two additional response guards and weapons upgraded to automatics, the guards have a higher probability of winning engagements once they intercept the adversaries.

In Cases 3, 4, 5, and 6, safeguards systems similar to the one in Case 2 are evaluated. In each of these cases, the safeguards system is identical to the system of Case 2 except that one or more upgrades are removed. The purpose of Cases 3 through 6 is to show the contribution of the individual upgrades to the system performance shown in Case 2.

In Case 3, upgrades that help guards win engagements are removed from the configuration of Case 2. The system performance drops to .43 because guards have a lower probability of winning engagements. In Case 4, CCTV detection in the fence area is removed from the system of Case 2. The system performance drops only to .86 indicating that CCTV is not critical to safeguards performance.

Table D-3

Scenario C Results

Case Number	Interruption Upgrades: Harden, Lock, and Alarm Doors	Interruption Upgrades: Two Guard Stations	Interruption Upgrades: CCTV Fence Area	Neutralization Upgrades: Automatics	Neutralization Upgrades: Two Additional Guards	P(System Win)
1						.00
2	X	X	X	X	X	.89
3	X	X	X			.43
4	X	X		X	X	.86
5	X		X	X	X	.20
6		X	X	X	X	.06

In Case 5, the upgraded guard station configuration is removed from the system of Case 2 and, in Case 6, the upgraded doors (hardened, locked, alarmed) are returned to their base case status (unlocked, unalarmed). Removing either of these upgrades severely affects safeguards performance. In Case 5, without the upgraded guard station configuration, the reinforcement guard's response is too slow to engage the main adversary force even though this adversary force is slowed down due to the hardened doors and detected because of the door alarms. In Case 6, the system performance is very poor because without the hardened, locked, alarmed doors the main adversary force can quickly get to the target (usually without detection until it triggers the alarm on the control room door). The probability of system win for Cases 5 and 6 is .20 and .06, respectively.

As in Scenarios A and B, base case safeguards performance is unacceptable for Scenario C but can be improved significantly with the addition of several safeguards upgrades. System performance was raised to a .89 probability of safeguards success with the upgrades of Case 2. Investigation of individual upgrades showed that CCTV in the fence area was not essential to safeguards performance, that upgrades to improve the probability that guards win engagements have a substantial effect on system performance, and that (of the upgrades tested) hardened, locked, alarmed doors and an upgraded guard station configuration are critical to safeguards success for Scenario C.

D.3 RESOURCE REQUIREMENTS

The resources required to build SNAP models are an important factor in determining the suitability of SNAP for safeguards analysis. The resource requirements are variable from project to project depending upon the size of the facility to be analyzed, the level of detail desired, and the objectives of the evaluation. The analyst's knowledge of the site to be evaluated and experience in using SNAP also directly affect resource requirements.

Table D-4 shows the computer and analyst requirements for the generic nuclear reactor safeguards evaluation and estimates for future studies. The generic reactor evaluation required 5 man-months of effort. This was the first time SNAP was used to evaluate a large nuclear reactor and was the first time SAFE was used in conjunction with SNAP. Future studies should benefit from the experience gained in this study

Table D-4

Resource Requirements

	Computer		Analyst				
	Time (Seconds per 100 Run Analysis)	Memory (Words Octal)	Select Scenarios	Design Model Initial Runs	Revise/ Embellish Model	Run/ Analyze	Total
Generic Reactor Evaluation	30 to 70	100,000	1/2 mo.	1-1/2 mos.	2 mos.	1 mo.	5 mos.
Future Studies	15 to 100	100,000 to 130,000	1/2 day to 1/2 mo.	1-1/2 days to 1 mo.	2 days to 1-1/2 mos.	1 day to 1 mo.	1 wk. to 4 mos.

and require less analyst time. In addition, future studies should also benefit from the automated SAFE/SNAP interface and the SNAP graphical input editor (GIE), which are under development.

The estimated maximum effort required for future SNAP analyses of reactor facilities is 4 man-months. With the experience of previous modeling efforts and the new SAFE/SNAP interface and SNAP GIE these future studies should be able to consider more detailed tactical options and/or more safeguards upgrades with reduced analyst effort. If required, future studies could be accomplished in 1 week with a much lower level of detail. These models, although less detailed, could provide much greater scenario flexibility than global methods and significant insight into safeguards evaluation.

Two enhancements to SNAP capabilities are under development which will save time for future SNAP users.

A SAFE-to-SNAP interface is being developed which will automatically create a SNAP facility model. Simple guard and adversary models based on SAFE-generated paths will also be created automatically. These models can be embellished with SNAP scenario-specific details to form more complex SNAP models. The SAFE-to-SNAP interface will save considerable effort in getting an initial SNAP model running. A SNAP graphical input editor (GIE) is being developed which will facilitate easier input and editing of SNAP models at a computer terminal and will aid model debugging. The GIE will draw the SNAP network and will display necessary information upon command. When completed, the GIE should significantly speed up the input, modification, and debugging of SNAP models.

The computer requirements for a SNAP model are large but not excessive. Approximately 100,000 words (octal) of central memory and from 30 to 70 seconds of CPU time (per 100 run analysis) were required for the SNAP analysis of the generic nuclear reactor. For future studies, computer requirements will be similar, varying somewhat depending on the level of detail modeled.

D.4 SUMMARY

SNAP has been used to evaluate, on a scenario-specific level, a hypothetical safeguards system of a generic type of nuclear reactor

facility against three adversary attack scenarios. The purpose of this report has been to

1. Analyze the performance of the hypothetical safeguards system assumed for this nuclear reactor facility,
2. Demonstrate that SNAP is an effective tool for analysis of nuclear reactor facility safeguards systems at the scenario-specific level with reasonable requirements, and
3. Demonstrate that SNAP can effectively interface with the SAFE global analysis technique to provide a more robust efficient analysis than either a scenario-specific or a global analysis technique can provide alone.

The SNAP analysis of the nuclear reactor facility showed that the hypothetical baseline safeguards system was unacceptable against all three scenarios. A force of three adversaries equipped with automatics was able to sabotage the facility with approximately a 100% chance of success in Scenarios A and C and with a 68% chance of success in Scenario B. These baseline system results indicate a definite need for improvements to the safeguards system.

Several upgrades to the baseline safeguards system were tested using SNAP. These improvements included hardening selected interior and exterior doors, adding CCTV in the fence areas, adding a second guard station, upgrading the guard weapon type, adding two extra response guards and stationing an additional response guard on level 6 of the facility. In addition, safeguards performance sensitivity to engagement conditions was tested by changing the guard posture from standing to prone for selected engagements when the adversary was engaged in the field between the building and the perimeter fence. In each of the three scenarios, the probability of the safeguards system preventing sabotage of the facility was increased to near .90 by adding these safeguards upgrades.

In the scenario analyses, SNAP demonstrated that upgrades to improve the probability of timely guard response (CCTV in the fence area, additional guard station, hardened facility doors) or upgrades to improve the probability that guards win engagements (upgrade guard weapon to automatics, add two additional response guards) alone are not enough to improve the safeguards performance to an acceptable level. These measures must be used in combination if adequate protection of the facility is to be assured. The SNAP analyses also demonstrated the sensitivity of safeguards performance to engagement conditions and to a stronger, smarter adversary force.

Through analysis of the baseline safeguards system and several upgrades and sensitivities, SNAP has provided assessment of and insight into the performance of safeguards at a proposed nuclear reactor facility. Because of the many assumptions that must be made in formulating an adversary attack scenario, performance measures output by SNAP cannot be considered precise measures of actual safeguards performance. But, analysis of various safeguards configurations and assumptions does provide a relative assessment of the system and insight into those factors or combinations of factors which affect safeguards performance the most. The experienced analyst will find SNAP to be a highly useful tool in contributing to improved safeguards performance.

The SNAP scenario-specific analysis was performed in conjunction with a SAFE global analysis of the generic reactor facility. SAFE provided an initial global analysis of the facility. Through the use of the SAFE analysis, the most vulnerable adversary paths were selected from among many thousands of possible adversary paths. From this greatly reduced set of paths, three were selected for SNAP scenario-specific analysis. The SNAP analyses, documented in this report, provided insight into the safeguards system performance on a scenario level that cannot be obtained from a global technique. Then, information from the SNAP results (recommended facility upgrades, important engagement locations and conditions, guard response times) was fed back into SAFE for further global analysis to complete the SAFE/SNAP global/scenario-specific analysis cycle.

D.5 SUPPLEMENTS

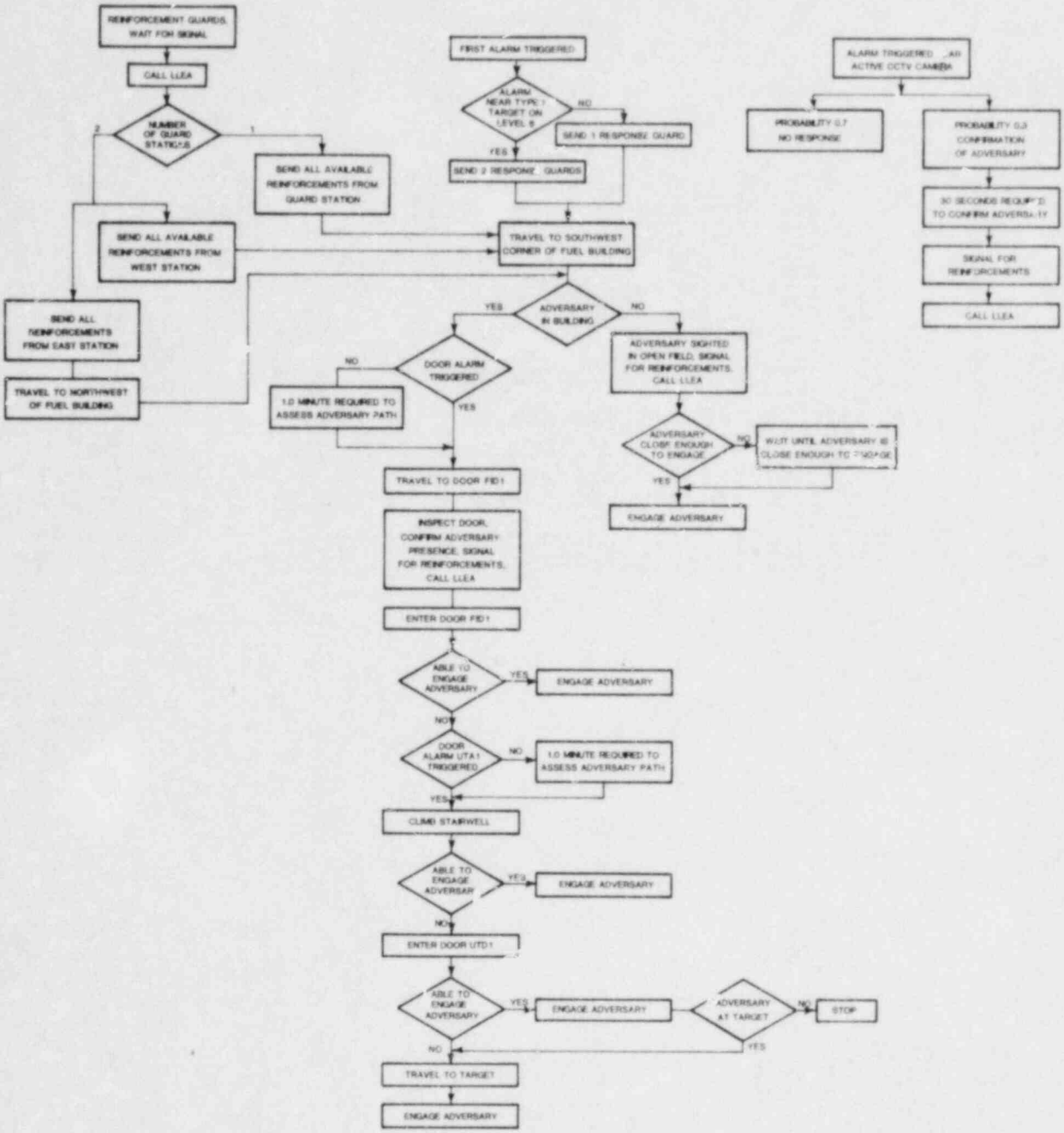
The following supplements are included for each of the scenarios (Scenarios A, B, and C):

1. A description of the guard model for the scenario in flowchart form,
2. The SNAP input listing for the scenario,
3. The SNAP general performance statistics output for each of the cases considered for the scenario (base case and other cases which consider potential upgrades),
4. The SNAP facility statistics output for each of the cases considered for the scenario, and
5. An example event trace.

For a detailed description of the SNAP inputs and outputs, refer to the "User's Guide for SNAP."

D.5.1 Scenario A

- Guard Model Flowchart
- SNAP Input Listing
- SNAP General Performance Statistics
  Cases 1 through 6
- SNAP Facility Statistics
  Cases 1 through 6
- SNAP Trace of Case 1



GUARD MODEL FLOWCHART
SCENARIO A

```
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PWR,2,0.09,0.06,0.12;
PAR,3,0.06,0.03,0.09;
PWP,4,0.03,0.01,0.05;
PAR,5,0.25,0.10,0.40;
PAR,6,0.166,0.0666,0.2666;
PAP,7,0.03,0.03,0.13;
PAR,8,0.10,0.05,0.15;
PAR,9,3.,2.,4.;
PAR,10,0.166667,0.1,0.2333333;
PAR,11,3.5,2.5,4.5;
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PAR,13,2.0,1.5,2.5;       2STA EST
PAR,14,1.1,0.8,1.4;    RSP LEVEL 6
STATUS;
;ENGAGEMENT PARAMETERS
;
;OPEN FIELD
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EOF2  MENG,DOF1,TINC.GE.0.05;
EOF3  MENG,DOF2;
;
;BUILDING CORNER
;
EBC1  MENG,DBC1,TINC.GE.9999999.0;
;
;STAIRWELL
;
;HIGH LEVEL DEFENDING
EHS1  MENG,DSH1;
;LOW LEVEL ATTACKING
ESL1  MENG,DSL1;
;EXPOSURE IN 1ST LEVEL STWELL FROM GROUND
ES11  MENG,DS11,TINC.GE.0.05;
ES12  MENG,DS12;
;
;BUILDING INTERIOR NO COVER
;
NC11  MENG,DNC1,TINC.GE.0.05;
NC12  MENG,DNC2,TINC.GE.0.05;
NC13  MENG,DNC3;
;
;BUILDING INTERIOR HIGH COVER
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EBHA  MENG,DBH1,TINC.GE.0.05;
EBH1  MENG,DBH1,TINC.GE.0.05;
EBH2  MENG,DBH2,TINC.GE.0.05;
EBH3  MENG,DBH3;
;
;BUILDING INTERIOR LOW COVER
;
EBLA  MENG,DBL1,TINC.GE.0.05;
EBL1  MENG,DBL1,TINC.GE.0.05;
EBL2  MENG,DBL2,TINC.GE.0.05;
EBL3  MENG,DBL3;
;
;ATTACKING LOW COVER
;
EBA1  MENG,DBA1;
;
;ATTACKING HIGH COVER
;
EBA2  MENG,DBA2;
;
;ATTACKING NON-AGGRESSIVE HIGH COVER
;
EBA3  MENG,DBA3;
;
;ATTACKING DEFENDED ROOM
;
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ERA2  MENG,DRA1,TINC.GE.0.05;
ERA3  MENG,DRA1,TINC.GE.0.05;
ERA4  MENG,DRA2;
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;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
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DSL1  DENG,1, 80, 60, 10, 50, NO;
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DRA2  DENG,2, 60, 60,  0, 30,NO;
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DNC2  DENG,3,100,100,100,100,YES;
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;;;;;;;;;;;;;CONTROL PARAMETERS;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
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DOOR  GLOBAL,0.20;
DOOX  GLOBAL,0.00;
DOR2  GLOBAL,0.20;
DOX2  GLOBAL,0.00;
WRSP  GLOBAL, 9; SET$ WSTA
ERSP  GLOBAL, 9; SET$ ESTA
WR    GLOBAL,0;     $EAST GUARDS-1
ER    GLOBAL,4;     $WEST GUARDS
LGG   GLOBAL,1;     $LEVEL 6 GUARDS
TAST  GLOBAL,11;  SET$ TARGET TASK TIME
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
FLG1  FLAG,DIS;
FLG2  FLAG,DIS;
FLG3  FLAG,DIS;   FENCE CCTV
FLG4  FLAG,ACT;   INT CCTV
FLG5  FLAG,DIS;
FLG6  FLAG,DIS;    LEVEL 6 GUARDS
FLG7  FLAG,DIS;
FLG8  FLAG,DIS;
      ENDSTATUS;
FACILITY;
USR2  SPA;
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SNAP INPUT LISTING--SCENARIO A

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USR3  SPA;
UPR2  SPA;
UPR3  SPA;
UPP4  SPA;
USP2  SPA;
USP3  SPA;
SW1F  SPA;
SW13  SPA;
SW14  SPA;
USR1  SPA;
URR2  SPA;
USTA  SPA;
ESTA  SPA;
X6SK  SPA;
FFF1  SPA;
FGF1  SPA;
FHC1  SPA;
FHC2  SPA;
FHC3  SPA;
FHC4  SPA;
FHR1  SPA;
FHD1  BAR,ACTIVE,/FHA1;
FIC1  SPA;
FIC2  SPA;
FIC3  SPA;
FIC4  SPA;
FIR1  SPA;
FIF1  SPA;
FID1  BAR,ACTIVE,/FIA1;
FIX1  SPA;
AHF1  SPA;
AHD1  BAR,ACTIVE,/AHA1;
AHX1  SPA;
AHC1  SPA;
AHC2  SPA;
BHF1  SPA;
CHF1  SPA;
DHF1  SPA;
EHF1  SPA;
EIF1  SPA;
EIC1  SPA;
GDSK  SPA;
CC    SPA;
URR1  SPA;
USR1  SPA;
UTR1  SPA;
UTR2  SPA;
UTD1  BAR,ACTIVE,/UTA1;
UTX1  SPA;
UTC1  SPA;
UTC2  SPA;
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VRTT  TAP;
VSR1  SPA;
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VUR1  SPA;
VVR1  SPA;
SW11  SPA;
SW12  SPA;
SW21  SPA;
SW22  SPA;
SW23  SPA;
SW24  SPA;
FHA1  SEN,.85,PERM,LRG2;
FIA1  SEN,.85,PERM,LRG2;
AHA1  SEN,.90,PERM,LRG2;
UTA1  SEN,.85,PERM,LRG1;
LRG1  LOGIC,M1;
LRG2  LOGIC,M2;
M1    MON,URG1;
M2    MON,URG2;
      ENDFACILITY;
ADVERSARY;
      OBJ,SABOTAGE,VRTT;
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TAS1  TAS,AHD1,PEME,EXP(0.1.1);
      DEC,(FLG3.IS.ACT,AHA1.IS.TRIGGERED),TSXX;
      REG,TAS2;
TSXX  SIGNAL,VDUM,TEMP;
TAS2  TAS,AHF1,ENTE,TRI(1,1);
TAS3  TAS,BHF1,,TRI(1,1);
TAS4  TAS,CHF1,,TRI(2,1);
UTAS  TAS,,,CON(0),ACT(FLG2);
USGX  SIG,GTV;
TAS5  TAS,DHF1,,TRI(2,1),,CONT,,,FHC3,30,EOF3;
TAS6  TAS,EHF1,,TRI(3,1),,CONT,,,FHC3,25,EOF3;
TAS7  TAS,EIF1,,TRI(4,1),,CONT,,,FHC3,25,EOF3;
TAS8  TAS,FIX1,,EXP(DOOX,1),,CONT,,,FHC3,25,EOF3;
TS8X  TAS,FID1,PEME,EXP(DOOR,1),,CONT,,,FHC3,25,EOF3;
TASF  TAS,SW1F,ENTE,TRI(8,1),ACT(FLG1),CONT,,,FID1,5,ES12/
       SW1F,3,ES12;
TAS9  TAS,SW11,,TRI(5,1),,CONT,,,SW11,4,EHS1;
TS10  TAS,SW12,,TRI(5,1),,CONT,,,SW12,4,EHS1;
TS11  TAS,SW13,,TRI(6,1),,CONT,,,SW13,4,EHS1;
TS12  TAS,SW14,,TRI(6,1),,CONT,,,SW14,4,EHS1;
TS13  TAS,UTR2,,TRI(7,1),,CONT,,,SW14,4,EOF3;
TSX2  TAS,UTX1,,EXP(DOX2,1),,CONT,,,UTR2,5,EOF3;
TXX5  TAS,UTD1,PEME,EXP(DOR2,1),,CONT,,,UTR2,5,EOF3;
      DEC,(FLG4.IS.ACT,UTA1.IS.TRIGG),TSTU;
      REG,TS14;
TSTU  SIG,VDUM,TEMP;
TS14  TAS,USR1,ENTE,TRI(7,1),,CONT,,,UTD1,3,EBL3;
TS15  TAS,USR2,,TRI(7,1),,CONT,,2,UTD1,8,EBL3;
      DEC,(FLG6.IS.ACT,SIZE.GE.2),TS16,2;
      DEC,(FLG6.IS.DIS/SIZE.EQ.1),TS16,1;
      DEC,(SIZE.GT.2),CP1,0;
      DEC,(SIZE.EQ.2,FLG6.IS.DIS),CP1,0;
TS16  TAS,URR1,,TRI(8,1),,CONT,,,UTD1,8,EBL3;
TS17  TAS,URR2,,TRI(8,1),,CONT,,,USR2,10,EBL3;
TS18  TAS,URR3,,TRI(8,1),,CONT,,,URR1,10,EBL3;
TS19  TAS,VRR1,,TRI(8,1),,CONT,,,URR1,10,EBL3;
TS20  TAS,VRT1,,TRI(11,1),,CONT,,,USR1,15,EBL3/
       USR3,15,EBL3/USR2,4,EBL3/URR1,7,EBL3/
       URR3,13,EBL3;
SUCC  TAS,VRTT,,CON(0);
EXTS  EXIT,STOP;
CP1   TAS,URR4,,CON(100),,CONT,,,UTD1,13,EBL3;
EXIX  EXIT;
      ENDADVERSARY;
GUARD;
      ENG,(SIZE.LT.1),EBL2;
EBAS  BASE,8,SHOTGUNS G,1;
UBAS  BASE,8,SHOTGUNS G,1;
EQ1   ENT,0.0,USTA,1;
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SNAP INPUT LISTING--SCENARIO A (Continued)

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EG1   ENT,0.0,USTA,1;
;
;INITIAL RESPONSE
;
ALL1  ALL,EBAS,,SIZE-2;
WRG2  WAIT,(ADD,M1.OR.ADD,M2.OR.SIGNAL),,2;**
      DEC,(TRGR.IS.2),DDT4,1;
      DEC,(TRGR.IS.2),GT1,0;
      REG,GTIX,0;
GTIX  TAS,,,CON(0),ACT(FLG5);
;
;RESPONSE PATH TO TARGET
;
GT1   TAS,FGF1,NEUT,TRI(WRSP,1);
GTD   TAS,,,CON(0);
      DEC,(FLG2.IS.DIS),GTW;
      DEC,(FLG1.IS.DIS),GT2;
      DEC,(FIA1.IS.TRIGG/UTA1.IS.TRIGG/FLG7.IS.ACT),GTA;
      REG,GTAA;
GTW   WAIT,(SIGNAL);
GT2   SIG,WRG1;
GT2A  TAS,,,CON(0.01);
XT2A  TAS,FHC3,,CON(0.1),,CONT,,AHF1,110,EBC1/
       AHD1,110,EBC1/BHF1,80,EBC1/CHF1,60,EBC1/
       DHF1,30,EBC1/EHF1,25,EBC1/EIF1,25,EBC1/
       FID1,25,EBC1/FIX1,25,EBC1;
EXTZ  EXIT,STOP;
GTAA  TAS,,,EXP(1.0,1),ACT(FLG7);
GTA   TAS,FIC3,,TRI(10,1);
GTA0  SIG,WRG1;
GT3   TAS,FID1,,CON(0.1),,CONT,,SW1F,5,EBA2;
      DEC,(FLG8.IS.ACT/UTA1.IS.TRIGG),GT4;
      REG,GT3A;
GT3A  TAS,,,EXP(1.0),ACT(FLG8);
GT4   TAS,SW1F,,TRI(8,1),,CONT,,SW1F,3,ESL1;
GT5   TAS,SW11,,TRI(5,1),,CONT,,SW11,4,ESL1;
GT6   TAS,SW12,,TRI(5,1),,CONT,,SW12,4,ESL1;
GT7   TAS,SW13,,TRI(6,1),,CONT,,SW13,4,ESL1;
GT8   TAS,SW14,,TRI(6,1),,CONT,,SW14,4,ESL1/
     UTR2,5,ESL1;
GT9   TAS,UTR2,,TRI(7,1),,CONT,,UTD1,3,EBA3/UTX1,3,EBA3;
GT10  TAS,UTD1,,CON(0.1),,CONT,,USR1,3,EBC1/
       USR2,8,EBL1/URR1,8,EBL1/URR4,13,EBL2;
GT11  TAS,USR1,,TRI(7,1);
GT12  TAS,USR2,,TRI(7,1),,CONT,,URR2,10,EBL3;
GT13  TAS,URR1,,TRI(8,1),,CONT,,URR3,10,EBL3/
       URR1,15,EBL3;
GT14  TAS,URR2,,TRI(8,1);
GT15  TAS,URR3,,TRI(8,1),,EXX,,URT1,15,EBL3;
EXX   EXIT,STOP;
ENTE  ENT,0.0,USTA;
;
;REINF RESP USTA
;
ALLE  ALL,EBAS,1,SIZE-WR;
WRG1  WAIT,(ADD,M1.OR.SIGNAL),,3;
      DEC,(FLG5.IS.ACT),DDT4,1;
      REG,SIGW,0;
      REG,TSLL,0;
SIGW  SIG,WRGW;
SIGL  SIG,USIX,TEMP;
      DEC,(SIZE.EQ.0),EXTW;
      REG,GT1;
TSLL  TAS,,,CON(15);
EXLL  EXIT,STOP;
;
;REINF RESP ESTA
;
ENTW  ENT,0.0,ESTA;
ALLW  ALL,WBAS,1,SIZE-ER;
      DEC,(SIZE.EQ.0),EXTW;
      REG,WRGW;
EXTW  EXIT;
WRGW  WAIT,(SIGNAL);
TASW  TAS,FGF1,,TRI(ERSP,1);
      REG,GTD;
;
;CCTV SIGNAL NETWORK
;
ZZET  ENT,0.0,ESTA;
WDUM  WAIT,(SIGNAL);
      PRO,0.7,WDUM;
      PRO,0.3,YDDT;
YDDT  TAS,,,EXP(0.5,1);
TTT2  SIG,WRG2;
DD13  SIG,WRG1;
      REG,WDUM;
DDT4  EXIT;
E6    ENT,0.0,X6SK;
ALLS  ALL,WBAS,1,SIZE-L6G;
      DEC,(FLG5.IS.ACT),WSIX;
      REG,DDT4;
WSIX  WAIT,(SIGNAL);
RSSX  TAS,,,TRI(14,1);
RSS2  TAS,USR3,NEUT,CON(100),,EXX,,URT1,15,EBL3;
RSS3  EXIT;
      ENDGUARD;
      ENDSNAP;
END OF FILE
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SNAP INPUT LISTING--SCENARIO A (Continued)

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	1.500	1.142	.011	0.000	5.000	100
NO. ADVER CSLTY	.280	.668	.007	0.000	3.000	100
DEG OBJ SATISFD	.970	.171	.002	0.000	1.000	100
TIME FOR ENG	.358	.325	.003	.000	1.423	105
TOTAL ENG TIME	.376	.387	.004	0.000	1.845	100
NO. ENG/RUN	1.050	.520	.005	0.000	3.000	100
TIME BET ENT/ENG	4.554	.526	.005	3.529	6.449	98
SIMULATION TIME	7.374	.599	.006	6.278	8.733	100
SIM TIME/AD SUC	7.347	.580	.006	6.278	8.587	97
SIM TIME/AD FAIL	8.259	.598	.199	7.587	8.733	3

AVG NUMBER OF ENGAGEMENTS PER RUN	1.05
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.09
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.96
PROBABILITY SYSTEM WINS	.03
PROBABILITY AN INTERRUPT OCCURS	.98

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO A

CASE 1

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	4.490	1.020	.010	1.000	5.000	100
NO. ADVER CSLTY	.610	.994	.010	0.000	3.000	100
DEG OBJ SATISFD	.880	.327	.003	0.000	1.000	100
TIME FOR ENG	.417	.673	.002	.000	5.862	276
TOTAL ENG TIME	1.151	1.025	.010	0.000	6.679	100
NO. ENG/RUN	2.760	.668	.007	0.000	4.000	100
TIME BET ENT/ENG	1.152	1.125	.011	.492	5.736	100
SIMULATION TIME	9.038	1.439	.015	2.638	13.906	100
SIM TIME/AD SUC	9.237	1.254	.014	7.266	13.906	88
SIM TIME/AD FAIL	7.576	2.264	.189	2.638	12.136	12

AVG NUMBER OF ENGAGEMENTS PER RUN	2.76
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.22
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	2.54
PROBABILITY SYSTEM WINS	.12
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO A

CASE 2

GENERAL SYSTEM PERFORMANCE STATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	1.180	.833	.008	0.000	4.000	100
NO. ADVER CSLTY	.930	1.121	.011	0.000	3.000	100
DEG OBJ SATISFD	.860	.349	.003	0.000	1.000	100
TIME FOR ENG	.373	.347	.003	.000	2.110	133
TOTAL ENG TIME	.496	.507	.005	0.000	2.178	100
NO. ENG/RUN	1.330	.726	.007	0.000	3.000	100
TIME BET ENT ENG	4.450	.539	.006	3.431	6.743	95
SIMULATION TIME	7.386	.534	.005	6.131	9.041	100
SIM TIME/AD SUC	7.313	.476	.006	6.131	8.380	86
SIM TIME/AD FAIL	7.836	.662	.047	6.730	9.041	14

AVG NUMBER OF ENGAGEMENTS PER RUN	1.33
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.45
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.88
PROBABILITY SYSTEM WINS	.14
PROBABILITY AN INTERRUPT OCCURS	.95

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO A

CASE 3

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	4.750	2.105	.021	0.000	7.000	100
NO. ADVER CSLTY	2.040	1.222	.012	0.000	3.000	100
DEG OBJ SATISFD	.410	.494	.005	0.000	1.000	100
TIME FOR ENG	.368	.446	.001	.000	2.755	311
TOTAL ENG TIME	1.146	.776	.008	.194	3.961	100
NO. ENG/RUN	3.110	.695	.007	1.000	4.000	100
TIME BET ENT/ENG	1.072	.978	.010	.492	4.990	100
SIMULATION TIME	8.072	2.318	.023	2.260	16.607	100
SIM TIME/AD SUC	9.917	1.352	.033	7.488	12.642	41
SIM TIME/AD FAIL	6.791	1.959	.033	2.260	16.607	59

AVG NUMBER OF ENGAGEMENTS PER RUN	3.11
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.06
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	2.05
PROBABILITY SYSTEM WINS	.59
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO A

CASE 4

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	4.840	2.364	.024	0.000	8.000	100
NO. ADVER CSLTY	2.320	.994	.010	0.000	3.000	100
DEG OBJ SATISFD	.300	.461	.005	0.000	1.000	100
TIME FOR ENG	.381	.474	.001	.000	3.642	377
TOTAL ENG TIME	1.437	.843	.008	.238	4.780	100
NO. ENG/RUM	3.770	.863	.009	1.000	5.000	100
TIME BET ENT/ENG	.920	.737	.007	.478	4.010	100
SIMULATION TIME	7.663	2.516	.025	2.835	14.174	100
SIM TIME/AD SUC	10.883	1.712	.057	7.796	14.174	30
SIM TIME/AD FAIL	6.284	1.187	.017	2.835	9.397	70

AVG NUMBER OF ENGAGEMENTS PER RUN	3.77
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.17
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	2.60
PROBABILITY SYSTEM WINS	.70
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO A

CASE 5

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	3.520	2.435	.024	0.000	8.000	100
NO. ADVER CSLTY	2.760	.668	.007	0.000	3.000	100
DEG OBJ SATISFD	.130	.338	.003	0.000	1.000	100
TIME FOR ENG	.669	.667	.002	.000	3.502	296
TOTAL ENG TIME	1.979	1.303	.013	.414	5.086	100
NO. ENG/RUN	2.960	1.205	.012	1.000	5.000	100
TIME BET ENT/ENG	.980	.699	.003	.490	5.617	100
SIMULATION TIME	6.320	2.952	.030	2.279	15.261	100
SIM TIME/AD SUC	12.414	2.122	.163	8.758	15.261	13
SIM TIME/AD FAIL	5.409	1.718	.020	2.279	9.841	87

AVG NUMBER OF ENGAGEMENTS PER RUN	2.96
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.18
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	1.78
PROBABILITY SYSTEM WINS	.87
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO A

CASE 6

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
USR2	1.00000	2.00000	0.00000	0.00000	100
URR2	1.00000	1.00000	0.00000	0.00000	100
URR3	1.00000	1.00000	0.00000	0.00000	100
URR4	.06000	.06000	.23868	.02239	100
SW1F	1.00000	1.00000	0.00000	0.00000	100
SW13	1.00000	1.00000	0.00000	0.00000	100
SW14	1.00000	1.00000	0.00000	0.00000	100
FID1	1.00000	1.00000	0.00000	0.00000	100
FIX1	1.00000	1.00000	0.00000	0.00000	100
AHF1	1.00000	1.00000	0.00000	0.00000	100
AHD1	1.00000	1.00000	0.00000	0.00000	100
BHF1	1.00000	1.00000	0.00000	0.00000	100
CHF1	1.00000	1.00000	0.00000	0.00000	100
DHF1	1.00000	1.00000	0.00000	0.00000	100
EHF1	1.00000	1.00000	0.00000	0.00000	100
EIF1	1.00000	1.00000	0.00000	0.00000	100
URR1	1.00000	1.00000	0.00000	0.00000	100
USR1	1.00000	1.00000	0.00000	0.00000	100
UTR2	1.00000	1.00000	0.00000	0.00000	100
UTD1	1.00000	1.00000	0.00000	0.00000	100
UTX1	1.00000	1.00000	0.00000	0.00000	100
URR1	1.00000	1.00000	0.00000	0.00000	100
URT1	1.00000	1.00000	0.00000	0.00000	100
URTT	.97000	.97000	.17145	.00171	100
SW11	1.00000	1.00000	0.00000	0.00000	100
SW12	1.00000	1.00000	0.00000	0.00000	100

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FACILITY STATISTICS--SCENARIO A

CASE 1

* FACILITY STATISTICS *

** STATISTICS FOR FACILITY NODES **

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
USR2	.97000	1.93000	.35548	.00355	100
URR2	.96000	.96000	.19695	.00197	100
URR3	.96000	.96000	.19695	.00197	100
URR4	.12000	.12000	.32660	.00327	100
SW1F	1.00000	1.00000	0.00000	0.00000	100
SW13	.99000	.99000	.10000	.00100	100
SW14	.99000	.99000	.10000	.00100	100
FID1	1.00000	1.00000	0.00000	0.00000	100
FIX1	1.00000	1.00000	0.00000	0.00000	100
AHF1	1.00000	1.00000	0.00000	0.00000	100
AHD1	1.00000	1.00000	0.00000	0.00000	100
BHF1	1.00000	1.00000	0.00000	0.00000	100
CHF1	1.00000	1.00000	0.00000	0.00000	100
DHF1	1.00000	1.00000	0.00000	0.00000	100
EHF1	1.00000	1.00000	0.00000	0.00000	100
EIF1	1.00000	1.00000	0.00000	0.00000	100
URR1	.97000	.97000	.17145	.00171	100
USR1	.97000	.97000	.17145	.00171	100
UTR2	.99000	.99000	.10000	.00100	100
UTD1	.98000	.98000	.14071	.00141	100
UTX1	.99000	.99000	.10000	.00100	100
VRR1	.96000	.96000	.19695	.00197	100
VRT1	.96000	.96000	.19695	.00197	100
VRTT	.88000	.88000	.32660	.00327	100
SW11	.99000	.99000	.10000	.00100	100
SW12	.99000	.99000	.10000	.00100	100

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FACILITY STATISTICS--SCENARIO A

CASE 2

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FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
USR2	1.00000	2.00000	0.00000	0.00000	100
URR2	1.00000	1.00000	0.00000	0.00000	100
URR3	1.00000	1.00000	0.00000	0.00000	100
URR4	.31000	.31000	.46482	.00465	100
SW1F	1.00000	1.00000	0.00000	0.00000	100
SW13	1.00000	1.00000	0.00000	0.00000	100
SW14	1.00000	1.00000	0.00000	0.00000	100
FID1	1.00000	1.00000	0.00000	0.00000	100
FIX1	1.00000	1.00000	0.00000	0.00000	100
AHF1	1.00000	1.00000	0.00000	0.00000	100
AHD1	1.00000	1.00000	0.00000	0.00000	100
BHF1	1.00000	1.00000	0.00000	0.00000	100
CHF1	1.00000	1.00000	0.00000	0.00000	100
DHF1	1.00000	1.00000	0.00000	0.00000	100
EHF1	1.00000	1.00000	0.00000	0.00000	100
EIF1	1.00000	1.00000	0.00000	0.00000	100
URP1	1.00000	1.00000	0.00000	0.00000	100
USR1	1.00000	1.00000	0.00000	0.00000	100
UTR2	1.00000	1.00000	0.00000	0.00000	100
UTD1	1.00000	1.00000	0.00000	0.00000	100
UTX1	1.00000	1.00000	0.00000	0.00000	100
URR1	1.00000	1.00000	0.00000	0.00000	100
URT1	1.00000	1.00000	0.00000	0.00000	100
URTT	.86000	.86000	.34874	.00349	100
SW11	1.00000	1.00000	0.00000	0.00000	100
SW12	1.00000	1.00000	0.00000	0.00000	100

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FACILITY STATISTICS--SCENARIO A

CASE 3

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
USR2	.87000	1.70000	.68902	.00689	100
URR2	.82000	.82000	.38612	.00386	100
URR3	.82000	.82000	.38612	.00386	100
URR4	.50000	.50000	.50252	.00503	100
SW1F	.95000	.95000	.21904	.00219	100
SW13	.94000	.94000	.23868	.00239	100
SW14	.94000	.94000	.23868	.00239	100
FID1	1.00000	1.00000	0.00000	0.00000	100
FIX1	1.00000	1.00000	0.00000	0.00000	100
AHF1	1.00000	1.00000	0.00000	0.00000	100
AHD1	1.00000	1.00000	0.00000	0.00000	100
BHF1	1.00000	1.00000	0.00000	0.00000	100
CHF1	1.00000	1.00000	0.00000	0.00000	100
DHF1	1.00000	1.00000	0.00000	0.00000	100
EHF1	1.00000	1.00000	0.00000	0.00000	100
EIF1	1.00000	1.00000	0.00000	0.00000	100
URR1	.84000	.84000	.36845	.00363	100
USR1	.88000	.88000	.32660	.00327	100
UTR2	.94000	.94000	.23868	.00239	100
UTD1	.94000	.94000	.23868	.00239	100
UTX1	.94000	.94000	.23868	.00239	100
VRR1	.82000	.82000	.38612	.00386	100
VRT1	.82000	.82000	.38612	.00386	100
VRTT	.41000	.41000	.49431	.00494	100
SW11	.94000	.94000	.23868	.00239	100
SW12	.94000	.94000	.23868	.00239	100

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FACILITY STATISTICS--SCENARIO A

CASE 4

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*    FACILITY STATISTICS    *
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** STATISTICS FOR FACILITY NODES **

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
USR2	.57000	1.53000	.71711	.00717	100
URR2	.86000	.86000	.34874	.00349	100
URR3	.86000	.86000	.34874	.00349	100
URR4	.48000	.48000	.50212	.00502	100
SW1F	.96000	.96000	.19695	.00197	100
SW13	.96000	.96000	.19695	.00197	100
SW14	.96000	.96000	.19695	.00197	100
FID1	.99000	.99000	.10000	.00100	100
FIX1	1.00000	1.00000	0.00000	0.00000	100
AHF1	1.00000	1.00000	0.00000	0.00000	100
AHD1	1.00000	1.00000	0.00000	0.00000	100
BHF1	1.00000	1.00000	0.00000	0.00000	100
CHF1	1.00000	1.00000	0.00000	0.00000	100
DHF1	1.00000	1.00000	0.00000	0.00000	100
EHF1	1.00000	1.00000	0.00000	0.00000	100
EIF1	1.00000	1.00000	0.00000	0.00000	100
URR1	.87000	.87000	.33800	.00338	100
USR1	.88000	.88000	.32663	.00327	100
UTR2	.96000	.96000	.19695	.00197	100
UTD1	.96000	.96000	.19695	.00197	100
UTX1	.96000	.96000	.19695	.00197	100
VRR1	.86000	.86000	.34874	.00349	100
VRT1	.85000	.85000	.35887	.00359	100
VRTT	.30000	.30000	.46057	.00461	100
SW11	.96000	.96000	.19695	.00197	100
SW12	.96000	.96000	.19695	.00197	100

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FACILITY STATISTICS--SCENARIO A
CASE 5

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
USR2	.53000	.88000	.90207	.00902	100
URR2	.52000	.52000	.50212	.00502	100
URR3	.52000	.52000	.50212	.00502	100
URR4	.31000	.31000	.46482	.00465	100
SW1F	.57000	.57000	.49757	.00498	100
SW13	.57000	.57000	.49757	.00498	100
SW14	.57000	.57000	.49757	.00498	100
FID1	.76000	.76000	.42923	.00429	100
FIX1	.91000	.91000	.28762	.00288	100
AHF1	1.00000	1.00000	0.00000	0.00000	100
AHD1	1.00000	1.00000	0.00000	0.00000	100
AHF1	1.00000	1.00000	0.00000	0.00000	100
CHF1	1.00000	1.00000	0.00000	0.00000	100
DHF1	1.00000	1.00000	0.00000	0.00000	100
EHF1	.97000	.97000	.17145	.00171	100
EIF1	.93000	.93000	.25643	.00256	100
URF1	.52000	.52000	.50212	.00502	100
USR1	.53000	.53000	.50161	.00502	100
UTR2	.57000	.57000	.49757	.00498	100
UTD1	.56000	.56000	.49889	.00499	100
UTX1	.57000	.57000	.49757	.00498	100
URR1	.52000	.52000	.50212	.00502	100
URT1	.51000	.51000	.50242	.00502	100
URTT	.13000	.13000	.33800	.00338	100
SW11	.57000	.57000	.49757	.00498	100
SW12	.57000	.57000	.49757	.00498	100

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FACILITY STATISTICS--SCENARIO A
CASE 6

1

TRACE
RUN NO 1

FORCE	EVENT	NODE	FACILITY NODE	TIME
GUARD	0 ENTER	EG1	USTA	0.00
	BRANCHED TO ALL1			
	SIZE - 0.			
GUARD	1 ALLOCATE FROM BASE EBAS	ALL1	USTA	0.00
	SIZE - 2.			
	TOTALS =			
	SIZE - 2.			
	TRAINING - 1.			
	BRANCHED TO URG2			
	SIZE - 2.			
GUARD	1 WAITING FOR	URG2	USTA	0.00
	ADV DETECTION DEVICE M1			
	OR ADV DETECTION DEVICE M2			
	OR SIGNAL			
GUARD	0 ENTER	ENTE	USTA	0.00
	BRANCHED TO ALLE			
	SIZE - 0.			
GUARD	2 ALLOCATE FROM BASE EBAS	ALLE	USTA	0.00
	SIZE - 0.			
	TOTALS =			
	SIZE - 0.			
	TRAINING - 1.			
	BRANCHED TO URG1			
	SIZE - 0.			
GUARD	2 WAITING FOR	URG1	USTA	0.00
	ADV DETECTION DEVICE M1			
	OR SIGNAL			
GUARD	0 ENTER	ENTW	ESTA	0.00
	BRANCHED TO ALLW			
	SIZE - 0.			
GUARD	3 ALLOCATE FROM BASE WBAS	ALLW	ESTA	0.00
	SIZE - 4.			
	TOTALS =			
	SIZE - 4.			
	TRAINING - 1.			
	BRANCHED TO URGW			
	SIZE - 4.			
GUARD	3 WAITING FOR		URGW	ESTA	0.00
	SIGNAL				
GUARD	0 ENTER		ZZET	ESTA	0.00
	BRANCHED TO WDUM				
	SIZE - 0.				
GUARD	0 WAITING FOR		WDUM	ESTA	0.00
	SIGNAL				
GUARD	0 ENTER		00	XESK	0.00
	BRANCHED TO ALLS				
	SIZE - 0.				
GUARD	4 ALLOCATE FROM BASE WBAS		ALLS	XESK	0.00
	SIZE - 1.				
	TOTALS =				
	SIZE - 1.				
	TRAINING - 1.				
	BRANCHED TO DDT4				
	SIZE - 1.				
GUARD	4 EXIT		DDT4	XESK	0.00
ADVER	1 ENTER		ENT1	AHD1	1.00
	SIZE - 3.				
	TRAINING - 1.				
	BRANCHED TO TAS1				
	SIZE - 3.				
ADVER	1 START OF TASK		TAS1	AHD1	1.00
	DISABLE BARRIER AHD1				
	TRIGGERED SENSOR AHA1				
GUARD	1 WAIT MODE TRIGGERED		URG2	USTA	1.00
	BY TRIGGER NUMBER 2				
	BRANCHED TO DDT4				
	SIZE - 1.				
	BRANCHED TO GT1				
	SIZE - 1.				
GUARD	1 EXIT		DDT4	USTA	1.00
GUARD	5 START OF TASK		GT1	FQF1	1.00
ADVER	1 END OF TASK		TAS1	AHD1	1.27
	BRANCHED TO TAS2				
	SIZE - 3.				
ADVER	1 START OF TASK		TAS2	AHF1	1.27
ADVER	1 END OF TASK		TAS2	AHF1	1.43
	BRANCHED TO TAS3				
	SIZE - 3.				
ADVER	1 START OF TASK		TAS3	BHF1	1.43
ADVER	1 END OF TASK		TAS3	BHF1	1.56

SCENARIO A--TRACE CASE 1

ADVER	1	END OF TASK			TAS3	DHF1	1.56			BRANCHED TO	TS10			
		BRANCHED TO	TAS4							SIZE -	3.			
		SIZE -	3.					ADVER	1	START OF TASK		TS10	SW12	2.44
ADVER	1	START OF TASK			TAS4	CHF1	1.56	ADVER	1	END OF TASK		TS10	SW12	2.66
ADVER	1	END OF TASK			TAS4	CHF1	1.66			BRANCHED TO	TS11			
		BRANCHED TO	WTAS							SIZE -	3.			
		SIZE -	3.					ADVER	1	START OF TASK		TS11	SW13	2.66
ADVER	1	START OF TASK			WTAS	CHF1	1.66	ADVER	1	END OF TASK		TS11	SW13	2.85
		ACTIVATE FLAG	FLG2							BRANCHED TO	TS12			
ADVER	1	END OF TASK			WTAS	CHF1	1.66			SIZE -	3.			
		BRANCHED TO	WSGX					ADVER	1	START OF TASK		TS12	SW14	2.85
		SIZE -	3.					ADVER	1	END OF TASK		TS12	SW14	3.07
ADVER	1	SIGNAL	CTW		WSGX	CHF1	1.66			BRANCHED TO	TS13			
		BRANCHED TO	TAS5							SIZE -	3.			
		SIZE -	3.					ADVER	1	START OF TASK		TS13	UTR2	3.07
ADVER	1	START OF TASK			TAS5	DHF1	1.66	ADVER	1	END OF TASK		TS13	UTR2	3.17
ADVER	1	END OF TASK			TAS5	DHF1	1.76			BRANCHED TO	TSX2			
		BRANCHED TO	TAS6							SIZE -	3.			
		SIZE -	3.					ADVER	1	START OF TASK		TSX2	UTX1	3.17
ADVER	1	START OF TASK			TAS6	EHF1	1.76	ADVER	1	END OF TASK		TSX2	UTX1	3.17
ADVER	1	END OF TASK			TAS6	EHF1	1.83			BRANCHED TO	TXXS			
		BRANCHED TO	TAS7							SIZE -	3.			
		SIZE -	3.					ADVER	1	START OF TASK		TXXS	UTD1	3.17
ADVER	1	START OF TASK			TAS7	EIF1	1.83			DISABLE BARRIER	UTD1			
ADVER	1	END OF TASK			TAS7	EIF1	1.86			TRIGGERED SENSOR	UTA1			
		BRANCHED TO	TAS8					GUARD	2	WAIT MODE TRIGGERED		WRG1	WSTA	3.17
		SIZE -	3.							BY TRIGGER NUMBER	1			
ADVER	1	START OF TASK			TAS8	FIX1	1.86			BRANCHED TO	SIGW			
ADVER	1	END OF TASK			TAS8	FIX1	1.86			SIZE -	0.			
		BRANCHED TO	TSBX							BRANCHED TO	TSLL			
		SIZE -	3.							SIZE -	0.			
ADVER	1	START OF TASK			TSBX	FID1	1.86	GUARD	0	SIGNAL		WRGW	SIGW	WSTA 3.17
		DISABLE BARRIER	FID1							BRANCHED TO	SIGL			
		TRIGGERED SENSOR	FIA1							SIZE -	0.			
ADVER	1	END OF TASK			TSBX	FID1	1.99	GUARD	3	WAIT MODE TRIGGERED		WRGW	ESTA	3.17
		BRANCHED TO	TASF							BY TRIGGER NUMBER	1			
		SIZE -	3.							BRANCHED TO	TASW			
ADVER	1	START OF TASK			TASF	SW1F	1.99			SIZE -	4.			
		ACTIVATE FLAG	FLG1					GUARD	3	START OF TASK		TASW	FQF1	3.17
ADVER	1	END OF TASK			TASF	SW1F	2.13	GUARD	0	SIGNAL		WSIX	SIGL	WSTA 3.17
		BRANCHED TO	TAS9							BRANCHED TO	EXTW			
		SIZE -	3.							SIZE -	0.			
ADVER	1	START OF TASK			TAS9	SW11	2.13	GUARD	0	EXIT		EXTW	WSTA	3.17
ADVER	1	END OF TASK			TAS9	SW11	2.44	GUARD	0	START OF TASK		TSLL	WSTA	3.17
								ADVER	1	END OF TASK		TXXS	UTD1	3.20

SCENARIO A--TRACE CASE 1 (Continued)

ADVER	1 END OF TASK BRANCHED TO SIZE -	TSTU 3.	TXXS	UTD1	3.20
ADVER	1 SIGNAL BRANCHED TO SIZE -	UDUM TS14 3.	TSTU	UTD1	3.20
GUARD	0 WAIT NODE TRIGGERED BY TRIGGER NUMBER 1 BRANCHED TO SIZE -	YDDT 0.	UDUM	ESTA	3.20
GUARD	0 START OF TASK		YDDT	ESTA	3.20
ADVER	1 START OF TASK		TS14	USR1	3.20
ADVER	1 END OF TASK BRANCHED TO SIZE -	TS15 3.	TS14	USR1	3.30
ADVER	1 START OF TASK		TS15	USR2	3.30
ADVER	1 END OF TASK BRANCHED TO SIZE - BRANCHED TO SIZE -	TS16 1. CP1 2.	TS15	USR2	3.40
ADVER	1 START OF TASK		TS16	URR1	3.40
ADVER	2 START OF TASK		CP1	URR4	3.40
ADVER	1 END OF TASK BRANCHED TO SIZE -	TS17 1.	TS16	URR1	3.50
ADVER	1 START OF TASK		TS17	URR2	3.50
ADVER	1 END OF TASK BRANCHED TO SIZE -	TS18 1.	TS17	URR2	3.62
ADVER	1 START OF TASK		TS18	URR3	3.62
ADVER	1 END OF TASK BRANCHED TO SIZE -	TS19 1.	TS18	URR3	3.74
ADVER	1 START OF TASK		TS19	URR1	3.74
ADVER	1 END OF TASK BRANCHED TO SIZE -	TS20 1.	TS19	URR1	3.87
ADVER	1 START OF TASK		TS20	URT1	3.87
GUARD	5 END OF TASK BRANCHED TO SIZE -	GTD 1.	GT1	FGF1	3.89
GUARD	5 START OF TASK		GTD	FGF1	3.89
GUARD	5 END OF TASK BRANCHED TO SIZE -	GTA 1.	GTD	FGF1	3.89
GUARD	5 START OF TASK		GTA	FIC3	3.89
GUARD	5 END OF TASK BRANCHED TO SIZE -	GTA0 1.	GTA	FIC3	4.06
GUARD	5 SIGNAL BRANCHED TO SIZE -	URG1 GT3 1.	GTA0	FIC3	4.06
GUARD	5 START OF TASK		GT3	FID1	4.06
GUARD	5 END OF TASK BRANCHED TO SIZE -	GT4 1.	GT3	FID1	4.16
GUARD	5 START OF TASK		GT4	SW1F	4.16
GUARD	5 END OF TASK BRANCHED TO SIZE -	GT5 1.	GT4	SW1F	4.30
GUARD	5 START OF TASK		GT5	SW11	4.30
GUARD	5 END OF TASK BRANCHED TO SIZE -	GT6 1.	GT5	SW11	4.56
GUARD	5 START OF TASK		GT6	SW12	4.56
GUARD	5 END OF TASK BRANCHED TO SIZE -	GT7 1.	GT6	SW12	4.78
GUARD	5 START OF TASK		GT7	SW13	4.78
GUARD	5 END OF TASK BRANCHED TO SIZE -	GT8 1.	GT7	SW13	5.00
GUARD	5 START OF TASK		GT8	SW14	5.00
GUARD	5 END OF TASK BRANCHED TO SIZE -	GT9 1.	GT8	SW14	5.20
GUARD	5 START OF TASK		GT9	UTR2	5.20
GUARD	5 END OF TASK BRANCHED TO SIZE -	GT10 1.	GT9	UTR2	5.30
GUARD	5 START OF TASK		GT10	UTD1	5.30
****	ENGAGEMENT				5.30
GUARD	5 INCLUDE				
ADVER	2 INCLUDE				

SCENARIO A--TRACE CASE 1 (Continued)

```
                ENGAGEMENT NUMBER      1
ADU   1 T O T A L S
          SIZE -                2.
          TRAINING -            0.
GUA   1 T O T A L S
          SIZE -                1.
          TRAINING -            0.

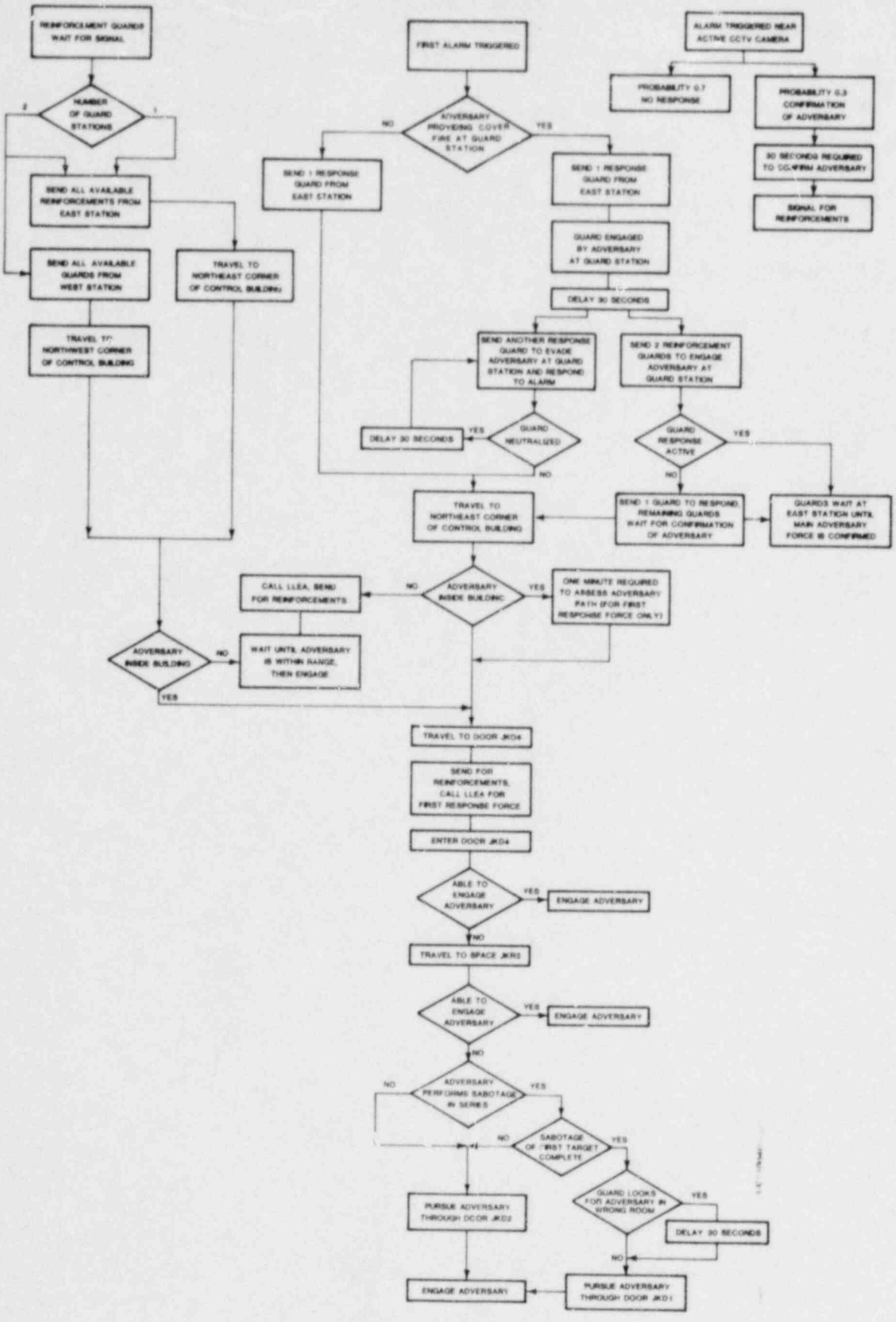
GUA   1 CASUALTY                                                    5.34
          SIZE -                0.

####  1 END ENGAGEMENT                                            5.34
GUARD 5 NEUTRALIZED                     GT10    UTD1              5.34
ADVER 2 RESUMED TASK                    CP1     URR4              5.34
          SIZE -                2.
          TRAINING -            1.
GUARD 0 END OF TASK                     YDDT    ESTA              5.55
          BRANCHED TO           TTT2
          SIZE -                0.
GUARD 0 SIGNAL                  URG2    TTT2    ESTA              5.55
          BRANCHED TO           DDT3
          SIZE -                0.
GUARD 0 SIGNAL                  URG1    DDT3    ESTA              5.55
          BRANCHED TO           WDUM
          SIZE -                0.
GUARD 0 WAITING FOR                     WDUM    ESTA              5.55
          SIGNAL
GUARD 3 END OF TASK                     TASU    FGF1              6.52
          BRANCHED TO           GTD
          SIZE -                4.
GUARD 3 START OF TASK                   GTD     FGF1              6.52
GUARD 3 END OF TASK                     GTD     FGF1              6.52
          BRANCHED TO           GTA
          SIZE -                4.
GUARD 3 START OF TASK                   GTA     FIC3              6.52
GUARD 3 END OF TASK                     GTA     FIC3              6.68
          BRANCHED TO           GTA0
          SIZE -                4.
GUARD 3 SIGNAL                  URG1    GTA0    FIC3              6.68
          BRANCHED TO           GT3
          SIZE -                4.
GUARD 3 START OF TASK                   GT3     FID1              6.68
GUARD 3 END OF TASK                     GT3     FID1              6.78
          BRANCHED TO           GT4
          SIZE -                4.
GUARD 3 START OF TASK                   GT4     SU1F              6.78
GUARD 3 END OF TASK                     GT4     SU1F              6.91
          BRANCHED TO           GT5
          SIZE -                4.
GUARD 3 START OF TASK                   GT5     SU11              6.91
GUARD 3 END OF TASK                     GT5     SU11              7.13
          BRANCHED TO           GT6
          SIZE -                4.
GUARD 3 START OF TASK                   GT6     SU12              7.13
GUARD 3 END OF TASK                     GT6     SU12              7.37
          BRANCHED TO           GT7
          SIZE -                4.
GUARD 3 START OF TASK                   GT7     SU13              7.37
GUARD 3 END OF TASK                     GT7     SU13              7.48
          BRANCHED TO           GT8
          SIZE -                4.
GUARD 3 START OF TASK                   GT8     SU14              7.48
GUARD 3 END OF TASK                     GT8     SU14              7.68
          BRANCHED TO           GT9
          SIZE -                4.
GUARD 3 START OF TASK                   GT9     UTR2              7.68
GUARD 3 END OF TASK                     GT9     UTR2              7.74
          BRANCHED TO           GT10
          SIZE -                4.
GUARD 3 START OF TASK                   GT10    UTD1              7.74
####    ENGAGEMENT                                                7.74
GUARD 3 INCLUDE
ADVER 2 INCLUDE
                ENGAGEMENT NUMBER      2
  ADU 2 T O T A L S
          SIZE -                2.
          TRAINING -            0.
  GUA 2 T O T A L S
          SIZE -                4.
          TRAINING -            0.
ADVER 1 END OF TASK                     TS20    VRT1              8.02
          BRANCHED TO           SUCC
          SIZE -                1.
ADVER 1 START OF TASK                   SUCC    VRTT              8.02
ADVER 1 END OF TASK                     SUCC    VRTT              8.02
          BRANCHED TO           EXTS
          SIZE -                1.
ADVER 1 EXIT                      STOP  EXTS    VRTT              8.02
```

SCENARIO A--TRACE CASE 1 (Continued)

D.5.2 Scenario B

- Guard Model Flowchart
- SNAP Input Listing
- SNAP General Performance Statistics
  Cases 1 through 6
- SNAP Facility Statistics
  Cases 1 through 6
- SNAP Trace of Case 1



GUARD MODEL FLOWCHART
SCENARIO B

```
SNAP,KIMPEL,           7/24/80,100,100.,50,P,N;
TRACE,10,12;
PAR,1,0.0666,0.0366,0.0966;
PAR,2,0.1,0.05,0.15;
PAR,3,0.07,0.04,0.1;
PAR,4,0.33,0.23,0.43;
PAR,5,0.5,0.35,0.65;
PAR,6,2.0,1.5,2.5;
PAR,7,1.1,0.7,1.5;
PAR,8,0.7,0.5,0.9;
PAR,9,1.5,1.1,1.9;
STATUS;
;ENGAGEMENT PARAMETERS
;
;OPEN FIELD
;
EOF1  NENG,DOF1,TINC.GE.0.05;
EOF2  NENG,DOF1,TINC.GE.0.05;
EOF3  NENG,DOF2;
;
;BUILDING CORNER
;
EBC1  NENG,DBC1;
;
;STAIRWELL
;
;HIGH LEVEL DEFENDING
EHS1  NENG,DSH1;
;LOW LEVEL ATTACKING
ESL1  NENG,DSL1;
;EXPOSURE IN 1ST LEVEL STWELL FROM GROUND
ES11  NENG,DS11,TINC.GE.0.05;
ES12  NENG,DS12;
;
;BUILDING INTERIOR NO COVER
;
NC11  NENG,DNC1,TINC.GE.0.05;
NC12  NENG,DNC2,TINC.GE.0.05;
NC13  NENG,DNC3;
;
;BUILDING INTERIOR HIGH COVER
;
EBHA  NENG,DBH1,TINC.GE.0.05;
EBH1  NENG,DBH1,TINC.GE.0.05;
EBH2  NENG,DBH2,TINC.GE.0.05;
EBH3  NENG,DBH3;
;
;BUILDING INTERIOR LOW COVER
;
EBLA  NENG,DBL1,TINC.GE.0.05;
EBL1  NENG,DBL1,TINC.GE.0.05;
EBL2  NENG,DBL2,TINC.GE.0.05;
EBL3  NENG,DBL3;
;
;ATTACKING LOW COVER
;
EBA1  NENG,DBA1;
;
;ATTACKING HIGH COVER
;
EBA2  NENG,DBA2;
;
;ATTACKING NON-AGGRESSIVE HIGH COVER
;
EBA3  NENG,DBA3;
;
;ATTACKING DEFENDED ROOM
;
ERA1  NENG,DRA1,TINC.GE.0.05;
ERA2  NENG,DRA1,TINC.GE.0.05;
ERA3  NENG,DRA1,TINC.GE.0.05;
ERA4  NENG,DRA2;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
DOF1  DENG,1,100,100,100,100,YES;
DOF2  DENG,3, 80, 90,  0,  0, NO;
DBC1  DENG,1, 60,  0, 60, 50, NO;
DSH1  DENG,2, 40, 40, 30, 50, NO;
DSL1  DENG,1, 80, 60, 10, 50, NO;
DS11  DENG,1, 90, 90,100,100,YES;
DS12  DENG,2, 70, 70, 10, 60, NO;
DBH1  DENG,1, 80, 80,100,100,YES;
DBH2  DENG,2, 40, 40,100,100,YES;
DBH3  DENG,2, 20,  0, 50, 30, NO;
DBL1  DENG,1,100,100,100,100,YES;
DBL2  DENG,2, 60, 60,100,100,YES;
DBL3  DENG,2, 40, 20, 50, 50, NO;
DBA1  DENG,2, 70, 20, 20, 40, NO;
DBA2  DENG,2, 50, 20, 20, 30, NO;
DBA3  DENG,2, 30, 10, 50, 40, NO;
DRA1  DENG,1, 90, 90,  0, 30, NO;
DRA2  DENG,2, 60, 60,  0, 30, NO;
DNC1  DENG,1,100,100,100,100,YES;
DNC2  DENG,3,100,100,100,100,YES;
DNC3  DENG,3,100,100,  0,  0, NO;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;CONTROL PARAMETERS;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;      SHOTGUNS G
;      SEMIAUTOMATICS CC
;
DOOR  GLOBAL,0.20;
DOOX  GLOBAL,0.00;
DOR2  GLOBAL,0.20;
DOX2  GLOBAL,0.00;
ER    GLOBAL,6;     SET# EAST RESP
WR    GLOBAL,6;     SET# WEST RESP
ERG   GLOBAL,2;     #EAST GUARDS-1
WRG   GLOBAL,2;     #WEST GUARDS
FLG8  FLAG,DIS;     TWO SHACK
FLGT  FLAG,DIS;       FLAG FOR FENCE CCTV
FLGI  FLAG,ACT;       FLAG FOR INTERIOR CCTV
FLGP  FLAG,DIS;       FLAG FOR PARALLEL TASKS
TAST  GLOBAL,6;     PARM FOR SAB. TIME
FLGW  FLAG,DIS;     WAIT FOR ADV TO ENT BLDG
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
FLP1  FLAG,DIS;
FLG1  FLAG,DIS;
FLG2  FLAG,DIS;
FLG3  FLAG,DIS;
FLG4  FLAG,DIS;
FLG5  FLAG,DIS;
FLG6  FLAG,DIS;
FLG9  FLAG,DIS;
FL11  FLAG,DIS;
FL12  FLAG,DIS;
FL13  FLAG,DIS;
```

SNAP INPUT LISTING--SCENARIO B

```
FL13   FLAG,DIS;
       ENDSTATUS;
FACILITY;
IOA1   BAR,ACTIVE,/IOA1;
IOF1   SPA;
INF1   SPA;
IMF1   SPA;
JLF1   SPA;
JKX1   SPA;
JKX2   SPA;
JKX3   SPA;
JKX4   SPA;
JKD1   BAR,ACTIVE,/JKA1;
JKD2   BAR,ACTIVE,/JKA2;
JKD3   BAR,ACTIVE,/JKA3;
JKD4   BAR,ACTIVE,/JKA4;
JKR1   SPA;
JKR2   SPA;
JKR3   SPA;
JKR4   SPA;
IKR1   SPA;
IKR2   SPA;
IKR3   SPA;
IKT1   SPA;
IKT2   SPA;
MKF1   SPA;
HKF1   SPA;
WSHK   SPA;
ESHK   SPA;
CC     SPA;
GSKP   SPA;
IOA1   SEN,.90,PERM,M1;
JKA1   SEN,.90,PERM,M2;
JKA2   SEN,.90,PERM,M2;
JKA3   SEN,.95,PERM,M1;
JKA4   SEN,.95,PERM,M1;
M2     LOGIC,L2;
M1     LOGIC,L1;
L1     MON,WG1;
L2     MON,WG1;
       ENDFACILITY;
ADVERSARY;
       OBJ,SAB,IKT1,IKT2;
       ENGAGEMENT,(SIZE.LT.1),EOF3;
EXTA   EXIT;
EXTS   EXIT,STOP;
ENT1   ENT,2,AUTOMATICS,1,1.0,IOD1;
TS1    TAS,IOD1,PENE,EXP(0.1,1),,CONT;
       DEC,(FLGT.IS.ACT,IOA1.IS.TRIGGERED),CCTV;
       REG,TS2;
CCTV   SIGNAL,UGF,TEMP;
TS2    TAS,IOF1,ENTE,TRI(1,1);
TS3    TAS,INF1,,TRI(1,1);
TS4    TAS,IMF1,,TRI(1,1);
INS1   SIGNAL,R2A;
       DEC,(FLGU.IS.ACT),TS5;
       REG,INS2;
INS2   SIGNAL,ER1,PERM;
TS5    TAS,JLF1,,TRI(1,1),ACT(FLG9),CONT,,,MKF1,50,EOF3/
         HKF1,30,EOF3;
TS6    TAS,JKX4,,EXP(DOOX,1),,CONT,,,MKF1,50,EOF3/
         HKF1,30,EOF3;
TS6X   TAS,JKD4,PENE,EXP(DOR,1),,CONT,,,MKF1,50,EOF3/
         HKF1,30,EOF3;
       DEC,(SIZE.LT.2),EXTS;
       REG,T6SA;
T6SA   SIG,ER1,PERM;
TS6A   TAS,JKR4,ENTE,TRI(2,1),ACT(FL13),CONT,,,JKD4,2,ES12;
TS7    TAS,JKX3,,EXP(DOX2,1),,CONT,,,JKD4,2,ES12;
TS7X   TAS,JKD3,PENE,EXP(DOR2,1),,CONT,,,JKD4,2,ES12;
       REG,TS8;
TS7Y   TAS,JKD3,ENTE,EXP(DOR2,1),,CONT,,,JKD4,2,ES12;
TS8    TAS,JKR1,ENTE,TRI(3,1),,CONT,,,JKR1,3,EBL3;
TS9    TAS,JKR2,ENTE,TRI(3,1),,CONT,,2,JKR1,6,EBL3;
       DEC,(SIZE.LT.2),EXTS;
       DEC,(SIZE.EQ.5),CP1,3;
       DEC,(SIZE.EQ.4),CP1,2;
       DEC,(SIZE.EQ.3),CP1,1;
       DEC,(FLGI.IS.DIS),TS10;
       REG,TSA2;
TSA2   SIG,UGF,TEMP;
TS10   TAS,JKR3,,TRI(3,1),,CONT,,2,JKR2,4,EBL3;
       DEC,(SIZE.LT.2),EXTS;
       DEC,(FLGP.IS.DIS),TS21,0;
       DEC,(FLGP.IS.DIS),EXCC;
       REG,TS21,1;
       REG,TS11,1;
TS11   TAS,JKX1,,EXP(DOX2,1),,CONT,,,JKR3,4,EBL3;
TS1X   TAS,JKD1,PENE,EXP(DOR2,1),,CONT,,,JKR3,4,EBL3;
TS12   TAS,IKR1,ENTE,TRI(3,1),ACT(FLP1),CONT,,,IKR1,5,EBL3;
TS13   TAS,IKR1,,TRI(TAST,1),,CONT,,,IKR1,5,EBL3;
TS14   TAS,IKT1,,CON(0),ACT(FLG4);
       DEC,(FLG3.IS.ACT),EXTS;
       REG,EXTA;
TS21   TAS,JKX2,,EXP(DOX2,1),,CONT,,,JKR3,4,EBL3;
TS2X   TAS,JKD2,PENE,EXP(DOR2,1),,CONT,,,JKR3,4,EBL3;
TS22   TAS,IKR2,ENTE,TRI(3,1),,CONT,,,IKR2,3,EBL3;
TS23   TAS,IKR3,,TRI(3,1),,CONT,,,IKR2,6,EBL3;
TS24   TAS,IKR3,,TRI(TAST,1),,CONT,,,IKR2,8,EBL3;
TS25   TAS,IKT2,,CON(0),ACT(FLG3);
       DEC,(FLGP.IS.DIS),XTAR;
       DEC,(FLG4.IS.ACT),EXTS;
       REG,EXTA;
CP1    TAS,JKR3,,CON(100),,CONT,,,JKR1,8,EBL3;
       REG,EXTS;
ETCC   ENT,1,AUTOMATIC,1,0.0,CC;
       DEC,(FLGB.IS.ACT),EXCC;
       REG,TCC;
       REG,EXCC;
TCC1   TAS,CC,ENTE,CON(100),,CONT,STCC,,GSKP,20,EBA3;
STCC   TAS,,,CON(0),,,,2;
       REG,TCC,0;
       REG,XTCC,0;
XTCC   TAS,,,CON(15);
XXTC   EXIT,STOP;
TCC    TAS,CC,ENTE,CON(100),,CONT,,,GSKP,20,EBA3;
EXCC   EXIT;
XTAR   TAS,IKR3,,TRI(3,1),,CONT,,,IKR2,6,EBL3;
WXR2   TAS,IKR2,,TRI(3,1),,CONT,,,IKR2,3,EBL3;
WXR3   TAS,JKX2,,CON(0.2),,CONT,,,JKR3,4,EBL3;
       REG,TS11;
       ENDADVERSARY;
GUARD;
       ENGAGEMENT,(SIZE.LT.1),EBL1;
;BASE  PARAMETERS
;
LBAS   BASE,8,SHOTGUNS G,1;
```

SNAP INPUT LISTING--SCENARIO B (Continued)

```
UBAS  BASE,8,SHOTGUNS G,1;
EBAS  BASE,8,SHOTGUNS G,1;
ABAS  BASE,2,SEMIAUTOMATICS CC,1;
BASX  BASE,20;
;
;INITIAL RESPONSE GUARD
;
ENT2  ENT,0.0,USHK;
ALL1  ALL,UBAS,,SIZE=1;
UG1   WAIT,(ADD,L1.OR.ADD,L2);
SIG1  SIG,UG2,TEMP; SIGNAL NEXTNRESPONSE ATTEMPT
SIGX  SIG,UG5;SIGNAL GUARDS TO ENG/ADV AT CC
      DEC,(FLG5.IS.DIS),T1;
      PRO,0.2,RMVE;
      PRO,0.8,T2;
RMVE  TAS,,,CON(0);GUARD NEUTRALIZED IF ADV AT CC
      DEC,(ADV.AT.CC),EXTK;
      REG,T2;
EXTK  EXIT;
T1    TAS,GSKP,NEUT,CON(0),ACT(FLG5),CONT,,,CC,20,EOF1;
;      GUARD SUPRIZED BY ADV
T2    TAS,GSKP,NEUT,CON(0),ACT(FLG1);
;      GUARD GETS PAST ADV AT CC--RESPONDS TO ALARM
      DEC,(FLG2.IS.ACT),R2,0;
      REG,R1,0;
;
;SECONDARY RESPONSE GUARDS
;
ENT2  ENT,0.0,ESHK;
ALL2  ALL,EBAS,1,SIZE=URG;
      DEC,(FLG8.IS.ACT),UG8;
      REG,UG3;
UG3   WAIT,(SIGNAL),,2;
      DEC,(FLG1.IS.ACT,FLG2.IS.DIS),UG3,0;
      DEC,(FLG1.IS.ACT,FLG2.IS.DIS),XDUM;
;      RESPONSE ACTIVE,--NO CONFIRM
      DEC,(FLG1.IS.DIS),SIG1.1;
      DEC,(SIZE.EQ.1,FLG1.IS.DIS),XDUM,0;
      DEC,(FLG1.IS.DIS),UG3,0;
;      NO RESPONSE GUARD ACTIVE
      REG,R2,0;
UG8   WAIT,(SIGNAL);
      DEC,(FLG2.IS.DIS),UG8;
      REG,URSP;
;
;GUARD RESPONDS TO ADV AT CC
;
ENT5  ENT,0.0,GSKP;
      DEC,(FLG8.IS.ACT),ASLL;
      REG,ALL5;
ASLL  ALL,UBAS,1,SIZE=ERG;
      DEC,(SIZE.EQ.1),XDUM;
      REG,UG3;
ALL5  ALL,ABAS,1,SIZE=2;
UG5   WAIT,(SIGNAL);
UG6   WAIT,(TIME,0.5);
EA    TAS,GSKP,NEUT,CON(0),,CONT,,,CC,20,EBL3;
      DEC,(SIZE.EQ.1),SDUM;
      REG,TTDM ;
TTDM  TAS,,,CON(0),ACT(FLG6);
SDUM  SIG,UDUM;
XDUM  EXIT;
EDUM  ENT,0.0,USHK;
```

```
UDUM  WAIT,(SIGNAL);
      DEC,(FLG6.IS.ACT),ALL6,0;
      REG,ADUM;
ADUM  ALL,UBAS,,SIZE=1;
      REG,XSSZ;
ALL6  ALL,UBAS,,SIZE=2;
XSSZ  TAS,,,CON(0);
TDUM  SIG,UG3,TEMP;
TDMX  TAS,,,CON(0),,,,2;
      DEC,(FLG2.IS.ACT),R2,0; ADU CONFIRM
      DEC,(FLG2.IS.ACT),XDUM;
      DEC,(FLG1.IS.ACT),UG3,0;RESPONSE ACTIVE
      DEC,(FLG1.IS.ACT),XDUM;
      REG,SIG1,1;NO RESPONSE ACTIVE--SO RESPOND
      REG,UG3,1;
;
;DUMMY TRANSACTION SIGNALS SECONDARY RESPONSE
;
ENT4  ENT,0.0,USHK;
ALL3  ALL,BASX,,SIZE=20;
UG2   WAIT,(SIGNAL),,2;
      REG,TX1,1;
      REG,UG2,0;
TX1   TAS,,,CON(0.5);
SIG2  SIG,UG3,TEMP;
SIGG  SIG,UG8,TEMP;
EXTX  EXIT;
;
;RESPONSE TO ADVERSARY FORCE
;
R1    TAS,,,CON(0);
R2    TAS,MKF1,,TRI(ER,1);
      DEC,(FLG13.IS.DIS),RX2;
      DEC,(JKA4.IS.TRIG/JKA3.IS.TRIGG/JKA2.IS.TRIGG/
            JKA1.IS.TRIG),RX2;
      DEC,(FLG2.IS.ACT),RX2;
      REG,RX2A;
;
;ASSESSMENT TIME
;
RX2A  TAS,,,EXP(1.0,1);
RX2   TAS,,,CON(0),ACT(FLG2),,,2;
      REG,RX3,0;
      REG,XTC1,0;
XTC1  TAS,,,CON(15);
XTC2  EXIT,STOP;
RX3   SIG,UG3,TEMP;
RX4   SIG,UG8,TEMP;
      DEC,(FLG9.IS.ACT),R2AA;
      REG,R2A;
R2A   WAIT,(SIGNAL);
R2AA  TAS,MKF1,,CON(0.1),,R2B,,,JLF1,50,EBC1/
      JKD4,50,EBC1/JKX4,50,EBC1;
R2B   TAS,JLF1,,TRI(5,1);
      REG,CA1,0;
;
;RESPONSE FROM EAST SHACK
;
URSP  TAS,MKF1,,TRI(WR,1);
      DEC,(FLGW.IS.ACT),ER1;
      DEC,(FLG9.IS.ACT),ER11;
      REG,ER1;
ER1   WAIT,(SIGNAL);
ER11  TAS,MKF1,,CON(0.1),,ER2,,,JLF1,30,EBC1/
```

SNAP INPUT LISTING--SCENARIO B (Continued)

```
EP1!    AS,HKF1,,CON(0.1),,ER2,,,JLF1,30,EBC1/
        JKD4,30,EBC1/JKX4,30,EBC1;
;
;RESPONSE INTO BLDG
;
ER2     TAS,JLF1,,TRI(4,1);
        DEC,(FL12.IS.ACT),CA12;
        DEC,(FL11.IS.ACT),CA11;
        REG,CA1;
CA1     TAS,JKD4,,CON(0.1),ACT(FL11),CONT,,,JKR4,2,EBC1/
        JKD3,2,EBC1/JKX3,2,EBC1;
        REG,CA2;
CA11    TAS,JKD4,,CON(0.1),ACT(FL12),CONT,,,JKR4,2,EBC1/
        JKD3,2,EBC1/JKX3,2,EBC1;
        REG,CA2;
CA12    TAS,JKD4,,CON(0.1),,CONT,,,JKR4,2,EBC1/
        JKD3,2,EBC1/JKX3,2,EBC1;
CA2     TAS,JKR4,,TRI(2,1);
CA3     TAS,JKD3,,CON(0.1);
CA4     TAS,JKR1,,TRI(3,1),,CONT,,,JKR1,3,EBA1/
        JKR2,6,EBA1/JKR3,8,EBA1;
CA5     TAS,JKR2,,TRI(3,1),,CONT,,,JKR3,4,EBC1;
CA6     TAS,JKR3,,TRI(3,1),,CONT,,,JKD1,4,EBC1/
        JKD2,4,EBC1/JKX2,4,EBC1/JKX1,4,EBC1;
        DEC,(FLGP.IS.DIS),GST,0;
        REG,CA7;
CA7     TAS,JKD2,,CON(0.1);
CA8     TAS,IKR2,,CON(0),,EXTG,,,IKR2,3,ERA1/
        IKR3,6,ERA1/IKT2,8,ERA1;
        DEC,(FLG4.IS.DIS,FLGP.IS.ACT),GST2;
        REG,EXTG;
EXTG    EXIT,STOP;
GST     TAS,JKR3,,CON(0);
        DEC,(FLP1.IS.DIS),CA7;
        PRO,0.5,GST2;
        PRO,0.5,GST3;
GST2    TAS,JKR3,,EXP(0.5);
GST3    TAS,JKD1,,CON(0.1);
GST4    TAS,IKR1,,CON(0.1),,EXTG,,,IKR1,5,EBL1;
X000    EXIT;
EMTP    EMT,0.0,USHK;
WGF     WAIT,(SIGNAL);
        PRO,0.7,WGF;
        PRO,0.3,TEXP;
TEXP    TAS,,,EXP(0.5,1);
TFLG    TAS,,,CON(0),ACT(FLG2);
SSSX    SIGNAL,UG3,TEMP;
SXXX    SIGNAL,UG8,TEMP;
XXXX    EXIT;
        ENDGUARD;
        ENDSHAR;
END OF FILE
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SWAP INPUT LISTING--SCENARIO B (Continued)

GENERAL SYSTEM PERFORMANCE STATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	3.360	1.673	.017	0.000	5.000	100
NO. ADVER CSLTY	1.480	1.000	.010	0.000	3.000	100
DEG OBJ SATISFD	.805	.309	.003	0.000	1.000	100
TIME FOR ENG	.359	.477	.001	.000	2.770	362
TOTAL ENG TIME	1.300	.781	.008	.105	4.864	100
NO. ENG/RUN	3.620	.982	.010	1.000	5.000	100
TIME BET ENT/ENG	.036	.122	.001	0.000	.681	100
SIMULATION TIME	6.974	1.204	.012	4.371	9.197	100
SIM TIME/AD SUC	7.564	.667	.010	6.465	9.197	68
SIM TIME/AD FAIL	5.720	1.131	.035	4.371	8.065	32

AVG NUMBER OF ENGAGEMENTS PER RUN	3.62
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.11
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	2.51
PROBABILITY SYSTEM WINS	.32
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO B

CASE 1

GENERAL SYSTEM PERFORMANCE STATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	3.540	2.007	.020	0.000	7.000	100
NO. ADVER CSLTY	1.870	1.134	.011	0.000	3.000	100
DEG OBJ SATISFD	.710	.258	.003	0.000	1.000	100
TIME FOR ENG	.380	.569	.002	.000	4.000	339
TOTAL ENG TIME	1.288	.920	.009	.233	4.468	100
NO. ENG/RUN	3.390	.886	.009	1.000	5.000	100
TIME BET ENT/ENG	.062	.162	.002	0.000	.754	100
SIMULATION TIME	6.841	1.015	.010	4.227	9.641	100
SIM TIME/AD SUC	7.261	.716	.017	6.049	9.641	43
SIM TIME/AD FAIL	6.524	1.095	.019	4.227	8.710	57

AVG NUMBER OF ENGAGEMENTS PER RUN	3.39
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.31
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	2.08
PROBABILITY SYSTEM WINS	.57
PROBABILITY AN INTERRUPT OCCURS	1.00

GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO B

CASE 2

GENERAL SYSTEM PERFORMA[illegible]TATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	4.310	2.301	.025	0.000	7.000	100
NO. ADVER CSLTY	2.210	1.122	.011	0.000	3.000	100
DEG OBJ SATISFD	.315	.464	.005	0.000	1.000	100
TIME FOR ENG	.401	.551	.006	.000	3.411	263
TOTAL ENG TIME	1.054	.761	.008	.094	3.770	100
NO. ENG/RUN	2.630	.812	.008	1.000	4.000	100
TIME BET ENT/ENG	1.312	.815	.008	.580	4.575	100
SIMULATION TIME	6.986	3.334	.033	3.314	15.223	100
SIM TIME/AD SUC	11.627	1.668	.054	8.993	15.223	31
SIM TIME/AD FAIL	4.901	.848	.012	3.314	7.387	69

AVG NUMBER OF ENGAGEMENTS PER RUN 2.63

AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN 1.01

AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES 1.62

PROBABILITY SYSTEM WINS .69

PROBABILITY AN INTERRUPT OCCURS 1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO B

CASE 3

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	2.610	2.020	.025	0.000	7.000	100
NO. ADVER CSLTY	2.840	.507	.005	0.000	3.000	100
DEG OBJ SATISFD	.060	.239	.002	0.000	1.000	100
TIME FOR ENG	.924	1.318	.007	.004	7.635	197
TOTAL ENG TIME	1.819	1.498	.015	.150	8.338	100
NO. ENG/RUN	1.970	.926	.009	1.000	4.000	100
TIME BET ENT/ENG	1.298	.831	.008	.598	4.360	100
SIMULATION TIME	5.675	2.166	.022	3.447	16.806	100
SIM TIME/AD SUC	12.236	3.052	.509	8.956	16.806	6
SIM TIME/AD FAIL	5.256	1.241	.013	3.447	10.172	94

AVG NUMBER OF ENGAGEMENTS PER RUN	1.97
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.19
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.78
PROBABILITY SYSTEM WINS	.94
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO B

CASE 4

GENERAL SYSTEM PERFORMANCE STATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	1.510	1.185	.012	0.000	4.000	100
NO. ADVER CSLTY	1.040	.751	.008	0.000	3.000	100
DF OBJ SATISFD	.965	.163	.002	0.000	1.000	100
TIME FOR ENG	.346	.467	.002	.001	2.360	219
TOTAL ENG TIME	.758	.576	.006	.026	2.604	100
NO. ENG/RUN	2.190	.800	.008	1.000	4.000	100
TIME BET ENT/ENG	.048	.146	.001	0.000	.728	100
SIMULATION TIME	4.682	.411	.004	3.895	5.959	100
SIM TIME/AD SUC	4.668	.409	.004	3.895	5.959	95
SIM TIME/AD FAIL	4.961	.384	.077	4.450	5.416	5

AVG NUMBER OF ENGAGEMENTS PER RUN	2.19
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.04
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	1.15
PROBABILITY SYSTEM WINS	.05
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO B

CASE 5

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	4.780	2.394	.024	0.000	7.000	100
NO. ADVER CSLTY	2.350	1.540	.015	0.000	4.000	100
DEG OBJ SATISFD	.445	.487	.005	0.000	1.000	100
TIME FOR ENG	.274	.381	.001	.001	3.640	308
TOTAL ENG TIME	.844	.551	.006	.006	3.640	100
NO. ENG/RUN	3.080	.939	.009	1.000	5.000	100
TIME BET ENT/ENG	1.379	.900	.009	.593	4.425	100
SIMULATION TIME	8.738	4.433	.044	3.875	18.189	100
SIM TIME/AD SUC	8.690	1.912	.046	5.123	14.642	42
SIM TIME/AD FAIL	8.773	5.612	.097	3.875	18 [illegible]	58

AVG NUMBER OF ENGAGEMENTS PER RUN	3.08
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.13
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	1.95
PROBABILITY SYSTEM WINS	.58
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO B

CASE 6

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I    FACILITY STATISTICS    I
I                           I
IIIIIIIIIIIIIIIIIIIIIIIIIIIII
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II   STATISTICS FOR FACILITY NODES   II
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NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
IOD1	1.00000	1.00000	0.00000	0.00000	100
IOF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
JLF1	1.00000	1.00000	0.00000	0.00000	100
JKX1	.80000	.80000	.40202	.00402	100
JKX2	1.00000	1.84000	.36845	.00368	100
JKX3	1.00000	1.00000	0.00000	0.00000	100
JKX4	1.00000	1.00000	0.00000	0.00000	100
JKD1	.80000	.80000	.40202	.00402	100
JKD2	1.00000	1.00000	0.00000	0.00000	100
JKD3	1.00000	1.00000	0.00000	0.00000	100
JKD4	1.00000	1.00000	0.00000	0.00000	100
JKP1	1.00000	1.00000	0.00000	0.00000	100
JKR2	1.00000	1.00000	0.00000	0.00000	100
JKR3	1.00000	2.00000	0.00000	0.00000	100
JKR4	1.00000	1.00000	0.00000	0.00000	100
IKR1	.80000	.80000	.40202	.00402	100
IKR2	1.00000	1.92000	.27266	.00273	100
IKR3	1.00000	1.93000	.25643	.00256	100
IKT1	.68000	.68000	.46883	.00469	100
IKT2	.93000	.93000	.25643	.00256	100
CC	.86000	.86000	.34874	.00349	100

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FACILITY STATISTICS--SCENARIO B

CASE 1

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
IOD1	1.00000	1.00000	0.00000	0.00000	100
IOF1	1.00000	1.00000	0.00000	0.00000	100
INF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
JLF1	1.00000	1.00000	0.00000	0.00000	100
JKX1	.88000	.88000	.32660	.00327	100
JKX2	1.00000	1.89000	.31447	.00314	100
JKX3	1.00000	1.00000	0.00000	0.00000	100
JKX4	1.00000	1.00000	0.00000	0.00000	100
JKD1	.88000	.88000	.32660	.00327	100
JKD2	1.00000	1.00000	0.00000	0.00000	100
JKD3	1.00000	1.00000	0.00000	0.00000	100
JKD4	1.00000	1.00000	0.00000	0.00000	100
JKR1	1.00000	1.00000	0.00000	0.00000	100
JKR2	1.00000	1.00000	0.00000	0.00000	100
JKR3	1.00000	2.00000	0.00000	0.00000	100
JKR4	1.00000	1.00000	0.00000	0.00000	100
IKR1	.86000	.86000	.34874	.00349	100
IKR2	1.00000	1.97000	.17145	.00171	100
IKR3	1.00000	1.99000	.10000	.00100	100
IKT1	.43000	.43000	.49757	.00498	100
IKT2	.99000	.99000	.10000	.00100	100
CC	.81000	.81000	.39428	.00394	100

FACILITY STATISTICS--SCENARIO B

CASE 2

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
IOD1	1.00000	1.00000	0.00000	0.00000	100
IOF1	1.00000	1.00000	0.00000	0.00000	100
INF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
JLF1	1.00000	1.00000	0.00000	0.00000	100
JKX1	.31000	.31000	.46482	.00465	100
JKX2	.67000	.98000	.80378	.00804	100
JKX3	.82000	.82000	.38612	.00386	100
JKX4	1.00000	1.00000	0.00000	0.00000	100
JKD1	.31000	.31000	.46482	.00465	100
JKD2	.66000	.66000	.47610	.00476	100
JKD3	.81000	.81000	.39428	.00394	100
JKD4	.96000	.96000	.19695	.00197	100
JKR1	.70000	.70000	.46057	.00461	100
JKR2	.70000	1.22000	.88283	.00883	100
JKR3	.67000	1.73000	1.28594	.01286	100
JKR4	.82000	.82000	.38612	.00386	100
IKR1	.31000	.31000	.46482	.00465	100
IKR2	.50000	.81000	.88415	.00884	100
IKR3	.50000	.82000	.89194	.00892	100
IKT1	.31000	.31000	.46482	.00465	100
IKT2	.32000	.32000	.46883	.00469	100
CC	1.00000	1.00000	0.00000	0.00000	100

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FACILITY STATISTICS--SCENARIO B

CASE 3

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
IOD1	1.00000	1.00000	0.00000	0.00000	100
IOF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
JLF1	1.00000	1.00000	0.00000	0.00000	100
JKX1	.06000	.06000	.23868	.00239	100
JKX2	.35000	.41000	.60461	.00605	100
JKX3	.48000	.48000	.50212	.00502	100
JKX4	1.00000	1.00000	0.00000	0.00000	100
JKD1	.06000	.06000	.23868	.00239	100
JKD2	.35000	.35000	.47937	.00479	100
JKD3	.48000	.48000	.50212	.00502	100
JKD4	.96000	.96000	.19695	.00197	100
JKR1	.37000	.37000	.48524	.00485	100
JKR2	.37000	.68000	.91982	.00920	100
JKR3	.35000	1.00000	1.38535	.01385	100
JKR4	.48000	.48000	.50212	.00502	100
IKR1	.06000	.06000	.23868	.00239	100
IKR2	.23000	.29000	.57375	.00574	100
IKR3	.23000	.29000	.57375	.00574	100
IKT1	.06000	.06000	.23868	.00239	100
IKT2	.06000	.06000	.23868	.00239	100
CC	1.00000	1.00000	0.00000	0.00000	100

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FACILITY STATISTICS--SCENARIO B

CASE 4

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
IOD1	1.00000	1.00000	0.00000	0.00000	100
IOF1	1.00000	1.00000	0.00000	0.00000	100
INF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
JLF1	1.00000	1.00000	0.00000	0.00000	100
JKX1	1.00000	1.00000	0.00000	0.00000	100
JKX2	1.00000	1.00000	0.00000	0.00000	100
JKX3	1.00000	1.00000	0.00000	0.00000	100
JKX4	1.00000	1.00000	0.00000	0.00000	100
JKD1	1.00000	1.00000	0.00000	0.00000	100
JKD2	1.00000	1.00000	0.00000	0.00000	100
JKD3	1.00000	1.00000	0.00000	0.00000	100
JKD4	1.00000	1.00000	0.00000	0.00000	100
JKR1	1.00000	1.00000	0.00000	0.00000	100
JKR2	1.00000	2.00000	0.00000	0.00000	100
JKR3	1.00000	2.24000	.42923	.00429	100
JKR4	1.00000	1.00000	0.00000	0.00000	100
IKR1	.98000	.98000	.14071	.00141	100
IKR2	1.00000	1.00000	0.00000	0.00000	100
IKR3	1.00000	1.00000	0.00000	0.00000	100
IKT1	.98000	.98000	.14071	.00141	100
IKT2	.95000	.95000	.21904	.00219	100
CC	.75000	.75000	.43519	.00435	100

FACILITY STATISTICS--SCENARIO B

CASE 5

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*    FACILITY STATISTICS    *
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** STATISTICS FOR FACILITY NODES **

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
IOD1	1.00000	1.00000	0.00000	0.00000	100
IOF1	1.00000	1.00000	0.00000	0.00000	100
INF1	1.00000	1.00000	0.00000	0.00000	100
IMF1	1.00000	1.00000	0.00000	0.00000	100
JLF1	1.00000	1.00000	0.00000	0.00000	100
JKX1	.84000	.84000	.36845	.00368	100
JKX2	.84000	.84000	.36845	.00368	100
JKX3	.96000	.96000	.19695	.00197	100
JKX4	1.00000	1.00000	0.00000	0.00000	100
JKD1	.82000	.82000	.38612	.00386	100
JKD2	.80000	.80000	.40202	.00402	100
JKD3	.96000	.96000	.19695	.00197	100
JKD4	.99000	.99000	.10000	.00100	100
JKR1	.88000	.88000	.32660	.00327	100
JKR2	.88000	1.66000	.68490	.00685	100
JKR3	.84000	2.13000	1.04112	.01041	100
JKR4	.96000	.96000	.19695	.00197	100
IKR1	.52000	.52000	.50212	.00502	100
IKR2	.70000	.70000	.46057	.00461	100
IKR3	.70000	.70000	.46057	.00461	100
IKT1	.45000	.45000	.50000	.00500	100
IKT2	.44000	.44000	.49889	.00499	100
CC	1.00000	1.00000	0.00000	0.00000	100

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FACILITY STATISTICS--SCENARIO B

CASE 6

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TRACE
RUN NO 10
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FORCE	EVENT	NODE	FACILITY NODE	TIME
ADVER	2 ENTER	ETCC	CC	0.00
	SIZE - 1.			
	TRAINING - 1.			
	BRANCHED TO TCC			
	SIZE - 1.			
ADVER	2 START OF TASK	TCC	CC	0.00
GUARD	0 ENTER	ENT9	WSHK	0.00
	BRANCHED TO ALL1			
	SIZE - 0.			
GUARD	1 ALLOCATE FROM BASE UBAS	ALL1	WSHK	0.00
	SIZE - 1.			
	TOTALS *			
	SIZE - 1.			
	TRAINING - 1.			
	BRANCHED TO UG1			
	SIZE - 1.			
GUARD	1 WAITING FOR ADV DETECTION DEVICE L1 OR ADV DETECTION DEVICE L2	UG1	WSHK	0.00
GUARD	0 ENTER	ENT2	ESHK	0.00
	BRANCHED TO ALL2			
	SIZE - 0.			
GUARD	2 ALLOCATE FROM BASE EBAS	ALL2	ESHK	0.00
	SIZE - 2.			
	TOTALS *			
	SIZE - 2.			
	TRAINING - 1.			
	BRANCHED TO UG3			
	SIZE - 2.			
GUARD	2 WAITING FOR SIGNAL	UG3	ESHK	0.00
GUARD	0 ENTER	ENT5	GSKP	0.00
	BRANCHED TO ALL5			
	SIZE - 0.			
GUARD	3 ALLOCATE FROM BASE ABAS	ALL5	GSKP	0.00
	SIZE - 2.			
	TOTALS *			
	SIZE - 2.			
	TRAINING - 1.			
	BRANCHED TO UG5			
	SIZE - 2.			
GUARD	3 WAITING FOR SIGNAL	UG5	GSKP	0.00
GUARD	0 ENTER	EDUM	WSHK	0.00
	BRANCHED TO WDUM			
	SIZE - 0.			
GUARD	0 WAITING FOR SIGNAL	WDUM	WSHK	0.00
GUARD	0 ENTER	ENT4	WSHK	0.00
	BRANCHED TO ALL3			
	SIZE - 0.			
GUARD	4 ALLOCATE FROM BASE BASX	ALL3	WSHK	0.00
	SIZE - 20.			
	TOTALS *			
	SIZE - 20.			
	TRAINING - 0.			
	BRANCHED TO UG2			
	SIZE - 20.			
GUARD	4 WAITING FOR SIGNAL	UG2	WSHK	0.00
GUARD	0 ENTER	ENTP	WSHK	0.00
	BRANCHED TO UGF			
	SIZE - 0.			
GUARD	0 WAITING FOR SIGNAL	UGF	WSHK	0.00
ADVER	1 ENTER	ENT1	IOD1	1.00
	SIZE - 2.			
	TRAINING - 1.			
	BRANCHED TO TS1			
	SIZE - 2.			
ADVER	1 START OF TASK	TS1	IOD1	1.00
	DISABLE BARRIER IOD1			
	TRIGGERED SENSOR IOA1			
GUARD	1 WAIT NODE TRIGGERED BY TRIGGER NUMBER 1	UG1	WSHK	1.00
	BRANCHED TO SIG1			
	SIZE - 1.			
GUARD	1 SIGNAL UG2	SIG1	WSHK	1.00
	BRANCHED TO SIGX			
	SIZE - 1.			

SCENARIO B--TRACE CASE 1

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GUARD   4 WAIT NODE TRIGGERED                    WG2     WSHK    1.00
            BY TRIGGER NUMBER   1
              BRANCHED TO          TX1
                SIZE -        1.
              BRANCHED TO          WG2
                SIZE -       19.

GUARD   4 START OF TASK                          TX1     WSHK    1.00

GUARD   5 WAITING FOR                            WG2     WSHK    1.00
              SIGNAL

GUARD   1 SIGNAL                      WG5        SIGX    WSHK    1.00
              BRANCHED TO             T1
                SIZE -        1.

GUARD   3 WAIT NODE TRIGGERED                    WG5     GSKP    1.00
            BY TRIGGER NUMBER   1
              BRANCHED TO          WG6
                SIZE -        2.

GUARD   3 WAITING FOR                            WG6     GSKP    1.00
              TIME INCREMENT OF      .50

GUARD   1 START OF TASK                          T1      GSKP    1.00
              ACTIVATE FLAG       FLG5

****      ENGAGEMENT                                             1.00

GUARD   1 INCLUDE

ADVER   2 INCLUDE

            ENGAGEMENT NUMBER     1

  ADV   1 T O T A L S
              SIZE -        1.
              TRAINING -    0.

  GUA   1 T O T A L S
              SIZE -        1.
              TRAINING -    0.

ADVER   1 END OF TASK                            TS1     IOD1    1.02
              BRANCHED TO          TS2
                SIZE -        2.

ADVER   1 START OF TASK                          TS2     IOF1    1.02

  GUA   1 CASUALTY                                               1.02
              SIZE -        0.

****    1 END ENGAGEMENT                                         1.02

GUARD   1 NEUTRALIZED                            T1      GSKP    1.02

ADVER   2 RESUMED TASK                           TCC     CC      1.02
              SIZE -        1.
              TRAINING -    1.

ADVER   1 END OF TASK                            TS2     IOF1    1.10
              BRANCHED TO          TS3
                SIZE -        2.

ADVER   1 START OF TASK                          TS3     INF1    1.10

ADVER   1 END OF TASK                            TS3     INF1    1.19
              BRANCHED TO          TS4
                SIZE -        2.

ADVER   1 START OF TASK                          TS4     INF1    1.19

ADVER   1 END OF TASK                            TS4     INF1    1.26
              BRANCHED TO          INS1
                SIZE -        2.

ADVER   1 SIGNAL                      R2A        INS1    INF1    1.26
              BRANCHED TO             INS2
                SIZE -        2.

ADVER   1 SIGNAL                      ER1        INS2    INF1    1.26
              BRANCHED TO             TS5
                SIZE -        2.

ADVER   1 START OF TASK                          TS5     JLF1    1.26
              ACTIVATE FLAG       FLG9

ADVER   1 END OF TASK                            TS5     JLF1    1.34
              BRANCHED TO          TS6
                SIZE -        2.

ADVER   1 START OF TASK                          TS6     JKX4    1.34

ADVER   1 END OF TASK                            TS6     JKX4    1.34
              BRANCHED TO          TS6X
                SIZE -        2.

ADVER   1 START OF TASK                          TS6X    JKD4    1.34
              DISABLE BARRIER     JKD4
              TRIGGERED SENSOR    JKA4

GUARD   4 END OF TASK                            TX1     WSHK    1.50
              BRANCHED TO          SIG2
                SIZE -        1.

GUARD   4 SIGNAL                      WG3        SIG2    WSHK    1.50
              BRANCHED TO             SIGG
                SIZE -        1.

GUARD   2 WAIT NODE TRIGGERED                    WG3     ESHK    1.50
            BY TRIGGER NUMBER   1
              BRANCHED TO          SIG1
                SIZE -        1.
              BRANCHED TO          WG3
                SIZE -        1.

GUARD   3 WAIT NODE TRIGGERED                    WG6     GSKP    1.50
            BY TRIGGER NUMBER   1
              BRANCHED TO          EA
                SIZE -        2.

GUARD   3 START OF TASK                          EA      GSKP    1.50

****      ENGAGEMENT                                             1.50

GUARD   3 INCLUDE

ADVER   2 INCLUDE
```

SCENARIO B--TRACE CASE 1 (Continued)

```
ADVER  2 INCLUDE
             ENGAGEMENT NUMBER      2
MAIN   2 T O T A L S
             SIZE -                 1.
             TRAINING -             0.
GUA    2 T O T A L S
             SIZE -                 2.
             TRAINING -             0.

GUARD  2 SIGNAL                     UG2     SIG1    ESHK    1.50
             BRANCHED TO            SIGX
             SIZE -                 1.

GUARD  5 WAIT MODE TRIGGERED                UG2     WSHK    1.50
             BY TRIGGER NUMBER      1
             BRANCHED TO            TX1
             SIZE -                 1.
             BRANCHED TO            UG2
             SIZE -                 18.

GUARD  5 START OF TASK                      TX1     WSHK    1.50

GUARD  7 WAITING FOR                        UG2     WSHK    1.50
             SIGNAL

GUARD  2 SIGNAL                     UG5     SIGX    ESHK    1.50
             BRANCHED TO            T2
             SIZE -                 1.

GUARD  2 START OF TASK                      T2      GSKP    1.50
             ACTIVATE FLAG          FLG1

GUARD  2 END OF TASK                        T2      GSKP    1.50
             BRANCHED TO            R1
             SIZE -                 1.

GUARD  2 START OF TASK                      R1      GSKP    1.50

GUARD  2 END OF TASK                        R1      GSKP    1.50
             BRANCHED TO            R2
             SIZE -                 1.

GUARD  2 START OF TASK                      R2      MCF1    1.50

GUARD  6 WAITING FOR                        UG3     ESHK    1.50
             SIGNAL

GUARD  4 SIGNAL                     UG8     SIGG    WSHK    1.50
             BRANCHED TO            EXTX
             SIZE -                 1.

GUARD  4 EXIT                               EXTX    WSHK    1.50

ADVER  1 END OF TASK                        TS6X    JKD4    1.51
             BRANCHED TO            T6SA
             SIZE -                 2.

ADVER  1 SIGNAL                     ER1     T6SA    JKD4    1.51
             BRANCHED TO            TS6A
             SIZE -                 2.

ADVER  1 START OF TASK                      TS6A    JKR4    1.51
             ACTIVATE FLAG          FL13

ADVER  1 END OF TASK                        TS6A    JKR4    1.63
             BRANCHED TO            TS7
             SIZE -                 2.

ADVER  1 START OF TASK                      TS7     JKX3    1.63

ADVER  1 END OF TASK                        TS7     JKX3    1.63
             BRANCHED TO            TS7X
             SIZE -                 2.

ADVER  1 START OF TASK                      TS7X    JKD3    1.63
             DISABLE BARRIER        JKD3
             TRIGGERED SENSOR       JKA3

GUA    2 CASUALTY                                           1.74
             SIZE -                 1.

ADVER  1 END OF TASK                        TS7X    JKD3    1.80
             BRANCHED TO            TS8
             SIZE -                 2.

ADVER  1 START OF TASK                      TS8     JKR1    1.80

ADVER  1 END OF TASK                        TS8     JKR1    1.88
             BRANCHED TO            TS9
             SIZE -                 2.

ADVER  1 START OF TASK                      TS9     JKR2    1.88

ADVER  1 END OF TASK                        TS9     JKR2    1.95
             BRANCHED TO            TSA2
             SIZE -                 2.

ADVER  1 SIGNAL                     UGF     TSA2    JKR3    1.95
             BRANCHED TO            TS10
             SIZE -                 2.

GUARD  0 WAIT MODE TRIGGERED                UGF     WSHK    1.95
             BY TRIGGER NUMBER      1
             BRANCHED TO            TEXP
             SIZE -                 0.

GUARD  0 START OF TASK                      TEXP    WSHK    1.95

ADVER  1 START OF TASK                      TS10    JKR3    1.95

GUARD  5 END OF TASK                        TX1     WSHK    2.00
             BRANCHED TO            SIG2
             SIZE -                 1.

GUARD  5 SIGNAL                     UG3     SIG2    WSHK    2.00
             BRANCHED TO            SIGG
             SIZE -                 1.

GUARD  6 WAIT MODE TRIGGERED                UG3     ESHK    2.00
             BY TRIGGER NUMBER      1
             BRANCHED TO            UG3
             SIZE -                 1.
             BRANCHED TO            XDUM
             SIZE -                 0.

GUARD  6 WAITING FOR                        UG3     ESHK    2.00
```

SCENARIO B--TRACE CASE 1 (Continued)

```
GUARD  6 WAITING FOR SIGNAL                    UG3   ESHK  2.00
GUARD  0 EXIT                                  XDUM  ESHK  2.00
GUARD  5 SIGNAL                                SIGG  USHK  2.00
           BRANCHED TO                UG8
           SIZE -                     1.      EXTX
GUARD  5 EXIT                                  EXTX  USHK  2.00
ADVER  1 END OF TASK                           TS10  JKR3  2.00
           BRANCHED TO                TS21
           SIZE -                     2.
           BRANCHED TO                EXCC
           SIZE -                     0.
ADVER  1 START OF TASK                         TS21  JKX2  2.00
ADVER  1 END OF TASK                           TS21  JKX2  2.00
           BRANCHED TO                TS2X
           SIZE -                     2.
ADVER  1 START OF TASK                         TS2X  JKD2  2.00
           DISABLE BARRIER            JKD2
           TRIGGERED SENSOR           JKA2
ADVER  2 EXIT                                  EXCC  JKR3  2.00
ADVER  1 END OF TASK                           TS2X  JKD2  2.04
           BRANCHED TO                TS22
           SIZE -                     2.
ADVER  1 START OF TASK                         TS22  IKR2  2.04
ADVER  1 END OF TASK                           TS22  IKR2  2.09
           BRANCHED TO                TS23
           SIZE -                     2.
ADVER  1 START OF TASK                         TS23  IKR3  2.09
ADVER  1 END OF TASK                           TS23  IKR3  2.16
           BRANCHED TO                TS24
           SIZE -                     2.
ADVER  1 START OF TASK                         TS24  IKR3  2.16
GUARD  0 END OF TASK                           TEXP  USHK  2.28
           BRANCHED TO                TFLG
           SIZE -                     0.
GUARD  0 START OF TASK                         TFLG  USHK  2.28
           ACTIVATE FLAG              FLG2
GUARD  0 END OF TASK                           TFLG  USHK  2.28
           BRANCHED TO                SSSX
           SIZE -                     0.
GUARD  0 SIGNAL                                SSSX  USHK  2.28
           BRANCHED TO                UG3
           SIZE -                     0.      SXXX
GUARD  6 WAIT MODE TRIGGERED                   UG3   ESHK  2.28
           BY TRIGGER NUMBER          1
           BRANCHED TO                R2
           SIZE -                     1.
GUARD  5 START OF TASK                                R2    MKF1  2.28
GUARD  0 SIGNAL                                UG8   SXXX  USHK  2.28
           BRANCHED TO                XXXX
           SIZE -                     0.
GUARD  0 EXIT                                         XXXX  USHK  2.28
GUA    2 CASUALTY                                                   2.60
           SIZE -                     0.
****   2 END ENGAGEMENT                                             2.60
GUARD  3 NEUTRALIZED                                  EA    GSKP  2.60
ADVER  2 RESUMED TASK                                 TCC   CC    2.60
           SIZE -                     1.
           TRAINING -                 1.
GUARD  2 END OF TASK                                  R2    MKF1  3.36
           BRANCHED TO                RX2
           SIZE -                     1.
GUARD  2 START OF TASK                                RX2   MKF1  3.36
           ACTIVATE FLAG              FLG2
GUARD  2 END OF TASK                                  RX2   MKF1  3.36
           BRANCHED TO                RX3
           SIZE -                     1.
           BRANCHED TO                XTC1
           SIZE -                     0.
GUARD  2 SIGNAL                                UG3   RX3   MKF1  3.36
           BRANCHED TO                RX4
           SIZE -                     1.
GUARD  2 SIGNAL                                UG8   RX4   MKF1  3.36
           BRANCHED TO                R2AA
           SIZE -                     1.
GUARD  2 START OF TASK                                R2AA  MKF1  3.36
GUARD  0 START OF TASK                                XTC1  MKF1  3.36
GUARD  2 END OF TASK                                  R2AA  MKF1  3.46
           BRANCHED TO                R2B
           SIZE -                     1.
GUARD  2 START OF TASK                                R2B   JLF1  3.46
GUARD  2 END OF TASK                                  R2B   JLF1  4.00
           BRANCHED TO                CA1
           SIZE -                     1.
GUARD  2 START OF TASK                                CA1   JKD4  4.00
           ACTIVATE FLAG              FL11
GUARD  2 END OF TASK                                  CA1   JKD4  4.10
           BRANCHED TO                CA2
           SIZE -                     1.
```

SCENARIO B--TRACE CASE 1 (Continued)

```
                SIZE -          1.
GUARD  2 START OF TASK                  CA2     JKR4    4.10
GUARD  2 END OF TASK                    CA2     JKR4    4.21
            BRANCHED TO          CA3
              SIZE -          1.
GUARD  2 START OF TASK                  CA3     JKD3    4.21
ADVER  1 END OF TASK                    TS24    IKR3    4.23
            BRANCHED TO          TS25
              SIZE -          2.
ADVER  1 START OF TASK                  TS25    IKT2    4.23
            ACTIVATE FLAG        FLG3
ADVER  1 END OF TASK                    TS25    IKT2    4.23
            BRANCHED TO          XTAR
              SIZE -          2.
ADVER  1 START OF TASK                  XTAR    IKR3    4.23
ADVER  1 END OF TASK                    XTAR    IKR3    4.30
            BRANCHED TO          WXR2
              SIZE -          2.
ADVER  1 START OF TASK                  WXR2    IKR2    4.30
GUARD  2 END OF TASK                    CA3     JKD3    4.31
            BRANCHED TO          CA4
              SIZE -          1.
GUARD  2 START OF TASK                  CA4     JKR1    4.31
ADVER  1 END OF TASK                    WXR2    IKR2    4.39
            BRANCHED TO          WXR3
              SIZE -          2.
ADVER  1 START OF TASK                  WXR3    JKX2    4.39
GUARD  2 END OF TASK                    CA4     JKR1    4.41
            BRANCHED TO          CA5
              SIZE -          1.
GUARD  2 START OF TASK                  CA5     JKR2    4.41
GUARD  6 END OF TASK                    R2      MKF1    4.43
            BRANCHED TO          RX2
              SIZE -          1.
GUARD  6 START OF TASK                  RX2     MKF1    4.43
            ACTIVATE FLAG        FLG2
GUARD  6 END OF TASK                    RX2     MKF1    4.43
            BRANCHED TO          RX3
              SIZE -          1.
            BRANCHED TO          XTC1
              SIZE -          0.
GUARD  6 SIGNAL                 WG3     RX3     MKF1    4.43
            BRANCHED TO          RX4
              SIZE -          1.
GUARD  6 SIGNAL                 WG8     RX4     MKF1    4.43
            BRANCHED TO          R2AA
              SIZE -          1.
GUARD  6 START OF TASK                  R2AA    MKF1    4.43
GUARD  0 START OF TASK                  XTC1    MKF1    4.43
GUARD  2 END OF TASK                    CA5     JKR2    4.50
            BRANCHED TO          CA6
              SIZE -          1.
GUARD  2 START OF TASK                  CA6     JKR3    4.50
****     ENGAGEMENT                                     4.50
GUARD  2 INCLUDE
ADVER  1 INCLUDE
            ENGAGEMENT NUMBER    3
ADV    3 T O T A L S
              SIZE -          2.
              TRAINING -      0.
GUA    3 T O T A L S
              SIZE -          1.
              TRAINING -      0.
GUARD  6 END OF TASK                    R2AA    MKF1    4.53
            BRANCHED TO          R2B
              SIZE -          1.
GUARD  6 START OF TASK                  R2B     JLF1    4.53
ADV    3 CASUALTY                                       4.57
              SIZE -          1.
GUA    3 CASUALTY                                       4.62
              SIZE -          0.
****   3 END ENGAGEMENT                                 4.62
GUARD  2 NEUTRALIZED                    CA6     JKR3    4.62
ADVER  1 RESUMED TASK                   WXR3    JKX2    4.62
              SIZE -          1.
              TRAINING -      1.
ADVER  1 END OF TASK                    WXR3    JKX2    4.71
            BRANCHED TO          TS11
              SIZE -          1.
ADVER  1 START OF TASK                  TS11    JKX1    4.71
ADVER  1 END OF TASK                    TS11    JKX1    4.71
            BRANCHED TO          TS1X
              SIZE -          1.
ADVER  1 START OF TASK                  TS1X    JKD1    4.71
            DISABLE BARRIER      JKD1
            TRIGGERED SENSOR     JKA1
ADVER  1 END OF TASK                    TS1X    JKD1    4.88
```

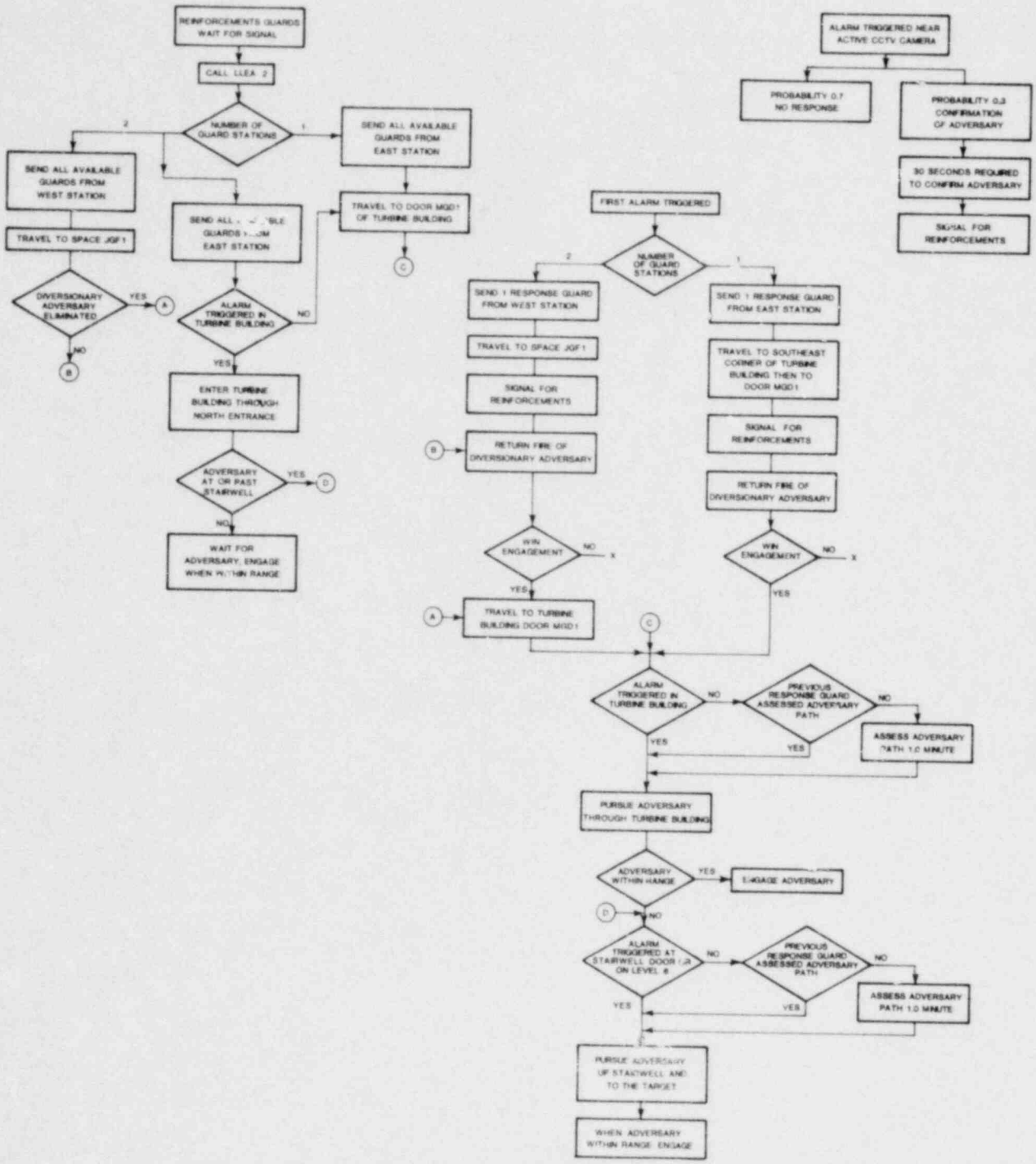
SCENARIO B--TRACE CASE 1 (Continued)

```
ADVER  1 END OF TASK                    TS1X   JKD1   4.88
         BRANCHED TO                TS12
         SIZE -                     1.
ADVER  1 START OF TASK                  TS12   IKR1   4.88
         ACTIVATE FLAG              FLP1
ADVER  1 END OF TASK                    TS12   IKR1   4.95
         BRANCHED TO                TS13
         SIZE -                     1.
ADVER  1 START OF TASK                  TS13   IKR1   4.95
GUARD  6 END OF TASK                    R2B    JLF1   5.13
         BRANCHED TO                CA1
         SIZE -                     1.
GUARD  6 START OF TASK                  CA1    JKD4   5.13
         ACTIVATE FLAG              FL11
GUARD  6 END OF TASK                    CA1    JKD4   5.23
         BRANCHED TO                CA2
         SIZE -                     1.
GUARD  6 START OF TASK                  CA2    JKR4   5.23
GUARD  6 END OF TASK                    CA2    JKR4   5.37
         BRANCHED TO                CA3
         SIZE -                     1.
GUARD  6 START OF TASK                  CA3    JKD3   5.37
GUARD  6 END OF TASK                    CA3    JKD3   5.47
         BRANCHED TO                CA4
         SIZE -                     1.
GUARD  6 START OF TASK                  CA4    JKR1   5.47
GUARD  6 END OF TASK                    CA4    JKR1   5.55
         BRANCHED TO                CA5
         SIZE -                     1.
GUARD  6 START OF TASK                  CA5    JKR2   5.55
GUARD  6 END OF TASK                    CA5    JKR2   5.62
         BRANCHED TO                CA6
         SIZE -                     1.
GUARD  6 START OF TASK                  CA6    JKR3   5.62
GUARD  6 END OF TASK                    CA6    JKR3   5.71
         BRANCHED TO                GST
         SIZE -                     1.
GUARD  6 START OF TASK                  GST    JKR3   5.71
GUARD  6 END OF TASK                    GST    JKR3   5.71
         BRANCHED TO                GST2
         SIZE -                     1.
GUARD  6 START OF TASK                  GST2   JKR3   5.71
GUARD  6 END OF TASK                    GST2   JKR3   5.90
         BRANCHED TO                GST3
         SIZE -                     1.
GUARD  6 START OF TASK                  GST3   JKD1   5.90
GUARD  6 END OF TASK                    GST3   JKD1   6.00
         BRANCHED TO                GST4
         SIZE -                     1.
GUARD  6 START OF TASK                  GST4   IKR1   6.00
****     ENGAGEMENT                             6.00
GUARD  6 INCLUDE
ADVER  1 INCLUDE
         ENGAGEMENT NUMBER          4
ADV    4 T O T A L S
         SIZE -                     1.
         TRAINING -                 0.
GUA    4 T O T A L S
         SIZE -                     1
         TRAINING -                 0.
GUA    4 CASUALTY                              6.38
         SIZE -                     0.
****   4 END ENGAGEMENT                        6.38
GUARD  6 NEUTRALIZED                   GST4   IKR1   6.38
ADVER  1 RESUMED TASK                  TS13   IKR1   6.38
         SIZE -                     1.
         TRAINING -                 1.
ADVER  1 END OF TASK                   TS13   IKR1   7.60
         BRANCHED TO                TS14
         SIZE -                     1.
ADVER  1 START OF TASK                 TS14   IKT1   7.60
         ACTIVATE FLAG              FLG4
ADVER  1 END OF TASK                   TS14   IKT1   7.60
         BRANCHED TO                EXTS
         SIZE -                     1.
ADVER  1 EXIT                          STOP   EXTS   IKT1   7.60
```

SCENARIO B--TRACE CASE 1 (Continued)

D.5.3 Scenario C

- Guard Model Flowchart
- SNAP Input Listing
- SNAP General Performance Statistics
  Cases 1 through 6
- SNAP Facility Statistics
  Cases 1 through 6
- SNAP Trace of Case 1



GUARD MODEL FLOWCHART
SCENARIO C

```
SNAP,KIMPEL,          9/26/80,100,100,25,P,M;
TRACE,1,4;
PAR,1,0.0666,0.0366,0.0966;
PAR,2,0.057,0.032,0.082;
PAR,3,0.1,0.05,0.15;
PAR,4,0.23,0.15,0.31;
PAR,5,0.17,0.10,0.24;
PAR,6,0.25,0.15,0.35;
PAR,7,1.40,1.10,1.70;
PAR,8,1.60,1.15,2.05;
PAR,9,0.34,0.20,0.48;
PAR,10,0.29,0.20,0.38;
PAR,11,0.80,0.50,1.10;
PAR,12,0.40,0.27,0.53;
PAR,13,0.75,0.50,1.00;
PAR,14,0.25,0.15,0.35;
PAR,15,0.001,0.00001,0.0011;
PAR,16,0.2,0.1,0.3;
PAR,17,0.5,0.4,0.6;
PAR,18,0.35,0.25,0.45;
PAR,19,0.4,0.3,0.5;
PAR,20,0.05,0.049,0.051;
STATUS;
FLG2  FLAG,DIS;INITIAL RSP 2 GUARDS
FLG4  FLAG,DIS;INITIAL RSP OF EST GUARD
FLG5  FLAG,DIS;INITIAL RSP OF WST GUARD
FLG6  FLAG,DIS;ADV CONFIRMED IN TURB
FLG7  FLAG,DIS;ADV CONFIRMED IN STWY
FLGA  FLAG,DIS;
FLGB  FLAG,DIS;
FLGC  FLAG,DIS;
FLGD  FLAG,DIS;
FLGE  FLAG,DIS;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;CONTROL PARAMETERS;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;            AUTOMATICS G
FLG1  FLAG,ACT;TWO SHACK SCENARIO
FLG3  FLAG,DIS;ESHK RSP-TBLG
FLGT  FLAG,ACT;CCTV IN FENCE AREA
FLGI  FLAG,ACT;CCTV IN BLG INTERIOR
FLGL  FLAG,ACT;EXT DOOR LOCKED
FLGS  FLAG,ACT;STAIRWAY DOOR LOCKED
SPR0  GLOBAL,0.95;MGA1  PR
SPR1  GLOBAL,0.95;LJA1  PR
SPR2  GLOBAL,0.00;ZUA1  PR
DOR1  GLOBAL,13 ;PARM BEFORE PENE EXT DOOR
DOR2  GLOBAL,14;      AFTER
DOR3  GLOBAL,13 ;PARM BEFORE PENE DOOR
DOR4  GLOBAL,14;       AFTER
DR11  GLOBAL,15;PARM BEFORE PENE INT DOOR
DR12  GLOBAL,16;      AFTER
WR    GLOBAL,3;     $WEST RSP GUARDS
ER    GLOBAL,4;     $EAST RSP GUARDS
EEEE  GLOBAL,17;  PARM SET FOR ERSP
;7-1SHK       17-2SHK
WWWW  GLOBAL,11;   PARM SET FOR WRSP
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
ONE   GLOBAL,0.06;TASK TIME IN TURB;
TWO   GLOBAL,0.048;    ''
THRE  GLOBAL,0.043;TASK TIME ON LEVEL SIX
;ENGAGEMENT PARAMETERS
;
;OPEN FIELD
;
EOF1  NENG,DOF1,TINC.GE.0.05;
EOF2  NENG,DOF1,TINC.GE.0.05;
EOF3  NENG,DOF2;
;
;BUILDING CORNER
;
EBC1  NENG,DBC1;
;
;STAIRWELL
;
;HIGH LEVEL DEFENDING
EHS1  NENG,DSH1;
;LOW LEVEL ATTACKING
ESL1  NENG,DSL1;
;EXPOSURE IN 1ST LEVEL STWELL FROM GROUND
ES11  NENG,DS11,TINC.GE.0.05;
ES12  NENG,DS12;
;
;BUILDING INTERIOR NO COVER
;
NC11  NENG,DNC1,TINC.GE.0.05;
NC12  NENG,DNC2,TINC.GE.0.05;
NC13  NENG,DNC3;
;
;BUILDING INTERIOR HIGH COVER
;
EBHA  NENG,DBH1,TINC.GE.0.05;
EBH1  NENG,DBH1,TINC.GE.0.05;
EBH2  NENG,DBH2,TINC.GE.0.05;
EBH3  NENG,DBH3;
;
;BUILDING INTERIOR LOW COVER
;
EBLA  NENG,DBL1,TINC.GE.0.05;
EBL1  NENG,DBL1,TINC.GE.0.05;
EBL2  NENG,DBL2,TINC.GE.0.05;
EBL3  NENG,DBL3;
;
;ATTACKING LOW COVER
;
EBA1  NENG,DBA1;
;
;ATTACKING HIGH COVER
;
EBA2  NENG,DBA2;
;
;ATTACKING NON-AGGRESSIVE HIGH COVER
;
EBA3  NENG,DBA3;
;
;ATTACKING DEFENDED ROOM
;
ERA1  NENG,DRA1,TINC.GE.0.05;
ERA2  NENG,DRA1,TINC.GE.0.05;
ERA3  NENG,DRA1,TINC.GE.0.05;
ERA4  NENG,DRA2;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
DOF1  DENG,1,100,100,100,100,YES;
DOF2  DENG,3, 80, 90,  0,  0, NO;
DBC1  DENG,1, 60,  0, 60, 50, NO;
```

SNAP INPUT LISTING--SCENARIO C

```
DRC1   DENG,1, 60,  0, 60, 50, NO;
DSH1   DENG,2, 40, 40, 30, 50, NO;
DSL1   DENG,1, 80, 60, 10, 50, NO;
DS11   DENG,1, 90, 90,100,100,YES;
DS12   DENG,2, 70, 70, 10, 60, NO;
DBH1   DENG,1, 80, 80,100,100,YES;
DBH2   DENG,2, 40, 40,100,100,YES;
DBH3   DENG,2, 20,  0, 50, 30, NO;
DBL1   DENG,1,100,100,100,100,YES;
DBL2   DENG,2, 60, 60,100,100,YES;
DBL3   DENG,2, 40, 20, 50, 50, NO;
DBA1   DENG,2, 70, 20, 20, 40, NO;
DBA2   DENG,2, 50, 20, 20, 30, NO;
DBA3   DENG,2, 30, 10, 50, 40, NO;
DRA1   DENG,1, 90, 90,  0, 30, NO;
DRA2   DENG,2, 60, 60,  0, 30, NO;
DMC1   DENG,1,100,100,100,100,YES;
DMC2   DENG,3,100,100,100,100,YES;
DMC3   DENG,3,100,100,  0,  0, NO;
       ENDSTATUS;
FACILITY;
ESHX   SPA;
WSHX   SPA;
OGF1   SPA;
NGF1   SPA;
HGF1   SPA;
JGF1   SPA;
JDD1   BAR,ACTIVE,/JDA1;
JDX1   SPA;
JDF1   SPA;
JEF1   SPA;
JFF1   SPA;
KGF1   SPA;
LGF1   SPA;
MGF1   SPA;
MGD1   BAR,DISABLED,/MGA1;
MGX1   SPA;
MHR1   SPA;
MHR2   SPA;
MHR3   SPA;
LHR1   SPA;
LHR2   SPA;
LIR1   SPA;
LIR2   SPA;
LIR3   SPA;
LIR4   SPA;
LIR5   SPA;
MIR1   SPA;
LJR1   SPA;
LJD1   BAR,DISABLED,/LJA1;
LJX1   SPA;
SW2F   SPA;
SW21   SPA;
SW22   SPA;
SW23   SPA;
SW24   SPA;
ZUX1   SPA;
ZUD1   BAR,DISABLED,/ZUA1;
ZUX1   SPA;
ZUR1   SPA;
ZUR2   SPA;
ZUR3   SPA;
ZUR1   SPA;
```

```
ZXR1   SPA;
ZXD1   BAR,ACTIVE,/ZXA1;
ZXX1   SPA;
YXR1   SPA;
YXT1   TAR;
JDA1   SEN,0.90,PERM,L1;
MGA1   SEN,SPR0,PERM,L1,L4;
LJA1   SEN,SPR1,PERM,L1,L3;
ZUA1   SEN,SPR2,PERM,L2;
ZXA1   SEN,0.95,PERM,L2;
L1     MON,WG1;
L2     MON,WG1,STW2,TRB2,T29B;
L3     MON,TRB2,T29B;
L4     MON,TRB2;
       ENDFACILITY;
ADVERSARY;
       OBJ,SAB,YXT1;
       ENG,(SIZE.LT.1),EOF1;
ENTA   ENT,3,AUTOMATIC$,1,1.0,JDD1;
TS01   TAS,JDD1,PENE,EXP(0.1,1);
       DEC,(FLGT.IS.ACT,JDA1.IS.TRIGGERED),CCTV;
       REG,TS02;
CCTV   SIG,WGTV,TEMP;
TS02   TAS,JDF1,ENTE,TRI(1,1),,,,2;
TS03   TAS,JEF1,,TRI(1,1);
TS04   TAS,JFF1,,TRI(1,1),,,,2;
       REG,TS99,1;
       REG,TS05,0;
TS05   TAS,,,CON(0.0001);
TS0X   SIG,T14W,PERM;
TS05   TAS,KGF1,,TRI(2,1),,CONT,,,JGF1,14,EBC1;
TS06   TAS,LGF1,,TRI(2,1),,CONT,,,JFF1,25,EOF3;
TS07   TAS,MGF1,,TRI(1,1),,CONT,,,OGF1,50,EOF3/
           MGF1,10,EOF3;
TS08   TAS,MGX1,,TRI(DOR1,1),,CONT,,,OGF1,50,EOF3/
           MGF1,10,EOF3;
TS09   TAS,MGD1,PENE,TRI(DOR2,1),,CONT,,,OGF1,50,EOF3/
           MGF1,10,EOF3;
TS10   TAS,MHR1,ENTE,EXP(ONE,1),ACT(FLGA),CONT,,,MGD1,3,EBL3;
TS11   TAS,MHR2,,EXP(ONE,1),ACT(FLGB),CONT,,,MHR1,6,EBL3;
TS12   TAS,MHR3,,EXP(ONE,1),ACT(FLGC),CONT,,,MHR1,13,EBL3;
TS13   TAS,LHR1,,EXP(TWO,1),,CONT,,,MHR2,10,EBL3;
TS14   TAS,LHR2,,EXP(ONE,1),ACT(FLGD),CONT,,,MHR3,10,EBL3;
TA14   SIG,T28Z,PERM;
TS15   TAS,LIR1,,EXP(TWO,1),,CONT,,,LHR1,8,EBL3;
TS16   TAS,LIR2,,EXP(TWO,1),,CONT,,,LHR1,13,EBL3;
TS17   TAS,LIR3,,EXP(TWO,1),,CONT,,,LIR1,10,EBL3/
           MIR1,15,EBL3;
TS18   TAS,LIR4,,EXP(TWO,1),,CONT,,,LIR1,15,EBL3/
           MIR1,12,EBL3;
TS19   TAS,LJR1,,EXP(TWO,1),,CONT,,,LIR3,12,EBL3/
           MIR1,8,EBL3;
T20A   TAS,LJX1,,TRI(DOR3,1),,CONT,,,LIR3,12,EBL3/
           MIR1,8,EBL3;
TS20   TAS,LJD1,PENE,TRI(DOR4,1),,CONT,,,LIR3,12,EBL3/
           MIR1,8,EBL3;
A20T   SIG,TG2B,PERM;
TS21   TAS,SW2F,ENTE,TRI(3,1),ACT(FLGE),CONT,,,LJD1,4,ES12;
TS22   TAS,SW21,,TRI(4,1),,CONT,,,SW2F,5,EHS1;
TS23   TAS,SW22,,TRI(5,1),,CONT,,,SW21,5,EHS1;
TS24   TAS,SW23,,TRI(5,1),,CONT,,,SW22,5,EHS1;
TS25   TAS,SW24,,TRI(6,1),,CONT,,,SW23,5,EHS1;
TS26   TAS,ZUR1,,EXP(THREE,1),,CONT,,,ZUR1,2,EOF3;
T26A   TAS,ZUX1,,CON(0),,CONT,,,ZUR1,2,EOF3;
```

SNAP INPUT LISTING--SCENARIO C (Continued)

```
T26A  TAS,ZUX1,,CON(0),,CONT,,,ZUR1,2,EOF3;
TS27  TAS,ZUD1,,CON(0.05),,CONT,,,ZUR1,2,EOF3;
      DEC,(FLG1.IS.ACT,ZUD1.IS.TRIGGERED),CITV;
      REG,TS28;
CITV  SIG,UGTV,TEMP;
TS28  TAS,ZUR1,,EXP(THREE,1),,CONT,,,ZUD1,3,EOF3;
TS29  TAS,ZUR2,,EXP(THREE,1),,CONT,,,ZUD1,8,EOF3;
TS30  TAS,ZUR3,,EXP(THREE,1),,CONT,,,ZUD1,14,EOF3;
TS31  TAS,ZUR1,,EXP(THREE,1),,CONT,,,ZUR2,12,EOF3;
TS32  TAS,ZXR1,,EXP(THREE,1),,CONT,,,ZUR2,17,EOF3;
TS33  TAS,ZXX1,,TRI(DR11,1),,CONT,,,ZUR2,17,EOF3;
TS34  TAS,ZXD1,PENE,TRI(DR12,1),,CONT,,,ZUR2,17,EOF3;
TS35  TAS,YXT1,ENTE,CON(0);
TS36  EXIT,STOP;
TS99  TAS,KGF1,,CON(100),,CONT,,,JGF1,14,EBC1/
        MGD1,50,EBC1;
TSEX  EXIT;
      ENDADVERSARY;
GUARD;
      ENG,(SIZE.LT.1),EBL3;
EBAS  BASE,10,AUTOMATICS G,1;
WBAS  BASE,10,AUTOMATICS G,1;
;
;  INITIAL RESPONSE
;
ENG1  ENT,0.0,WSHK;
WG1   WAIT,(ADD,L1.OR.ADD,L2);
      DEC,(FLG1.IS.ACT,TRGR.IS.1),TG01;
      DEC,(TRGR.IS.1),TG03;
      REG,TG05;

TG01  ALL,WBAS,1,SIZE*1;
T01A  TAS,,,,ACT(FLG5);
      REG,WRSP;

TG03  ALL,EBAS,1,SIZE*1;
T03A  TAS,,,,ACT(FLG4);
      REG,ERSP;

TG05  ALL,EBAS,1,SIZE*2;
T05A  TAS,,,,ACT(FLG2);
      DEC,(FLG1.IS.DIS),ERSP;
      REG,TBLG;
;
;  REINFORCEMENT RESPONSE
;
ENG2  ENT,0.0,WSHK;
TG06  ALL,WBAS,1,SIZE*WR;
TG07  WAIT,(SIGNAL),,3;
      DEC,(FLG5.IS.ACT),EXTG,1;
      DEC,(SIZE.GT.1,FLG5.IS.ACT),WRSP;
      DEC,(SIZE.GT.0,FLG5.IS.DIS),WRSP;
      REG,LLEA;
LLEA  TAS,,,CON(15);
EXLL  EXIT,STOP;

ENG3  ENT,0.0,ESHK;
TG08  ALL,EBAS,1,SIZE*ER;
TG09  WAIT,(SIGNAL),,2;
      DEC,(FLG2.IS.ACT),EXTG,2;
      DEC,(FLG4.IS.ACT),EXTG,1;
      DEC,(SIZE.EQ.1,FLG4.IS.ACT),EXTG,0;
      DEC,(SIZE.EQ.2,FLG2.IS.ACT),EXTG,0;
      REG,ERSP,0;
;
;  RESPONSE FROM EAST SHACK AROUND BLDG.
;               OR FROM FENCE AREA
;
ERSP  TAS,ESHK,NEUT,TRI(EEEE,1);
      DEC,(FLGA.IS.DIS,FLG1.IS.DIS),SZ21;
      DEC,(FLG1.IS.DIS),TG10;
      DEC,(FLG3.IS.ACT),TBLG,0;
      DEC,(ZUA1.IS.TRIGG/ZXA1.IS.TRIGG/LJA1.IS.TRIGG/
           MGA1.IS.TRIGG),TBLG,0;
      REG,ERS2,0;
ERS2  TAS,ESHK,NEUT,TRI(18,1);
      DEC,(ZUA1.IS.TRIGG/ZXA1.IS.TRIGG/LJA1.IS.TRIGG/
           MGA1.IS.TRIGG),TBLG,0;
      REG,ERS3,0;
ERS3  TAS,ESHK,,TRI(18,1);
      DEC,(ZUA1.IS.TRIGG/ZXA1.IS.TRIGG/LJA1.IS.TRIGG/
           MGA1.IS.TRIGG),TBLG,0;
      REG,ERS4,0;
ERS4  TAS,,,TRI(18,1);
      DEC,(FLGA.IS.DIS),SZ21,0;
      REG,TG10,0;
SZ21  SIG,TG07,TEMP;
SZ22  SIG,TG09,TEMP;
TG10  TAS,QGF1,,TRI(9,1),,CONT,,,MGF1,50,EBC1/
        MGD1,50,EBC1/MGX1,50,EBC1;
TG11  TAS,MGF1,,TRI(10,1);
      REG,TURB;
;
;  RESPONSE FROM WEST SHACK
;
WRSP  TAS,WSHK,NEUT,TRI(WWWW,1);
T14W  WAIT,(ADD,KGF1.OR.SIGNAL);
      DEC,(TRGR.IS.2),T14X;
      REG,TG12;
TG12  SIGNAL,TG07,TEMP;
TG13  SIG,TG09,TEMP;
T14X  SIG,T14W,PERM;
TG14  TAS,JGF1,,CON(0.1),,CONT,,,KGF1,14,EBC1;
TG1Z  TAS,,,CON(0);
      DEC,(FLGA.IS.DIS),TG1B,0;
      REG,TG1A,0;
TG1B  SIG,TG07,TEMP;
TG1C  SIG,TG09,TEMP;
TG1A  TAS,JFF1,,TRI(1,1),,CONT,,,LGF1,25,EBC1;
TG15  TAS,KGF1,,TRI(1,1);
TG16  TAS,LGF1,,TRI(2,1);
TG17  TAS,MGF1,,TRI(1,1),,CONT,,,MGX1,10,EBC1/
        MGD1,10,EBC1,MGF1,10,EOF3;
TG18  TAS,MGX1,,CON(0.1);
      REG,TURB,0;
;
;  RESPONSE INTO TURBINE BUILDING
;
TURB  TAS,,,CON(0);
      DEC,(FLG6.IS.ACT),TRB3,0;
      DEC,(FLG1.IS.ACT),TRB2;
      REG,TRBZ,0;
TRBZ  SIG,TG07,TEMP;
TRBX  SIG,TG09,TEMP;
TRBY  TAS,MGD1,,CON(0.1),,CONT,,,KGF1,50,EBC1;
TRB2  WAIT,(ADD,L3.OR.ADD,L2.OR.ADD,L4.OR.TINC,1.0);
TRB3  TAS,,,CON(0);
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SNAP INPUT LISTING--SCENARIO C (Continued)

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TRB3  TAS,,,CON(0);
      DEC,(FLGA.IS.ACT,FLGB.IS.DIS),S11G;
      REG,TIRB,0;
S11G  SIG,TG07,TEMP;
S12G  SIG,TG09,TEMP;
TIRB  TAS,MGD1,,CON(0.1),ACT(FLG6),CONT,,,MHR1,3,EBC1;
      DEC,(FLGL.IS.ACT),S21G;
      DEC,(FLGB.IS.ACT,FLGC.IS.DIS),S21G,0;
      REG,TG19,0;
S21G  SIG,TG07,TEMP;
S22G  SIG,TG09,TEMP;
TG19  TAS,MHR1,,EXP(ONE,1),,CONT,,,MHR2,6,EBL3/
          MHR3,13,EBL3;
      DEC,(FLGC.IS.ACT,FLGD.IS.DIS),S31G,0;
      REG,TG20,0;
S31G  SIG,TG07,TEMP;
S32G  SIG,TG09,TEMP;
TG20  TAS,MHR2,,EXP(ONE,1),,CONT,,,LHR1,10,EBL3;
TG21  TAS,MHR3,,EXP(ONE,1),,CONT,,,LHR2,10,EBL3;
      DEC,(FLGD.IS.ACT,FLGE.IS.DIS),S41G,0;
      REG,TG22,0;
S41G  SIG,TG07,TEMP;
S42G  SIG,TG09,TEMP;
TG22  TAS,LHR1,,EXP(TWO,1),,CONT,,,LIR1,8,EBL3/
          LIR2,13,EBL3;
TG23  TAS,LHR2,,EXP(ONE,1);
TG24  TAS,LIR1,,EXP(TWO,1),,CONT,,,LIR3,10,EBL3/
          LIR4,15,EBL3;
TG25  TAS,LIR2,,EXP(TWO,1);
TG26  TAS,LIR3,,EXP(TWO,1),,CONT,,,LJR1,12,EBL3/
          LJD1,12,EBL3/LJX1,12,EBL3;
TG27  TAS,LIR4,,EXP(TWO,1);
      REG,STWY,0;
;
;  RESPONSE THROUGH NORTH ENTRANCE TO TURBINE BLDG
;
TBLG  TAS,MIR1,NEUT,TRI(12,1);
T28Z  WAIT,(SIGNAL);
      DEC,(FLGE.IS.DIS),SZ11;
      REG,TG29;
SZ11  SIG,TG07,TEMP;
SZ12  SIG,TG09,TEMP;
TG28  WAIT,(SIGNAL),,,EXTT,,LIR3,15,EBL3/
            LIR4,12,EBL3/LJR1,8,EBL3/LJD1,8,EBL3/
            LJX1,8,EBL3;
TG29  TAS,LIR3,,EXP(ONE,1);
T29A  TAS,,,CON(0);
      DEC,(FLG7.IS.ACT),STWY,0;
      REG,T29B,0;
T29B  WAIT,(ADD,L2.OR.ADD,L3.OR.TIMC,1.0);
      REG,STWY,0;
EXTT  EXIT,STOP;
EXTG  EXIT;
;
;  RESPONSE UP STAIRWAY TO TARGET
;
STWY  TAS,,,CON(0);
      DEC,(FLG7.IS.ACT),STWA,0;
      REG,STW2,0;
STW2  WAIT,(ADD,L2.OR.ADD,L3.OR.TIMC,1.0);
STWA  TAS,LJR1,,EXP(ONE,1),ACT(FLG7);
TG30  TAS,LJD1,,CON(0.1),,CONT,,,SW2F,4,EBC1;
      DEC,(FLGS.IS.ACT),DS13,0;
      REG,TG31,0;
DS13  SIG,TG07,TEMP;
DS14  SIG,TG09,TEMP;
TG31  TAS,SW2F,,TRI(3,1),,CONT,,,SW21,5,ESL1;
TG32  TAS,SW21,,TRI(4,1),,CONT,,,SW22,5,ESL1;
TG33  TAS,SW22,,TRI(5,1),,CONT,,,SW23,5,ESL1;
TG34  TAS,SW23,,TRI(5,1),,CONT,,,SW24,5,ESL1;
TG35  TAS,SW24,,TRI(6,1);
TG36  TAS,ZUR1,,EXP(THREE,1),,CONT,,,ZUR1,2,EBC1/
          ZUD1,2,EBC1,ZUX1,2,EBC1;
TG37  TAS,ZUD1,,CON(0.1),,CONT,,,ZUR1,3,EBC1/
          ZUR2,8,EBC1/ZUR3,14,EBC1;
XG37  SIG,TG07,TEMP;
YG37  SIG,TG09,TEMP;
TG38  TAS,ZUR1,,EXP(THREE,1);
TG39  TAS,ZUR2,,EXP(THREE,1),,CONT,,,ZUR1,12,EBL3/
          ZXR1,17,EBL3/ZXX1,17,EBL3/ZXD1,17,EBL3;
TG40  EXIT,STOP;
;
;  CCTV SIGNAL NETWORK
;
ENTG  ENT,0.00,ESHK;
WGTV  WAIT,(SIGNAL);
      PRO,0.7,WGTV;
      PRO,0.3,TG50;
TG50  TAS,,,EXP(0.5,1),ACT(FLG3);
TG51  SIG,TG07,TEMP;
TG52  SIG,TG09,TEMP;
TG53  EXIT;
      ENDGUARD;
      ENDSNAP;
END OF FILE
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SNAP INPUT LISTING--SCENARIO C (Continued)

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	.100	.302	.003	0.000	1.000	100
NO. ADVER CSLTY	.620	.141	.001	0.000	1.000	100
DEG OBJ SATISFD	1.000	0.000	0.000	1.000	1.000	100
TIME FOR ENG	.370	.232	.019	.016	.663	12
TOTAL ENG TIME	.044	.143	.001	0.000	.663	100
NO. ENG/RUN	.120	.327	.003	0.000	1.000	100
TIME BET ENT/ENG	2.099	.139	.002	1.756	2.415	86
SIMULATION TIME	[illegible]56	.196	.002	3.185	4.243	100
SIM TIME/AD SUC	3.656	.196	.002	3.185	4.243	100
SIM TIME/AD FAIL	NO VALUES RECORDED					

AVG NUMBER OF ENGAGEMENTS PER RUN	.12
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.02
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.10
PROBABILITY SYSTEM WINS	0.00
PROBABILITY AN INTERRUPT OCCURS	.86

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO C

CASE 1

GENERAL SYSTEM PERFORMANCE STATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	1.800	1.752	.018	0.000	7.000	100
NO. ADVER CSLTY	2.640	.689	.007	0.000	3.000	100
DEG OBJ SATISFD	.110	.314	.003	0.000	1.000	100
TIME FOR ENG	.480	.500	.002	.001	2.992	251
TOTAL ENG TIME	1.204	.794	.008	.085	3.743	100
NO. ENG/RUN	2.510	.745	.007	1.000	4.000	100
TIME BET ENT/ENG	.954	.517	.005	.546	4.039	100
SIMULATION TIME	4.279	1.340	.013	2.928	8.897	100
SIM TIME/AD SUC	6.575	1.452	.132	5.181	8.897	11
SIM TIME/AD FAIL	3.996	1.020	.011	2.928	7.514	89

AVG NUMBER OF ENGAGEMENTS PER RUN	2.51
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.73
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.78
PROBABILITY SYSTEM WINS	.89
PROBABILITY AN INTERRUPT OCCURS	1.00

GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO C

CASE 2

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	3.360	1.795	.018	0.000	5.000	100
NO. ADVER CSLTY	1.450	1.123	.011	0.000	3.000	100
DEG OBJ SATISFD	.570	.498	.005	0.000	1.000	100
TIME FOR ENG	1.031	1.016	.004	.002	5.840	246
TOTAL ENG TIME	2.536	1.505	.015	0.000	7.320	100
NO. ENG/RUN	2.460	.717	.007	0.000	4.000	100
TIME BET ENT/ENG	1.062	.611	.006	.570	3.484	100
SIMULATION TIME	6.177	2.022	.020	3.234	11.495	100
SIM TIME/AD SUC	7.429	1.607	.028	5.194	11.495	57
SIM TIME/AD FAIL	4.519	1.120	.026	3.234	8.113	43

AVG NUMBER OF ENGAGEMENTS PER RUN	2.46
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.89
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	1.57
PROBABILITY SYSTEM WINS	.43
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO C

CASE 3

GENERAL SYSTEM PERFORMANCE STATISTICS

	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	2.000	1.608	.016	0.000	7.000	100
NO. ADVER CSLTY	2.610	.737	.007	0.000	3.000	100
DEG OBJ SATISFD	.140	.349	.003	0.000	1.000	100
TIME FOR ENG	.474	.472	.002	.000	2.710	253
TOTAL ENG TIME	1.200	.856	.009	.100	5.102	100
NO. ENG. RUN	2.530	.731	.007	1.000	4.000	100
TIME BET ENT/ENG	1.014	.631	.006	.530	3.973	100
SIMULATION TIME	4.291	1.172	.012	2.949	8.104	100
SIM TIME/AD SUC	5.994	.548	.039	5.140	6.960	14
SIM TIME/AD FAIL	4.014	.999	.012	2.949	8.104	86

AVG NUMBER OF ENGAGEMENTS PER RUN	2.53
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	1.72
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.81
PROBABILITY SYSTEM WINS	.86
PROBABILITY AN INTERRUPT OCCURS	1.00

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO C

CASE 4

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	1.050	1.123	.011	0.000	7.000	100
NO. ADVER CSLTY	1.200	1.015	.010	0.000	3.000	100
DEG OBJ SATISFD	.800	.402	.004	0.000	1.000	100
TIME FOR ENG	.533	.502	.003	.000	3.190	164
TOTAL ENG TIME	.874	.745	.007	0.000	4.326	100
NO. ENG/RUN	1.640	.835	.008	0.000	3.000	100
TIME BET ENT/ENG	1.834	.768	.008	1.165	3.673	98
SIMULATION TIME	6.395	1.092	.011	5.075	11.370	100
SIM TIME/AD SUC	5.944	.502	.006	5.075	8.688	80
SIM TIME/AD FAIL	8.199	.943	.047	7.009	11.370	20

AVG NUMBER OF ENGAGEMENTS PER RUN	1.64
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.96
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.68
PROBABILITY SYSTEM WINS	.20
PROBABILITY AN INTERRUPT OCCURS	.98

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO C

CASE 5

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*  GENERAL SYSTEM PERFORMANCE STATISTICS  *
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	MEAN VALUE	STANDARD DEVIATION	STAND DEV OF MEAN	MINIMUM VALUE	MAXIMUM VALUE	NUM OF OBS.
NO. GUARD CSLTY	.500	.823	.008	0.000	3.000	100
NO. ADVER CSLTY	.850	.575	.006	0.000	3.000	100
DEG OBJ SATISFD	.940	.239	.002	0.000	1.000	100
TIME FOR ENG	.347	.329	.003	.001	1.770	116
TOTAL ENG TIME	.403	.380	.004	0.000	1.770	100
NO. ENG/RUN	1.160	.677	.007	0.000	2.000	100
TIME BET ENT. ENG	.802	.120	.001	.563	1.054	86
SIMULATION TIME	3.548	.405	.004	2.089	4.220	100
SIM TIME/AD SUC	3.629	.246	.003	2.996	4.220	94
SIM TIME/AD FAIL	2.266	.129	.021	2.089	2.411	6

AVG NUMBER OF ENGAGEMENTS PER RUN	1.16
AVG NUMBER OF ENGAGEMENTS WON BY GUARDS PER RUN	.79
AVG NUMBER OF ENGAGEMENTS WON BY ADVERSARIES	.37
PROBABILITY SYSTEM WINS	.86
PROBABILITY AN INTERRUPT OCCURS	.86

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GENERAL SYSTEM PERFORMANCE STATISTICS--SCENARIO C

CASE 6

FACILITY STATISTICS

STATISTICS FOR FACILITY MODES

MODE LABEL	PROBABILITY MODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
JDD1	1.00000	1.00000	0.00000	0.00000	100
JDF1	1.00000	1.00000	0.00000	0.00000	100
JEF1	1.00000	1.00000	0.00000	0.00000	100
JFF1	1.00000	2.00000	0.00000	0.00000	100
KGF1	1.00000	1.02000	.14071	.00141	100
LGF1	1.00000	1.00000	0.00000	0.00000	100
MGF1	1.00000	1.00000	0.00000	0.00000	100
MGD1	1.00000	1.00000	0.00000	0.00000	100
MGX1	1.00000	1.00000	0.00000	0.00000	100
MHR1	1.00000	1.00000	0.00000	0.00000	100
MHR2	1.00000	1.00000	0.00000	0.00000	100
MHR3	1.00000	1.00000	0.00000	0.00000	100
LHR1	1.00000	1.00000	0.00000	0.00000	100
LHR2	1.00000	1.00000	0.00000	0.00000	100
LIR1	1.00000	1.00000	0.00000	0.00000	100
LIR2	1.00000	1.00000	0.00000	0.00000	100
LIR3	1.00000	1.00000	0.00000	0.00000	100
LIR4	1.00000	1.00000	0.00000	0.00000	100
LJR1	1.00000	1.00000	0.00000	0.00000	100
LJD1	1.00000	1.00000	0.00000	0.00000	100
LJX1	1.00000	1.00000	0.00000	0.00000	100
SW2F	1.00000	1.00000	0.00000	0.00000	100
SW21	1.00000	1.00000	0.00000	0.00000	100
SW22	1.00000	1.00000	0.00000	0.00000	100
SW23	1.00000	1.00000	0.00000	0.00000	100
SW24	1.00000	1.00000	0.00000	0.00000	100
ZUR1	1.00000	1.00000	0.00000	0.00000	100

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FACILITY STATISTICS--SCENARIO C

CASE 1

FACILITY STATISTICS

** STATISTICS FOR FACILITY MODES **

MODE LABEL	PROBABILITY MODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
JDD1	1.00000	1.00000	0.00000	0.00000	100
JDF1	1.00000	1.00000	0.00000	0.00000	100
JEF1	1.00000	1.00000	0.00000	0.00000	100
JFF1	1.00000	2.00000	0.00000	0.00000	100
KGF1	1.00000	1.84000	.36845	.00368	100
LGF1	1.00000	1.00000	0.00000	0.00000	100
MGF1	1.00000	1.00000	0.00000	0.00000	100
MGD1	1.00000	1.00000	0.00000	0.00000	100
MGX1	1.00000	1.00000	0.00000	0.00000	100
MHR1	.97000	.97000	.17145	.00171	100
MHR2	.96000	.96000	.19695	.00197	100
MHR3	.95000	.95000	.21904	.00219	100
LHR1	.95000	.95000	.21904	.00219	100
LHR2	.95000	.95000	.21904	.00219	100
LIR[illegible]	.94000	.94000	.23868	.00239	100
LIR[illegible]	.94000	.94000	.23868	.00239	100
LIR3	.92000	.92000	.27266	.00273	100
LIR4	.36000	.36000	.48242	.00482	100
LJR1	.30000	.30000	.46057	.00461	100
LJD1	.13000	.13000	.33800	.00338	100
LJX1	.26000	.26000	.44084	.00441	100
SW2F	.11000	.11000	.31447	.00314	100
SW21	.11000	.11000	.31447	.00314	100
SW22	.11000	.11000	.31447	.00314	100
SW23	.11000	.11000	.31447	.00314	100
SW24	.11000	.11000	.31447	.00314	100
ZUR1	.11000	.11000	.31447	.00314	100

FACILITY STATISTICS--SCENARIO C

CASE 2

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
JDD1	1.00000	1.00000	0.00000	0.00000	100
JDF1	1.00000	1.00000	0.00000	0.00000	100
JEF1	1.00000	1.00000	0.00000	0.00000	100
JFF1	1.00000	2.00000	0.00000	0.00000	100
KGF1	1.00000	1.46000	.50091	.00501	100
LGF1	1.00000	1.00000	0.00000	0.00000	100
MGF1	1.00000	1.00000	0.00000	0.00000	100
MGD1	1.00000	1.00000	0.00000	0.00000	100
MGX1	1.00000	1.00000	0.00000	0.00000	100
MHR1	1.00000	1.00000	0.00000	0.00000	100
MHR2	1.00000	1.00000	0.00000	0.00000	100
MHR3	1.00000	1.00000	0.00000	0.00000	100
LHR1	1.00000	1.00000	0.00000	0.00000	100
LHR2	1.00000	1.00000	0.00000	0.00000	100
LIR1	1.00000	1.00000	0.00000	0.00000	100
LIR2	1.00000	1.00000	0.00000	0.00000	100
LIR3	1.00000	1.00000	0.00000	0.00000	100
LIR4	.75000	.75000	.43519	.00435	100
LJR1	.72000	.72000	.45126	.00451	100
LJD1	.59000	.59000	.49431	.00494	100
LJX1	.69000	.69000	.46482	.00465	100
SW2F	.57000	.57000	.49757	.00498	100
SW21	.57000	.57000	.49757	.00498	100
SW22	.57000	.57000	.49757	.00498	100
SW23	.57000	.57000	.49757	.00498	100
SW24	.57000	.57000	.49757	.00498	100
ZUR1	.57000	.57000	.49757	.00498	100

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FACILITY STATISTICS--SCENARIO C

CASE 3

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
JDD1	1.00000	1.00000	0.00000	0.00000	100
JDF1	1.00000	1.00000	0.00000	0.00000	100
JEF1	1.00000	1.00000	0.00000	0.00000	100
JFF1	1.00000	2.00000	0.00000	0.00000	100
KGF1	1.00000	1.86000	.34874	.00349	100
LGF1	1.00000	1.00000	0.00000	0.00000	100
MGF1	1.00000	1.00000	0.00000	0.00000	100
MGD1	.99000	.99000	.10000	.00100	100
MGX1	1.00000	1.00000	0.00000	0.00000	100
MHR1	.96000	.96000	.19695	.00197	100
MHR2	.96000	.96000	.19695	.00197	100
MHR3	.96000	.96000	.19695	.00197	100
LHR1	.96000	.96000	.19695	.00197	100
LHR2	.96000	.96000	.19695	.00197	100
LIR1	.96000	.96000	.19695	.00197	100
LIR2	.96000	.96000	.19695	.00197	100
LIR3	.95000	.95000	.21904	.00219	100
LIP4	.42000	.42000	.49604	.00496	100
LJR1	.36000	.36000	.48242	.00482	100
LJD1	.17000	.17000	.37753	.00378	100
LJX1	.31000	.31000	.46482	.00465	100
SW2F	.14000	.14000	.34874	.00349	100
SW21	.14000	.14000	.34874	.00349	100
SW22	.14000	.14000	.34874	.00349	100
SW23	.14000	.14000	.34874	.00349	100
SW24	.14000	.14000	.34874	.00349	100
ZUR1	.14000	.14000	.34874	.00349	100

FACILITY STATISTICS--SCENARIO C

CASE 4

FACILITY STATISTICS

STATISTICS FOR FACILITY NODES

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
JDD1	1.00000	1.00000	0.00000	0.00000	100
JDF1	1.00000	1.00000	0.00000	0.00000	100
JEF1	1.00000	1.00000	0.00000	0.00000	100
JFF1	1.00000	2.00000	0.00000	0.00000	100
KGF1	1.00000	1.76000	.42923	.00429	100
LGF1	1.00000	1.00000	0.00000	0.00000	100
MGF1	1.00000	1.00000	0.00000	0.00000	100
MGD1	.96000	.96000	.19695	.00197	100
MGX1	1.00000	1.00000	0.00000	0.00000	100
MHR1	.88000	.88000	.32660	.00327	100
MHR2	.88000	.88000	.32660	.00327	100
MHR3	.88000	.88000	.32660	.00327	100
LHR1	.88000	.88000	.32660	.00327	100
LHR2	.88000	.88000	.32660	.00327	100
LIR1	.88000	.88000	.32660	.00327	100
LIR2	.88000	.88000	.32660	.00327	100
LIR3	.88000	.88000	.32660	.00327	100
LIR4	.88000	.88000	.32660	.00327	100
LJR1	.88000	.88000	.32660	.00327	100
LJD1	.84000	.84000	.36845	.00368	100
LJX1	.88000	.88000	.32660	.00327	100
SW2F	.80000	.80000	.40202	.00402	100
SW21	.80000	.80000	.40202	.00402	100
SW22	.80000	.80000	.40202	.00402	100
SW23	.80000	.80000	.40202	.00402	100
SW24	.80000	.80000	.40202	.00402	100
ZUR1	.80000	.80000	.40202	.00402	100

>?

FACILITY STATISTICS--SCENARIO C

CASE 5

FACILITY STATISTICS

** STATISTICS FOR FACILITY NODES **

NODE LABEL	PROBABILITY NODE WAS REACHED AT LEAST ONCE	NUMBER OF TIMES OCCUPIED BY ADVERSARIES PER RUN			
		MEAN	STANDARD DEVIATION	STD. DEV. OF MEAN	NO. OF OBS.
JDD1	1.00000	1.00000	0.00000	[illegible]	100
JDF1	1.00000	1.00000	0.00000	[illegible]	100
JEF1	1.00000	1.00000	0.00000	0.00000	100
JFF1	1.00000	2.00000	0.00000	0.00000	100
KGF1	1.00000	1.73000	.44620	.00446	100
LGF1	1.00000	1.00000	0.00000	0.00000	100
MGF1	1.00000	1.00000	0.00000	0.00000	100
MGD1	1.00000	1.00000	0.00000	0.00000	100
MGX1	1.00000	1.00000	0.00000	0.00000	100
MHR1	1.00000	1.00000	0.00000	0.00000	100
MHR2	1.00000	1.00000	0.00000	0.00000	100
MHR3	1.00000	1.00000	0.00000	0.00000	100
LHR1	1.00000	1.00000	0.00000	0.00000	100
LHR2	1.00000	1.00000	0.00000	0.00000	100
LIR1	1.00000	1.00000	0.00000	0.00000	100
LIR2	1.00000	1.00000	0.00000	0.00000	100
LIR3	1.00000	1.00000	0.00000	0.00000	100
LIR4	.99000	.99000	.10000	.00100	100
LJR1	.98000	.98000	.14071	.00141	100
LJD1	.94000	.94000	.23868	.00239	100
LJX1	.97000	.97000	.17145	.00171	100
SW2F	.94000	.94000	.23868	.00239	100
SW21	.94000	.94000	.23868	.00239	100
SW22	.94000	.94000	.23868	.00239	100
SW23	.94000	.94000	.23868	.00239	100
S[illegible]	.94000	.94000	.23868	.00239	100
ZUR[illegible]	.94000	.94000	.23868	.00239	100

>?

FACILITY STATISTICS--SCENARIO C

CASE 6

1

TRACE
RUN NO 1

FORCE	EVENT	NODE	FACILITY NODE	TIME
GUARD	0 ENTER	ENG1	WSHK	0.00
	BRANCHED TO WG1			
	SIZE - 0.			
GUARD	0 WAITING FOR ADV DETECTION DEVICE L1 OR ADV DETECTION DEVICE L2	WG1	WSHK	0.00
GUARD	0 ENTER	ENG2	WSHK	0.00
	BRANCHED TO TG06			
	SIZE - 0.			
GUARD	1 ALLOCATE FROM BASE WBAS	TG06	WSHK	0.00
	SIZE - 0.			
	TOTALS *			
	SIZE - 0.			
	TRAINING - 1.			
	BRANCHED TO TG07			
	SIZE - 0.			
GUARD	1 WAITING FOR SIGNAL	TG07	WSHK	0.00
GUARD	0 ENTER	ENG3	ESHK	0.00
	BRANCHED TO TG08			
	SIZE - 0.			
GUARD	2 ALLOCATE FROM BASE EBAS	TG08	ESHK	0.00
	SIZE - 5.			
	TOTALS *			
	SIZE - 5.			
	TRAINING - 1.			
	BRANCHED TO TG09			
	SIZE - 5.			
GUARD	2 WAITING FOR SIGNAL	TG09	ESHK	0.00
GUARD	0 ENTER	ENT9	ESHK	0.00
	BRANCHED TO WGTV			
	SIZE - 0.			
GUARD	0 WAITING FOR SIGNAL	WGTV	ESHK	0.00
ADVER	1 ENTER	ENTA	JDD1	1.00
	SIZE - 3.			
	TRAINING - 1.			
	BRANCHED TO TS01			
	SIZE - 3.			
ADVER	1 START OF TASK	TS01	JDD1	1.00
	DISABLE BARRIER JDD1			
	TRIGGERED SENSOR JDA1			
GUARD	0 WAIT NODE TRIGGERED BY TRIGGER NUMBER 1	WG1	WSHK	1.00
	BRANCHED TO TG03			
	SIZE - 0.			
GUARD	3 ALLOCATE FROM BASE EBAS	TG03	WSHK	1.00
	SIZE - 1.			
	TOTALS *			
	SIZE - 1.			
	TRAINING - 1.			
	BRANCHED TO T03A			
	SIZE - 1.			
GUARD	3 START OF TASK	T03A	WSHK	1.00
	ACTIVATE FLAG FLG4			
GUARD	3 END OF TASK	T03A	WSHK	1.00
	BRANCHED TO ERSP			
	SIZE - 1.			
GUARD	3 START OF TASK	ERSP	ESHK	1.00
ADVER	1 END OF TASK	TS01	JDD1	1.27
	BRANCHED TO TS02			
	SIZE - 3.			
ADVER	1 START OF TASK	TS02	JDF1	1.27
ADVER	1 END OF TASK	TS02	JDF1	1.35
	BRANCHED TO TS03			
	SIZE - 3.			
ADVER	1 START OF TASK	TS03	JEF1	1.35
ADVER	1 END OF TASK	TS03	JEF1	1.43
	BRANCHED TO TS04			
	SIZE - 3.			
ADVER	1 START OF TASK	TS04	JFF1	1.43
ADVER	1 END OF TASK	TS04	JFF1	1.50
	BRANCHED TO TS99			
	SIZE - 1.			
	BRANCHED TO TS05			
	SIZE - 2.			
ADVER	1 START OF TASK	TS99	KQF1	1.50
ADVER	2 START OF TASK	TS05	JFF1	1.50

SCENARIO C--TRACE CASE 1

```
P127
ADVER   2 START OF TASK                                  TS05   JFF1   1.50
ADVER   2 END OF TASK                                    TS05   JFF1   1.50
            BRANCHED TO    TS0X
            SIZE -         2.
ADVER   2 SIGNAL           T14U  TS0X   JFF1   1.50
            BRANCHED TO    T05S
            SIZE -         2.
ADVER   2 START OF TASK                                  T05S   KGF1   1.50
ADVER   2 END OF TASK                                    T05S   KGF1   1.57
            BRANCHED TO    TS06
            SIZE -         2.
ADVER   2 START OF TASK                                  TS06   LGF1   1.57
ADVER   2 END OF TASK                                    TS06   LGF1   1.63
            BRANCHED TO    TS07
            SIZE -         2.
ADVER   2 START OF TASK                                  TS07   MGF1   1.63
ADVER   2 END OF TASK                                    TS07   MGF1   1.73
            BRANCHED TO    TS08
            SIZE -         2.
ADVER   2 START OF TASK                                  TS08   MGX1   1.73
ADVER   2 END OF TASK                                    TS08   MGX1   1.73
            BRANCHED TO    TS09
            SIZE -         2.
ADVER   2 START OF TASK                                  TS09   MGD1   1.73
            DISABLE BARRIER    MGD1
ADVER   2 END OF TASK                                    TS09   MGD1   1.78
            BRANCHED TO    TS10
            SIZE -         2.
ADVER   2 START OF TASK                                  TS10   MHR1   1.78
            ACTIVATE FLAG  FLGA
ADVER   2 END OF TASK                                    TS10   MHR1   1.83
            BRANCHED TO    TS11
            SIZE -         2.
ADVER   2 START OF TASK                                  TS11   MHR2   1.83
            ACTIVATE FLAG  FLGB
ADVER   2 END OF TASK                                    TS11   MHR2   1.84
            BRANCHED TO    TS12
            SIZE -         2.
ADVER   2 START OF TASK                                  TS12   MHR3   1.84
            ACTIVATE FLAG  FLGC
ADVER   2 END OF TASK                                    TS12   MHR3   1.91
            BRANCHED TO    TS13
            SIZE -         2.
ADVER   2 START OF TASK                                  TS13   LHR1   1.91
ADVER   2 END OF TASK                                    TS13   LHR1   1.92
            BRANCHED TO    TS14
            SIZE -         2.
ADVER   2 START OF TASK                                  TS14   LHR2   1.92
            ACTIVATE FLAG  FLGD
ADVER   2 END OF TASK                                    TS14   LHR2   2.00
            BRANCHED TO    TA14
            SIZE -         2.
ADVER   2 SIGNAL           T28Z  TA14   LHR2   2.00
            BRANCHED TO    TS15
            SIZE -         2.
ADVER   2 STAR  OF TASK                                  TS15   LIR1   2.00
ADVER   2 END OF TASK                                    TS15   LIR1   2.06
            BRANCHED TO    TS16
            SIZE -         2.
ADVER   2 START OF TASK                                  TS16   LIR2   2.06
ADVER   2 END OF TASK                                    TS16   LIR2   2.16
            BRANCHED TO    TS17
            SIZE -         2.
ADVER   2 START OF TASK                                  TS17   LIR3   2.16
ADVER   2 END OF TASK                                    TS17   LIR3   2.17
            BRANCHED TO    TS18
            SIZE -         2.
ADVER   2 START OF TASK                                  TS18   LIR4   2.17
ADVER   2 END OF TASK                                    TS18   LIR4   2.18
            BRANCHED TO    TS19
            SIZE -         2.
ADVER   2 START OF TASK                                  TS19   LJR1   2.18
GUARD   3 END OF TASK                                    ERSP   ESHK   2.37
            BRANCHED TO    TG10
            SIZE -         1.
GUARD   3 START OF TASK                                  TG10   OGF1   2.37
ADVER   2 END OF TASK                                    TS19   LJR1   2.41
            BRANCHED TO    T20A
            SIZE -         2.
ADVER   2 START OF TASK                                  T20A   LJX1   2.41
ADVER   2 END OF TASK                                    T20A   LJX1   2.41
            BRANCHED TO    TS20
            SIZE -         2.
ADVER   2 START OF TASK                                  TS20   LJD1   2.41
            DISABLE BARRIER    LJD1
ADVER   2 END OF TASK                                    TS20   LJD1   2.46
            BRANCHED TO    A20T
            SIZE -         2.
```

SCENARIO C--TRACE CASE 1 (Continued)

```
                SIZE -          2.
ADVER  2 SIGNAL                      TG28  A20T  LJD1  2.46
           BRANCHED TO                TS21
           SIZE -          2.
ADVER  2 START OF TASK               TS21  SW2F  2.46
           ACTIVATE FLAG              FLGE
ADVER  2 END OF TASK                 TS21  SW2F  2.58
           BRANCHED TO                TS22
           SIZE -          2.
ADVER  2 START OF TASK               TS22  SW21  2.58
GUARD  3 END OF TASK                 TG10  OGF1  2.66
           BRANCHED TO                TG11
           SIZE -          1.
GUARD  3 START OF TASK               TG11  MGF1  2.66
ADVER  2 END OF TASK                 TS22  SW21  2.78
           BRANCHED TO                TS23
           SIZE -          2.
ADVER  2 START OF TASK               TS23  SW22  2.78
ADVER  2 END OF TASK                 TS23  SW22  3.00
           BRANCHED TO                TS24
           SIZE -          2.
ADVER  2 START OF TASK               TS24  SW23  3.00
GUARD  3 END OF TASK                 TG11  MGF1  3.01
           BRANCHED TO                TURB
           SIZE -          1.
GUARD  3 START OF TASK               TURB  MGF1  3.01
GUARD  3 END OF TASK                 TURB  MGF1  3.01
           BRANCHED TO                TRBZ
           SIZE -          1.
GUARD  3 SIGNAL                      TG07  TRBZ  MGF1  3.01
           BRANCHED TO                TRBX
           SIZE -          1.
GUARD  1 WAIT NODE TRIGGERED         TG07  WSHK  3.01
           BY TRIGGER NUMBER  1
           BRANCHED TO                LLEA
           SIZE -          0.
GUARD  0 START OF TASK               LLEA  WSHK  3.01
GUARD  3 SIGNAL                      TG09  TRBX  MGF1  3.01
           BRANCHED TO                TRBY
           SIZE -          1.
GUARD  2 WAIT NODE TRIGGERED         TG09  ESHK  3.01
           BY TRIGGER NUMBER  1
           BRANCHED TO                EXTG
           SIZE -          1.
           BRANCHED TO                ERSP
```

```
                SIZE -          4.
GUARD  2 EXIT                                    EXTG  ESHK  3.01
GUARD  4 START OF TASK                           ERSP  ESHK  3.01
GUARD  3 START OF TASK                           TRBY  MGD1  3.01
****     ENGAGEMENT                                          3.01
GUARD  3 INCLUDE
ADVER  1 INCLUDE
             ENGAGEMENT NUMBER      1
ADV    1 T O T A L S
             SIZE -          1.
             TRAINING -      0.
GUA    1 T O T A L S
             SIZE -          1.
             TRAINING -      0.
ADVER  2 END OF TASK                             TS24  SW23  3.17
           BRANCHED TO                TS25
           SIZE -          2.
ADVER  2 START OF TASK                           TS25  SW24  3.17
ADVER  2 END OF TASK                             TS25  SW24  3.42
           BRANCHED TO                TS26
           SIZE -          2.
ADVER  2 START OF TASK                           TS26  ZUR1  3.42
GUA    1 CASUALTY                                            3.44
           SIZE -          0.
****   1 END ENGAGEMENT                                      3.44
GUARD  3 NEUTRALIZED                             TRBY  MGD1  3.44
ADVER  1 RESUMED TASK                            TS99  KGF1  3.44
           SIZE -          1.
           TRAINING -      1.
ADVER  2 END OF TASK                             TS26  ZUR1  3.47
           BRANCHED TO                T26A
           SIZE -          2.
ADVER  2 START OF TASK                           T26A  ZUX1  3.47
ADVER  2 END OF TASK                             T26A  ZUX1  3.47
           BRANCHED TO                TS27
           SIZE -          2.
ADVER  2 START OF TASK                           TS27  ZUD1  3.47
ADVER  2 END OF TASK                             TS27  ZUD1  3.52
           BRANCHED TO                TS28
           SIZE -          2.
ADVER  2 START OF TASK                           TS28  ZUR1  3.52
ADVER  2 END OF TASK                             TS28  ZUR1  3.52
```

SCENARIO C--TRACE CASE 1 (Continued)

```
P127
ADVER   2 END OF TASK                                    TS28    ZVR1    3.52
            BRANCHED TO      TS29
              SIZE -       2.
ADVER   2 START OF TASK                                  TS29    ZVR2    3.52
ADVER   2 END OF TASK                                    TS29    ZVR2    3.54
            BRANCHED TO      TS30
              SIZE -       2.
ADVER   2 START OF TASK                                  TS30    ZVR3    3.54
ADVER   2 END OF TASK                                    TS30    ZVR3    3.54
            BRANCHED TO      TS31
              SIZE -       2.
ADVER   2 START OF TASK                                  TS31    ZVR1    3.54
ADVER   2 END OF TASK                                    TS31    ZVR1    3.59
            BRANCHED TO      TS32
              SIZE -       2.
ADVER   2 START OF TASK                                  TS32    ZXR1    3.59
ADVER   2 END OF TASK                                    TS32    ZXR1    3.59
            BRANCHED TO      TS33
              SIZE -       2.
ADVER   2 START OF TASK                                  TS33    ZXX1    3.59
ADVER   2 END OF TASK                                    TS33    ZXX1    3.59
            BRANCHED TO      TS34
              SIZE -       2.
ADVER   2 START OF TASK                                  TS34    ZXD1    3.59
            DISABLE BARRIER  ZXD1
ADVER   2 END OF TASK                                    TS34    ZXD1    3.87
            BRANCHED TO      TS35
              SIZE -       2.
ADVER   2 START OF TASK                                  TS35    YXT1    3.87
ADVER   2 END OF TASK                                    TS35    YXT1    3.87
            BRANCHED TO      TS36
              SIZE -       2.
ADVER   2 EXIT                                           STOP    TS36    YXT1    3.87


1                    ################
                     #              #
                     #    TRACE     #
```

SCENARIO C--TRACE CASE 1 (Continued)

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16. ABSTRACT (200 words or less)

The applications of four safeguards evaluation models to two different example facilities are presented in order to demonstrate and evaluate the overall utility of the models. The models used as (1) Safeguards Automated Facility Evaluation (SAFE), (2) Safeguards Network Analysis Procedures (SNAP), (3) Forcible Entry Safeguards Effectivness Model (FESEM), and (4) Insider Safeguards Effectiveness Model (ISEM). A series of observations is made on the utility of the models based on the applications. Pros and cons for each of the models are identified, model inputs and outputs are summarized, resource requirements are specified, and their utility, both general and for Nuclear Regulatory Commission (NRC) purposes, is discussed. Finally, recommendations are made regarding the use of these models for safeguards system evaluation and for operational use by the NRC.

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