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AVIONICS EVALUATION PROGRAM: MULTIPLE MISSIONS AND ANTIAIRCRAFT--ETC(U)

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AVIONICS EVALUATION PROGRAM: MULTIPLE MISSIONS AND ANTIAIRCRAFT ARTILLERY SIMULATION

BATTELLE'S COLUMBUS LABORATORIES
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JUNE 1977

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A multiple mission version of the AEP designed specifically for analysis of RPV weapon system concepts has been developed. This program is a Monte Carlo simulation of up to four missions consisting of up to four aircraft for a specified number of days of operation. Functions considered include ground service, communications, navigation, refueling, target acquisition, weapon delivery, enemy jamming, ECM support and payload dispersion. Emphasis was placed on RPV related functions and intermission dependence factors. The previous framework for consideration of hardware reliability and backup modes has been retained.

The Antiaircraft Artillery Simulation, AFATL Program P001, has been incorporated as part of the interactive AEP. The conversational mode provides data storage and retrieval, on-line execution of the simulation, selective tabulation or plotting of results and off-line printing of the total detailed output.

FOREWORD

This is the final report on work conducted to develop a multiple mission version of the Avionics Evaluation Program (AEP) and to incorporate an Antiaircraft Artillery Simulation capability and other new features within the interactive AEP. This work was performed by Battelle's Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201, for the U. S. Air Force Avionics Laboratory, Wright-Patterson Air Force Base, Ohio 45433. Information in this report covers work conducted under Contract F33615-76-C-1299, Project 2003/09/08. The Air Force Program Monitor is Captain Ken Almquist (AFAL/AAA), Systems Avionics Division. Research for this final report was conducted from June 15, 1976, through January 3, 1977. No copyrighted material is included. This report was submitted by the authors on January 27, 1977.

LIST OF ABBREVIATIONS

Item	Description
AAA	Antiaircraft Artillery
AEP	Avionics Evaluation Program
AM	Amplitude Modulation
ASK	Amplitude Shift Keying
BER	Bit Error Rate
CEP	Circular Error Probable
C/N	Carrier to Noise Ratio
db	Decibel
DRSM	Dynamic RPV System Model
ECM	Electronic Counter Measures
FOV	Field of View
FM	Frequency Modulation
FSK	Frequency Shift Keying
Hz	Hertz
IF	Intermediate Frequency
JTIDS	Joint Tactical Information Distribution System
KEOPS	Thousands of Equivalent Add Operations per Second
PCM	Pulse Code Modulation
PSK	Pulse Shift Keying
REECE	Reconnaissance
RF	Radio Frequency
RPV	Remotely Piloted Vehicle
SAM	Surface to Air Missile
SIGINT	Signal Intelligence Station
WUC	Work Unit Code

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SECTION I

INTRODUCTION

This report documents the results of an effort to develop a version of the Avionics Evaluation Program (AEP) for analysis of Remotely Piloted Vehicle (RPV) weapon systems and to incorporate an analysis program for anti-aircraft artillery (AAA). Development of the AEP was initiated in 1968 to provide the Air Force Avionics Laboratory with an efficient tool for conducting in-house analyses of current and postulated weapon system concepts performing air-to-ground missions in a wide spectrum of operational environments. Under previous contracts, the AEP has become a collection of five avionics performance assessment models: (1) a detailed multiple aircraft, multiple sortie air-to-ground mission analysis program, (2) a free fall weapon delivery analysis program, (3) a multi-sensor target acquisition analysis program, (4) a multiple aircraft air-to-air mission analysis program and (5) an air-to-air dogfight simulation with a comprehensive graphics capability. In January, 1973, an interactive graphics capability was added to provide much more efficient use of the program. This conversational mode provides a unique "Teach" feature with simple instructions, an on-line user's manual, and management of a complex data base. The interactive capability has allowed use of the AEP with a minimum of training.

The purpose of the present effort was twofold: (1) to develop a multiple mission version of the air-to-ground AEP for the analysis of RPV weapon system concepts and (2) to incorporate a detailed antiaircraft artillery attrition analysis program within the AEP. The effort started in July, 1976, with a conversion of the air-to-ground program to a multiple mission analysis program. A copy of the Antiaircraft Artillery Simulation (AFATL Program P001) developed by the Air Force Armament Laboratory, Eglin AFB, was provided by Air Force personnel for addition to the AEP. Planned program development for the RPV analysis program and for the P001 input-output program was reviewed and approved in October, 1976.

This report contains the following elements:

1) A description of the multiple mission AEP

2) A description of the RPV communications program

3) A description of the interactive processor for the AAA attrition program.

SECTION II

SUMMARY

A multiple mission version of the AEP designed specifically for analysis of RPV weapon system concepts has been developed. This program is a Monte Carlo simulation of up to four missions consisting of up to four aircraft each for a specified number of days of operation. Functions considered include ground service, communications, navigation, refueling, target acquisition, weapon delivery, enemy jamming, ECM support and payload dispersion. Emphasis was placed on RPV related functions and intermission dependence factors. The previous framework for consideration of hardware reliability and backup modes has been retained. The program operates as follows:

1) The user provides data for each mission which: (a) defines the flight profile, (b) lists the hardware makeup (all aircraft within a mission are identically equipped) and (c) defines the functions and associated performance for the simulation.

2) The program makes a deterministic evaluation of the missions. As part of this evaluation, the vehicle equations of motion are integrated to determine the nominal time history of the flight. In addition, a common waypoint for each mission is used to determine the time sequence for proper synchronization of the profiles. The aircraft states are stored as a function of time for use during the Monte Carlo evaluation.

3) A Monte Carlo simulation is conducted. A single Monte Carlo trial is represented by simulating the scheduled flight operations for a specified number of days. The events that occur during a mission depend on random draws from probability distributions described by function performance data and hardware reliability. Numerous trials are simulated to estimate: (a) mission success, (b) mission aborts, (c) aircraft losses, and (d) mission cost.

The Antiaircraft Artillery Simulation, AFATL Program P001, has been incorporated as part of the interactive AEP. The conversational mode provides data storage and retrieval, on-line execution of the simulation, selective tabulation or plotting of results and off-line printing of the total detailed output.

SECTION III

MULTIPLE MISSION PROGRAM

The objective in developing a multiple mission version of the air-to-ground AEP was to provide a tool for the analysis of RPV weapon system concepts. The resulting program provides a mechanism for assessing the mission impact of varying avionics hardware configurations (navigation, target acquisition, weapon delivery, etc.). This includes hardware reliability as well as performance. In addition, the multiple sortie feature provides a measure of maintainability with respect to preparing the aircraft for the next flight. The program allows users to obtain a quantitative (rather than qualitative) view of the importance and interaction of the hardware characteristics. It can also provide a common framework through which various Air Force and contractor agencies can effectively communicate requirements, portray results, and make cost-effective judgements.

General Description

The RPV multiple mission version of the AEP air-to-ground mission analysis program provides analyses of functions unique to RPV missions. Additionally, this version of the AEP has been expanded to allow the evaluation of up to four simultaneous cooperating missions. The user is able to specify up to four different air vehicles, each with its own hardware complement, performance functions, and flight profile. Up to four duplicate aircraft can be utilized for each mission with RPV missions operating along with manned missions. Thus, the user is able to specify a problem involving up to 16 aircraft with a maximum of four different flight profiles. One arbitrary waypoint on each flight profile represents a common nominal time.

In stepping through a Monte Carlo sample, events for all aircraft are examined as they occur so that effects of one aircraft's or one mission's performance or malfunctions can accurately affect other members of the same mission or other missions. The extent of the cooperation or dependence among missions is controlled via user specification of intermission dependence keys. These intermission dependence keys are described in the next section.

Several features of the Westinghouse Dynamic RPV System (DRSM) (Reference Number 3) have been included in the RPV version of the AEP, primarily data link communications and jamming. The data link programs compute the likelihood of communicating between the control station and RPV's over three channels (telemetry, command and control and video) in the presence of enemy jamming. The section entitled Communications Model provides a detailed description of the communications and jamming model incorporated in the AEP.

The updated version also keeps track of the utilization of the on board computer systems throughout the mission, accumulating statistics on core requirements and processing times.

The resulting RPV version of the AEP offers a single program which can be utilized for manned or unmanned vehicles (RPV's) or any combination of each. The cost and ground turnaround features of the single mission AEP have been maintained.

Intermission Dependence Keys

In order to characterize the interaction and dependence among missions, a set of intermission dependence keys has been defined. The single mission version of the AEP allowed the user to define states and modes for each of the subfunctions. The RPV version of the AEP allows the user to provide one additional level of input, namely, the intermission dependence keys. The keys are predefined and are part of the aircraft state requirements for a particular subfunction mode of operation.

A state is a suite of hardware selected from the available equipment items. The equipment items are described by two terms, section and candidate, which are defined below.

> A section is a general category of hardware such as fire control system or navigation system. In general, the first two digits of the standard five digit Air Force Work Unit Code (WUC) defines a section.
>
> A candidate is a specific hardware item within a given section. For example, candidates for an inertial navigation system might be LN-15, LN-12, INS-16, or some other specific system.

Section 99 has been reserved for the set of defined keys. By reserving a section for the keys, it was very simple to incorporate them as part of the aircraft state requirements. Each key then becomes a unique candidate of Section 99. Table 1 lists the set of intermission dependence keys defined to date. As the need arises for more keys, additional candidates can be added to Section 99.

The first four keys allow the user to require the presence of another mission or missions in order to satisfy the state requirements. For example, a particular scenario may be such that mission number one cannot take off until mission number two is airborne. The user would specify 99-2 as part of the state requirements for the launch subfunction (4.1) of mission number one. Until the state requirement is satisfied, (that is until mission number two is airborne) mission one will remain on the ground.

TABLE 1. INTERMISSION DEPENDENCE KEYS

Key	Requirement	Section-Candidate Designation
1	Mission Number 1 Present	99-1
2	Mission Number 2 Present	99-2
3	Mission Number 3 Present	99-3
4	Mission Number 4 Present	99-4
5	Chaff Effectively Dispersed	99-5
6	Airborne Jammers Effectively Dispersed	99-6
7	Implant Jammers Effectively Dispersed	99-7
8	ECM Support Being Provided	99-8
9	RECCE Support Being Provided	99-9

The first four keys are unique in that they take on a second interpretation when specified as part of the state requirements for modes of subfunctions other than the launch subfunction. For instance, if 99-2 is specified as part of the weapon delivery state requirements for mission number one (meaning that the presence of mission number two is required), and mission number two has aborted, the state requirements cannot be met. In this case, mode regression occurs to the next mode whose state requirements can be satisfied. Thus, the first four keys can either cause a mission launch to be delayed, or cause mode regression if the state requirements cannot be satisfied.

The remaining keys, five through nine, can only cause mode regression. For example, the probability of aircraft hit from enemy fire may increase drastically if chaff has not been effectively dispersed. In this case, the user would specify 99-5 as part of the state requirements for the primary survivability mode. If chaff has not been effectively dispersed by another mission, the state requirements cannot be met, and the primary survivability mode cannot be satisfied. At this point, mode regression will occur to the next mode not requiring effective chaff dispersion. The data for the backup mode would reflect the higher probability of enemy hits. The logic employed in determining the extent of the mode regression is the same as that employed when there are equipment failures. For a complete discussion of sections, candidates, states and modes refer to Reference 1.

Flight Profile

Flight path definition is essentially unchanged from the single mission version of the AEP. The only difference with the RPV version is that when a multiple mission problem is defined, the user must specify one of the waypoints of each mission's flight profile as a common nominal waypoint in time. The common waypoints are utilized to achieve the appropriate time difference between missions. In a single mission problem, the common waypoint has no meaning or use.

Nominal Simulation

The mission simulation is separated into two parts; a nominal or deterministic evaluation and a Monte Carlo simulation. The purpose of the nominal simulation is to establish the aircraft time history in the absence of uncertainties. The aircraft equations of motion are stored for use in the Monte Carlo. In addition, any deterministic calculations required by the functions are performed with the results saved for the Monte Carlo. The functions for which computations are performed during the nominal simulations include target acquisition, weapon delivery, formation, communications, and survivability.

Monte Carlo Evaluation

While the number of Monte Carlo events has increased from the single mission version of the AEP, the logic within the Monte Carlo executive routine remains unchanged. Table 2 is a listing of the events in the RPV version of the AEP. The program sequences through the daily operations, as shown in Figure 1 for each mission for a given number of days. Random numbers are drawn from the uncertain event distributions given by the user to determine actual occurrences during the evaluation. Statistics describing the simulation results are accumulated for each mission for examination by the user.

The simulation of equipment malfunctions also remains unchanged from the single mission version. Both undetected and false failures are accounted for to evaluate the impact of imperfect equipment monitoring.

For detailed descriptions of the logic within the Monte Carlo routine and the equipment failure model, refer to Reference 1.

Monte Carlo Output

The results of the simulation are stored as a permanent file and accessed via the updated AEP interactive program. The output is composed of statistics describing random variables, number of occurrences of random events, and function/subfunction utilization for each mission. The user can selectively

TABLE 2. MONTE CARLO EVENT INDICES

LEVEL 1	LEVEL 2	LEVEL 3	
1. Call Scheduled Maintenance	1 Call Preflight	1.	Initial entry, set end of preflight
		20+I.	Aircraft I finishes preflight, check for additional failures
		30+I.	Aircraft I not finished with post-flight, check again later
	2 Call Thruflight	1.	Initial entry, set end of thru-flight
		3.	Ground abort of mission
		3+I.	Aircraft I finishes thruflight, check for additional failures
	3 Call Postflight	1.	Initial entry, set end of postflight
		20+I.	Aircraft I finishes postflight, check for additional failures
2. Call Ordnance	1 Call General Purpose Munitions	10+I.	Aircraft I loading, calculate total loading time
		20+I.	Aircraft I dearming for maintenance, calculate total dearming time
		30+I.	Aircraft I has expended all ordnance
	2 Call Rockets	10+I.	Aircraft I loading, calculate total loading time
		20+I.	Aircraft I dearming for maintenance, calculate total dearming time
		30+I.	Aircraft I has expended all ordnance

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2	LEVEL 3
2. Call Ordnance (Continued)	3 Call Guided Weapons	10+I. Aircraft I loading, calculate total loading time
		20+I. Aircraft I dearming for maintenance, calculate total dearming time
		30+I. Aircraft I has expended all ordnance
	4 Call Chaff	10+I. Aircraft I Loading, calculate total loading time
		20+I. Aircraft I unloading for maintenance, calculate total unloading time
	5 Call Implant Jammers	10+I. Aircraft I loading, calculate total loading time
		20+I. Aircraft I unloading for maintenance, calculate total unloading time.
	6 Call Airborne Jammers	10+I. Aircraft I loading, calculate total loading time
		20+I. Aircraft I unloading for maintenance, calculate total unloading time
	7 Initiate Loading	
	8 Terminate Loading	
	9 Initiate Unloading/Dearming	
	10 Terminate Unloading/Dearming	
3. Call Fueling	1 Call Fuel Loading	1. Loading fuel, calculate fuel loading time
	2 Call Fuel Usage	1. Check fuel level against bingo fuel level

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2		LEVEL 3
3. Call Fueling (Continued)	3 Call Air Refueling	1.	Initial entry, calculate hookup time for each aircraft
		2.	Hook[illegible]raft 1
		3.	H[illegible]aft 2
		4.	[illegible]raft 3
		5.	H[illegible]craft 4
		6.	[illegible]ot released
4. Call Flight	1 Call Launch	1.	Initial entry, calculate launch time
		2.	Takeoff, turn flight subfunctions on, set mission present key
	2 Call Inflight Aircraft Abort	101.	Abort aircraft, check other aircraft requirements
	3 Call Mission Abort		
	4 Call Loss of Aircraft		
	5 Call Landing	1.	Landing, turn flight subfunctions off
	6 Call RPV Airborne Launch	1.	Airborne launch, check carrier equipment states, put call to launch
	7 Call RPV Recovery	1.	Recovery, check for navigation within specified corridor
5. Call Mission	1 Call Schedule	1.	Beginning of day, set preflight and scheduled launch time
		2.	Preflight/thruflight finished, check for delay or launch
		3.	End of sortie, check for next sortie or end of day
	2 Call Cost Accumulation	1.	Calculate total simulated cost

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2	LEVEL 3	
7. Call Navigation	1 Call Radio-Aided Navigation	1.	Initial entry, calculate current navigation error, add in processor requirements
		100.	Mode change, calculate current navigation error, add new processor requirements
		102.	Turn off, remove processor requirements
	2 Call Self-Contained Navigation	1.	Initial entry, calculate current navigation error, add in processor requirements
		100.	Mode change, calculate current navigation error, add new processor requirements
		102.	Turn off, remove processor requirements
8. Call Navigation Update	1 Call Automatic Navigation	1.	Calculate sensor field of view; calculate navigation update error, add in processor requirements
		100.	Mode change, calculate current navigation error,add new processor requirements
		102.	Turn off, remove processor requirements
	2 Call Radar Navigation Update	1.	Calculate sensor field of view; calculate navigation update error, add in processor requirements
		100.	Mode change, calculate current navigation error, add new processor requirements
		102.	Turn off, remove processor requirements

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2	LEVEL 3	
8. Call Navigation Update (Continued)	3 Call Visual Navigation Update	1.	Calculate sensor field of view; calculate navigation update error. Add in processor requirements
		100.	Mode change, calculate current navigation error, add new processor requirements
		102.	Turn off, remove processor requirements
	4 Call External Navigation Update	1.	Initial entry, add in processor requirements, check probability of communication, calculate current navigation error, put call for next update based on user frequency
		2.	Check probability of communication, calculate current navigation error, put call for next update based on user frequency.
		100.	Mode change, add new processor requirements
		102.	Turn off, remove processor requirements
10. Call Survivability	1-5 Call Survivability	1.	Initial entry, calculate time of hit for each aircraft
		I+1.	Hit processor, assess damage to Aircraft I
		100.	Mode change remove old hit events; calculate new hit events

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2	LEVEL 3
10. Call Survivability (Continued)	1-5 Call SAM Survivability Subfunctions	1. Initial entry, calculate time to read hit probabilities
		201. Calculate next time to read hit probabilities
		202. Read hit probabilities, assess aircraft damage for current mode, put call to calculate next read time.
	6 Call AAA Survivability	1. Initial entry, calculate time to read hit probabilities
		2. Calculate next time to read hit probabilities
		3. Read hit probabilities, assess aircraft damage for current mode, put call to calculate next read time.
11. Call Target Acquisition	1 Call Display Acquisition	1. Initial entry, calculate detection times
		2. Target detected, calculate time of detection
		100. Mode change, remove old detection times
	2 Call Visual Acquisition	1. Initial entry, calculate detection times
		2. Target detected, calculates time of detection
		100. Mode change, remove old detection times

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2	LEVEL 3
11. Call Target Acquisition (Continued)	3 Remote Display Acquisition	1. Initial entry, check probability of video communication, calculate detection times
		2. Target detected, calculates time of detection
		100. Mode change, remove old detection times
12. Call Weapon Delivery	1 Call Manual Weapon Delivery	1. Initialization
		2. Check equipment status
		3. Check for weapon release ranges, add in processor requirements
		4. Ready for attack, check for undetected failures
		5. Attack target
		100. Mode change, find usable mode, add new processor requirements
		102. Turn off, remove processor requirements
	2 Call Automatic Weapon Delivery	1. Initialization
		2. Check equipment status
		3. Check for weapon release ranges, add in processor requirements
		4. Ready for attack, check for undetected failures
		5. Attack target
		100. Mode change, find usable mode, add new processor requirements
		102. Turn off, remove processor requirements

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2		LEVEL 3	
13. Call Target	1-5	Get Target (1-5) Data		
16. Call Payload Dispersion	1	Call Chaff Dispersion	1.	Initial entry, check navigation error, check for successful dispersion, set dispersion key.
	2	Call Inplant Jammer Dispersion	1.	Initial entry, check navigation error, check for successful dispersion, set dispersion key
	3	Call Airborne Jammer Dispersion	1.	Initial entry, check navigation error, check for successful dispersion, set dispersion key.
17. Call Mission Support	1	Call ECM Support	1.	Initial entry, check for navigation within operating corridor, set ECM support key
			102.	Turn off, check for other missions providing ECM support
	2	Call RECCE Support	1.	Initial entry, check for navigation within operating corridor, SET RECCE support key
			102.	Turn off, check for other missions providing RECCE support
18. Call On-Board Processing	1-9	Call Segment 1-9	1.	Initial entry, put call back at T_{NOW} + 1 second.
			2.	Sample processing requirements, put call back at T_{NOW} + 60 seconds
21. Get Aircraft States at Next Waypoint				
23. Create Next Failure Event				
24. End of Day				

TABLE 2. MONTE CARLO EVENT INDICES (Continued)

LEVEL 1	LEVEL 2		LEVEL 3	
25. Function on/off	1-20	Function Number (1-20)	-1.	Turn function off
			1-9.	Turn subfunction (1-9) on
26. Test Print				
27. Equipment Failure	10J+I	Item J on Aircraft I failed		
28. Turn Mission Present Key Off				
30. Accumulate costs				

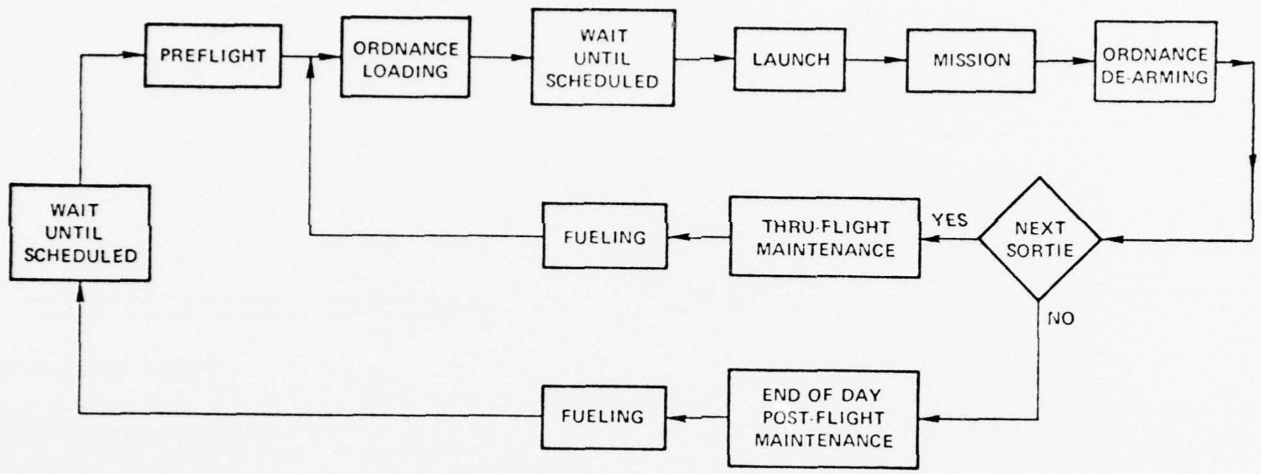


FIGURE 1. GROUND SUPPORT FUNCTIONS

examine the output of each mission with different levels of detail. A detailed description of the output is given under the section titled "Interactive Processor".

Appendix A shows the input and full output for a sample 2 mission execution of the RPV version of the AEP. The data and results shown are for illustrative purposes only, and should not be interpreted as an evaluation of any real system.

Description of Individual Functions

Table 3 lists the AEP functions and associated subfunctions. Most of the functions have computations only in the Monte Carlo portion of the program. When a function or subfunction creates an event, the following information is required by the executive routine:

1) Level 1 event type (generally the number of the function which will process the event)

2) Level 2 event type (generally the number of the associated subfunction)

3) Level 3 event type

4) Time of event

Table 2 showed all of the current events in the AEP.

The general format of the functions consists of seven subroutines defined as follows:

1) RSETXX - routine to retrieve the data associated with the current mode of subfunction under function XX

2) FUNXX - routine to perform calculations for function XX during the nominal evaluation

3) SUBXXY - routine for each subfunction Y under function XX to perform nominal calculations

4) MCFNXX - routine to perform Monte Carlo calculations for function XX

5) MSBXXY - routine for each subfunction Y under function XX for Monte Carlo calculations

6) ABRTXX - routine containing logic for aborting an aircraft if no equipment states are available for function XX

7) FABTXX - routine containing logic for aborting sortie if no modes remain for function XX

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS

1. Scheduled Maintenance
   - 1.1 Preflight
     - a. Mean Duration
     - b. Standard Deviation
     - c. Equipment List
   - 1.2 Thruflight
     - a. Mean Duration
     - b. Standard Deviation
     - c. Equipment List
   - 1.3 Postflight
     - a. Mean Duration
     - b. Standard Deviation
     - c. Equipment List
2. Ordnance
   - 2.1 General Purpose Munitions
     - a. Number of Weapons Carried
     - b. Mean Loading + Arming Time Per Weapon
     - c. Standard Deviation
     - d. Mean Dearming + Arming Time Per Weapon
     - e. Standard Deviation
   - 2.2 Rockets
     - a. Number of Weapons Carried
     - b. Mean Loading + Arming Time Per Weapon
     - c. Standard Deviation
     - d. Mean Dearming + Arming Time Per Weapon
     - e. Standard Deviation
   - 2.4 Chaff
     - a. Units Carried
     - b. Mean Loading Time Per Unit
     - c. Standard Deviation
     - d. Mean Unloading Time Per Unit
     - e. Standard Deviation

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

2.5 Implant Jammers
- a. Units Carried
- b. Mean Loading Time Per Unit
- c. Standard Deviation
- d. Mean Unloading Time Per Unit
- e. Standard Deviation

2.6 Airborne Jammers
- a. Units Carried
- b. Mean Loading Time Per Unit
- c. Standard Deviation
- d. Mean Unloading Time Per Unit
- e. Standard Deviation

3. Fueling

3.1 Fuel Loading
- a. Fueling Rate

3.2 Fuel Usage
- a. Bingo Fuel Level

3.3 Refueling
- a. Minimum Hookup Time
- b. Maximum Hookup Time
- c. Refueling Rate
- d. Number of Aircraft Refueled Simultaneously

4. Flight

4.1 Launch
- a. Mean Wait Time
- b. Standard Deviation

4.2 Inflight Aircraft Abort
- a. Required Equipment
- b. Required Aircraft

4.3 Mission Abort
- a. Required Aircraft

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

4.4 Loss of Aircraft

  a. Required Equipment

4.5 Landing

4.6 RPV Airborne Lauach

  a. Mission Number Being Launched

4.7 RPV Recovery

  a. Recovery Corridor Width

5. Mission

5-1. Schedule

  a. Earliest Time to Begin Preflight

  b. Earliest Time to Begin Launch

  c. Minimum Time Until Next Sortie

  d. Latest Time to Launch Sortie

  e. Maximum Delay Before Cancel

  f. Number of Days to Simulate

5-2. Cost Accumulation

  a. Number of Aircraft per Squadron

  b. Fuel Cost

  c. Per Flight Cost

  d. Per Unit of Flight Time Cost

  e. Flight Crew Size

  f. Flight Crew Cost

  g. Ground Crew Size

  h. Ground Crew Cost

  i. Munitions Crew Size

  j. Munitions Crew Cost

  k. Command Staff Size

  l. Command Staff Cost

  m. Number of Additional Personnel

  n. Additional Personnel Cost

  o. Investment Peculair to System

  p. Amoritization Period

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

6. Formation

6-1 Nominal Flight

a. Position of Aircraft 2 Relative to Aircraft 1

b. Position of Aircraft 3 Relative to Aircraft 1

c. Position of Aircraft 4 Relative to Aircraft 1

7. Navigation

7-1 Radio-Aided Navigation

a. Fixed Position Error

b. Correlation Time Constant

c. Processor KEOPS

d. Processor Bytes

7-2 Self-Contained Navigation

a. Per Unit Time Error Growth Rate

b. Correlation Time Constant

c. Processor KEOPS

d. Processor Bytes

8. Navigation Update

8-1 Automatic Navigation Update

a. Depression Angle to Center of Field of View

b. Horizontal Width of Field of View

c. Checkpoint Location CEP

d. Probability of Detection/Recognition

e. Accuracy of Update

f. Processor KEOPS

g. Processor Bytes

8-2 Radar Navigation Update

a. Depression Angle to Center of Field of View

b. Horizontal Width of Field of View

c. Checkpoint Location CEP

d. Probability of Detection/Recognition

e. Accuracy of Update

f. Processor KEOPS

g. Processor Bytes

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

- 8-3 Visual Navigation Update
  - a. Depression Angle to Center of Field of View
  - b. Horizontal Width of Field of View
  - c. Checkpoint Location CEP
  - d. Probability of Detection/Recognition
  - e. Accuracy of Update
  - f. Processor KEOPS
  - g. Processor Bytes
- 8-4 External Navigation Update
  - a. Accuracy of Update
  - b. Frequency of External Update
  - c. Processor KEOPS
  - d. Processor Bytes

9. Communications
- 9-1 Interflight
- 9-2 External
- 9-3 Command and Control
  - a. Transmitter Power
  - b. Transmitter Frequency
  - c. Bandwidth
  - d. Modulation Code
  - e. Noise Figure
  - f. Modulation Index
  - g. Signal Improvement Factor
  - h. Insertion Loss
  - i. Fade Margin
  - j. Receiving Antenna Type
  - k. Optimum Horn Azimuth Dimension
  - l. Optimum Horn Elevation Dimension
  - m. Parabolic Dish Diameter
  - n. Broadside Array Horizontal Dimension
  - o. Broadside Array Vertical Dimension
  - p. User Defined Antenna Main Lobe Gain

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

q. User Defined Antenna Beamwidth

r. User Defined Antenna Average Side Lobe Gain

s. Front-to-back Ratio

t. Transmitting Antenna Type

u. Optimum Horn Azimuth Dimension

v. Optimum Horn Elevation Dimension

w. Parabolic Dish Diameter

x. Broadside Array Horizontal Dimension

y. Broadside Array Vertical Dimension

z. User Defined Antenna Main Lobe Gain

aa. User Defined Antenna Beamwidth

bb. User Defined Antenna Average Side Lobe Gain

cc. Front-to-back Ratio

9.4 Video

a-cc. Same as Command and Control Data

9.5 Telemetry

a-cc. Same as Command and Control Data

9.6 Jammer Definition

a. SIGINT Gain (Command and Control)

b. SIGINT Gain (Telemetry)

c. SIGINT Gain (Video)

d. SIGINT Receiver Noise Figure (Command and Control)

e. SIGINT Receiver Noise Figure (Telemetry)

f. SIGINT Receiver Noise Figure (Video)

g. Jammer Bandwidth (Command and Control)

h. Jammer Bandwidth (Telemetry)

i. Jammer Bandwidth (Video)

j. Jammer Power (Command and Control)

k. Jammer Power (Telemetry)

l. Jammer Power (Video)

m. Jammer Frequency (Command and Control)

n. Jammer Frequency (Telemetry)

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

o. Jammer Frequency (Video)
p. Jammer Gain (Command and Control)
q. Jammer Gain (Telemetry)
r. Jammer Gain (Video)
s. Shadow Probability (Command and Control)
t. Shadow Probability (Telemetry)
u. Shadow Probability (Video)
v. Jammer 1 Type
w. X Location
x. Y Location
y. Z Location
z. Jammer 2 Type
aa. X Location
bb. Y Location
cc. Z Location
dd. Jammer 3 Type
ee. X Location
ff. Y Location
gg. Z Location
hh. Jammer 4 Type
ii. X Location
jj. Y Location
kk. Z Location
ll. Jammer 5 Type
mm. X Location
nn. Y Location
oo. Z Location

9.7 Base/Environment Definition

a. Rain Rate
b. Rain Path Fraction
c. Base X Location
d. Base Y Location

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

e. Base Z Location

f. Communications Time Step

10. Survivability

10.1-10.5
Survivability Subfunctions

a. Constant Probability of Hit

b. Per Unit Time Probability of Hit

c. Probability of Aircraft Kill

d. Table of SAM Engagement Ranges

e. Corresponding Vehicle Altitudes

f. SAM Site Density

g. Missile System Reliability Factor

h. Average Number of Fire Commands per Encounter

i. Probability of Hit for a Single Missile Fire

10.6 AAA Survivability

a. Table of AAA Engagement Ranges

b. Corresponding Vehicle Altitudes

c. Probability of Hit for a Single AAA Encounter

d. Probability of Aircraft Kill

11. Target Acquisition

11.1 Display Acquisition

a. Horizontal Width of Sensor Field of View

b. Side Look Angle for Each Aircraft

c. Table of Depression Angles

d. Cumulative Probability of Detection vs. Depression Angle

11.2 Visual Acquisition

a. Horizontal Width of Sensor Field of View

b. Side Look Angle for Each Aircraft

c. Table of Depression Angles

d. Cumulative Probability of Detection vs. Depression Angle

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

11.3 Remote Display Acquisition

a. Horizontal Width of Sensor Field of View

b. Side Look Angle for Each Aircraft

c. Table of Depression Angles

d. Cumulative Probability of Detection vs. Depression Angle

12. Weapon Delivery

12.1 Manual Weapon Delivery

a. Weapon Release Distance

b. Set-Up Time

c. Aiming CEP

d. Primary Kill Radius

e. Secondary Kill Radius

f. Ordnance Subfunction Type

g. Number Dropped per Pass

h. Targets

i. Processor KEOPS

j. Processor Bytes

12.2 Automatic Weapon Delivery

a. Weapon Release Distance

b. Set-Up Time

c. Aiming CEP

d. Primary Kill Radius

e. Secondary Kill Radius

f. Ordnance Subfunction Type

g. Number Dropped per Pass

h. Targets

i. Processor KEOPS

j. Processor Bytes

13. Target

13.1-13.5
Target Subfunctions

a. Number of Attack Passes

b. X Location Uncertainty

c. Y Location Uncertainty

TABLE 3. FUNCTION/SUBFUNCTION DATA REQUIREMENTS (Continued)

14. Miscellaneous I
    - 14.1-14.9
      Miscellaneous Subfunctions

15. Miscellaneous
    - 15.1-15.9
      Miscellaneous Subfunctions

16. Payload Dispersion
    - 16.1 Chaff Dispersion
        - a. Probability of Successful Dispersion
        - b. Dispersion Corridor Width
    - 16.2 Implant Jammer Dispersion
        - a. Probability of Successful Dispersion
        - b. Dispersion Corridor Width
    - 16.3 Airborne Jammer Dispersion
        - a. Probability of Successful Dispersion
        - b. Dispersion Corridor Width

17. Mission Support
    - 17.1 ECM Support
        - a. Operating Corridor Width
    - 17.2 RECCE Support
        - a. Operating Corridor Width

18. On-Board Data Processing
    - 18.1 Segment 1 Data Processing
    - 18.2 Segment 2 Data Processing
    - 18.3 Segment 3 Data Processing
    - 18.4 Segment 4 Data Processing
    - 18.5 Segment 5 Data Processing
    - 18.6 Segment 6 Data Processing
    - 18.7 Segment 7 Data Processing
    - 18.8 Segment 8 Data Processing
    - 18.9 Segment 9 Data Processing

In general, each subfunction creates events for any calculations or decisions required by that subfunction. However, the executive routine always forces the following subfunction events for any required action by the subfunctions:

(1) Event (I, J, 1) when Function I, Subfunction J is turned on

(2) Event (I, J, 100) when a mode regression for Function I, Subfunction J occurs

(3) Events (I_i, J_i, 101) for all Functions I; Subfunctions J, that are active, whenever some aircraft in the flight aborts or is lost

Some of the functions are turned on/off by user input with the flight profile definition, while others are controlled internally by the program. Table 4 lists the type of control for each function.

TABLE 4. LIST OF INITIAL FUNCTION CALLS

Function	Control
1. Scheduled Maintenance	Internal
2. Ordnance	Internal
3. Fuel	
3-1. Loading	Internal
3-2. Usage	User turn on
3-3. Refueling	User turn on
4. Flight	
4-1. Launch	Internal
4-2. Inflight A/C Abort	Internal
4-3. Mission Abort	Internal
4-4. Loss of Aircraft	Internal

TABLE 4. LIST OF INITIAL FUNCTION CALLS
(Continued)

Function	Control
4-5. Landing	Internal
4-6. RPV Air-borne Launch	User turn-On
4-7. RPV Recovery	Internal
5. Schedule	Internal
6. Formation	User turn on
7. Navigation	User turn on
8. Navigation Update	User turn on
9. Communication	User turn on
10. Survivability	User turn on
11. Target Acquisition	User turn on
12. Weapon Delivery	a. Turned on and activated internally by target detection or b. User turn on prior to target detection, then activated at detection
13. Target	Internal
14. Misc. I	User turn on
15. Misc. II	User turn on
16. Payload Dispersion	User turn on
17. Mission Support	User turn on
18. On Board Data Processing	User turn on

A description of only those functions and subfunctions which have been added or modified since the single mission version of the AEP follows. For a description of the remaining functions and subfunctions refer to Reference 1.

Ordnance Function

The mechanics of the Ordnance Function remain unchanged from the single mission version of the AEP. However, three additional subfunctions have been added to characterize the time required to load and unload three additional types of mission payloads. The three additional subfunctions are: Chaff Loading, Implant Jammers Loading, and Airborne Jammers Loading. The subfunctions calculate the time required to load the payloads prior to each sortie, and also calculate the time required to unload the payload at the end of each sortie. The three subfunctions are identical.

The input items for each of the subfunctions are: the number of units carried, the mean and standard deviation of the loading time for each unit, and the mean and standard deviation of the unloading time for each unit. There are no nominal calculations, aircraft aborts, or mission aborts associated with this function.

The three new payload loading subfunctions can be used in conjunction with the weapon loading subfunctions. In the Monte Carlo routine (MCFN02) each of the subfunctions for which data has been supplied are called to determine total loading plus arming time prior to each sortie and total unloading plus de-arming time after each sortie for each aircraft. After unloading and dearming, control passes to fuel loading. After loading and arming, control returns to preflight or thruflight as appropriate.

One assumption that is made in the new subfunctions is that the entire payload of chaff and/or jammers is expended at one time. Thus, there will be no required unloading time after a sortie for these payloads if a dispersal takes place during flight.

Flight

This function provides a means of specifying the equipment requirements for various portions of the mission. In addition to the five subfunctions of the single mission version (Launch, Aircraft Abort, Mission Abort, Aircraft Loss, and Landing) there are two new subfunctions; RPV Airborne Launch, and RPV recovery. Abort logic is provided under each subfunction.

RPV Airborne Launch. The RPV Airborne Launch subfunction characterizes the airborne launch of a mission of RPV's from a mission of carrier aircraft. The subfunction is associated with the carrier mission, and is turned on by the user at the point of launch in the flight profile of the carrier mission.

The input data required for this subfunction is the mission number that is being launched by the carrier mission. When the subfunction is turned on, the equipment states of the carrier are checked. If no carrier equipment states exist, the carrier mission is aborted and the RPV mission is never launched. Both missions are then sequenced through thruflight when the carrier mission lands 30 minutes later (an arbitrary 30 minutes of time is added when any mission aborts). If the carrier equipment states can be satisfied, a call is made to the launch subfunction of the RPV mission. Within the launch subfunction; the equipment states of the RPV mission are checked and a random sortie launch time, representative of the time interval between engine start and actual launch, is generated. If the RPV equipment states are not satisfied, both the carrier and RPV missions are aborted and sequenced through thruflight when the carrier mission lands 30 minutes later.

The carrier mission will always wait for the RPV mission to finish ground maintenance before the carrier mission takes off. Depending upon the maintenance times generated, this could produce somewhat longer launch delay times than expected.

RPV Recovery. The RPV Recovery subfunction characterizes the recovery of a mission of RPV's. When the mission is completed or when there is a mission abort, a check is made to determine if the user has supplied data for the Landing subfunction or for the RPV Recovery subfunction. If data has been supplied for the Landing subfunction, it is utilized. Otherwise, the RPV Recovery subfunction is called. In this subfunction, the RPV equipment states are checked. If the equipment states cannot be satisfied, the aircraft is counted as lost. If the equipment states are available, a check is made on the accuracy of the RPV navigation relative to the width of the RPV recovery corridor (input by the user). If the RPV cannot navigate within the specified corridor, recovery is impossible, and the vehicle is counted as lost.

To determine if the RPV is within the specified corridor, the current navigation error is computed. The calculation of the navigation error is identical to the method employed in the single mission version of the AEP. For a detailed description of the navigation error model, refer to Reference 1.

Navigation

The mechanics of the navigation subfunctions are unchanged from the single mission version. However, two additional input data items are now required by each subfunction. These two items are the processor KEOPS (thousands of equivalent add operations per second) and the processor bytes required to perform the two types of navigation. Consult the "On Board Processing" section of this report for more detail on computer workload analysis.

Navigation Update

The navigation update model is unchanged from the single mission version of the AEP. However, like the navigation subfunctions, processor KEOPS and processor bytes have been added to the required input items to account for the on board processor requirements for performing the navigation update. Additionally, an External Navigation Update subfunction has been added and is described below.

The External Navigation Update subfunction characterizes a navigation update received from an external source such as an RPV control station. The input items required for this subfunction are the accuracy of the update, the frequency at which the updates are transmitted, the processor KEOPS, and the processor bytes. Since the navigation is received from an external source, the sensor field of view and checkpoint calculations of the navigation update model are not required. Instead, the success of the navigation updates hinges upon the ability to receive the update over the Command and Control uplink communications channel.

When the External Navigation Update subfunction is called, the Command and Control communications probability is evaluated from the table of probabilities produced by the communications model. The computation is a linear interpolation for the probability based on the current time. If communications between the base and RPV over the Command and Control channel is impossible, (based on the random draw) the navigation update does not occur. When communication is possible, the navigation error is reset based upon a random draw from the input update accuracy.

A call back to the External Navigation Update subfunction is then placed in the events table. The time of this call is determined from the input frequency of update. Using this feature, the user has the capability of attempting a navigation update every designated period of time. When communication over the command and control link is impossible, the navigation error will continue to grow. There are no nominal calculations, aircraft aborts, or mission aborts associated with this subfunction.

Communications

In addition to the Interflight and External Communications Subfunctions of the single mission version of the AEP, five more communications subfunctions are provided. These subfunctions are Command and Control Communications, Video Communications, Telemetry communications, Jammer Definition, and Base/Environment Definition. The description of each subfunction follows:

Command and Control Communications. The Command and Control Communications subfunction serves two purposes. The first purpose is to provide a means of assessing the reliability of the communications equipment required for communicating with the base over the command and control uplink channel. Loss of all vehicle equipment states for command and control communications causes the vehicle to be counted as lost. Loss of all modes will cause a mission abort.

The second purpose of this subfunction is to provide the user with a convenient place in which to input the necessary command and control communications information required by the communications model. The input data is listed in Table 3. Only the data provided under the first mode of operation is utilized by the communications model. The input data is used solely by the communications model.

Video Communications. The Video Communications subfunction is similar to the Command and Control subfunction in that it exists for the same two purposes. The only difference is that loss of all vehicle equipment states for this subfunction has no impact. However, loss of all modes will cause a mission abort.

The input data, which is used solely by the communications model, is listed in Table 3. Again, only the data provided under the first mode of operation is utilized by the Communications model.

Telemetry Communications. The Telemetry Communications subfunction is similar to the two communications subfunctions already described. This subfunction serves the same two purposes. Loss of all modes for this subfunction will cause a mission abort, and loss of all equipment states has no impact. The input data is used solely by the communications model, and is listed in Table 3. Only the mode one data is utilized.

Jammer Definition. The Jammer Definition subfunction exists only to provide a convenient place for the user to input the various jammer and SIGINT (Signal Intelligence Station) characteristics. There are no equipment states or modes associated with this subfunction. The input data is listed in Table 3. Examination of the data shows a list of jammer and SIGINT characteristics followed by five sets of location variables. This allows the user to locate up to five jammers. The jammer and SIGINT characteristics apply to all jammers and SIGINTS defined. A detailed discussion of the jammer and SIGINT characteristics can be found in the section titled "Communications Program".

Base/Environment Definition. The Base/Environment Definition subfunction exists merely to provide a place for the user to input the base location and the environment variables. There are no equipment states or modes associated with this subfunction. The input data is listed in Table 3 and is used solely by the communications model.

Survivability

The five survivability subfunctions which exist in the single mission version of the AEP have been maintained in the RPV version. However, a slightly modified version of the Westinghouse SAM Survivability model from the Dynamic RPV System Model (DRSM) (Reference 3) has been added to each of the five subfunctions. In addition, a sixth survivability subfunction, consisting of the Westinghouse AAA Survivability model from the DRSM, has also been provided.

The user thus has the capability of selecting either survivability model for any one defense segment of the flight profile. Combinations of the old model along with the SAM/AAA models are acceptable.

Internally, the program makes the determination of which model to use based upon an examination of the input data. The SAM model is based on the density of SAM sites in the defense area. If site density has been provided by the user, the SAM model is utilized. Otherwise, the model existing in the single mission version of the AEP is utilized.

When the SAM or AAA models are utilized, the calculation of the actual hit probabilities are computed for all modes during the nominal simulation and written to a data file for later use in the Monte Carlo evaluation.

During the Monte Carlo evaluation, the hit probabilities for the current mode are read from the file. An assessment of the vehicle damage is then made based on the hit probabilities and the probability of aircraft kill. It should be noted that the probability of aircraft kill is common to both survivability models and must always be input regardless of the model used.

A description of the SAM and AAA survivability models follows.

SAM Survivability Subfunctions 1-5. The five SAM survivability subfunctions are provided so that the user may have direct control over when each is used. For example, a particular mission profile may progress through defensive zones with different probabilities of survival and different site densities. The user can key the use of each subfunction (with different data) to waypoints defining the flight profile. This switching cannot occur with the mode structure since equipment failures, not geographical location, causes a regression to an alternate mode.

The calculation of hit probabilities is performed in the nominal portion of the simulation for all subfunction modes. The required input items for these subfunctions are a table of weapon engagement ranges versus vehicle altitude; SAM site density; missile system reliability factor; average number of fire commands per encounter; probabilitiy of hit for a single missile fire; and the probability of aircraft kill. The missile system reliability factor is given as a fraction of the missiles which fire on command. The SAM site density is input in terms of sites per square nautical mile. The actual calculation of the probability of hit is performed as follows.

1. Compute the average number of encounters with the weapon site

   $$N = 2DR\sigma$$

   where

   D = Distance flown within the defense zone
   R = Weapon engagement range
   σ = Weapon site density

   The defense zone is assumed to begin at the point within the flight profile where the subfunction is turned on by the user. The distance flown within the defense zone is then updated at each waypoint. The weapon engagement range is computed by a linear interpolation on the table of engagement ranges versus altitude based on the average vehicle altitude between waypoints.

2. Compute the expected total number of missiles fired

   $$K = NFM$$

   where

   N = Average number of encounters
   F = Missile system reliability factor
   M = Average number of fire commands per encounter

3. Compute the probability of hit

$$P = 1.0 - (1.0 - PH_1)^K$$

where

PH_1 = Probability of hit for a single missile fire

K = Expected number of missiles fired.

During the Monte Carlo evaluation, the hit probabilities are read from the file at times which are always midway between waypoints. Only the hit probability associated with the current subfunction mode is processed.

When a hit probability is being processed, a uniform random number representing the probability of aircraft kill is generated. This number is compared to the input probability of kill to determine if the aircraft has been lost. A lost aircraft is removed from the mission, and a check is made to determine if the mission must be aborted.

When examining an aircraft which has only been damaged, the vulnerability associated with each hardware item is checked to determine if the item has failed because of the hit. The failure of a hardware item requires that the subfunction modes be checked to determine if mode regression is possible.

It is assumed that the loss of critical ECM equipment could make the aircraft too vulnerable to enemy fire, hence loss of all modes for a subfunction causes a mission abort. To negate this option, the user only needs to specify one extra "trap" mode with no equipment requirements.

AAA Survivability. The only difference between the SAM survivability subfunctions and the AAA subfunction is that the probability of hit per encounter is input, rather than the probability of hit per shot. The probabilities of hit are calculated for each mode in the nominal portion of the simulation and written to a data file for processing during the Monte Carlo evaluation.

The input data items for the AAA subfunction are a table of weapon engagement ranges versus vehicle altitude, the probability of hit for a single AAA encounter, AAA site density, and the probability of vehicle kill. The calculation of the probability of hit is as follows.

1. Compute the average number of encounters with the AAA site

$$N = 2DR\sigma$$

where

D = Distance flown within the defense zone

R = Weapon engagement range

σ = AAA site density

2. Compute the probability of hit

$$P = 1.0 - (1.0 - PH_1)^N$$

where

PH_1 = Probability of hit for a single AAA encounter

N = Average number of encounters with the AAA site

The hit probabilities are processed exactly the same as in the SAM subfunctions. The same assumption about loss of critical ECM equipment also holds for this subfunction.

Target Acquisition

In addition to the Display and Visual Acquisition subfunctions, a Remote Display Target Acquisition subfunction has been provided.

The Remote Display Target Acquisition Subfunction characterizes target acquisition from a remotely based video display. The performance data is the same as that for the Display and Visual Acquisition subfunctions and is listed in Table 3. The only difference between the Remote Display Acquisition subfunction and the other two acquisition subfunctions is that the probability of video communication is a factor.

In the Monte Carlo routine (MSB113), before the check is made for targets within the field of view, the probability of communicating over the video downlink is calculated. The probability is calculated by means of a linear interpolation on the table of probabilities versus time based on the current time. The table of probabilities is produced by the communications model. If communication over the video downlink is not possible, the target cannot be acquired. If communication is possible, the normal procedures to determine targets in the field of view are followed.

When the target falls within the FOV, a random depression angle is obtained from the user table of detection probability versus depression angle. Based upon the aircraft flight profile, the time when that depression angle occurs is calculated and a target detection event is created at that time. If the next waypoint is reached prior to detection, the predicted detection is cancelled and another check for detection is made based on the FOV for the new flight segment.

All targets specified by the user are checked for detection during each search segment, with attack passes occurring based on the sequence of detection. Thus, for relatively close targets, the order of attack can be different than the order to target locations. After an attack against one target, the acquisition process is resumed for the remaining targets. This feature allows a user to simulate a target of opportunity type mission.

There are no aircraft aborts due to loss of acquisition equipment items. A mission abort occurs only if all possible modes of all subfunctions have failed.

Weapon Delivery

The weapon delivery subfunctions have been maintained intact from the single mission version of the AEP. To account for the on board processor time and core required for weapon delivery, two data items, processor KEOPS and processor bytes, have been added. The section titled "On Board Processing" provides a detailed description of the computer workload analysis. Refer to Reference 1 for a detailed discussion of the logic within the weapon delivery subfunctions.

Payload Dispersion

Three Payload Dispersion subfunctions (Chaff Dispersion, Implant Jammer Dispersion and Airborne Jammer Dispersion) have been added to provide an assessment of the dispersion of non-ordnance type payloads. The required input data for all three subfunctions is the width of the dispersion corridor and the probability of successful dispersion. It is assumed that for any of these three payloads to be effective, they must be dispersed within some corridor near a target complex. Thus, if the vehicle cannot navigate within the user specified corridor, there is no dispersion. When the vehicle successfully navigates within the dispersion corridor, the entire payload is dispersed. It is assumed that the point of dispersion is the point of subfunction turn-on specified by the user within the flight profile. A random number is then drawn from a uniform probability distribution and compared to the user specified probability of successful dispersion to determine the success of the dispersion. Thus, even though the payload was dispersed, it may not have been effective. The probability feature was added to allow the user to account for degradation factors such as wind and weather.

When successful dispersion occurs, the appropriate intermission dependence key is set. This feature allows the user to have some other mission subfunction influenced by the effectiveness of the payload dispersion.

The logic within the three subfunctions is identical. The differences lie in the input data. Presumably, different size dispersion corridors will be required for each of the three types of payload along with different success probabilities.

The determination of whether or not the vehicle has navigated within the specified dispersion corridor is performed by calculating the current vehicle navigation error. The navigation error model is the same as the one used in the single mission version.

Statistics are compiled on successful and unsuccessful dispersions and unsuccessful dispersions due to excessive navigation error.

There are no aircraft aborts associated with these subfunctions. A mission abort occurs only if all possible modes of the subfunctions have failed.

Mission Support

Two mission support subfunctions, ECM Support and RECCE support, have been added to characterize one mission providing ECM and/or RECCE support for another mission. Again, the problem is assumed to be basically one of navigation. An ECM vehicle presumably must be radiating within some radius of the target or enemy radars at the time of strike in order for the ECM to be effective. Thus, the user must provide the width of the operating corridor. The support is counted as effective only if the vehicle can navigate within the operating corridor. The same navigation error model utilized for Payload Dispersion is used by the ECM and RECCE support subfunctions.

While ECM and/or RECCE support are being provided, the appropriate intermission dependent key is set. It is assumed that the support begins when the subfunctions are turned on in the flight profile by the user. Support continues until the function is turned off by the user, at which time the appropriate key is turned off if no other mission is providing the same type of support.

The logic within the two subfunctions is identical. The differences lie in the input data and the key which is set when the support is provided.

There are no aircraft aborts associated with these two subfunctions. A mission abort occurs only if all possible modes of the subfunctions have failed. If the mission providing the support does in fact abort, the appropriate intermission dependence key is turned off if no other mission is providing the same type of support.

On Board Data Processing

Nine on board data processing subfunctions have been provided to allow the assessment of the on board processor time and core requirements during nine separate segments of the flight profile. Presently, the program assumes that three functions require the use of the on board processor: navigation, navigation update, and weapon delivery. Each subfunction within the above functions has two additional data items associated with it (processor KEOPS and processor bytes). The analyses of the processor requirements was limited to the three functions rather than applying the analysis to all program functions to maintain a manageable amount of input data. However, it is a very minor task to add the processor workload analysis to any or all of the remaining subfunctions.

The KEOPS requirement for a task is determined by multiplying the equivalent adds per iteration by the processor update rate in iterations per second.

Total processor requirements are determined by a simple summing method. The requirements change when the following events occur:

(1) Subfunction turn-on

(2) Subfunction mode change

(3) Subfunction turn-off and

(4) Function abort

At subfunction turn-on, the processor KEOPS and bytes required to perform the subfunction are added to the total processor requirements at that point. When a subfunction mode changes, the requirements of the previous mode of operations are subtracted from the total requirements, and the requirements of the new mode are added. When a subfunction is turned off or a function aborts, requirements for the active subfunction or subfunctions are subtracted from the total requirements at that point in time.

The actual addition and subtraction of the individual subfunction requirements from the total processor requirements is performed by a summing routine that is called by the individual subfunctions. An additional Level 3 Monte Carlo event index of 102 was added to call the subfunctions utilizing the on board processor when the subfunctions were turned off. This was necessary since the processor requirements for performing the subfunctions must be subtracted from the total processor requirements when the subfunctions are turned off. Table 2 exhibits this new Monte Carlo event index.

The nine individual on board processing subfunctions merely sample the requirements periodically. When a subfunction is turned on by the user, a call is placed in the event table back to the subfunction at a time one second later. When control again returns to the subfunction, the total processor KEOPS and bytes, which are being used at that time and which have been tallied through the subfunctions actually utilizing the on board processor, are sampled. A call is then placed back to the subfunction at a time 60 seconds later. Thus, the processor requirements are sampled every 60 seconds. If the time of the next sample event is greater than the time of the next waypoint, the time is changed to one second after the next waypoint. This insures that a sample is taken immediately after any subfunctions are turned on or off at the waypoint.

The definition of the up to nine segments of the flight profile over which the processor requirements are analyzed is left to the user. A segment is assumed to begin when an on board processing subfunction is turned on, and is assumed to end when the subfunction is turned off. These segments may overlap each other without causing any difficulty.

The output resulting from the analysis consists of statistics for each of the defined segments. These statistics include the mean and standard deviation of both KEOPS and bytes, and the maximum and minimum requirements for each of the segments. The statistics allow the user to determine areas of peak processing requirements.

Loss of all vehicle equipment states cause an aircraft abort since a vehicle could not continue a mission without its on board processor. A mission abort occurs if all possible modes of all on board processing subfunctions have failed.

Interactive Graphics Processor

This section describes the changes made to the interactive processor in order to accommodate definition of multiple mission simulations. Since only the changes are described here, the reader who is unfamiliar with the single mission interactive processor should refer to Reference 1.

Flight Profile

Since a multiple mission simulation requires that the flight profiles of each of the missions be related by means of an arbitrary common waypoint, a command was added to the Flight Profile Section to allow the designation of the common waypoint number. The new command is WP,ID, where ID represents a waypoint number in the current flight profile. The designated common waypoint number is stored as part of the flight profile information and is displayed after the target information when the flight profile information is listed. Figure 2 shows an example of the use of the WP command. The user inputs are numbered to correspond to the explanations given below.

(1) The user entered the command to enter the Flight Profile Section of the processor.

(2) Previously created flight profiles are stored in the data file along with an alphanumeric description entered at the time they were stored. The user is asking for a listing of the stored profiles. The listing follows.

(3) Profile number 1 is selected by the user.

(4) The user has requested a listing of the information stored for profile number 1. The listing follows.

(5) The user desires to change the common waypoint number to waypoint number 3.

(6) The profile information is listed to show the new common waypoint number.

Multiple Mission Assignments

The major changes to the interactive processor occur in the actual set up of a multiple mission simulation. Individual execution records (previously created under AEPDECK) must be assigned to each mission along with flight profiles and number of aircraft. To assign these three categories of data to each mission, a new section was added to the interactive processor. This section is called AEPRUN and is entered from the AEP command level.

```
        AEP COMMAND
(1)     --       FP
        ENTER PROFILE ID
(2)     --       SHOW
          1  NRL DEMO PROFILE
          2  CURRENT COMMON WP FP
          3  COMM TEST PROFIL 3
          4  MISSION 1 PROFILE (CARRIER)
          5  MISSION 2 (RPV)
        ENTER PROFILE ID
(3)     --       1
        FP COMMAND
(4)     --       LIST
         ID       X         Y          H         V       ON            OFF
          1      0.00      0.00         0.      250.    302   702
                                                        902  1001
          2     10.00      0.00     10000.      350.
          3     20.00      0.00     20000.      400.
          4    100.00      0.00     20000.      400.
          5    110.00     10.00       500.      450.   1002             10
          6    150.00     50.00       500.      450.   1003             10      9
          7    170.00     70.00       500.      450.
          8    170.20     70.20      2000.      450.   1101
          9    172.00     72.00      2000.      450.   1004             10
         10    176.00     76.00      2000.      450.                    11
         11    172.00     78.00     10000.      450.   1003             10
         12    145.00     75.00     30000.      400.   1002             10
         13     60.00     60.00     30000.      400.   1001             10
         14     25.00     25.00     30000.      400.
         15      0.00      0.00         0.      150.                    10      3
                                                                         7
        TARGET 1 LOCATION -   X=        175.0    Y=          75.0
        COMMON WAYPOINT NUMBER= 15
        FP COMMAND
(5)     --       WP,3
        FP COMMAND
(6)     --       LIST
         ID       X         Y          H         V       ON            OFF
          1      0.00      0.00         0.      250.    302   702
                                                        902  1001
          2     10.00      0.00     10000.      350.
          3     20.00      0.00     20000.      400.
          4    100.00      0.00     20000.      400.
          5    110.00     10.00       500.      450.   1002             10
          6    150.00     50.00       500.      450.   1003             10      9
          7    170.00     70.00       500.      450.
          8    170.20     70.20      2000.      450.   1101
          9    172.00     72.00      2000.      450.   1004             10
         10    176.00     76.00      2000.      450.                    11
         11    172.00     78.00     10000.      450.   1003             10
         12    145.00     75.00     30000.      400.   1002             10
         13     60.00     60.00     30000.      400.   1001             10
         14     25.00     25.00     30000.      400.
         15      0.00      0.00         0.      150.                    10      3
                                                                         7
        TARGET 1 LOCATION -   X=        175.0    Y=          75.0
        COMMON WAYPOINT NUMBER=  3
```

FIGURE 2. COMMON WAYPOINT EXAMPLE

When the AEPRUN section is entered, the user is immediately asked to enter the number of missions for the current problem. One to four missions can be simulated simultaneously.

Within the AEPRUN section, there are five available commands: MISSION, FP, N, XEQ, SHOW. The MISSION command provides a means of assigning stored execution records, previously created under AEPDECK, to each of the missions. The mission number is designated by a single letter (A,B,C, or D). The letter A corresponds to mission 1, B to mission 2 and so on. An example of the command would be MISSION, B,4. This command assigns execution record number 4 to mission number 2.

The FP Command is very similar to the MISSION command except that it assigns stored flight profiles to each mission. For example, FP, B,3 assigns flight profile number 3 to mission number 2.

Along these same lines, the N command assigns the number of aircraft to each mission. The command N,B,2 assigns 2 aircraft to mission number 2. The MISSION and N commands may be combined in the following form - MISSION,A,3,N,2. This command assigns execution record number 3 to mission number 1 and assigns 2 aircraft to mission number 1.

Since the user may not know all of the stored execution records and all of the stored flight profiles, the commands MISSION, SHOW and FP, SHOW can be entered to list the stored execution records and stored flight profiles, respectively.

The SHOW command provides the user with a list of selected execution records, flight profiles and number of aircraft assigned to each mission at any one time.

The XEQ command retrieves the assigned execution records and flight profiles for each of the missions, and checks the assignments for errors and consistency. Any errors that are found are brought to the user's attention through an error message. If the assignments are consistent and there are no errors, an input file for the batch AEP program is created. A control card record required to run the batch program, along with the input file is then submitted to the input queue.

Figure 3 shows an example of the uses of the new AEPRUN commands. The user input are numbered to correspond to the explanations given.

(1) The AEPRUN section is entered.

(2) The user designates a 2 mission simulation.

(3) Request a list of available AEPRUN commands. The list follows.

(4) Request a listing and explanation of the legal MISSION command forms.

```
        AEP COMMAND
(1)     --        AEPRUN
        ENTER NUMBER OF MISSIONS FOR THIS PROBLEM
(2)     --        2
        AEPRUN COMMAND
(3)     --        ?
        VALID COMMANDS ARE
        MISSION  N  FP  XEQ  SHOW  QUIT
        AEPRUN COMMAND
(4)     --        MISSION?
        SELECT AN EXECUTION RECORD OR AN EXECUTION RECORD AND NUMBER OF
        AIRCRAFT FOR A PARTICULAR MISSION.
        EXAMPLES--
        MISSION,A,1      SWLECT EXECUTION RECORD NUMBER 1 FOR MISSION 1
        MISSION,B,3      SELECT EXECUTION RECORD NUMBER 3 FOR MISSION 2
        MISSION,C,2      SELECT EXECUTION RECORD NUMBER 2 FOR MISSION 3
        MISSION,D,5      SELECT EXECUTION RECORD NUMBER 5 FOR MISSION 4
        MISSION,C,3,N,2  SELECT EXECUTION RECORD NUMBER 3 FOR MISSION 3
                         AND ASSIGN 2 AIRCRAFT TO MISSION 3
        AEPRUN COMMAND
(5)     --        MISSION,SHOW
         ID          DESCRIPTION
          1  NLR DEMO EXECUTION
          2  DEMO
          3  KEY TEST RECORD
          4  COMM TEST REC
          5  RPV EX REC 3
          6  CARRIER EX REC
        AEPRUN COMMAND
(6)     --        MISSION,A,6,N,2
        AEPRUN COMMAND
(7)     --        MISSION,B,5,N,2
        AEPRUN COMMAND
(8)     --        FP?
        SELECT FLIGHT PROFILE FOR A PARTICULAR MISSION
        EXAMPLES--
        FP,A,3  SELECT FLIGHT PROFILE 3 FOR MISSION 1
        FP,B,5  SELECT FLIGHT PROFILE 5 FOR MISSION 2
        FP,C,1 SELECT FLIGHT PROFILE 1 FOR MISSION 3
        FP,D,2 SELECT FLIGHT PROFILE 2 FOR MISSION 4
        AEPRUN COMMAND
(9)     --        FP,SHOW
         ID          DESCRIPTION
          1  NRL DEMO PROFILE
          2  CURRENT COMMON WP FP
          3  COMM TEST PROFIL 3
          4  MISSION 1 PROFILE (CARRIER)
          5  MISSION 2 (RPV)
        AEPRUN COMMAND
(10)    --        FP,A,4
        AEPRUN COMMAND
(11)    --        FP,B,5
```

FIGURE 3. EXAMPLE AEPRUN COMMANDS

```
         AEPRUN COMMAND
(12)     --         SHOW?
         SHOW SELECTED EXECUTION RECORDS, FLIGHT PROFILES AND
               NUMBER OF AIRCRAFT FOR EACH MISSION.
         AEPRUN COMMAND
(13)     --         SHOW
         MSN NO 1-- NO OF A/C= 2 EXEC REC= CARRIER EX REC

         MSN NO 1-- PROFILE= MISSION 1 PROFILE (CARRIER)

         MSN NO 2-- NO OF A/C= 2 EXEC REC= RPV EX REC 3

         MSN NO 2-- PROFILE= MISSION 2 (RPV)

         AEPRUN COMMAND
(14)     --         XEQ?
         CHECK DATA FOR ERRORS AND EXECUTE BATCH AEP
         EXAMPLES--
         XEQ,WAIT   CHECK DATA FILE, BUT DO NOT EXECUTE BATCH AEP
         XEQ        CHECK DATA FILE AND EXECURE BATCH AEP
         AEPRUN COMMAND
(15)     --         XEQ,WAIT
         INITIATING MSN NO 1  DATA CHECK
         END MSN 1  DATA CHECK
         INITIATING MSN NO 2  DATA CHECK
         END MSN 2  DATA CHECK
         ENTER NUMBER OF MONTE CARLO TRIALS
(16)     --         10
```

FIGURE 3. EXAMPLE AEPRUN COMMANDS (Continued)

(5) Show the stored execution records.

(6) Assign execution record number 6 to mission number 1, and also assign 2 aircraft to mission number 1.

(7) Assign execution record number 5 to mission number 2 and, also assign 2 aircraft to mission number 2.

(8) Request a listing and explanation of the legal FP command forms.

(9) Show the stored flight profiles.

(10) Assign profile number 4 to mission number 1.

(11) Assign profile number 5 to mission number 2.

(12) Request an explanation of the SHOW command.

(13) Show the mission assignments made so far.

(14) Request a listing and explanation of the legal XEQ command forms.

(15) Check the assigned data for errors and consistency but do not submit the batch programs to the computer input queue.

(16) Select 10 Monte Carlo trials for the simulation.

Multiple Mission Output

Several changes were required within the AEPOUT section to allow the user to selectively view the simulation results of each mission. Upon entering the AEPOUT section, the user is asked to enter the mission number for which the results are to be viewed. Thus, the results of each mission are viewed separately. In order to change to the viewing of another mission, the AEPOUT section must be exited via a QUIT command and then re-entered. Upon reentry, the user should type the new desired mission number.

With the addition of the on board processor workload analysis, a command was added to allow the viewing of the data processing statistics independent of the ground and airborne statistics. The command is STAT, DP which will provide a listing of the on board processing statistics for each of the nine flight segments.

The probabilities of communication produced by the communications model may be of interest to the user. The command PROB or P will list communications probabilities for each of the three communications channels.

Figure 4 is an example of the use of these new commands. The user inputs are numbered to correspond to the following explanations.

(1) Enter the AEPOUT section to view simulation results.

(2) Request the viewing of mission number 2 results.

(3) Show mission number 2 title.

(4) Request a listing and explanation of the legal STAT command forms.

(5) List the on board processing statistics.

(6) Request a listing and explanation of the legal PROB command forms.

(7) List the communications probabilities versus time for each communications channel.

(8) Leave the AEPOUT section

(9) Re-enter the AEPOUT section.

(10) Request the viewing of mission number 1 results.

(11) Show mission number 1 title.

(12) List subfunction utilization statistics for mission number 1.

```
      AEP COMMAND
(1)   --        AEPOUT
      ENTER DESIRED MISSION NUMBER
      --        2
(2)   AEPOUT COMMAND
(3)   --        T

      RPV EX REC 3

         5 MONTE CARLO TRIALS, WITH 2AIRCRAFT, FOR ,  2 DAYS

      AEPOUT COMMAND
(4)   --        STAT?
      DISPLAY CONTINUOUS VARIABLE STATISTICS FOR A SPECIFIED DATA GROUP
         EXAMPLES
      STAT,GND,1     DISPLAY GROUND PREPARATION DATA STATISTICS
                     AT LOWEST LEVEL OF DETAIL (AGGREGATED DATA)
      S,AIR,2        DISPLAY AIRBORNE DATA STATISTICS AT HIGHLY
                     DETAILED LEVEL OF OUTPUT
      STAT,COST      DISPLAY COST DATA STATISTICS AT DEFAULT
                     LEVEL OF DETAIL (SEE LEVEL COMMAND)
      GROUP ID IS REQUIRED AND MUST BE ONE OF  GND, AIR, COST, ALL
      STAT,DP        DISPLAY DATA PROCESSING STATISTICS AT DEFAULT
                     LEVEL OF DETAIL
      AEPOUT COMMAND
(5)   --        STAT,DP

      DATA PROCESSING DATA
```

VARIABLE	SAMPLES	MEAN	STD DEV	MAX	MIN
SEGMENT 1 BYTES	288	900.	174.	1000.	600.
SEGMENT 1 KEOPS	288	201.	58.6	235.	100.
SEGMENT 2 BYTES	0	0.	0.	0.	0.
SEGMENT 2 KEOPS	0	0.	0.	0.	0.
SEGMENT 3 BYTES	0	0.	0.	0.	0.
SEGMENT 3 KEOPS	0	0.	0.	0.	0.
SEGMENT 4 BYTES	0	0.	0.	0.	0.
SEGMENT 4 KEOPS	0	0.	0.	0.	0.
SEGMENT 5 BYTES	0	0.	0.	0.	0.
SEGMENT 5 KEOPS	0	0.	0.	0.	0.
SEGMENT 6 BYTES	0	0.	0.	0.	0.
SEGMENT 6 KEOPS	0	0.	0.	0.	0.
SEGMENT 7 BYTES	0	0.	0.	0.	0.
SEGMENT 7 KEOPS	0	0.	0.	0.	0.
SEGEMNT 8 BYTES	0	0.	0.	0.	0.
SEGMENT 8 KEOPS	0	0.	0.	0.	0.
SEGMENT 9 BYTES	0	0.	0.	0.	0.
SEGMENT 9 KEOPS	0	0.	0.	0.	0.

FIGURE 4. NEW AEPOUT COMMANDS

```
          AEPOUT COMMAND
(6)       --        PROB?
          DISPLAY COMMUNICATION PROBABILITIES VS. TIME
          AEPOUT COMMAND
(7)       --        PROB
```

COMMUNICATION PROBABILITIES

COMMAND/CONTROL		TELEMETRY		VIDEO	
TIME	PROB	TIME	PROB	TIME	PROB
1023.98	0.	1023.98	0.	1023.98	0.
1083.98	.99837	1083.98	.98641	1083.98	.93410
1203.98	1.	1323.98	.98664	1323.98	.93433
1323.98	.99860	1383.98	0.	1383.98	0.
1383.98	0.	1696.97	0.	1696.97	0.
1696.97	0.	1699.28	.97432	1699.28	.92201
1699.28	.98627	1980.84	.96839	1980.84	.91608
1980.84	.98035	2214.23	.98135	2214.23	.92904
2214.23	.99331	2834.07	.98135	2834.07	.92904
2834.07	.99331	2841.49	.98207	2841.49	.92976
2841.49	.99402				

```
          AEPOUT COMMAND
(8)       --        QUIT
          AEP COMMAND
(9)       --        AEPOUT
          ENTER DESIRED MISSION NUMBER
(10)      --        1
          AEPOUT COMMAND
(11)      --        T

          CARRIER EX REC

              5 MONTE CARLO TRIALS, WITH 2AIRCRAFT, FOR ,  2 DAYS
```

FIGURE 4. NEW AEPOUT COMMANDS (Continued)

(12) AEPOUT COMMAND
-- SUBF

SUBFUNCTION/MODE UTILIZATION

SUBFUNCTION	NO. USES	FAILED	MODES (1-N)
PREFLIGHT (BEGINNING	10	0	0
THRU-FLIGHT	10	0	0
POST FLIGHT (END OF	8	0	0
GENERAL PURPOSE MUNI	20	0	0
FUEL LOADING	32	0	0
FUEL USAGE	19	1	19
LAUNCH	19	2	19
INFLIGHT AIRCRAFT AB	14	2	14
MISSION ABORT	14	2	14
AIRCRAFT LOSS	14	2	14
LANDING	13	1	12
RPV AIRBORNE LAUNCH	9	0	9
SCHEDULE	10	0	0
SELF-CONTAINED NAVIG	19	1	19
EXTERNAL COMMUNICATI	19	2	19
SURVIVABILITY SUBFUN	25	0	25
SURVIVABILITY SUBFUN	15	0	15
SURVIVABILITY SUBFUN	12	0	12
SURVIVABILITY SUBFUN	6	0	6
DISPLAY ACQUISITION	6	0	6
UNGUIDED AUTOMATIC W A/C 1	0	0	0
UNGUIDED AUTOMATIC W A/C 2	0	0	0
TARGET SUBFUNCTION 1	0	0	0

FIGURE 4. NEW AEPOUT COMMANDS (Continued)

SECTION IV

COMMUNICATIONS PROGRAM

Introduction

The purpose of the communications or data link model is to assess the likelihood of communicating data over the following RPV data links:

- Telemetry (RPV to control station)
- Command control (Control station to RPV)
- Wideband video (RPV to control station)

The model is used during the nominal or pre-Monte Carlo portion of the AEP calculations to compute probability of communicating versus time along the nominal flight profile. The calculations are initiated at the waypoint where any of the communications subfunctions are turned on. The tables of probabilities versus nominal time (one table for each link) are stored in an array for use during the Monte Carlo analysis. The time step between calculations is defined by the user as part of the input data.

The model allows the user to specify the parameters of the transmitters, receivers, models and antennas for the RPV, control station, and enemy jammers and SIGINT (Signal Intelligence). The following sequence of calculations is then made

- Path lengths, depression angles, off-angles, line of sight existence
- Path losses
- System gains and losses
- Carrier-to-noise ratios for friendly and enemy links
- Probability of communicating.

The communications program is an outgrowth of a program developed by Westinghouse as part of an earlier adaptation of the AEP for application to RPV missions (Reference 3). Several modifications were made to that model. These include

- Elimination of a relay link. The Westinghouse model assumed the presence of an airborne relay(s) operating in a specific orbital path. RPV System Program Office (SPO) personnel reported that this would be a very unlikely mode of operation. As a result, the airborne relay has been eliminated from the model.

(2) Calculations are made at user specified time steps. In the Westinghouse model, calculations were made only at flight profile waypoints.

(3) In the original model, the antenna patterns were specified by giving the gain relative to a reference level (the mainlobe gain) for each 15 degree increment out to 90 degrees. In the new model, the antenna patterns are described with known analytic expressions.

(4) The Westinghouse model assumed that the jammer bandwidth fully covered the communication bandwidth. The bandwidth and center frequency have been added as inputs so that this assumption can be deleted.

(5) Provisions for an additional modulation code (JTIDS) has been added.

(6) A new input data item, signal improvement factor, has been added for each channel to allow users to assess the effects of special modulation or signal processing techniques in a simple manner.

(7) An option has been provided to allow users to specify simplified antenna characteristics in addition to the existing seven antenna types.

(8) An option has been provided to specify a shadowing probability associated with the enemy jammers. The purpose of this term is to allow users to consider the likelihood that uneven terrain will obstruct line of sight. The line of sight calculations in the program are only for obstruction by a smooth round earth.

The resultant model is generally adequate for addressing sensitivity of mission success to the key data link parameters with one exception. There is no assessment in the model of the degrading effect of multipath interference which can be serious at low grazing angles relative to the earth. A proper assessment of multipath effects would require a very complicated model and thus has not been included.

Portions of the following description of the communications model have been taken directly from Reference 3 .

Input data is entered through several subfunctions under the Communications Function Data for each channel (command and control, telemetry, and video are entered through the appropriate subfunction. The input data for each of these channels is shown in Table 5.

TABLE 5. COMMUNICATIONS INPUT DATA FOR THE THREE DATA LINK CHANNELS

1. Transmitter power (watts)
2. Transmitter frequency (MHz)
3. Bandwidth (KHz)
4. Modulation code (1=AM, 2=FM, 3=Noncoherent FSK binary, 4=coherent FSK binary, 5=coherent PSK binary, 6 = differentially coherent PSK, 7=amplitude shift keying ASK, 8=PCM, 9=JTIDS)
5. Noise figure (db)
6. Modulation index (applicable to modulation codes 1 and 2 only)
7. Signal improvement factor (db)
8. Insertion loss (db)
9. Fade margin (db)
10. Receiver antenna type (1=isotropic, 2=infinitesimal dipole or loop, 3=linear half-wave dipole, 4=optimum horn, 5=parabolic reflector, 6=broadside array, 7=turnstile, 8=user defined)
11. Horn azimuth dimension (in.) (applicable to antenna type 4)
12. Horn elevation dimension (in.) (applicable to antenna type 4)
13. Parabolic dish diameter (in.) (applicable to antenna type 5)
14. Broadside array horizontal dimension (in.) (applicable to antenna type 6)
15. Broadside array vertical dimension (in.) (applicable to antenna type 6)
16. User antenna main lobe gain (db) (applicable to antenna type 8)
17. User antenna beamwidth (deg) (applicable to antenna type 8)
18. User antenna average side lobe gain (applicable to anntenna type 8)
19. Front-to-back ratio (db)
20. Transmitting antenna type (types available are the same as for the receiving antenna)

TABLE 5. COMMUNICATIONS INPUT DATA FOR THE THREE DATA LINK CHANNELS (Continued)

21.	Horn azimuth dimension (in.)(applicable to antenna type 4)
22.	Horn elevation dimension (in.)(applicable to antenna type 4)
23.	Parabolic dish diameter (in.)(applicable to antenna type 5)
24.	Broadside array horizontal dimension (in.)(applicable to antenna type 6)
25.	Broadside array vertical dimension (in.)(applicable to antenna type 6)
26.	User antenna main lobe gain (db)(applicable to antenna type 8)
27.	User antenna beamwidth (deg)(applicable to antenna type 8)
28.	User antenna average side lobe gain applicable to antenna type 8)
29.	Front-to-back ratio (db)

Data for the jammer and SIGINT stations are entered under the Jammer Definition Subfunction. This data is shown in Table 6. As indicated in the data, up to five enemy station locations can be defined. An expanded capability could be added with increases in a few dimension statements.

TABLE 6. COMMUNICATIONS INPUT DATA FOR THE JAMMER AND SIGINT STATIONS

1-3.	SIGINT gain for each channel (db)
4-6.	SIGINT receiver noise figure for each channel (db)
7-9.	Jammer bandwidth for each channel (KHz)
10-12.	Jammer power for each channel (KW)
13-15.	Jammer frequency for each channel (MHz)
16-18.	Jammer gain for each channel (db)
19-21.	Shadow probability for each channel
22.	Jammer 1 type (1=jammer station, 2=SIGINT station, 3=colocated jammer and SIGINT station)
23.	X location of jammer 1 (nmi)
24.	Y location of jammer 1 (nmi)
25.	Z location of jammer 1 (ft)
26-29.	Jammer 2 type and location
30-33.	Jammer 3 type and location
34-37.	Jammer 4 type and location
38-41.	Jammer 5 type and location

Some additional miscellaneous data are entered under the Base/Environment Definition Subfunction. This data is shown in Table 7.

TABLE 7. MISCELLANEOUS COMMUNICATION INPUT DATA

1. Rain rate (nm/hr)
2. Rain path fraction
3. X location of base (nmi)
4. Y location of base (nmi)
5. Z location of base (ft)
6. Computation time step (min)

Transmission Path Model

The transmission path model accounts for the losses (or allowances to compensate for losses) of RF energy associated with the transmission path:

Free space loss, FS

Atmospheric losses
Water vapor loss, AW
Oxygen loss, AO
Rain loss, RL

Equipment insertion loss, EQ

Fade margin allowance, FM

The user provides two data items which permit the calculation of rain loss:

Rain rate, mm per hour

Fraction of the path over which this rain rate applies

Free space loss or basic transmission loss of the radio link is the dilution of radiated power as a result of range-squared beam divergence. It is computed in dB's as

$$FS = 37.8 + 20 \log F + 20 \log R \tag{1}$$

where

F = frequency in Mhz

R = path length in nmi

Atmospheric losses are due to radiated power being absorbed by water vapor and oxygen in the atmosphere and also by water droplets from rain, clouds, or fog. These losses increase with frequency and are significant at carrier frequencies of 2 Ghz and above. Figure 5 shows absorption coefficients for oxygen (γ_{oo}) and water vapor (γ_{wo}) for frequencies up to 100 Ghz. Due to the irregular shape of these curves, absorption coefficients have been included in the model in tabular form. Rainfall loss is given by the following equation:

$$RL = R\, R_R^{\alpha}\, P\, R\, C \quad (2)$$

where

RL = rain loss in dbw

K = absorption coefficient

R_R = rain rate in mm/hr

α = absorption exponent

P = fraction of path over which rain is occurring

R = path length in Km

C = conversion factor, Km to nmi

The absorption coefficient and the absorption exponent are calculated from the formulas shown in Figures 6 and 7. Equipment insertion losses are specified by the user. They are intended to account for circuit elements such as transmission lines, diplexers and couplers and may range from 1 to 3 dB per terminal. The user also specifies the fade margin which is an allowance intended to account for all of the perturbations, degradations, anomalies and disturbances which have not been otherwise predicted. One of the principal allowances included in fade margin is the allowance for fluctuation in signal strength as a function of time of day. Detailed investigations of these effects have been made, and the data show for a particular geographical area what allowance should be made at each frequency band for the worst case four-hour time block in each day of the year. Volume 2 of Reference 4 shows these fade margin allowances. Total path losses are then computed by summing the separate loss components

$$TP = FS + AW + AO + RL + EQ + FM \quad (3)$$

Antenna Models

The user can select from eight antenna types. Table 8 shows the formulas used to compute the mainlobe gain and gain at off-angles. For communication between the RPV and control station, the mainlobe gain is always used. The off-angle gain is computed when assessing enemy SIGINT reception and jammer power received at the RPV or control station.

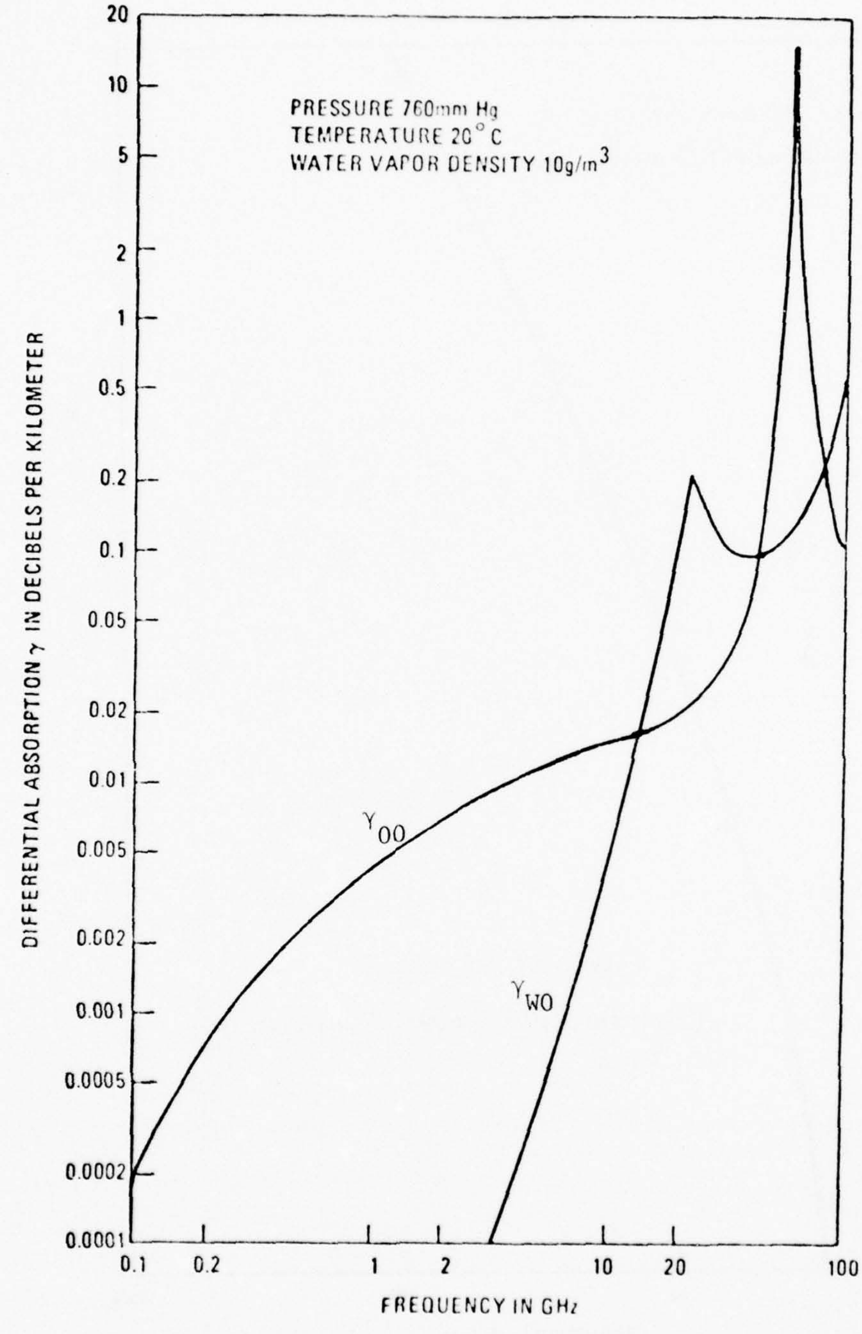


FIGURE 5. SURFACE VALUES OF ABSORPTION BY OXYGEN γ_{00} AND WATER VAPOR γ_{W0}

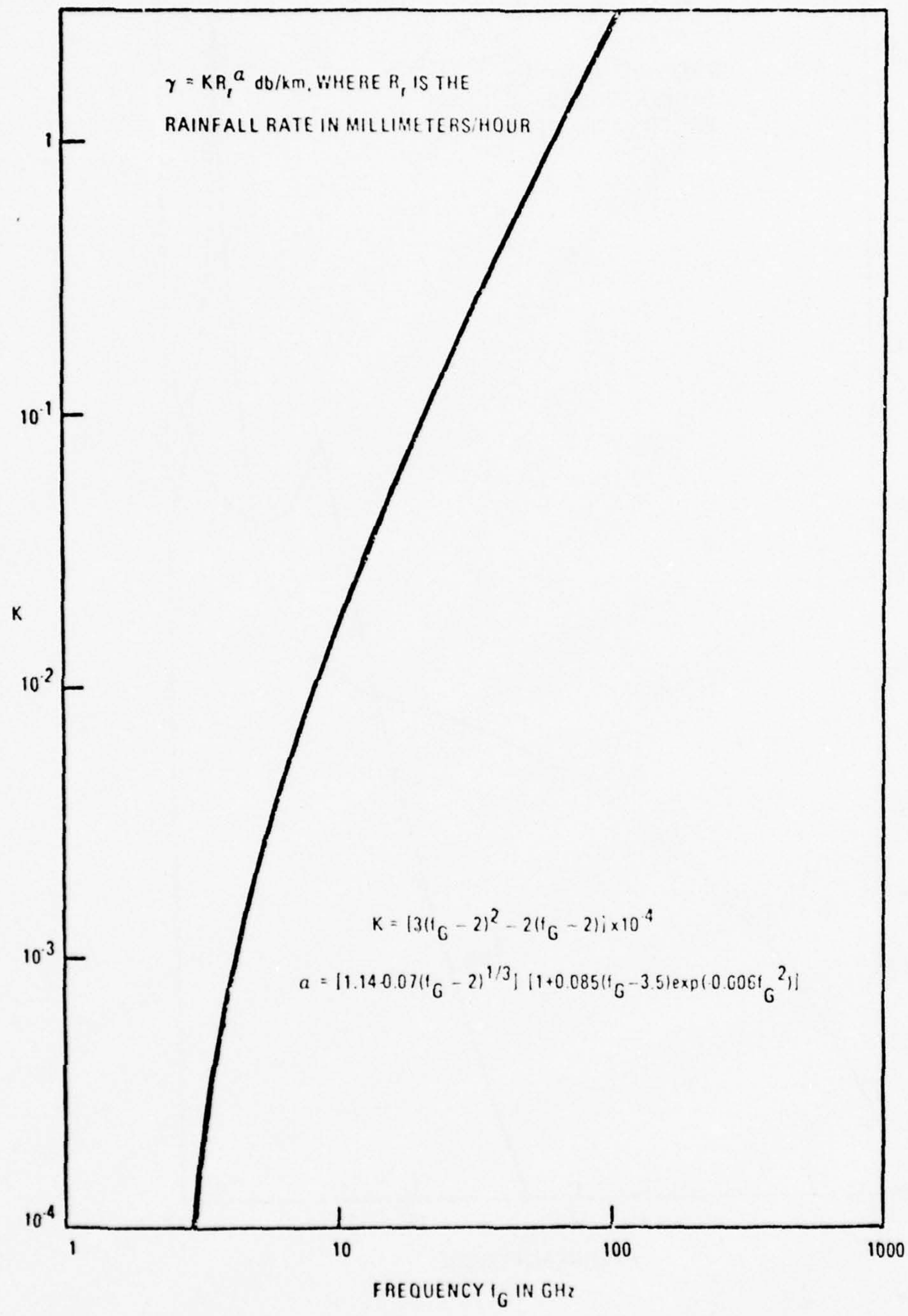


FIGURE 6. RAINFALL ABSORPTION COEFFICIENT K VS FREQUENCY

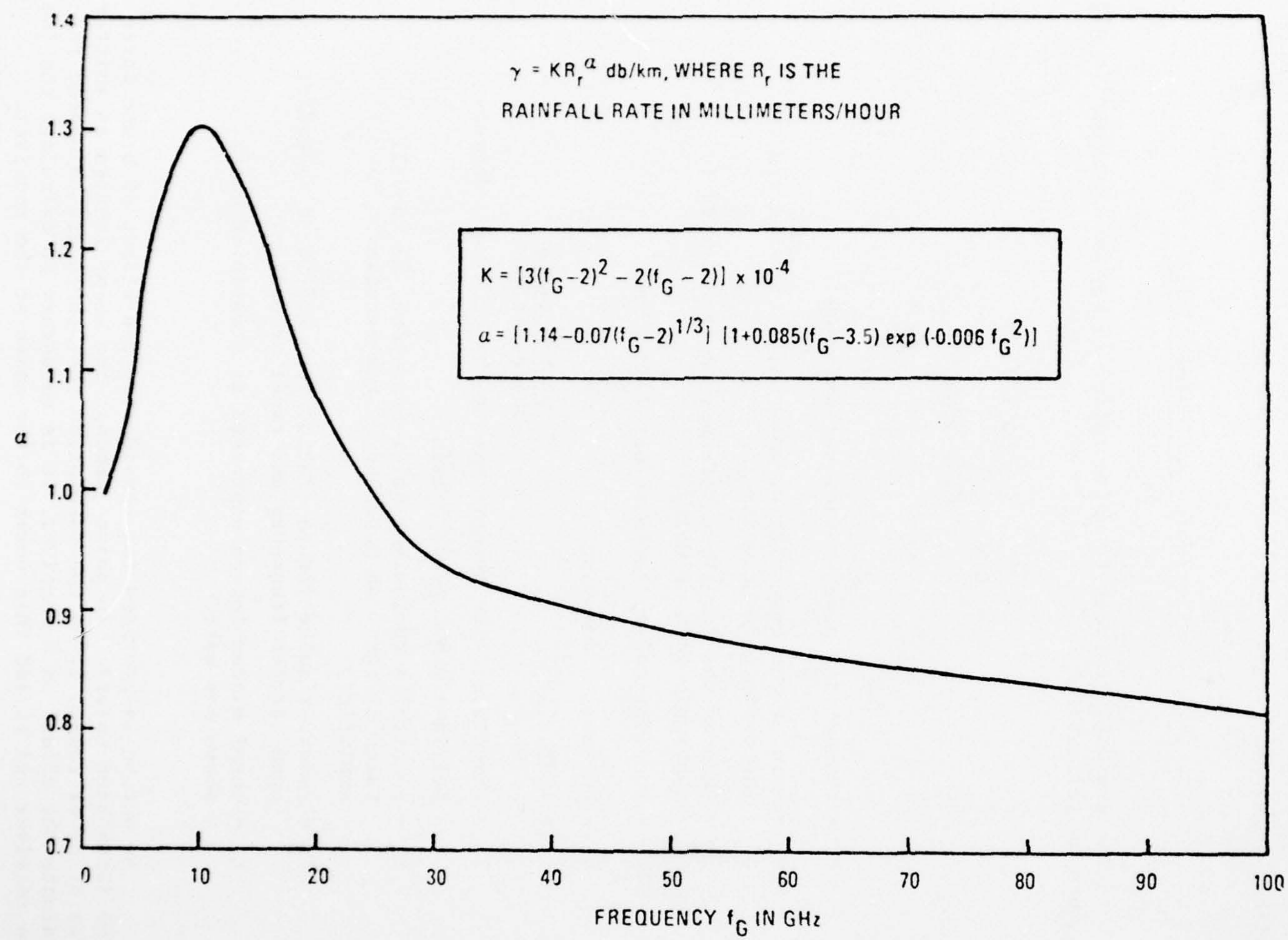


FIGURE 7. RAINFALL ABSORPTION EXPONENT Ø VS FREQUENCY

The off-angle gains shown in Table 8 for the optimum horn, parabolic reflector and broadside array are symmetric about ±90 degrees. Thus, the equations imply that the gain at 180 degrees is the same as the main lobe gain (0 degrees). An added input term - the front to back ratio - is used as a multiplier to modify the gain in the rear hemisphere.

An option (#8) is also available whereby the user can define an antenna by means of a main lobe gain and beamwidth and an average sidelobe level.

Carrier/Noise and Jammer Model

The available carrier to noise ratio C/N may be expressed in algebraic form as follows:

$$C/N = \frac{(P_T G_T G_R)}{KTB_R \ (F_N) \ L} \tag{4}$$

where

P_T = transmitter power ratio, watts/1 watt

G_T = gain of the transmitting antenna, ratio referred to isotropic gain or unity

G_R = gain of the receiving antenna, ratio referred to isotropic gain or unity

KTB_R = receiver noise, ratio referred to 1 watt

K = Boltzman's constant

$= 1.38 \times 10^{-23} \ \frac{\text{watt-seconds}}{\text{degree Kelvin}}$

T = effective noise temperature at the receiver, degrees Kelvin = 288 degrees Kelvin

B_R = receiver's equivalent noise bandwidth, Hz (usually taken as the 3 db passband of the receiver's IF amplifier)

F_N = receiver noise figure (ratios from 2.5 to 16 depending upon carrier frequency and receiver design)

L = total system losses expressed as a ratio of watts above one watt

An option is provided for considering the effect of brute force enemy jamming (broadband noise). In noise jamming, the enemy locates an emitter and directs RF power toward it on the assumption that there are colocated receivers. To evaluate the effect on a receiver, it is necessary to calculate the jam power at the receiver and to add this power to the noise at the receiver.

TABLE 8. POWER GAIN FOR AVAILABLE ANTENNAS

Antenna	Main Lobe Gain(G)	Off-Angle Gain
1 Isotropic	1	1
2 Infinitesimal Dipole or Loop	1.5	$G \cos^2 \theta$
3 Linear Half-Wave Dipole	1.64	$G \dfrac{\cos^2(\frac{\Pi}{2} \cos \theta)}{\sin^2 \theta}$
4 Optimum Horn	$7.16 \times 10^{-8} f^2 EA$	$G \left[\dfrac{\sin(\frac{\Pi E}{\lambda} \sin \theta_E)}{\frac{\Pi E}{\lambda} \sin \theta_E} \dfrac{\sin(\frac{\Pi A}{\lambda} \sin \theta_A)}{\frac{\Pi A}{\lambda} \sin \theta_A} \right]^2$
5 Parabolic Reflector	$3.54 \times 10^{-8} f^2 D^2$	$G \left[\dfrac{J_1(\frac{\Pi D}{\lambda} \sin \theta)}{\frac{\Pi D}{\lambda} \sin \theta} \right]^2$
6 Broadside Array	$9 \times 10^{-8} f^2 (EA)^2$	$G \left[\dfrac{\sin(\frac{\Pi E}{\lambda} \sin \theta_E)}{\frac{\Pi E}{\lambda} \sin \theta_E} \dfrac{\sin(\frac{\Pi A}{\lambda} \sin \theta_A)}{\frac{\Pi A}{\lambda} \sin \theta_A} \right]^2$
7 Turnstile	1.15	1.15
8 User Defined	User Defined	User Defined

SYMBOLS: θ = off-angle from the main lobe
θ_E = projection of θ in the elevation plane
θ_A = projection of θ in the azimuth plane
E = antenna vertical dimension (in)
A = antenna horizontal dimension (in)
D = antenna diameter
f = transmission frequency (Hz)
λ = transmission wavelength

Jamming can occur whenever the user has provided input data for at least one jammer and SIGINT (signal intelligence) station. If jammers are present, the following criteria for determining whether or not jamming can take place are used

(1) A SIGINT station must be within line of sight of a transmitted signal and receives it at a signal to noise ratio greater than 3 db. While the 3 db level is very marginal for purposes of intercepting a message, it is considered to be a completely adequate level for determining that an emission is present.

(2) The jammer must be within line of sight of the transmitted signal. The jammer simply assumes that there is a receiver colocated with the emitter.

It is assumed that adequate communications exists between all SIGINT and jammer stations so that reception of a signal by any SIGINT station can cause all appropriate jammers to transmit.

If the jammer power is treated as noise, the C/N at the friendly receiver becomes

$$CNJ = \frac{C}{N+\Sigma P_j} \tag{5}$$

where

P_j = power at the receiver due to the individual jammers

The effect of jamming is considered for both the RPV and control station receivers.

Line of Sight Calculations

A line of sight range taking into account atmospheric refraction effects via 1/3 earth radius model is given by

$$R = \sqrt{2h_R} + \sqrt{2h_T} \tag{6}$$

where

h_R is the receiver height in feet

h_T is the transmitter height in feet, and

R is the range in miles.

A test is applied to each RPV-base path to determine if radar line-of-sight exists. If line-of-sight does not exist, the corresponding probability of communication is set to zero. A line-of-sight test is also applied to every path between an RPV and base and jammers of signals. If no line-of-sight exists, the corresponding jammer powers are set to zero.

Modulation Models

The user may select, independently for each of the three channels, any one of eight types of modulation:

Analog types

(1) AM
(2) FM

Digital types

(3) Noncoherent FSK
(4) Coherent FSK
(5) Coherent PSK
(6) Differentially coherent PSK
(7) ASK
(8) PCM
(9) JTIDS

Analog Modulations

The customary calculations for analog or continuous modulations include the computation of signal-to-noise ratio S/N and the interpretation of S/N in terms of grade (or quality) of service. Numerous grade of service scales have been constructed most of which are in reasonable agreement at three main points:

(1) Excellent quality, noise free 35 db and above

(2) Medium quality 7-10db

(3) Marginal quality 0-3 db

Since the data link model must calculate the probability of communicating to accomodate evaluation in the Monte Carlo, a direct relationship between S/N and P_c has been constructed as shown in Figure 8 and Table 9 (taken from Reference 3. Its basis is a probabilistic interpretation or normalization of the grade of service scale.

The S/N for double sideband amplitude modulation is given by

$$S/N = 2\mu \frac{B_i}{2B_a} \; (C/N)$$

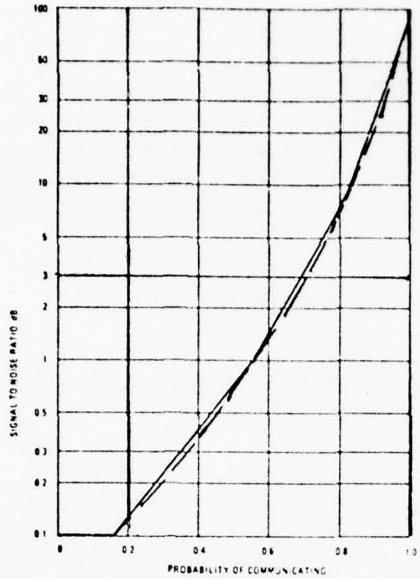


FIGURE 8. ANALOG MODULATION MODEL

TABLE 9. DATA FROM FIGURES 8 AND 9

ANALOG			DIGITAL		
S/N	P_c	Δ	BER	P_c	Δ
0.1	0.160	0.390	0.1	0	
1.0	0.550	0.285	0.01	0.5	0.5
10.0	0.835	0.165	0.001	0.8	0.3
10.0	1.0		0.0001	1.0	0.2

$$B_i = 2B_a \quad (7)$$

where

μ = modulation index, ≤ 1

B_i = bandwidth occupied by the modulated carrier

B_a = the bandwidth occupied by the signal

For frequency modulation, the relationship is

$$S/N = 3\mu^2 \frac{B_i}{2B_a} (C/N) \quad (8)$$

for $C/N \geq 6$

$$B_i = 2B_a(\mu + 1) \quad (9)$$

where

μ = frequency modulation index

= $\Delta f/B_a$

f = the deviation of the carrier frequency

Digital Modulations

For the digital modulations, bit error rate (BER) or probability of error (P_e) is calculated directly from C/N, and system performance is judged in terms of BER. In the communications model, a probabilistic interpretation was required, and it was derived by the normalization shown in Figure 9 and Table 9. For a given rate of information transmission, digital modulations in general, are characterized by requiring wider bandwidths at lower SN's than analog modulations.

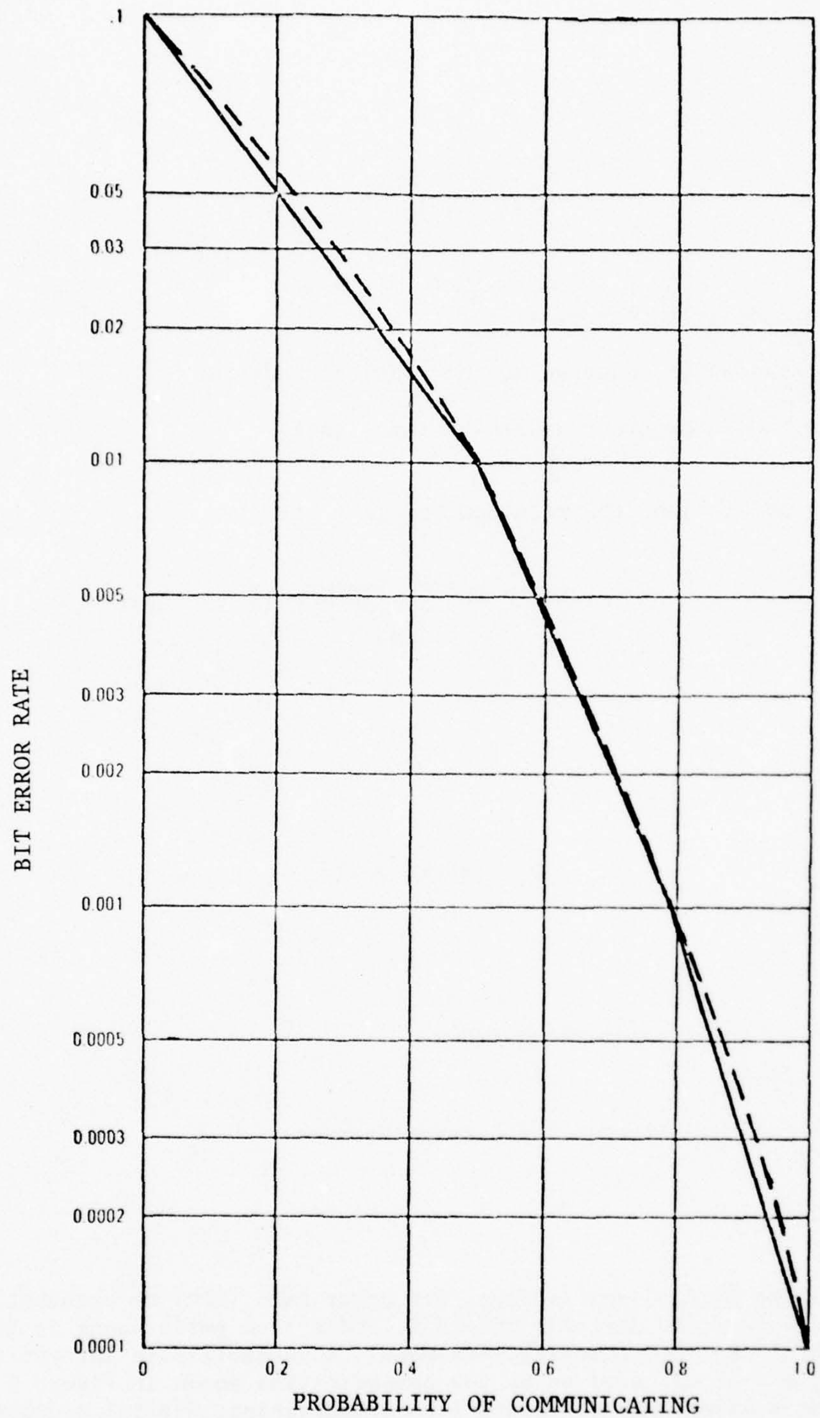


FIGURE 9. DIGITAL MODULATION MODEL

From Reference 5 , the BER equations are

Noncoherent FSK, Binary

$$P_e = 1/2 \exp (-1/2 \frac{C}{N}) \quad (10)$$

Coherent FSK, Binary

$$P_e = 1/2 [1 - \text{erf} (1/2\frac{C}{N})^{1/2}] \quad (11)$$

where

$$\text{erf}(x) \equiv \frac{1}{\sqrt{2\Pi}} \int_{-x}^{x} \exp (-\mu^2/2)\, du \quad (12)$$

Coherent PSK, Binary

$$P_e = 1/2 [1 - \text{erf} (C/N)^{1/2}] \quad (13)$$

Differentially Coherent PSK, Binary

$$P_e = 1/2 \exp (- C/N) \quad (14)$$

Amplitude Shift Keying

$$P_e = [\Pi(C/N)]^{-1/2} \exp(-1/4\frac{C}{N}) \quad (15)$$

Pulse Code Modulation

$$P_e = 1/2 [1 - \text{erf} (1/2 CN)] \quad (16)$$

Figure 10 which shows comparative plots for CSK and PSK modulation types indicates that, for a given $C/N \geq 6$, the PSK types achieve lower probability of error. It can also be observed that an SN of 10-12 db is sufficient for "error free" service as compared with about 35 db for "noise free" service in an analog system.

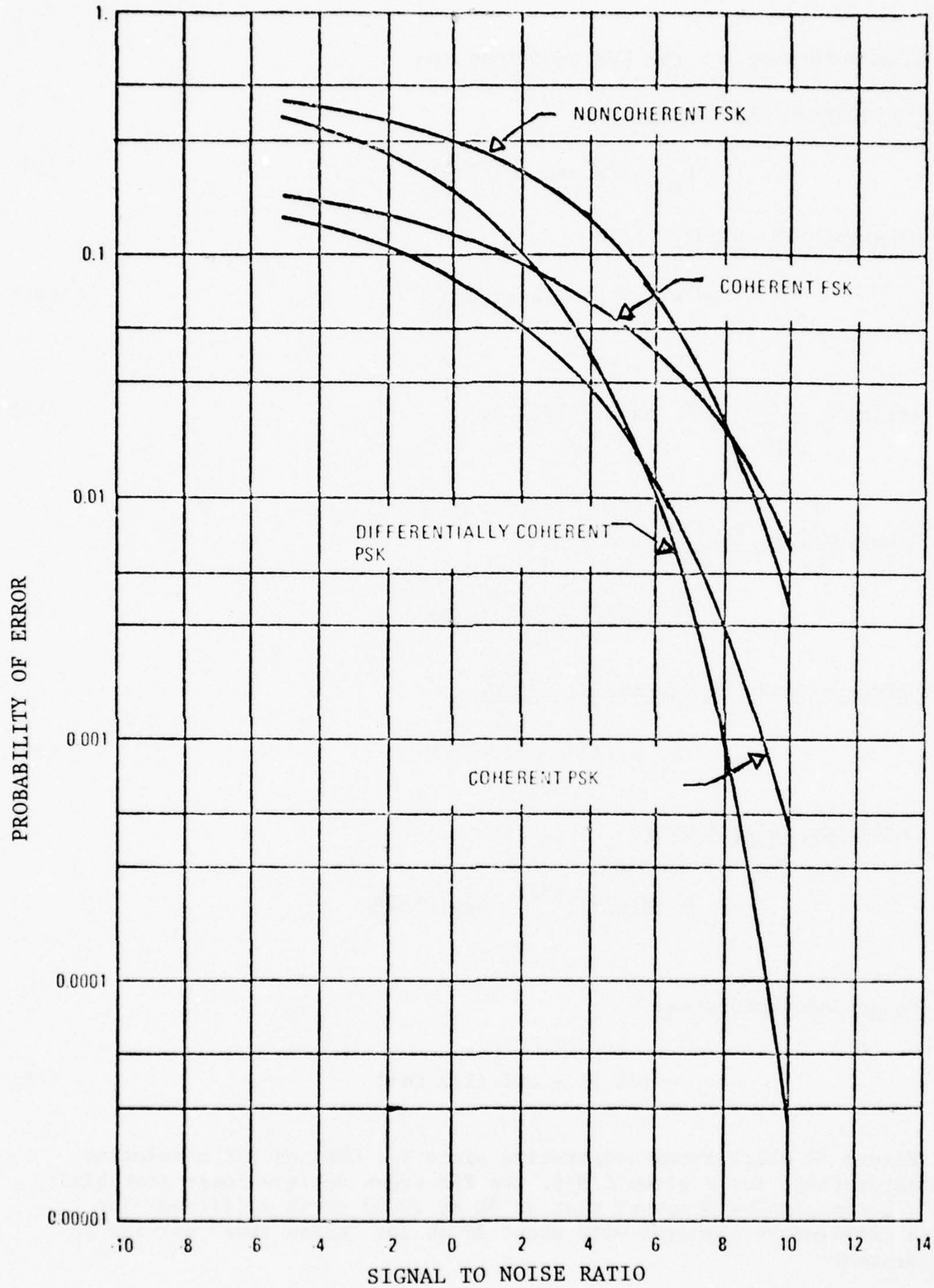


FIGURE 10. COMPARISON OF BINARY FSK AND BINARY PSK MODULATIONS

SECTION V

AAA SURVIVABILITY PROGRAM

Previous versions of the Avionics Evaluation Program (AEP) have contained detailed analytic models for target acquisition, weapon delivery, and dogfights. However, they did not include the capability to analyze aircraft survivability.

To assess the probability of survival, the Antiaircraft Artillery (AAA) Simulation Computer Program (AFATL - P001) developed at Eglin AFB and used by several components of the Air Force, Navy, and aerospace industry was selected for addition to the AEP. A complete description of this survivability program may be found in Reference 6.

General Description

The AAA simulation computes the single-shot probability of kill (Pk) of a target aircraft flying a predefined flight path within the range of an anti-aircraft artillery site. The Pk and other information concerning each round may then be examined or plotted by the user.

The flight path is entered as a series of waypoints using the Flight-Profile portion of the AEP. The AAA program computes instantaneous flight path information by linear interpolation.

Each ground weapon complex (gun site) is described by its location, number of guns and gun barrels, and gun and projectile parameters. Several sets of gun and projectile parameters may be stored in a data file and later selected for use in a AAA simulation run.

The target aircraft is described by a table of vulnerable areas which are functions of impact latitude and longitude in aircraft coordinates and the aircraft/projectile relative velocity. Table 10 shows the aircraft views for which vulnerability data must be given. This table is linearly interpolated to obtain the instantaneous vulnerable area. Several of these tables may be stored in the data file for use in AAA simulations.

Interactive Processor

The interactive processor for the AAA portion of AEP consists of two sections (input and output). The input processor allows the user to add, modify, review, and save gun and vulnerable area data; and to create an input deck and initiate execution of the AAA simulation. The output processor allows the user to view the simulation results and to produce various probability-of-kill tables. The output may be viewed in tabular form or (if a graphics terminal is used) in plotted form. The simulation itself is executed on-line and the user may view the results immediately.

TABLE 10. VULNERABLE AREA VIEWS FOR INPUT DATA

Vulnerable Area	Aircraft View
1	0^{o} Longitude, 0^{o} Latitude
2	0^{o} Longitude, 45^{o} Latitude
3	45^{o} Longitude, 45^{o} Latitude
4	90^{o} Longitude, 45^{o} Latitude
5	135^{o} Longitude, 45^{o} Latitude
6	180^{o} Longitude, 45^{o} Latitude
7	225^{o} Longitude, 45^{o} Latitude
8	270^{o} Longitude, 45^{o} Latitude
9	315^{o} Longitude, 45^{o} Latitude
10	0^{o} Longitude, 90^{o} Latitude
11	45^{o} Longitude, 90^{o} Latitude
12	90^{o} Longitude, 90^{o} Latitude
13	135^{o} Longitude, 90^{o} Latitude
14	180^{o} Longitude, 90^{o} Latitude
15	225^{o} Longitude, 90^{o} Latitude
16	270^{o} Longitude, 90^{o} Latitude
17	315^{o} Longitude, 90^{o} Latitude
18	0^{o} Longitude, 135^{o} Latitude
19	45^{o} Longitude, 135^{o} Latitude
20	90^{o} Longitude, 135^{o} Latitude
21	135^{o} Longitude, 135^{o} Latitude
22	180^{o} Longitude, 135^{o} Latitude
23	225^{o} Longitude, 135^{o} Latitude
24	270^{o} Longitude, 135^{o} Latitude
25	315^{o} Longitude, 135^{o} Latitude
26	0^{o} Longitude, 180^{o} Latitude

Latitude is measured from bottom of aircraft (0 deg) to top of aircraft (180 deg). Longitude is measured counterclockwise from the rear (0 deg) while viewing aircraft from above.

Following is an example case as run from a terminal. It is assumed that the user is familiar with both the AEP and the original AAA program which has been adapted into the AEP.

Figure 11 shows a sample entry into the AEP and creation of a flight-profile data file for a AAA simulation. The numbered user-responses are explained below.

1) Enter the user ID to select proper data file.

2) Enter the flight-profile portion of the processor

3) Select a previously stored profile for use in this run. Note that the units in FP are different from those in AAA.

4) Write data file for use by the AAA simulation. The profile is "flown" with user-selected aircraft and engine to insure that the profile is valid. The time step required for the TAPE command is the interval at which the profile information is written to the data file. This interval must be small enough to accurately describe the complex portions of the profiles but not too small such that processing time is significantly increased.

The user's data file can store up to 25 different sets of gun and shell parameters and up to 10 vulnerable area tables for use in the AAA simulation. There are 24 different gun and shell parameters in each set. The vulnerable area tables (VAT) contain 26 views of the aircraft with each view containing vulnerable areas for 8 specific impact velocities. Examples of this data are shown in Figure 12.

1) Enter the AAA portion of the AEP.

2) Enter the GUNS level of AAA.

3) Select a particular gun/shell combination for modification.

4) Enter new values for the data items to be changed.

5) Display data for review. Gun type and track mode are defined in Reference 6.

6) Save the altered data set.

7) Return to the AAA level.

8) Enter the VAT level of AAA.

9) Select a VAT for review.

10) Return to the AAA level. The double QUIT allows the user to leave the VAT level without saving the previously selected data. A warning message is issued if the user types 'QUIT' without saving data that has been selected.

```
     ENTER USER ID
(1)  --        TEST
     AEP COMMAND
     --        ?
     EXECUTIVE (AEP) COMMANDS
     EQUIP   FUN      WD       WDDECK   WDOUT   FP       MARSAM
      AEPDECK    AEPOUT   AAA    NEWS    QUIT
     AEP COMMAND
     --        FP?
     FLIGHT PROFILE GENERATION
     AEP COMMAND
(2)  --        FP
     ENTER PROFILE ID
     --        ?
     ENTER NUMBER ID OF STORED PROFILE, ENTER 0 TO CREATE NEW PROFILE
     ENTER SHOW FOR LIST OF STORED PROFILES
     ENTER PROFILE ID
     --        SHOW
       1  NRL DEMO PROFILE
       2  AAA TEST PROFILE
     ENTER PROFILE ID
(3)  --        2
     FP COMMAND
     --        LIST
      ID       X         Y        H          V        BANK      ON        OFF
       1     -5.4       0.      1640.       389.       0.
       2      5.4       0.      1640.       389.       0.
     COMMON WAYPOINT NUMBER=  0
     FP COMMAND
(4)  --        TAPE
     ENTER AIRCRAFT CANDIDATE ID
     --        2
     AIRCRAFT=  2 DEMO AIRCRAFT
     O.K. (Y,N)
     --        Y

     FILE NO      2  AIRCRAFT IS  WPAFB TARGET


               AIRCRAFT TYPE 1=WPAFB TARGET

        WEIGHT=   32834.0, REF. AREA=    530.00MAX NORMAL G=       8.500
     ENTER DESIRED WAYPOINTS
     --        1,2
     ENTER TIME STEP
     --        10
     FP COMMAND
     --
```

FIGURE 11. AAA FLIGHT PROFILE GENERATION

```
    AEP COMMAND
(1) --        AAA
    AAA COMMAND
    --        ?
      COMMANDS AVAILABLE ARE --
    GUNS   VAT   DECK   QUIT
    AAA COMMAND
    --        GUNS?
    ENTER, MODIFY, AND SAVE GUN PARAMETERS
    AAA COMMAND
(2) --        GUNS
    GUN COMMAND
    --        ?
      COMMANDS AVAILABLE ARE --
    LIST (L)   SELECT (SEL)   SHOW (S)   DATA (D)   DELETE (DEL)
    NAME   SAVE   QUIT
    GUN COMMAND
    --        LIST
     1  DATA FOR DOCUMENTATION EXAMPLE - GUN SITE 1 & 2
     2  DATA FOR DOCUMENTATION EXAMPLE - GUN SITE 3 & 4
     3  DATA FOR DOCUMENTATION EXAMPLE - GUN SITE 5 & 6
    GUN COMMAND
    --        SELECT?
    CHOOSES PARTICULAR GUN/VAT TO MODIFY OR USE AS STARTING POINT FOR NEW.
      SEL,0 = GENERATES BLANK TITLE AND ZEROED DATA FOR NEW START
      SEL,I = READS IN TITLE AND DATA OF GUN/VAT I FOR MODIFICATION.
    GUN COMMAND
(3) --        SELECT,1
    GUN COMMAND
    --        DATA?
    ENTERS DATA FOR GUN/VAT.  EACH VAT ASPECT SECTOR IS TREATED AS ONE
      VARIABLE WITH 8 PARTS (VELOCITY CLASSES).  EXAMPLES --
    <GUN>  D,X1=5,X7=2  --> GUN PARAMETER 1 = 5, PARAMETER 7 = 2
    <GUN>  D,X2=3,6,.5  --> GUN PARAMETER 2 = 3, PARAMETER 3 = 6, ETC.
    <VAT>  D,X8=1,2,3,4,5,6,7,8   --> THE 8 VELOCITY CLASSES FOR SECTOR 8
                                      WILL CONTAIN 1,2,3,4,5,6,7,8
    <VAT>  D,X9=1,2,3             --> THE 8 VELOCITY CLASSES FOR SECTOR 9
                                      WILL CONTAIN 1,2,3,3,3,3,3,3
    GUN COMMAND
(4) --        DATA,X1=3,4,.3,X9=300,500
    GUN COMMAND
    --        DATA,X21=930
    GUN COMMAND
    --
```

FIGURE 12. EXAMINATION AND MODIFICATION OF GUN AND VULNERABLE AREA STORED DATA

```
    GUN COMMAND
    --        SHOW?
    SHOWS REQUESTED DATA FOR GUN OR VAT.  FOR VAT, SHOWS DATA IN ALL
    VELOCITY CLASSES FOR SPECIFIED ASPECT SECTOR(S).
      S,I,J = SHOWS DATA FOR PARAMETERS/SECTORS I THRU J.
    GUN COMMAND
(5) --        SHOW,1,24
     1  DATA FOR DOCUMENTATION EXAMPLE - GUN SITE 1 & 2
       1  GUN TYPE                      3
       2  TRACK MODE                    4
       3  TROUND      (SECOND)         .3
       4  THDMAX      (DEG/SEC)      72.0
       5  PHDMAX      (DEG/SEC)      59.0
       6  PHIMIN      (DEGREE)      -10.0
       7  PHIMAX      (DEGREE)      89.99
       8  VELMIN      (M/SEC)          .0
       9  VELMAX      (M/SEC)       300.0
      10  RANMIN      (METER)       500.0
      11  RANMAX      (METER)      3300.0
      12  ATLAG       (SECOND)       1.33
      13  ETHMAX      (DEGREE)     5.7296
      14  EPHMAX      (DEGREE)     5.7296
      15  RMODES      (METER)       400.0
      16  BDACON      (MIL)         .0031
      17  TFMAX1      (SECOND)        3.8
      18  TFMAX2      (SECOND)        7.5
      19  RVACON      (1/SEC)      .22998
      20  RVBCON      (1/SEC**2)  -.00689
      21  VMUZEL      (M/SEC)       930.0
      22  TREACT      (SECOND)         .0
      23  TRACK1      (SECOND)        2.5
      24  TRACK2      (SECOND)        6.0
    GUN COMMAND
    --        SAVE?
    SAVES CURRENT DATA IN THE FILE.
      SAVE,OLD = OVERWRITES PREVIOUSLY STORED DATA FOR SELECTED GUN/VAT.
      SAVE     = PROGRAM FINDS NEW LOCATION TO STORE DATA.  A MESSAGE IS
                 ISSUED IF THE AVAILABLE SPACE IS FULL.
    GUN COMMAND
(6) --        SAVE,OLD
    GUN DATA SAVED AS NUMBER  1
    GUN COMMAND
(7) --        QUIT
```

FIGURE 12. EXAMINATION AND MODIFICATION OF GUN AND VULNERABLE AREA STORED DATA (Continued)

```
    AAA COMMAND
    --        VAT?
    ENTER, MODIFY, AND SAVE VULNERABLE AREA TABLES
    AAA COMMAND
(8) --        VAT
    VAT COMMAND
(9) --        SEL,1
    VAT COMMAND
    --        SHOW,1,26
     1  # INTERPOLATED VALUES FOR AC1; GT3  (A/H)  SABRE TIGER #
```

1	2.21	4.42	4.42	4.42	4.42	4.42	4.42	4.42
2	1.56	3.13	3.13	3.13	3.13	3.13	3.13	3.13
3	3.44	6.89	6.89	6.89	6.89	6.89	6.89	6.89
4	4.22	8.45	8.45	8.45	8.45	8.45	8.45	8.45
5	3.56	7.12	7.12	7.12	7.12	7.12	7.12	7.12
6	1.73	3.45	3.45	3.45	3.45	3.45	3.45	3.45
7	3.56	7.12	7.12	7.12	7.12	7.12	7.12	7.12
8	4.22	8.45	8.45	8.45	8.45	8.45	8.45	8.45
9	3.44	6.89	6.89	6.89	6.89	6.89	6.89	6.89
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	2.66	5.32	5.32	5.32	5.32	5.32	5.32	5.32
12	3.76	7.53	7.53	7.53	7.53	7.53	7.53	7.53
13	2.82	5.65	5.65	5.65	5.65	5.65	5.65	5.65
14	.23	.46	.46	.46	.46	.46	.46	.46
15	2.82	5.65	5.65	5.65	5.65	5.65	5.65	5.65
16	3.76	7.53	7.53	7.53	7.53	7.53	7.53	7.53
17	2.66	5.32	5.32	5.32	5.32	5.32	5.32	5.32
18	1.72	3.44	3.44	3.44	3.44	3.44	3.44	3.44
19	3.60	7.20	7.20	7.20	7.20	7.20	7.20	7.20
20	4.38	8.76	8.76	8.76	8.76	8.76	8.76	8.76
21	3.71	7.43	7.43	7.43	7.43	7.43	7.43	7.43
22	1.88	3.76	3.76	3.76	3.76	3.76	3.76	3.76
23	3.71	7.43	7.43	7.43	7.43	7.43	7.43	7.43
24	4.38	8.76	8.76	8.76	8.76	8.76	8.76	8.76
25	3.60	7.20	7.20	7.20	7.20	7.20	7.20	7.20
26	2.43	4.86	4.86	4.86	4.86	4.86	4.86	4.86

```
     VAT COMMAND
(10) --        QUIT,QUIT
```

FIGURE 12. EXAMINATION AND MODIFICATION OF GUN AND VULNERABLE AREA STORED DATA (Continued)

In setting up the input data for a AAA simulation, the user must describe the aircraft, the flight profile, and each of the gun sites to be used in the run. Before entering the DECK portion of AAA, the user must have previously created a flight-profile file using the TAPE command in the FP portion of AEP. If this has not been done, the program will not allow the user to enter DECK at the AAA COMMAND level. Once in the AAADECK level, the user may specify for each gun site the gun and VAT to be used from the stored data, the position of the site, the numbers of guns and gun barrels, the ground weapon densities, and the radius of the site if more than one gun is specified. When the data entered is complete, entering RUN will initiate data error checking and, if no errors are found, execution of the AAA simulation. Figure 13 shows an example of this procedure.

1) Enter the DECK level of AAA.

2) Enter title for this simulation run.

3) View the time range of the flight profile created earlier. Also shown are the default simulation time range and time increment which have been computed from the flight-profile times to use the maximum of 500 time points in the simulation.

4) Alter the simulation time range and increment. This step is entirely optional.

5) Enter the data for the first gun site. The gun parameters and VAT are selected from the stored data. The coordinates of the site are specified using the same reference system as the flight profile. Note that the units are now metric.

6) Enter data for the next gun site being sure that no site numbers are skipped. If part of the data for site 2 were omitted (i.e., VAT), the AAA simulation would use that data from the previous site (site 2 would also use VAT=1). However, the gun site position must be specified for each site to be used.

7) Review the data that has been entered.

8) Initiate execution.

Upon completion of the simulation run, a summary table is displayed and the user is placed in the AAAOUT level where the results of the run may be examined. Figure 14 shows a sample of how the user might view the results.

1) Since there may be a noticeable time lag during the simulation, a message is sent to the user upon completion of each gun site.

2) The summary table shows the date, time, some site parameters, the number of rounds fired, the start and stop times and duration of firing, and the total Pk for each site.

```
    AAA COMMAND
    --         DECK?
    PREPARE INPUT DATA FOR AAA SIMULATION AND EXECUTE PROGRAM
    AAA COMMAND
(1) --         DECK
    AAADECK COMMAND
    --         ?
      COMMANDS AVAILABLE ARE --
    NAME   SHOW   TIME   SITE   RUN   QUIT
    AAADECK COMMAND
    --         NAME?
    ENTERS TITLE (UP TO 60 CHARACTERS) FOR AAA SIMULATION.
    STRING THE COMMAND AS -- NAME,TITLE
    AAADECK COMMAND
(2) --         NAME, TEST SIMULATION FOR DOCUMENTATION
    AAADECK COMMAND
    --         SHOW?
    SHOWS DATA SPECIFIED FOR AAA SIMULATION.  OPTIONS ARE --
      SHOW,0 = DISPLAYS DATA PERTAINING TO ENTIRE SIMULATION.
      SHOW,I = DISPLAYS DATA PERTAINING TO GUN SITE I.
    AAADECK COMMAND
(3) --         SHOW,0
      TEST SIMULATION FOR DOCUMENTATION
    FLIGHT PROFILE MIN, MAX TIMES:       0.00   99.95 SEC
    SIMULATION MIN, MAX, INCR. TIMES:    0.00   99.95   .201 SEC
    NUMBER OF GUN SITES SELECTED:  0
    AAADECK COMMAND
    --         TIME?
    SPECIFIES SIMULATION START AND STOP TIMES AND TIME INCREMENT TO USE
      FOR FLIGHT PROFILE DATA IN AAA SIMULATION.  STRING COMMAND AS --
        TIME,START,STOP,DELT    WHERE TIMES ARE IN SECONDS.
    NOTE:  DELT MUST BE > OR = TO (STOP-START)/500.
    AAADECK COMMAND
(4) --         TIME,0,99:94,.2
```

FIGURE 13. SETUP AAA INPUT DATA AND INITIATE EXECUTION

```
AAADECK COMMAND
--         SITE?
ENTERS DATA FOR SPECIFIC GUN SITE.  STRING THE COMMAND AS --
    SITE,I,MNEM=DATA,MNEM=DATA,...    WHERE
I    = GUN SITE NUMBER
MNEM = MNEMONIC FOR TYPE OF DATA
DATA = ONE OR MORE VALUES (AS REQUIRED) FOR SELECTED DATA TYPE.
  AVAILABLE DATA TYPES ARE:  GUN  VAT  DENS  GSPOS  NGB  GSRAD
ENTER DESIRED MNEMONIC FOLLOWED BY A QUESTION MARK FOR DESCRIPTION.
  NOTE:  GSPOS MUST BE SPECIFIED FOR EACH GUN SITE SELECTED.
DATA FOR EACH SITE MAY BE ENTERED WITH ONE OR SEVERAL SITE COMMANDS.
AAADECK COMMAND
--         GUN?
SELECTS GUN PARAMETERS FROM PREVIOUSLY STORED DATA.
EXAMPLE:   SITE,1,GUN=4
AAADECK COMMAND
--         VAT?
SELECTS VULNERABLE AREA TABLE FROM PREVIOUSLY STORED DATA.
EXAMPLE:   SITE,1,VAT=2
AAADECK COMMAND
--         DENS?
SPECIFIES UP TO 9 GROUND WEAPON DENSITIES.
EXAMPLE:   SITE,1,DENS=1,0,0,1   SPECIFIES 4 DENSITIES
AAADECK COMMAND
--         GSPOS?
SPECIFIES X, Y, AND Z COORDINATES OF GUN SITE (MUST GIVE 3 VALUES).
EXAMPLE:   SITE,1,GSPOS=-500,1000,0          <UNITS ARE METERS>
  NOTE:  GSPOS MUST BE SPECIFIED FOR EACH GUN SITE SELECTED.
AAADECK COMMAND
--         NGB?
SPECIFIES NUMBER OF GUNS AT SITE (MAX=8); NUMBER OF CYCLIC BARRELS
  PER GUN; AND NUMBER OF SIMULTANEOUS BARRELS PER GUN.
EXAMPLE:   SITE,1,NGB=5,2,3   SELECTS 5 GUNS AT SITE 1 WITH 2 CYCLIC
  AND 3 SIMULTANEOUS BARRELS FOR EACH GUN.
AAADECK COMMAND
--         GSRAD?
SPECIFIES RADIUS OF GUN CIRCLE FOR SITES HAVING MORE THAN 1 GUN.
EXAMPLE:   SITE,1,GSRAD=100                  <UNITS ARE METERS>
AAADECK COMMAND
(5)--      SITE,1,GUN=1,VAT=1,NGB=1,2,1,GSPOS=-1000,1500,0,DENS=1,.75,.5,.25

AAADECK COMMAND
(6)--      SITE,2,GUN=3,VAT=3,NGB=2,2,1,GSPOS=1000,-500,0
AAADECK COMMAND
(6)--      SITE,2,DENS=1,.75,.5,.25,GSRAD=50
```

FIGURE 13. SETUP AAA INPUT DATA AND INITIATE EXECUTION (Continued)

```
      AAADECK COMMAND
(7) --        SHOW,0
        TEST SIMULATION FOR DOCUMENTATION
      FLIGHT PROFILE MIN, MAX TIMES:       0.00  99.95 SEC
      SIMULATION MIN, MAX, INCR. TIMES:    0.00  99.94    .200 SEC
      NUMBER OF GUN SITES SELECTED:  2
      AAADECK COMMAND
(7) --        SHOW,1
      [ 1]   GUN= 1    VAT= 1    NGUNS= 1    NCB= 2    NSB= 1
             XGUN= -1000.0   YGUN=  1500.0   ZGUN=      0.0    GSRAD=    0.0
             DENS=  1.00   .75   .50    .25
      AAADECK COMMAND
(7) --        SHOW,2
      [ 2]   GUN= 3    VAT= 3    NGUNS= 2    NCB= 2    NSB= 1
             XGUN=  1000.0   YGUN=  -500.0   ZGUN=      0.0    GSRAD=   50.0
             DENS=  1.00   .75   .50    .25
      AAADECK COMMAND
      --      RUN?
      CHECK DATA FOR ERRORS AND EXECUTE PROGRAM.
      AAADECK COMMAND
(8) --        RUN
```

FIGURE 13. SETUP AAA INPUT DATA AND INITIATE EXECUTION (Continued)

```
(1) GUN SITE  1 SIMULATION COMPLETED
    GUN SITE  2 SIMULATION COMPLETED


(2)    ***** SUMMARY OF AAA SIMULATION RUN  ---  04/25/77  16.41.03 *****

    LOC IGL  RADIUS   XGUN     YGUN   ROUNDS  F.TIME  START   STOP     PK

     1   1     0.0 -1000.0  1500.0      169   25.35  24.96  50.11  .356174
     2   2    50.0  1000.0  -500.0      279   59.78  13.31  73.09  .296493
(3) AAAOUT COMMAND
    --         ?
      COMMANDS AVAILABLE ARE --
    TIME (T)   DEFINE (D)   TABULATE (TAB)   PLOT (P)    SHOW (S)   PRINT
    DENS   SECT   VELI   TFIR   TINT   TABPK   PLTPK   MAP   QUIT
    AAAOUT COMMAND
    --          TIME?
    SETS THE TIME RANGE FOR PLOT OR TABULATION.  STRING COMMAND AS --
        TIME,START,STOP,ANNOTATION      WHERE
    START AND STOP ARE IN SECONDS, AND ANNOTATION IS TIME SPACING BETWEEN
      CURVE ANNOTATIONS (PLOT ONLY).  ZERO GIVES NO ANNOTATION.
    EXAMPLE:   T,20,50,10    WILL PLOT FROM 20 TO 50 SECONDS WITH
      ANNOTATION EVERY 10 SECONDS OR TABULATE FROM 20 TO 50 SECONDS.
    AAAOUT COMMAND
(4) --          TIME,45,50,1
    AAAOUT COMMAND
    --          DEFINE?
    DEFINES THE CURVES TO BE PLOTTED.  STRING THE COMMAND AS --
        DEFINE,CURVE NUMBER,MNEMONIC,SITE,GUN NUMBER      WHERE
    CURVE NO = NUMBER OF CURVE BEING DEFINED  (FROM 1 TO 6).
    MNEMONIC = MNEMONIC OF DATA DESIRED FOR CURVE.  ENTER MNEM FOLLOWED
               BY A QUESTION MARK TO SEE CURVE MNEMONICS.
    SITE     = SITE NUMBER OF DESIRED DATA  (OPTIONAL - DEFAULT=1)
    GUN NO   = GUN NUMBER AT SELECTED SITE  (OPTIONAL - DEFAULT=1).
    EXAMPLE:   D,1,PKC,2,1   WILL DEFINE CURVE 1 AS THE CUMULATIVE PK
      FOR GUN 1 OF SITE 2.
    AAAOUT COMMAND
    --          MNEM?
      AVAILABLE (TIME-VARIANT) CURVES ARE --
    PXA  PYA  PZA  PXR  PYR  PZR  VXA  VYA  VZA  VGA  VMA  HEAD  FPA  ROLL
    MODE  RF  RI  VI  TPF  VA  PKS  PKC  SRAZ  SREL  ERAZ  EREL
    SXF  SYF  BXF  BYF
      ENTER DESIRED MNEMONIC FOLLOWED BY A QUESTION MARK TO SEE DEF.
    AAAOUT COMMAND
    --          PXA?
    PXA,PYA,PZA = ABSOLUTE POSITION VECTORS OF AIRCRAFT  <METERS>
    AAAOUT COMMAND
    --          PKC?
    PKS,PKC = PROBABILITY-OF-KILL FOR SHOT AND CUMULATIVE  <--->
    AAAOUT COMMAND
(5) --          DEFINE,1,PXA
    AAAOUT COMMAND
    --          DEFINE,2,PKC
    AAAOUT COMMAND
    --          DEFINE,3,PKC,2
    AAAOUT COMMAND
    --          DEFINE,4,PKC,2,2
```

FIGURE 14. EXAMINATION OF SIMULATION RESULTS

```
   AAAOUT COMMAND
   --        SHOW?
     THE SHOW COMMAND OPTIONS ARE --
   SHOW,GSIT,I,J   = SHOWS PARAMETERS OF GUN SITE I THRU GUN SITE J
   SHOW,GPAR,I,J,K = SHOWS GUN PARAMETERS FOR SITES I,J,K
   SHOW,DENS,I,J   = SHOWS GROUND WEAPON DENSITIES FOR SITES I THRU J
   SHOW,VAT,I      = DISPLAYS VULNERABLE AREA TABLE FOR SITE I
   SHOW,PKLM       = SHOWS CURRENT PK TABLE OUTPUT LIMITS
   SHOW,D          = SHOWS CURRENT CURVE DEFINITIONS AND TIME LIMITS
   AAAOUT COMMAND
(6) --        SHOW,D
   +++++ CURRENT CURVE DEFINITIONS +++++
     1   PXA     SITE= 1   GUN=1
     2   PKC     SITE= 1   GUN=1
     3   PKC     SITE= 2   GUN=1
     4   PKC     SITE= 2   GUN=2
     5           SITE= 0   GUN=0
     6           SITE= 0   GUN=0
   TIME:  MIN= 45.0  MAX= 50.0  ANNOTATION= 1.00
   AAAOUT COMMAND
   --        TABULATE?

   TABULATES 1-5 CURVES WITH TIME.  STRING THE COMMAND AS --
       TABULATE,CURVE1,CURVE2,..,CURVE5      WHERE
   CURVE = PREVIOUSLY DEFINED CURVE NUMBER
   EXAMPLE:   TAB,1,2,6   WILL TABULATE CURVES 1, 2, AND 6 FROM START
     TIME TO STOP TIME SELECTED WITH TIME COMMAND.
   USE DEFINE COMMAND TO SPECIFY DATA FOR EACH CURVE
   AAAOUT COMMAND
(7) --        TABULATE,1,2,3,4
```

FIGURE 14. EXAMINATION OF SIMULATION RESULTS (Continued)

TABULATION NUMBER 1 OF 04/25/77 AT 16.41.03 PAGE 1

TEST SIMULATION FOR DOCUMENTATION

F.TIME	PXA _ 1/1	PKC _ 1/1	PKC _ 2/1	PKC _ 2/2
45.06	-984.243	.31147	.13788	
45.18	-958.628	.31421		
45.25				.14086
45.31	-933.013	.31691		
45.44			.14268	
45.50	-894.591	.31951		
45.63	-868.975	.32204		
45.70				.14557
45.76	-843.36	.32451		
45.89			.14717	
45.95	-804.938	.32690		
46.08	-779.323	.32921		.14992
46.21	-753.707	.33146		
46.34			.15124	
46.40	-715.285	.33357		
46.53	-689.67	.33558		.15375
46.66	-664.055	.33748		
46.72			.15483	
46.85	-625.632	.33924		
46.98	-600.017	.34091		.15698
47.10	-574.402	.34247		
47.17			.15780	
47.30	-535.979	.34391		
47.36				.15964
47.42	-510.364	.34526		
47.55	-484.749	.34652		
47.62			.16016	
47.74	-446.326	.34765		
47.81				.16158
47.87	-420.711	.34871		
48.00			.16192	
48.06	-382.288	.34964		
48.19	-356.673	.35051		
48.26				.16292
48.	-331.058	.35131		
48.4			.16356	
48.51	-292.636	.35201		
48.64	-267.02	.35265		.16402
48.77	-241.405	.35324		
48.90			.16466	
48.96	-202.983	.35375		
49.09	-177.368	.35420		.16520
49.22	-151.753	.35462		
49.28			.16595	
49.41	-113.33	.35497		
49.54	-87.7148	.35528		.16653
49.66	-62.0996	.35556		
49.73			.16736	
49.86	-23.677	.35579		
49.98	1.93811	.35599		.16802

<END>

FIGURE 14. EXAMINATION OF SIMULATION RESULTS (Continued)

```
    AAAOUT COMMAND
    --        PRINT?
    SENDS FILE CONTAINING SIMULATION OUTPUT TO LINE PRINTER.  STRING AS --
        PRINT,IPRF,LP      WHERE
    LP = TERMINAL ID OF LINE PRINTER  (C=CENTRAL OR 2-CHAR. INTERCOM ID)
    AAAOUT COMMAND
(8) --        PRINT,IPRF,C
    AAAOUT COMMAND
(9) --        SHOW,PKLM
    +++++ CURRENT LIMITS ON PK OUTPUT +++++
        LDENS1 = 1      LDENS2 = 5
        LSECT1 =12      LSECT2 =16
        LVELI1 = 1      LVELI2 = 5
        LTINT  = 5
               20.00   30.00   40.00   50.00   60.00
        LTFIR  = 5
               20.00   30.00   40.00   50.00   60.00
    AAAOUT COMMAND
    --        TABPK?
    PRODUCES REQUESTED PROBABILITY-OF-KILL TABLE.  STRING COMMAND AS --
        TABPK,HORIZ,VERT,SITE      WHERE
    HORIZ = QUANTITY TO BE DISPLAYED ACROSS SCREEN.
    VERT  = QUANTITY TO BE DISPLAYED VERTICALLY WITH PK TOTALS AT BOTTOM.
    SITE  = SITE NUMBER OF DESIRED PK DATA  (OPTIONAL - DEFAULT=1).
    EXAMPLE:   TABPK,VELI,SECT,2   WILL PRODUCE PK TABLE WITH IMPACT VEL.
      CLASS ACROSS AND ASPECT SECTOR DOWN USING SITE 2 DATA.
    ENTER PK FOLLOWED BY A QUESTION MARK TO SEE ALLOWABLE QUANTITIES.
    AAAOUT COMMAND
    --        PK?
      AVAILABLE PK TABLE/PLOT QUANTITIES ARE --
    DENS = WEAPON DENSITY CLASSES       SECT = AIRCRAFT ASPECT SECTORS
    VELI = IMPACT VELOCITY CLASSES      TFIR = TIME-OF-FIRE INTERVALS
    SITE = GUN SITE NUMBER              TINT = TIME-OF-INTERCEPT INTERVALS
      NOTES: NOT ALL COMBINATIONS ARE VALID; MESSAGE GIVEN FOR INVALIDS
             SITE CAN BE USED VERTICALLY ONLY IN PK TABLES
             TO OBTAIN TOTAL PK FOR DENS CLASS 1 BY SECTOR AND VEL CLASS,
               USE:  TABPK,VELI,SECT,T   OR   PLTPK,VELI,SECT,T
    AAAOUT COMMAND
(10)--        TABPK,VELI,SECT,1

    PROBABILITY-OF-KILL TABULATION      SITE 1        04/25/77   16.41.03
         TEST SIMULATION FOR DOCUMENTATION
    ASPCT                          IMPCT VELOC
    SECT         1          2          3          4          5
      12   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
      13   0.0000000  0.0000000   .0524192   .1147048  0.0000000
      14    .0005951   .0206306   .1253407   .0888674  0.0000000
      15    .0012784   .0148307  0.0000000  0.0000000  0.0000000
      16   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
    TOTAL   .0018727   .0351553   .1711897   .1933787  0.0000000
```

FIGURE 14. EXAMINATION OF SIMULATION RESULTS (Continued)

```
     AAAOUT COMMAND
(11) --          TABPK,VELI,SECT,2
     PROBABILITY-OF-KILL TABULATION      SITE 2         04/25/77  16.41.03
         TEST SIMULATION FOR DOCUMENTATION
     ASPCT                             IMPCT VELOC
     SECT         1          2          3          4          5
       12   0.0000000  0.0000000  0.0000000   .0155011   .0409758
       13   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
       14   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
       15   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
       16   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
     TOTAL  0.0000000  0.0000000  0.0000000   .0155011   .0409758
     AAAOUT COMMAND
(12) --          TABPK,VELI,SECT,T
     PROBABILITY-OF-KILL TABULATION      SITE T         04/25/77  16.41.03
         TEST SIMULATION FOR DOCUMENTATION
     ASPCT                             IMPCT VELOC
     SECT         1          2          3          4          5
       12   0.0000000  0.0000000  0.0000000   .0155011   .0409758
       13   0.0000000  0.0000000   .0524192   .1147048  0.0000000
       14    .0005951   .0206306   .1253407   .0888674  0.0000000
       15    .0012784   .0148307  0.0000000  0.0000000  0.0000000
       16   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
     TOTAL   .0018727   .0351553   .1711897   .2058822   .0409758
     AAAOUT COMMAND
     --          VELI?
     LIMITS PK TABLE OUTPUT OF AIRCRAFT VELOCITY CLASSES (8 CLASSES)
     EXAMPLE:   VELI,1,5  WILL LIMIT OUTPUT TO VELOCITY CLASSES 1 THRU 5.
     AAAOUT COMMAND
     --          SECT?
     LIMITS PK TABLE OUTPUT OF AIRCRAFT ASPECT SECTORS (32 SECTORS)
     EXAMPLE:   SECT,12,16  WILL LIMIT OUTPUT TO SECTORS 12 THRU 16.
     AAAOUT COMMAND
(13) --          VELI,1,8
     AAAOUT COMMAND
     --          SECT,8,12
     AAAOUT COMMAND
(14) --          TABPK,SECT,VELI,2
     PROBABILITY-OF-KILL TABULATION      SITE 2         04/25/77  16.41.03
         TEST SIMULATION FOR DOCUMENTATION
     IMPCT                             ASPCT SECT
     VELOC        8          9         10         11         12
        1   0.0000000   .0014463  0.0000000  0.0000000  0.0000000
        2   0.0000000   .0137825  0.0000000  0.0000000  0.0000000
        3   0.0000000   .0329494  0.0000000  0.0000000  0.0000000
        4   0.0000000   .0170368  0.0000000  0.0000000   .0155011
        5   0.0000000   .0067575   .0179650  0.0000000   .0409758
        6   0.0000000  0.0000000   .0075153   .0262579   .0979498
        7   0.0000000  0.0000000  0.0000000   .0093070   .0378524
        8   0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
     TOTAL  0.0000000   .0702078   .0253453   .0353204   .1805599
```

FIGURE 14. EXAMINATION OF SIMULATION RESULTS (Continued)

```
      AAAOUT COMMAND
(15)  --          TABPK,DENS,SITE
      PROBABILITY-OF-KILL TABULATION     SITE          04/25/77   16.41.03
          TEST SIMULATION FOR DOCUMENTATION
       GUN                              DENS  CLASS
      SITE        1          2          3          4          5
         1    .3561745   .2671309   .1780872   .0890436   0.0000000
         2    .2964925   .2223694   .1482463   .0741231   0.0000000
      TOTAL   .5470639   .4300985   .2999327   .1565666   0.0000000
      AAAOUT COMMAND
(16)  --          QUIT

      AAA COMMAND
      --
```

FIGURE 14. EXAMINATION OF SIMULATION RESULTS (Continued)

(3) The user is placed back into control in the output processor.

(4) Select a time range for tabulation or plotting of the time-variant data.

(5) Define the curves to be tabulated or plotted.

(6) Review the curve definitions.

(7) Tabulate the defined curves. Since each gun of each site fires at its own times, there will be blanks in the output wherever that gun did not fire. At the top of each column is shown the curve mnemonic, the gun site number, and the gun number at that site.

(8) During the simulation, an output file of the results is created. If the user desires, this file may be printed on the central site line printers or on a printer at a remote batch terminal with the PRINT command. This file is shown in Appendix C.

(9) Display the Pk output limits. The values shown are defaults and may be changed by the user.

(10) Display selected portions of the table of Pk as a function of impact velocity and aircraft aspect sector for gun site 1. The totals shown are probability sums of the displayed values only.

(11) Display same table for gun site 2.

(12) Display same table weighted by density class 1 for all gun sites (SITE=T).

(13) Change output limits for velocity classes and aspect sectors.

(14) Display same table as (11) with new limits and with horizontal and vertical quantities exchanged.

(15) Display table of Pk for each density class for each gun site.

(16) When finished reviewing the output of this case, type QUIT to return to the AAA level of the AEP. Once the user has left the AAOUT level, the output of that simulation can no longer be found.

Although no plots were made in this example, the user can plot any of the time-variant or Pk data on a graphics terminal. Figure 15 shows a plot of several curves versus time. The curve mnemonics are shown at the top along with the site number, gun number, scale factor, and annotation symbol. The scale factor here is the number by which all points of the curve have been multiplied to produce the plot. To obtain the correct value from the plot (e.g., peak value of PKC for site 1, gun 1), the user would divide the value

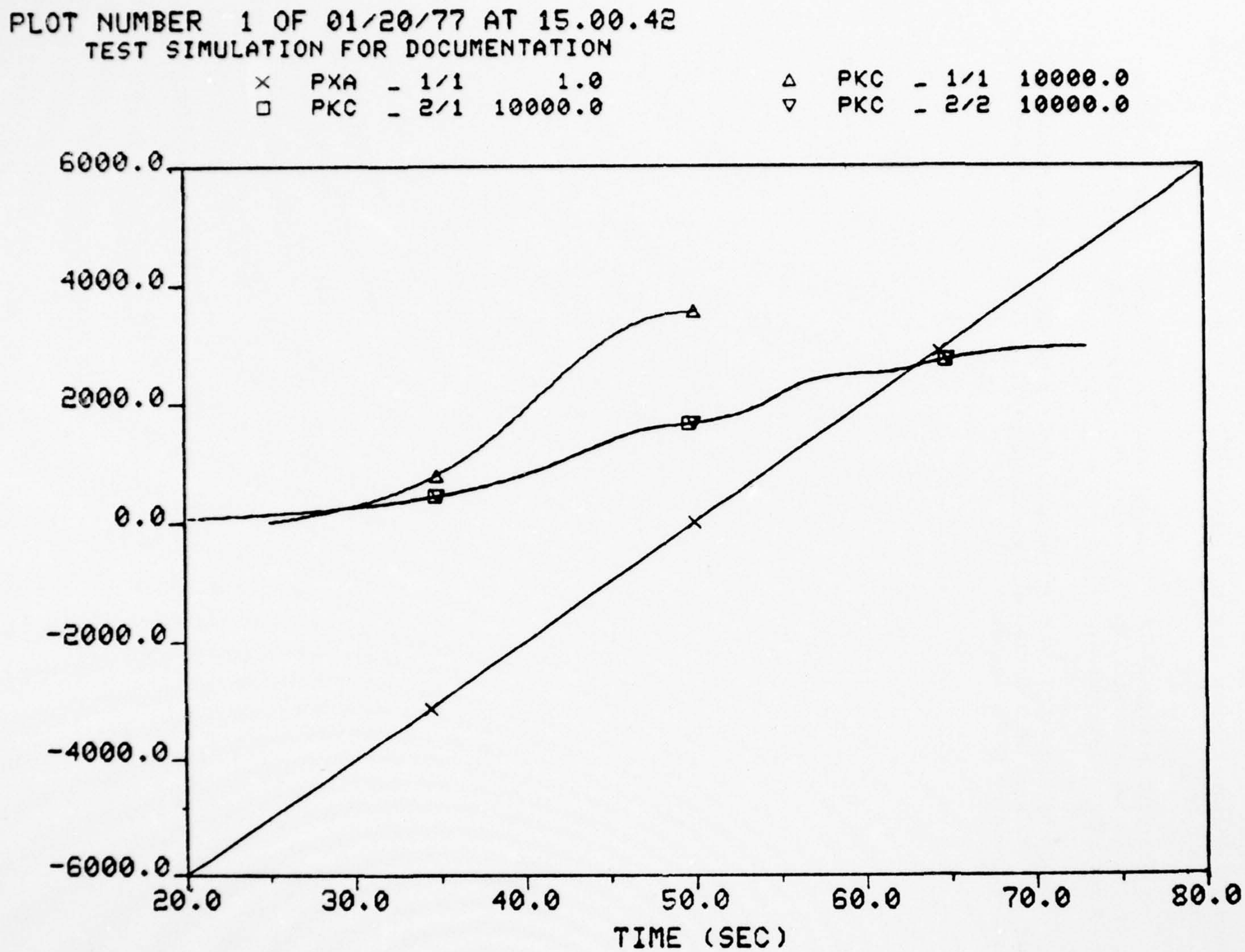
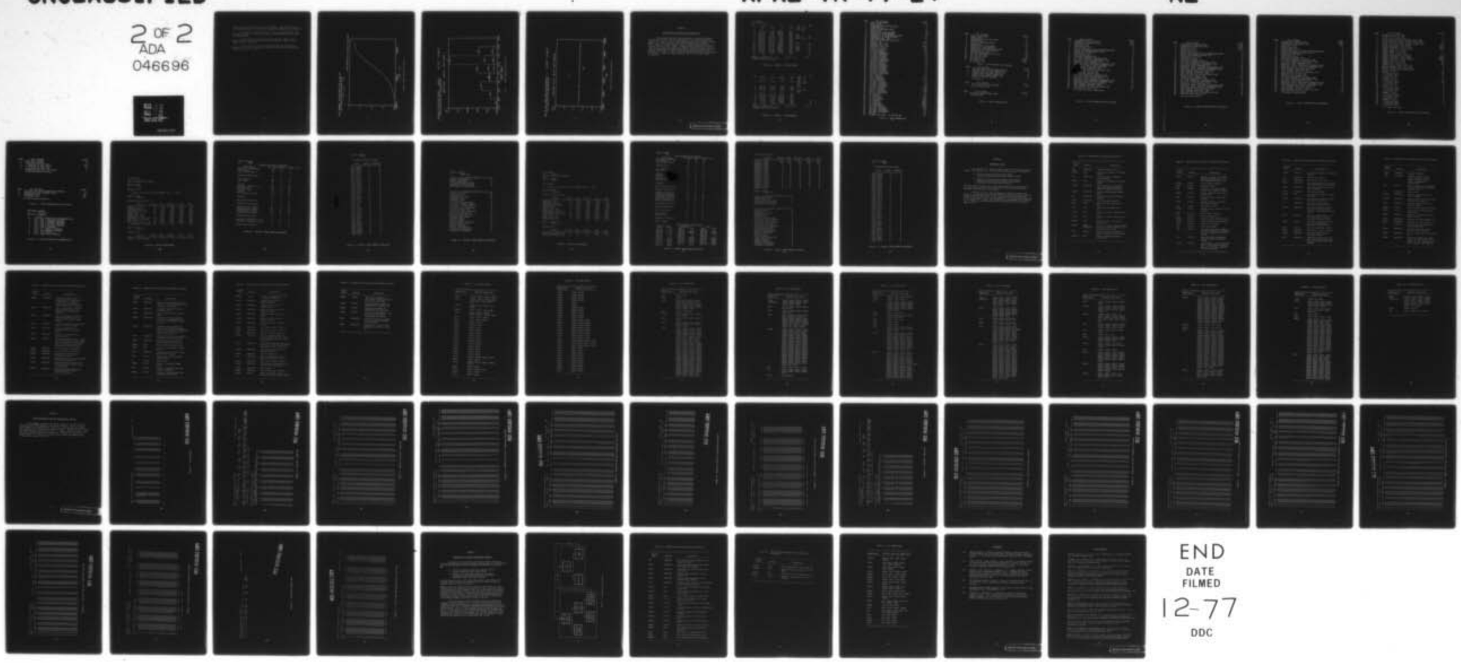


FIGURE 15. SAMPLE PLOT VERSUS TIME

AD-A046 696 BATTELLE COLUMBUS LABS OHIO F/G 9/3
AVIONICS EVALUATION PROGRAM: MULTIPLE MISSIONS AND ANTIAIRCRAFT--ETC(U)
JUN 77 R A BROWN, M KLUSE, M R NEALE F33615-76-C-1299
UNCLASSIFIED AFAL-TR-77-24 NL

2 OF 2
ADA
046696



END
DATE
FILMED
12-77
DDC

read from the plot (3500) by the scale factor (10000). The result in this case is 0.35 which compares well with the value shown in the summary table in Figure 10.

Plots may also be drawn with up to 5 curves versus another (not time) as shown in Figure 16. In this case, however, all curves must be from the same site and gun number.

The probability-of-kill data may also be plotted. Figure 17 is a plot of the Pk for aircraft aspect sectors 9-12 versus the 8 impact velocity classes for site 2 (all guns).

The MAP option in the output processor produces the plot shown in Figure 18. This is an X-Y view of the flight profile with the locations of the gun sites shown by the + symbol.

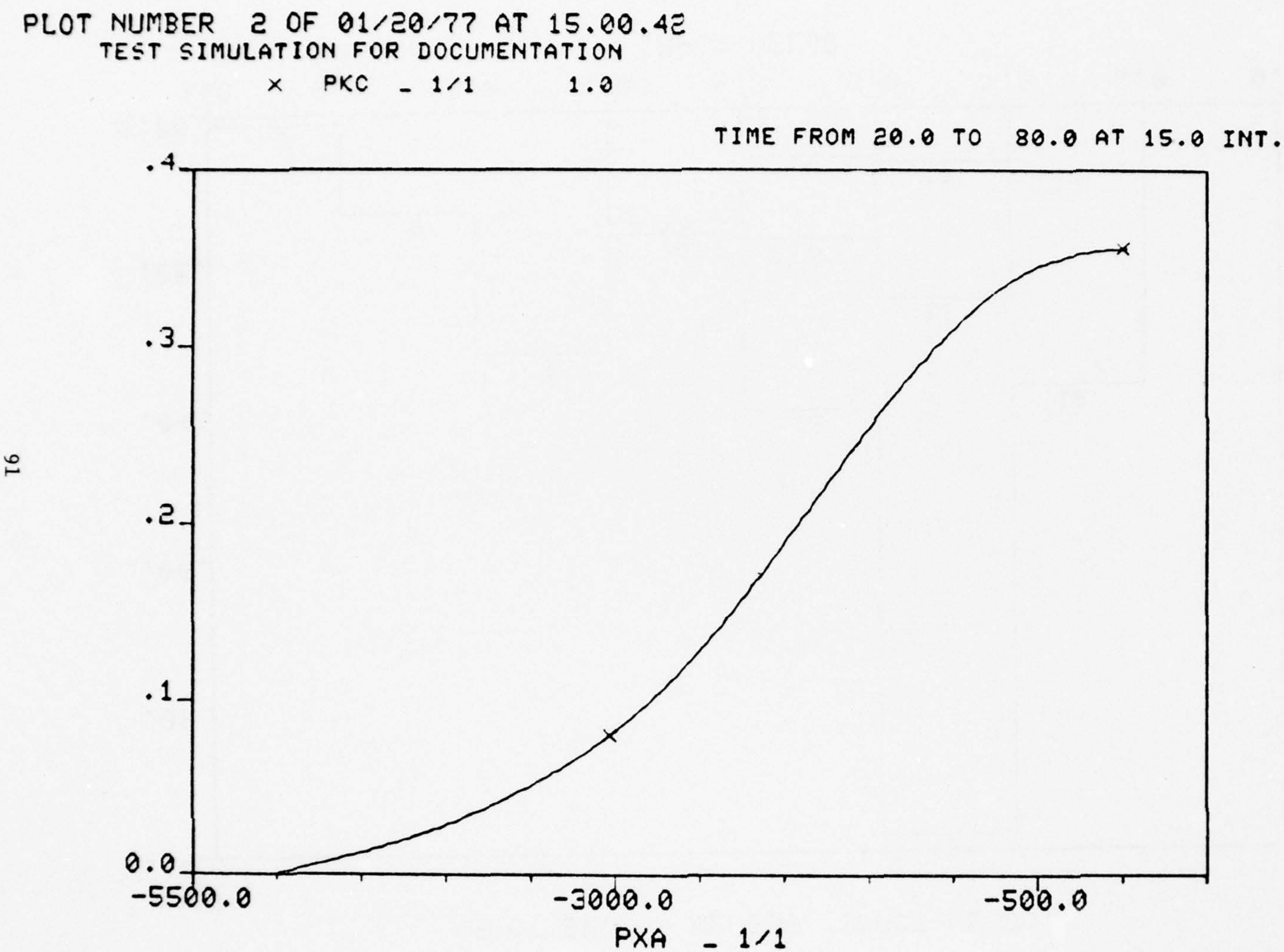
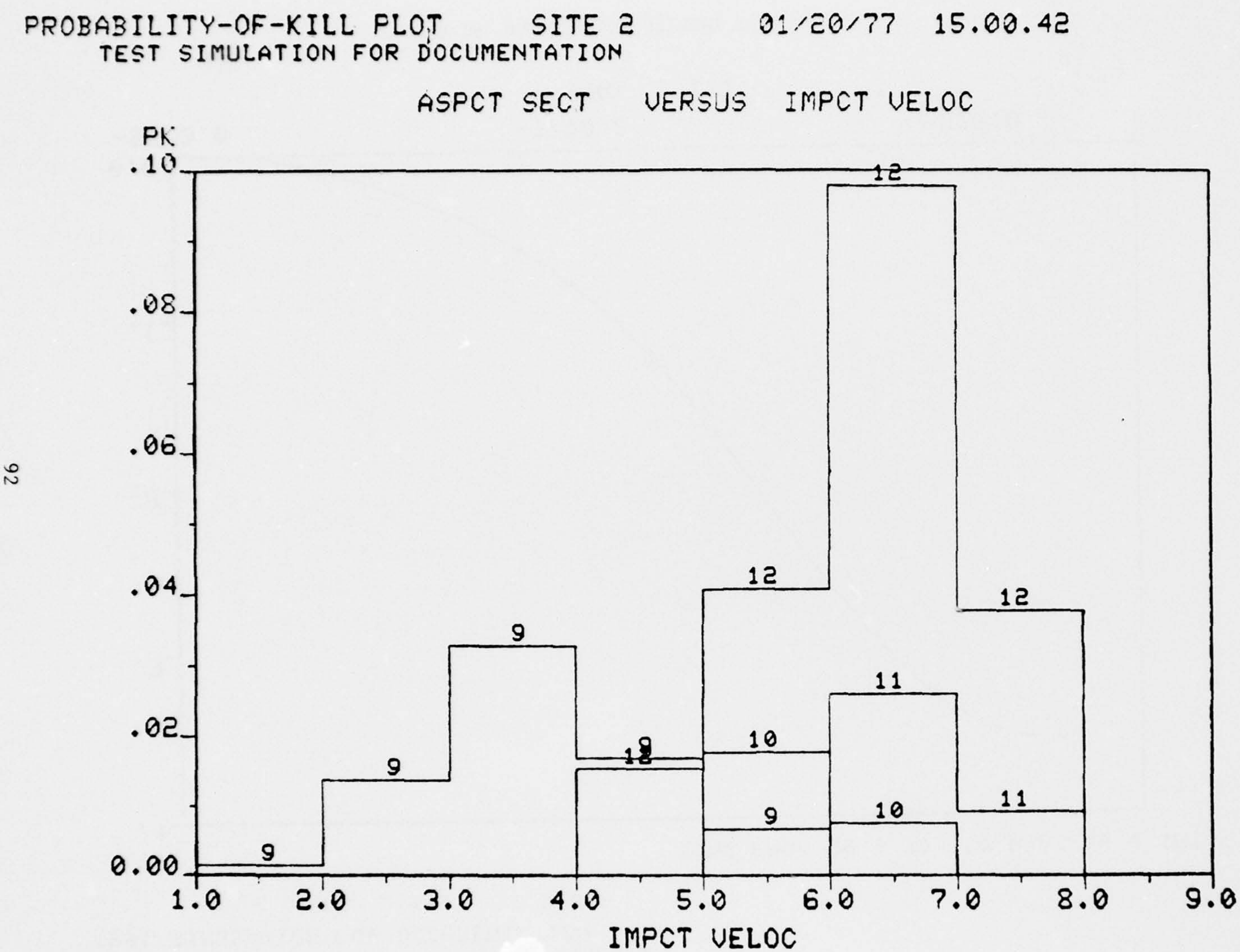


FIGURE 16. SAMPLE PLOT WITHOUT TIME AXIS



FIGU[illegible] SAMPLE PROBABILITY-OF-KILL PLOT

MAP OF GUN SITES AND FLIGHT PROFILE --- 01/20/77 16.38.53
TEST SIMULATION FOR DOCUMENTATION

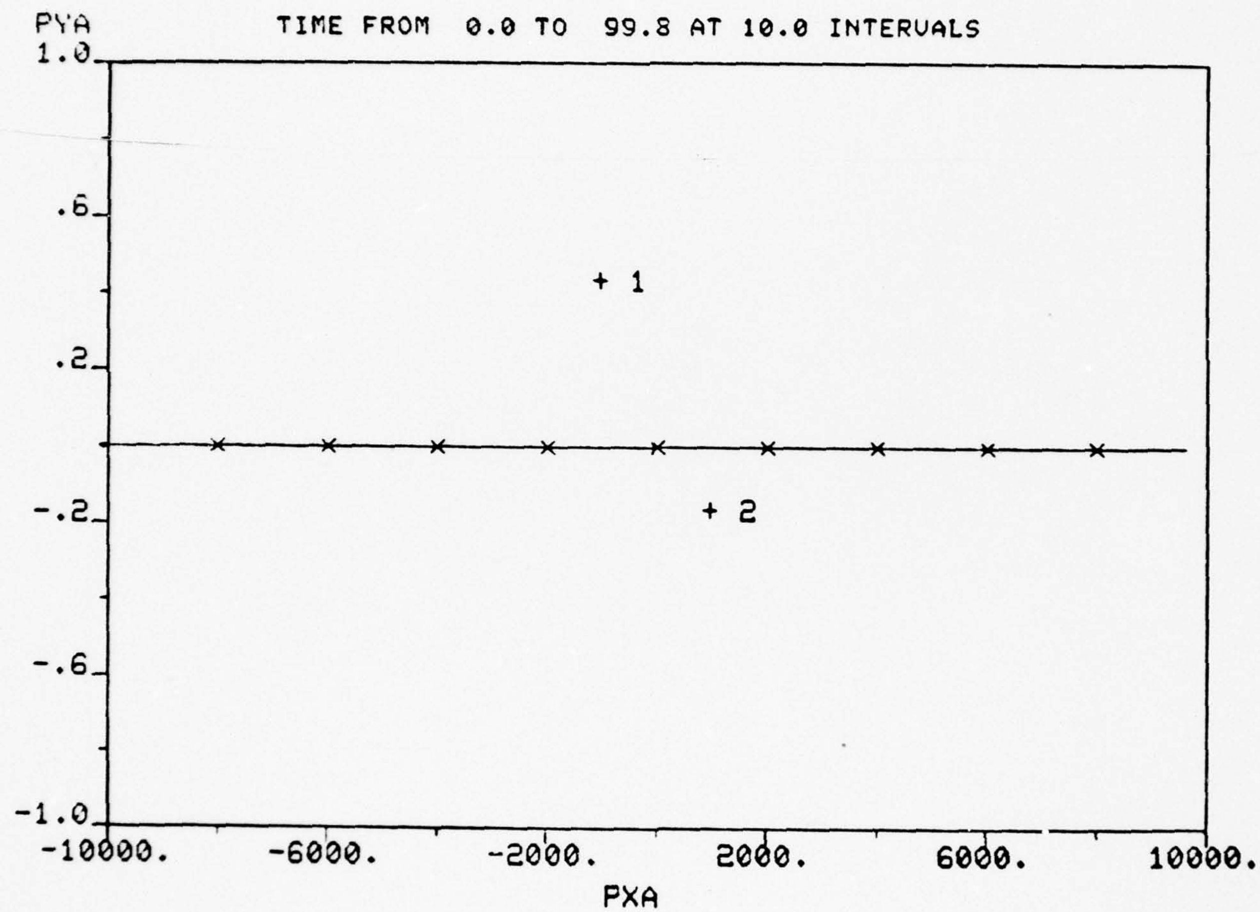


FIGURE 18. MAP FOR EXAMPLE SIMULATION

APPENDIX A

SAMPLE EXECUTION OF THE MULTIPLE MISSION AEP

This appendix describes a sample execution of the multiple mission RPV version of the AEP. The execution consists of a 2 mission simulation for 5 Monte Carlo trials for 2 days. Each mission consists of 2 aircraft. Mission number 1 is a carrier vehicle mission that air launches mission number 2. Mission number 2 is an RPV mission. Figures A-1 and A-2 show the flight profiles for the two missions. Figure A-3 shows selected hardware data. The aircraft of both missions are identically equipped. Figure A-4 shows the data for selected subfunctions. Figure A-5 shows the intermission dependence keys as candidates of Section 99. Figure A-6 shows a detailed list of the output results for mission 1. Figure A-7 shows a detailed list of of the output results for mission 2.

FP COMMAND

-- LIST

ID	X	Y	H	V	ON		OFF	
1	0.00	0.00	0.	250.	302	702		
					902	1001		
2	10.00	0.00	10000.	350.				
3	20.00	0.00	20000.	400.				
4	100.00	0.00	20000.	400.	406			
5	110.00	10.00	500.	450.	1002		10	
6	150.00	50.00	500.	450.	1101	1003	10	9
7	170.00	70.00	500.	450.				
8	170.20	70.20	2000.	450.				
9	172.00	72.00	2000.	450.	1004		10	
10	176.00	76.00	2000.	450.			11	
11	172.00	78.00	10000.	450.	1003		10	
12	145.00	75.00	30000.	400.	1002		10	
13	60.00	60.00	30000.	400.	1001		10	
14	25.00	25.00	30000.	400.				
15	0.00	0.00	0.	150.			10	3
							7	

TARGET 1 LOCATION - X= 175.0 Y= 75.0

COMMON WAYPOINT NUMBER= 4

FIGURE A-1. MISSION 1. FLIGHT PROFILE

ID	X	Y	H	V	ON		OFF	
1	100.00	0.00	20000.	400.	302	702		
					902			
2	110.00	10.00	500.	450.	1001	903		
					904	905		
					1801			
3	150.00	50.00	500.	450.	804			
4	170.00	70.00	500.	450.				
5	170.20	70.20	2000.	450.	1601	1701		
					1702			
6	172.00	72.00	2000.	450.				
7	176.00	76.00	2000.	450.				
8	172.00	78.00	10000.	450.				
9	145.00	75.00	30000.	400.				
10	60.00	60.00	30000.	400.			10	9
11	25.00	25.00	30000.	400.			8	
12	0.00	0.00	0.	150.			3	7

TARGET 1 LOCATION - X= 175.0 Y= 75.0

COMMON WAYPOINT NUMBER= 1

FIGURE A-2. MISSION 2. FLIGHT PROFILE

ITEM	DATA VARIABLE	VALUE
1	MTBF (FLIGHT HOURS)	10.
2	MTBMA (HOURS)	2.
3	OPERATIONAL/FLIGHT HOUR RATIO	1.
4	VULNERABILITY	0.
5	NUMBER OF REDUNDANT BOXES	0.
6	MTTR (HOURS)	.73
7	PROBABILITY OF REPLACEMENT	.206
8	PROBABILITY ITEM AVAILABLE	1.
9	PROBABILITY OF UNDETECTED FAILURE	0.
10	PROBABILITY OF FALSE FAILURE	.411
11	ACQUISTION COST ($K)	0.
12	COST PER MAINTENANCE ACTION ($)	0.
13	WEIGHT (LBS)	32834.
14	EXTERNAL FUEL (LBS)	0.
15	INTERNAL FUEL (LBS)	12053.
16	MEAN AERO CHORD (FT)	16.
17	WING AREA (SQ FT)	500.
18	CL-ALFA (TAKEOFF)	3.6
19	CL-ALFA(SUBSONIC)	3.6
20	CL-ALFA (TRANSONIC)	4.5
21	CL-ALFA(SUPERSONIC)	2.8
22	CL-DELTA (TAKEOFF)	.63
23	CL-DELTA(SUBSONIC)	.6
24	CL-DELTA (TRANSONIC)	.45
25	CL-DELTA(SUPERSONIC)	.34
26	CM-ALFA (TAKEOFF)	-.2
27	CM-ALFA(SUBSONIC)	-.2
28	CM-ALFA (TRANSONIC)	-.6
29	CM-ALFA(SUPERSONIC)	-.6
30	CM-DELTA (TAKEOFF)	-.9
31	CM-DELTA(SUBSONIC)	-.8
32	CM-DELTA (TRANSONIC)	-.7
33	CM-DELTA(SUPERSONIC)	-.4
34	CM-Q (TAKEOFF)	-3.7
35	CM-Q(SUBSONIC)	-3.2
36	CM-Q (TRANSONIC)	-4.5
37	CM-Q(SUPERSONIC)	-2.5
38	CD-ZERO (TAKEOFF)	.02
39	CD-ZERO (SUBSONIC)	.02
40	CD-ZERO (TRANSONIC)	.038
41	CD-ZERO(SUPERSONIC)	.043
42	ALFA-ZL (TAKEOFF)	-.008
43	ALFA-ZL(SUBSONIC)	-.008
44	ALFA-ZL (TRANSONIC)	-.008
45	ALFA-ZL(SUPERSONIC)	0.
46	D2 (TAKEOFF)	.1215
47	D2 (SUBSONIC)	.1215
48	D2 (TRANSONIC)	.1497
49	D2 (SUPERSONIC)	.4687
50	D4 (TAKEOFF)	.0873
51	D4 (SUBSONIC)	.0873
52	D4 (TRANSONIC)	.00794
53	D4 (SUPERSONIC)	.1563
54	ALFA-MAX (TAKEOFF)	13.5
55	ALFA-MAX (SUBSONIC)	18.
56	ALFA-MAX (TRANSONIC)	24.
57	ALFA-MAX (SUPERSONIC)	24.
58	CM-ZERO	-.01
59	CD-ZERO DRAG BRAKE	0.

(a) Airframe Data

FIGURE A-3. SAMPLE HARDWARE DATA

ITEM	DATA VARIABLE	VALUE
1	MTBF (FLIGHT HOURS)	15.
2	MTBMA (HOURS)	6.
3	OPERATIONAL/FLIGHT HOUR RATIO	1.
4	VULNERABILITY	0.
5	NUMBER OF REDUNDANT BOXES	0.
6	MTTR (HOURS)	3.72
7	PROBABILITY OF REPLACEMENT	0.
8	PROBABILITY ITEM AVAILABLE	1.
9	PROBABILITY OF UNDETECTED FAILURE	0.
10	PROBABILITY OF FALSE FAILURE	.487
11	ACQUISTION COST ($K)	0.
12	COST PER MAINTENANCE ACTION ($)	0.
13	MIL SPEC IMP (HRS)	.84
14	MAX SPEC IMP (HRS)	1.97
15	MIL THRUST (LB)	11870.
16	MAX THRUST (LB)	17900.

(b) Propulsion Data

FIGURE A-3. SAMPLE HARDWARE DATA (Continued)

ITEM	DATA VARIABLE	VALUE
1	EARLIEST TIME TO BEGIN PREFLIGHT (HR)	6.
2	EARLIEST TIME TO BEGIN LAUNCH (HR)	9.
3	MINIMUM TIME UNTIL NEXT SORTIE (HR)	3.
4	LATEST TIME TO LAUNCH SORTIE (HR)	17.
5	MAXIMUM DELAY BEFORE CANCEL (HR)	1.
6	NUMBER OF DAYS TO SIMULATE	2.

(a) Schedule

ITEM	DATA VARIABLE	VALUE
1	MISSION NUMBER BEING LAUNCHED	2.

(b) RPV Airborne Launch

ITEM	DATA VARIABLE	VALUE
1	RECOVERY CORRIDOR WIDTH (NMI)	5.

(c) RPV Recovery

FIGURE A-4. SAMPLE SUBFUNCTION DATA

ITEM	DATA VARIABLE	VALUE
1	TRANSMITTER POWER (WATTS)	200.
2	TRANSMITTER FREQUENCY (MHZ)	9500.
3	BANDWIDTH (KHZ)	5.
4	MODULATION CODE	1.
5	NOISE FIGURE (DB)	4.
6	MODULATION INDEX (ANALOG MODULATION ONLY)	.8
7	SIGNAL IMPROVEMENT FACTOR (DB)	0.
8	INSERTION LOSS (DB)	3.
9	FADE MARGIN (DB)	3.
10	RECEIVING ANTENNA TYPE	5.
11	OPT HORN DIMENSION (AZIMUTH) (IN)	0.
12	OPT HORN DIMENSION (ELEVATION) (IN)	0.
13	PARABOLIC DISH DIAMETER (IN)	24.
14	BROADSIDE ARRAY HORIZONTAL DIMENSION (IN)	0.
15	BROADSIDE ARRAY VERTICAL DIMENSION (IN)	0.
16	USER ANTENNA MAIN LOBE GAIN (DB)	0.
17	USER ANTENNA BEAMWIDTH (DEG)	0.
18	USER ANTENNA AVG SIDE LOBE GAIN (DB)	0.
19	FRONT-TO-BACK RATIO (DB)	30.
20	TRANSMITTING ANTENNA TYPE	5.
21	OPT HORN DIMENSION (AZIMUTH) (IN)	0.
22	OPT HORN DIMENSION (ELEVATION) (IN)	0.
23	PARABOLIC DISH DIAMETER (IN)	24.
24	BROADSIDE ARRAY HORIZONTAL DIMENSION (IN)	0.
25	BROADSIDE ARRAY VERTICAL DIMENSION (IN)	0.
26	USER ANTENNA MAIN LOBE GAIN (DB)	0.
27	USER ANTENNA BEAMWIDTH (DEG)	0.
28	USER ANTENNA AVG SIDE LOBE GAIN (DB)	0.
29	FRONT-TO-BACK RATIO (DB)	30.

(d) Command and Control Communication

FIGURE A-4. SAMPLE SUBFUNCTION DATA (Continued)

ITEM	DATA VARIABLE	VALUE
1	TRANSMITTER POWER (WATTS)	200.
2	TRANSMITTER FREQUENCY (MHZ)	15000.
3	BANDWIDTH (KHZ)	5000.
4	MODULATION CODE	1.
5	NOISE FIGURE (DB)	6.5
6	MODULATION INDEX (ANALOG MODULATION ONLY)	.8
7	SIGNAL IMPROVEMENT FACTOR (DB)	0.
8	INSERTION LOSS (DB)	3.
9	FADE MARGIN (DB)	3.
10	RECEIVING ANTENNA TYPE	5.
11	OPT HORN DIMENSION (AZIMUTH) (IN)	0.
12	OPT HORN DIMENSION (ELEVATION) (IN)	0.
13	PARABOLIC DISH DIAMETER (IN)	24.
14	BROADSIDE ARRAY HORIZONTAL DIMENSION (IN)	0.
15	BROADSIDE ARRAY VERTICAL DIMENSION (IN)	0.
16	USER ANTENNA MAIN LOBE GAIN (DB)	0.
17	USER ANTENNA BEAMWIDTH (DEG)	0.
18	USER ANTENNA AVG SIDE LOBE GAIN (DB)	0.
19	FRONT-TO-BACK RATIO (DB)	30.
20	TRANSMITTING ANTENNA TYPE	5.
21	OPT HORN DIMENSION (AZIMUTH) (IN)	0.
22	OPT HORN DIMENSION (ELEVATION) (IN)	0.
23	PARABOLIC DISH DIAMETER (IN)	24.
24	BROADSIDE ARRAY HORIZONTAL DIMENSION (IN)	0.
25	BROADSIDE ARRAY VERTICAL DIMENSION (IN)	0.
26	USER ANTENNA MAIN LOBE GAIN (DB)	0.
27	USER ANTENNA BEAMWIDTH (DEG)	0.
28	USER ANTENNA AVG SIDE LOBE GAIN (DB)	0.
29	FRONT-TO-BACK RATIO (DB)	30.

(e) Video Communications

FIGURE A-4. SAMPLE SUBFUNCTION DATA (Continued)

ITEM	DATA VARIABLE	VALUE
1	TRANSMITTER POWER (WATTS)	1000.
2	TRANSMITTER FREQUENCY (MHZ)	9000.
3	BANDWIDTH (KHZ)	5.
4	MODULATION CODE	1.
5	NOISE FIGURE (DB)	4.
6	MODULATION INDEX (ANALOG MODULATION ONLY)	.8
7	SIGNAL IMPROVEMENT FACTOR (DB)	0.
8	INSERTION LOSS (DB)	3.
9	FADE MARGIN (DB)	3.
10	RECEIVING ANTENNA TYPE	5.
11	OPT HORN DIMENSION (AZIMUTH) (IN)	0.
12	OPT HORN DIMENSION (ELEVATION) (IN)	0.
13	PARABOLIC DISH DIAMETER (IN)	24.
14	BROADSIDE ARRAY HORIZONTAL DIMENSION (IN)	0.
15	BROADSIDE ARRAY VERTICAL DIMENSION (IN)	0.
16	USER ANTENNA MAIN LOBE GAIN (DB)	0.
17	USER ANTENNA BEAMWIDTH (DEG)	0.
18	USER ANTENNA AVG SIDE LOBE GAIN (DB)	0.
19	FRONT-TO-BACK RATIO (DB)	30.
20	TRANSMITTING ANTENNA TYPE	5.
21	OPT HORN DIMENSION (AZIMUTH) (IN)	0.
22	OPT HORN DIMENSION (ELEVATION) (IN)	0.
23	PARABOLIC DISH DIAMETER (IN)	24.
24	BROADSIDE ARRAY HORIZONTAL DIMENSION (IN)	0.
25	BROADSIDE ARRAY VERTICAL DIMENSION (IN)	0.
26	USER ANTENNA MAIN LOBE GAIN (DB)	0.
27	USER ANTENNA BEAMWIDTH (DEG)	0.
28	USER ANTENNA AVG SIDE LOBE GAIN (DB)	0.
29	FRONT-TO-BACK RATIO (DB)	30.

(f) Telemetry Communications

FIGURE A-4. SAMPLE SUBFUNCTION DATA (Continued)

ITEM	DATA VARIABLE	VALUE
1	SIGINT GAIN (C/C) (DB)	3.
2	SIGINT GAIN (T/M) (DB)	3.
3	SIGINT GAIN (VIDEO) (DB)	3.
4	SIGINT RECEIVER NOISE FIGURE (C/C) (DB)	4.
5	SIGINT RECEIVER NOISE FIGURE (T/M) (DB)	4.
6	SIGINT RECEIVER NOISE FIGURE (VIDEO) (DB)	6.5
7	JAMMER BANDWIDTH (C/C) (KHZ)	1000.
8	JAMMER BANDWIDTH (T/M) (KHZ)	1000.
9	JAMMER BANDWIDTH (VIDEO) (KHZ)	1000.
10	JAMMER POWER (C/C) (KW)	1.
11	JAMMER POWER (T/M) (KW)	1.
12	JAMMER POWER (VIDEO) (KW)	1.
13	JAMMER FREQUENCY (C/C) (MHZ)	9000.
14	JAMMER FREQUENCY (T/M) (MHZ)	9500.
15	JAMMER FREQUENCY (VIDEO) (MHZ)	15000.
16	JAMMER GAIN (C/C) (DB)	10.
17	JAMMER GAIN (T/M) (DB)	10.
18	JAMMER GAIN (VIDEO) (DB)	10.
19	SHADOW PROBABILITY (C/C) (DB)	0.
20	SHADOW PROBABILITY (T/M) (DB)	0.
21	SHADOW PROBABILITY (VIDEO) (DB)	0.
22	JAMMER 1 TYPE	1.
23	X LOCATION (NMI)	160.
24	Y LOCATION (NMI)	60.
25	Z LOCATION (FT)	0.
26	JAMMER 2 TYPE	3.
27	X LOCATION (NMI)	150.
28	Y LOCATION (NMI)	80.
29	Z LOCATION (FT)	0.
30	JAMMER 3 TYPE	0.
31	X LOCATION (NMI)	0.
32	Y LOCATION (NMI)	0.
33	Z LOCATION (FT)	0.
34	JAMMER 4 TYPE	0.
35	X LOCATION (NMI)	0.
36	Y LOCATION (NMI)	0.
37	Z LOCATION (FT)	0.
38	JAMMER 5 TYPE	0.
39	X LOCATION (NMI)	0.
40	Y LOCATION (NMI)	0.
41	Z LOCATION (FT)	0.

(g) Jammer Definition

FIGURE A-4. SAMPLE SUBFUNCTION DATA (Continued)

ITEM	DATA VARIABLE	VALUE
1	RAIN RATE (MM/HR)	0.
2	RAIN PATH FRACTION	0.
3	X LOCATION OF BASE (NMI)	105.
4	Y LOCATION OF BASE (NMI)	50.
5	Z LOCATION OF BASE (FT)	0.
6	COMMUNICATIONS TIME STEP (MIN)	1.

(h) Base/Environment Definition

ITEM	DATA VARIABLE	VALUE
1	PER UNIT TIME ERROR GROWTH RATE (NM/HR)	.15
2	CORRELATION TIME CONSTANT (MIN)	0.
3	PROCESSOR KEOPS	100.
4	PROCESSOR BYTES	600.

(i) Self-Continued Navigation -

FIGURE A-4. SAMPLE SUBFUNCTION DATA (Continued)

```
EQUIPMENT COMMAND
--          SELECT,99
SECTION 99 COMMAND
--          LIST
 ID    CAND FOR INTERMISSION DEPENDENCE KEYS
 1     99-1  MSN 1 PRESENCE REQUIRED
 2     99-2  MSN 2 PRESENCE REQUIRED
 3     99-3  MSN 3 PRESENCE REQUIRED
 4     99-4  MSN 4 PRESENCE REQUIRED
 5     99-5  CHAFF DISPERSED
 6     99-6  A/B JAMMERS DISPERSED
 7     99-7  I/M JAMMERS DISPERSED
 8     99-8  ECM PROVIDED
 9     99-9  RECCE INFO PROVIDED
```

FIGURE A-5. EXISTING INTERMISSION DEPENDENCE KEYS

AEP COMMAND
-- AEPOUT
ENTER DESIRED MISSION NUMBER
-- 1
AEPOUT COMMAND
-- TITLE

CARRIER EX REC

5 MONTE CARLO TRIALS, WITH 2AIRCRAFT, FOR , 2 DAYS

AEPOUT COMMAND
-- STAT,GND

GROUND PREPARATION DATA .

VARIABLE	SAMPLES	MEAN	STD DEV	MAX	MIN
SORTIES PER DAY	10	1.40	.699	2.00	0.
PREFLIGHT TIME (HR)	19	1.09	.275	1.58	.619
THRU-FLIGHT TIME (HR)	19	2.93	1.35	6.19	.996
POSTFLIGHT TIME (HR)	16	2.60	1.21	6.01	1.26
LAUNCH (MIN)	19	4.71	1.96	9.82	2.45
LAUNCH DELAY (MIN)	9	39.5	59.2	195.	15.4
REPAIR DELAY (MIN)	9	110.	91.1	298.	22.9
MAINTENANCE ACTIONS (MIN)	56	134.	81.9	371.	22.9
FUEL LOADING TIME (MIN)	28	5.07	3.74	9.21	.446
FUEL LOADED (LB)	28	2533.	1869.	4604.	223.
G.P. MUNITIONS LOAD (MIN)	20	1.03	.157	1.28	.691
G.P. MUNITIONS DEARM(MIN)	30	0.	0.	0.	0.

AEPOUT COMMAND
-- STAT,AIR

AIRBORNE DATA

VARIABLE	SAMPLES	MEAN	STD DEV	MAX	MIN
NUMBER OF ATTACK PASSES	0	0.	0.	0.	0.

FIGURE A-6. MISSION 1 OUTPUT RESULTS

AEPOUT COMMAND
-- SUBF

SUBFUNCTION/MODE UTILIZATION

SUBFUNCTION	NO. USES	FAILED	MODES (1-N)
PREFLIGHT (BEGINNING	10	0	0
THRU-FLIGHT	10	0	0
POST FLIGHT (END OF	8	0	0
GENERAL PURPOSE MUNI	20	0	0
FUEL LOADING	32	0	0
FUEL USAGE	19	1	19
LAUNCH	19	2	19
INFLIGHT AIRCRAFT AB	14	2	14
MISSION ABORT	14	2	14
AIRCRAFT LOSS	14	2	14
LANDING	13	1	12
RPV AIRBORNE LAUNCH	9	0	9
SCHEDULE	10	0	0
SELF-CONTAINED NAVIG	19	1	19
EXTERNAL COMMUNICATI	19	2	19
SURVIVABILITY SUBFUN	25	0	25
SURVIVABILITY SUBFUN	15	0	15
SURVIVABILITY SUBFUN	12	0	12
SURVIVABILITY SUBFUN	6	0	6
DISPLAY ACQUISITION	6	0	6
UNGUIDED AUTOMATIC W A/C 1	0	0	0
UNGUIDED AUTOMATIC W A/C 2	0	0	0
TARGET SUBFUNCTION 1	0	0	0

FIGURE A-6. MISSION 1 OUTPUT RESULTS (Continued)

AEPOUT COMMAND
-- FAIL

EQUIPMENT FAILURES TOTAL

ITEM	GROUND	AIRBORNE
DEMO AIRCR	3	6
DEMO ENGIN	0	5
DEMO FUSEL	0	4
DEMO LANDI	2	10
DEMO AFCS	2	1
DEMO AIR C	1	2
DEMO ELECT	0	2
DEMO LIGHT	1	2
DEMO HYDRA	0	2
DEMO FUEL	1	2
DEMO OXYGE	0	0
DEMO UTILI	0	0
DEMO INSTR	0	0
DEMO INT G	0	1
DEMO UHF C	0	0
DEMO ARC-5	1	1
DEMO ADF	0	0
DEMO HEADI	0	0
DEMO COMPU	0	0
DEMO AIR D	0	0
DEMO DOPPL	1	0
DEMO HEAD	0	2
DEMO IMS	1	0
DEMO INTER	0	0
DEMO RADAR	0	0
DEMO FWD L	0	2
DEMO FLIR	0	1
DEMO WEAPO	0	0
DEMO WEAPO	0	1
DEMO PDMS	0	0
DEMO GUN	0	1
DEMO WEAPO	0	0
DEMO WEAPO	0	0
DEMO RF BL	0	0
DEMO ECM D	0	0
DEMO PASSI	0	0
DEMO EMERG	0	0
DEMO LAUNC	0	0
DEMO IFF S	0	0

FIGURE A-6. MISSION 1 OUTPUT RESULTS (Continued)

AEPOUT COMMAND

-- EVENTS, ALL

--------------GROUND EVENTS-------------	
GENERAL MAINTENANCE	17
SORTIE CANCELLED	9
NOT OPERATIONALLY READY	2
EQUIPMENT ITEM REPLACED	5
REPLACEMENT UNAVAILABLE	2

-------------AIRBORNE EVENTS------------	
DETECTED FAILURE	21
FALSE FAILURE	20
UNDETECTED FAILURE	0
AIRCRAFT ABORT	5
AIRCRAFT LOST	2
A/C LOST TO ENEMY FIRE	0
SUCCESSFUL CHAFF DISPERSI	0
U/S CHAFF DISP-NAV ERR	0
SUCCESSFUL IJ DISPERSION	0
U/S IJ DISP-NAV ERR	0
SUCCESSFUL ABJ DISPERSION	0
U/S ABJ DISP-NAV ERR	0
RECCE SUPPORT PROVIDED	0
RECOVERY IMPOSSIBLE	0
MISSION ABORT	13
LOW FUEL ABORT	0
VISUAL TARGET DETECTION	0
TARGET WITHIN FOV	0
TARGET ATTACKED	0
PRIMARY DESTRUCTION	0
SECONDARY DESTRUCTION	0
GO-AROUND FOR ATTACK	0

FIGURE A-6. MISSION 1 OUTPUT RESULTS (Continued)

```
AEP COMMAND
--        AEPOUT
ENTER DESIRED MISSION NUMBER
--        2
AEPOUT COMMAND
--        TITLE

RPV EX REC 3

    5 MONTE CARLO TRIALS, WITH 2AIRCRAFT, FOR ,  2 DAYS

AEPOUT COMMAND
--        STAT,GND

GROUND PREPARATION DATA
```

VARIABLE	SAMPLES	MEAN	STD DEV	MAX	MIN
SORTIES PER DAY	10	.700	.483	1.00	0.
PREFLIGHT TIME (HR)	20	.928	.265	1.72	.509
THRU-FLIGHT TIME (HR)	10	1.97	1.45	5.62	.768
POSTFLIGHT TIME (HR)	8	2.34	.732	3.57	1.76
LAUNCH (MIN)	9	5.31	1.38	7.98	3.31
LAUNCH DELAY (MIN)	9	195.	263.	547.	2.77
REPAIR DELAY (MIN)	8	127.	97.7	331.	45.2
MAINTENANCE ACTIONS (MIN)	24	129.	78.0	337.	32.8
FUEL LOADING TIME (MIN)	14	6.08	.608	6.44	4.66
FUEL LOADED (LB)	14	3041.	304.	3219.	2332.
CHAFF LOAD (MIN)	28	20.9	4.93	29.1	10.2
CHAFF UNLOAD (MIN)	4	11.7	.677	12.3	10.7

```
AEPOUT COMMAND
--        STAT,AIR

AIRBORNE DATA
```

VARIABLE	SAMPLES	MEAN	STD DEV	MAX	MIN
NAV UPDATE ACCURACY (FT)	99	624.	2801.	9280.	-4918.
NUMBER OF ATTACK PASSES	0	0.	0.	0.	0.

FIGURE A-7. MISSION 2 OUTPUT RESULTS

AEPOUT COMMAND
-- SUBF

SUBFUNCTION/MODE UTILIZATION

SUBFUNCTION	NO. USES	FAILED	MODES (1-N)
PREFLIGHT (BEGINNING	10	0	0
THRU-FLIGHT	5	0	0
POST FLIGHT (END OF	4	0	0
CHAFF LOADING	28	0	0
FUEL LOADING	16	0	0
FUEL USAGE	9	0	9
LAUNCH	9	2	9
INFLIGHT A[illegible]	7	0	7
MISSION AB[illegible]	7	0	7
AIRCRAFT LOS[illegible]	7	2	7
RPV RECOVERY	7	0	7
SCHEDULE	10	0	0
SELF-CONTAINED NAVIG	9	2	9
EXTERNAL NAVIGATION	6	0	6
EXTERNAL COMMUNICATI	9	1	9
COMMAND AND CONTROL	6	0	6
VIDEO COMMUNICATIONS	6	0	6
TELEMETRY COMMUNICAT	6	0	6
JAMMER DEFINITION	0	0	0
BASE/ENVIRONMENT DEF	0	0	0
SURVIVABILITY SUBFUN	6	0	6
TARGET SUBFUNCTION 1	0	0	0
CHAFF DISPERSION	6	0	6
ECM SUPPORT	6	0	6
RECCE SUPPORT	6	0	6
SEGMENT 1 DATA PROCE	6	0	6

AEPOUT COMMAND
-- P

COMMUNICATION PROBABILITIES

COMMAND/CONTROL		TELEMETRY		VIDEO	
TIME	PROB	TIME	PROB	TIME	PROB
1023.98	0.	1023.98	0.	1023.98	0.
1083.98	.99837	1083.98	.98641	1083.98	.93410
1203.98	1.	1323.98	.98664	1323.98	.93433
1323.98	.99860	1383.98	0.	1383.98	0.
1383.98	0.	1696.97	0.	1696.97	0.
1696.97	0.	1699.28	.97432	1699.28	.92201
1699.28	.98627	1980.84	.96839	1980.84	.91608
1980.84	.98035	2214.23	.98135	2214.23	.92904
2214.23	.99331	2834.07	.98135	2834.07	.92904
2834.07	.99331	2841.49	.98207	2841.49	.92976
2841.49	.99402				

FIGURE A-7. MISSION 2 OUTPUT RESULTS (Continued)

DATA PROCESSING DATA

VARIABLE	SAMPLES	MEAN	STD DEV	MAX	MIN
SEGMENT 1 BYTES	288	900.	174.	1000.	600.
SEGMENT 1 KEOPS	288	201.	58.6	235.	100.
SEGMENT 2 BYTES	0	0.	0.	0.	0.
SEGMENT 2 KEOPS	0	0.	0.	0.	0.
SEGMENT 3 BYTES	0	0.	0.	0.	0.
SEGMENT 3 KEOPS	0	0.	0.	0.	0.
SEGMENT 4 BYTES	0	0.	0.	0.	0.
SEGMENT 4 KEOPS	0	0.	0.	0.	0.
SEGMENT 5 BYTES	0	0.	0.	0.	0.
SEGMENT 5 KEOPS	0	0.	0.	0.	0.
SEGMENT 6 BYTES	0	0.	0.	0.	0.
SEGMENT 6 KEOPS	0	0.	0.	0.	0.
SEGMENT 7 BYTES	0	0.	0.	0.	0.
SEGMENT 7 KEOPS	0	0.	0.	0.	0.
SEGEMNT 8 BYTES	0	0.	0.	0.	0.
SEGMENT 8 KEOPS	0	0.	0.	0.	0.
SEGMENT 9 BYTES	0	0.	0.	0.	0.
SEGMENT 9 KEOPS	0	0.	0.	0.	0.

AEPOUT COMMAND

-- EVENTS, ALL

--------------GROUND EVENTS-------------	
GENERAL MAINTENANCE	8
SORTIE CANCELLED	4
NOT OPERATIONALLY READY	0
EQUIPMENT ITEM REPLACED	1
REPLACEMENT UNAVAILABLE	0

-------------AIRBORNE EVENTS------------	
DETECTED FAILURE	10
FALSE FAILURE	11
UNDETECTED FAILURE	0
AIRCRAFT ABORT	0
AIRCRAFT LOST	2
A/C LOST TO ENEMY FIRE	0
SUCCESSFUL CHAFF DISPERSI	6
U/S CHAFF DISP-NAV ERR	0
SUCCESSFUL IJ DISPERSION	0
U/S IJ DISP-NAV ERR	0
SUCCESSFUL ABJ DISPERSION	0
U/S ABJ DISP-NAV ERR	0
ECM SUPPORT PROVIDED	6
RECCE SUPPORT PROVIDED	4
RECOVERY IMPOSSIBLE	0
MISSION ABORT	5
LOW FUEL ABORT	0
VISUAL TARGET DETECTION	0
TARGET WITHIN FOV	0
TARGET ATTACKED	0
PRIMARY DESTRUCTION	0
SECONDARY DESTRUCTION	0
GO-AROUND FOR ATTACK	0

FIGURE A-7. MISSION 2 OUTPUT RESULTS (Continued)

AEPOUT COMMAND
-- FAIL

EQUIPMENT FAILURES TOTAL

ITEM	GROUND	AIRBORNE
DEMO AIRCR	1	3
DEMO ENGIN	0	4
DEMO FUSEL	0	0
DEMO LANDI	1	2
DEMO AFCS	1	3
DEMO AIR C	0	4
DEMO ELECT	0	0
DEMO LIGHT	0	0
DEMO HYDRA	0	0
DEMO FUEL	0	0
DEMO OXYGE	0	0
DEMO UTILI	0	0
DEMO INSTR	1	0
DEMO INT G	0	3
DEMO UHF C	0	0
DEMO ARC-5	0	2
DEMO ADF	0	1
DEMO HEADI	0	0
DEMO COMPU	0	0
DEMO AIR D	0	0
DEMO DOPPL	0	0
DEMO HEAD	1	0
DEMO IMS	0	0
DEMO INTER	0	0
DEMO RADAR	0	0
DEMO FWD L	0	0
DEMO FLIR	0	0
DEMO WEAPO	0	0
DEMO WEAPO	0	0
DEMO PDMS	0	0
DEMO GUN	0	0
DEMO WEAPO	0	0
DEMO WEAPO	0	0
DEMO RF BL	0	0
DEMO ECM D	0	0
DEMO PASSI	0	0
DEMO EMERG	0	0
DEMO LAUNC	0	2
DEMO IFF S	0	0

FIGURE A-7. MISSION 2 OUTPUT RESULTS (Continued)

APPENDIX B

PROGRAMMER'S GUIDE

This Appendix is to provide a descriptions of the Avionics Evaluation Program (AEP) Computer Code. The following references can also be consulted:

(1) "Avionics Evaluation Program User's Manual" Battelle-Columbus Laboratories (most recent version)

(2) "Application of Interactive Graphics to the Avionics Evaluation Program", Battelle-Columbus Laboratories, Programmer's Manual (most recent version).

The first reference is the user's manual which resides in the computer and is accessible from a terminal. The second describes the interactive graphics processor from which the AEP is operated.

Table B-1 contains a brief description of each of the program subroutines. In addition, the table shows where each subroutine occurs. Table B-2 defines where each common block occurs. The bulk of the code documentation resides in the program itself. At the beginning of the routines is a description of the purpose of the routine and a definition of the parameters in the calling list. In addition, all common variables are described in each routine where they are used.

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES

Routine Name	Category	Description
MAIN	EXECUTION	Calls Individual Overlays
COMBLK	DATA	Initialize variables in labelled common
ONE	EXECUTION	Calls routines to evaluate nominal mission
CMBLK1	DATA	Initialize variables in labelled common
ONEONE	EXECUTION	Calls routine to read mission input data and write system labels to random access file
ONETWO	EXECUTION	Calls data link communications model
TWO	EXECUTION	Calls Monte Carlo main control routine
THREE	EXECUTION	Calls the output routines
READ	DATA	Read data from random access file
WRITE	DATA	Write data to random access file
GENFLE	DATA	Routine to create a random access file
CLSFLE	DATA	Routine to close a random access file
NEWFLE	DATA	Routine to open a new random access file
ENDJOB	ERROR PROCESSING	Routine to insure complete writing of data to random access file if execution error occurs
IDLE	UTILITY	Routine to set file status to idle to avoid auto-recall errors
INDXSEQ	DATA	Machine laungauge routine to access files

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES (Continued)

Routine Name	Category	Description
SETADR	UTILITY	Routine to convert the FORTRAN extended parameter list to a RUN compatible parameter list
ADDSUM	UTILITY	Add or subtract matrices
TRANS	UTILITY	Transpose a matrix
PACK	UTILITY	Create an array of the upper triangle of a symmetric matrix
UNPACK	UTILITY	Restore symmetric matrix from packed array
MOVE	UTILITY	Transfer matrix to new memory location
MINUS	UTILITY	Transfer negative of matrix to new memory location
ZERO	UTILITY	Set matrix to zero
TADSUB	UTILITY	Transpose matrix addition or subtraction
CONST	UTILITY	Scalar times a matrix
MLT	UTILITY	Matrix multiplication
SYMMLT	UTILITY	Symmetric matrix multiplication
MLTADSU	UTILITY	Transpose matrix multiplication
CROSS	UTILITY	Vector cross product
DOT	UTILITY	Vector dot product
IRKG	UTILITY	Initializes certain variables for the Runge-Kutta-Gill integration routine. Standard BCL library routine.
RKG	UTILITY	Runge-Kutta-Gill integration routine Standard BCL library routine
BILIN1	UTILITY	Interpolates on a two dimensional table. Both arguments must be monotone increasing. Standard BCL library routine.

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES (Continued)

Routine Name	Category	Description
SETCON	UTILITY	Set natural constants, conversion factors
PUT	EXECUTION	Enter event in table
TAKE	EXECUTION	Remove event from table
PUTALL	EXECUTION	Put general event for all available subfunctions in event table
GETFND	EXECUTION	Move data from packed arrays to local variables
RESET	EXECUTION	Calls routine RSETXX
SETLAB	DATA	Set labels and units for output variables
NOMINL	EXECUTION	Calls aircraft flight routines and functions routines
FLY	EXECUTION	Simulates aircraft flight. Described in AFAL-TR-73-44
CONTROL	EXECUTION	Calculates required aircraft power setting for requested velocity. Described in AFAL-TR-73-44.
DERAC	EXECUTION	Calculates derivatives of aircraft equations of motion. Described in AFAL-TR-73-44.
VARMCH	UTILITY	Interpolates tabular data as a function of mach number. Described in AFAL-TR-73-44.
PRTST	UTILITY	Print aircraft flight status
FUNON	EXECUTION	Make initial calls to function
COMNAV	EXECUTION	Data link communications. Executive routine.
LINKI	EXECUTION	Computes Oxygen coefficients, water vapor coefficients, rain loss coefficients, rain loss exponent

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES (Continued)

Routine Name	Category	Description
LINKB	EXECUTION	Computes KTB Ratio
LINKL	EXECUTION	Computes carrier to noise ratios, signal to noise ration, off angle antenna gains, communications probabilities
EDIT	UTILITY	Edits communication probability tables to eliminate unnecessary probabilities
Q	EXECUTION	ERF Function
GEOMTY2	EXECUTION	Computes communication loss due to weather
GEOMTY1	EXECUTION	Checks for line of sight betwern BASE, RPV and Jammers
LINKG	EXECUTION	Computes main lobe gains for various antennas
REDRPV	UTILITY	Sets up antenna input data items
REDJAM	UTILITY	Sets up jammer and base input data items
ANGLE	EXECUTION	Computes off angles from RPV to base to jammer
LINKR	EXECUTION	Computes off angle antenna gains
BESSAL	EXECUTION	Evaluates a bessel function
QP	EXECUTION	Function used in computing off angle antenna gains
RSETXX	EXECUTION	Set data values for various modes of each subfunction
FUNXX	EXECUTION	Perform calculations for function XX
MCFNXX	EXECUTION	Contains the Monte Carlo computations for function XX. XX can range from 1-20. Main body of report contains flow diagrams.

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES (Continued)

Routine Name	Category	Description
MSBXXY	EXECUTION	Contains the Monte Carlo computations for subfunction 1 of function XX. Called by function XX. Main body of report contains flow diagrams.
ABRTXX	EXECUTION	Logic to determine if aircraft aborts when subfunction for function XX is lost by that aircraft.
FABTXX	EXECUTION	Logic to determine if mission aborts when subfunction for function XX is lost by entire flight
ALLOFF	EXECUTION	Turns all intermission dependence keys off at end of flight
WAITCK	EXECUTION	Checks intermission keys at launch and sets up the wait matrix
NAVPOS	EXECUTION	Routine to calculate current navigation error
NAVUPD	EXECUTION	Performs navigation update. Calculates sensor field of view. Determines if checkpoint is within the sensor field of view and if the checkpoint has been detected.
SUB10X	EXECUTION	SAM Survivability subfunction
SUB106	EXECUTION	AAA Survivability subfunction
SAMAAA	EXECUTION	Calculation of SAM and AAA probabilities of hit
DAMAGE	EXECUTION	Determine extent of aircraft damage resulting from enemy hit
SUB111	EXECUTION	Display acquisition subfunction. Calculates sensor field of view for each mode.
SUB112	EXECUTION	Visual acquisition subfunction. Calculates sensor field of view for each mode

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES (Continued)

Routine Name	Category	Description
SUB113	EXECUTION	Remote display acquisition subfunction. Calculates sensor field of view for each mode.
XTRACK	EXECUTION	Calculate current cross-track navigation error
TALLY	EXECUTION	Sum on board processor requirements
SENSOR	EXECUTION	Calculates the sensor ground coverage by computing the X and Y vertices of the sensor field of view.
ACQIRE	EXECUTION	Generates target acquisition times based on cumulative probability of detection vs. depression angle and the vertices of the sensor field of view.
SETST	EXECUTION	Calculate aircraft states inertial coordinate frame of reference
SAVEST	EXECUTION	Store aircraft states for use during Monte Carlo evaluation
READAT	DATA	Reads system and function data
CRUISE	DATA	Fits curve for heading in flight profile
PRTMC	EXECUTION	Prints Monte Carlo status during program error tracing
NORM	UTILITY	Generate unit variance normal random variate
F	UTILITY	Used by NORM
LGNORM	UTILITY	Generate a log-normal random variate
BETA	UTILITY	Generate a random variate from a Beta distribution
RAYLGH	UTILITY	Generate a random variabe from a Rayleigh distribution

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES (Continued)

Routine Name	Category	Description
RNDTME	UTILITY	Generate a random variate from a tabular distribution
SETVAR	EXECUTION	Accumulate statistics for random variables
SETEVT	EXECUTION	Accumulate ocurrences of random events
MCARLO	EXECUTION	Monte Carlo simulation main control program
MCINTL	EXECUTION	Initialize Monte Carlo variables
ACUPDT	EXECUTION	Update aircraft states as a function of time
MCFAIL	EXECUTION	Calculate time of equipment failure
CLKON	EXECUTION	Turn flight failure clock on
CLKOFF	EXECUTION	Turn flight failure clock off
FAIL	EXECUTION	Process equipment failures
REPAIR	EXECUTION	Calculate random repair time after equipment failure. Determine operationally ready status of aircraft.
UMAINT	EXECUTION	Calculate unshceduled maintenance delay time. Determine operationally ready status of aircraft.
FUNCHK	EXECUTION	Check subfunction modes after equipment failure
MCFON	EXECUTION	Turn on subfunction
USE	EXECUTION	Check for undetected failures when a subfunction is used
ACABRT	EXECUTION	Call aircraft abort routines
ACLOST	EXECUTION	Call required routines when aircraft is lost from flight
MISABT	EXECUTION	Abort mission
FNABRT	EXECUTION	Calls mission abort routines
RESULT	OUTPUT	Prints Monte Carlo results (3 levels of detail) for each flight

TABLE B-1. DESCRIPTION OF THE BATCH AEP ROUTINES (Continued)

Random Name	Category	Description
CONVRT	UTILITY	Converts real numbers to F type format if possible, otherwise uses E type format
ITOBCD	UTILITY	Converts integer numbers to alpha-numeric representation
RTOBCD	UTILITY	Converts real numbers to alphanumeric representation
GETDIG	UTILITY	Converts integer numbers to an array of BCD characters representing the integer
NEWAC	EXECUTION	Initialize aircraft variables for an aircraft lost during previous sortie
CANCEL	EXECUTION	Cancels rest of day to allow simulation to proceed to next day

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
ABTFLG	MISABT, MSB041, MSB045, MSB047
ACRAFT	CMBLK1, CONTRL, CRUISE, DERAC, FLY, PRTST, READAT, SAVEST, SETST
AIRCFT	CMBLK1, CONTRL, DERAC, FLY, READAT
ANTEN	LINKG, LINKL, LINKR, REDRPV
ATTACK	ABRT12, ACUPDT, MCFNON, MCFN12, MCFN13, MSB121, MSB122
AVAIL	MCARLO, MSB013, REPAIR
BASE	LINKL, LINKR, REDRPV
CMS011	MSB011, RSET01
CMS012	MSB012, RSET01
CMS013	MSB013, RSET01
CMS021	MSB021, RSET02
CMS022	MSB022, RSET02
CMS023	MSB023, RSET02
CMS024	MSB024, RSET02
CMS025	MSB025, RSET02
CMS026	MSB026, RSET02
CMS031	MSB031, RSET03
CMS032	MSB032, RSET03
CMS033	MSB033, RSET03
CMS041	MSB041, RSET04
CMS046	ABRT04, MSB046, MSB051, RSET04
CMS047	MSB047, RSET04
CMS051	MCARLO, MSB011, MSB012, MSB051, RSET 05
CMS052	MSB052, RSET05
CMS061	RSET06, SAMAAA, SETST
CMS071	MSB071, RSET07
CMS072	MSB072, RSET07

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
CMS081	MSB081, RSET08
CMS082	MSB082, RSET08
CMS083	MSB083, RSET08
CMS084	MSB084, RSET08
CMS091	RSET09
CMS092	RSET09
CMS093	REDRPV, RSET09
CMS094	REDRPV, RSET09
CMS095	REDRPV, RSET09
CMS096	REDJAM, RSET09
CMS097	REDRPV, RSET09
CMS101	MSB101, RSET10, SUB101
CMS102	MSB102, RSET10, SUB102
CMS103	MSB103, RSET10, SUB103
CMS104	MSB104, RSET10, SUB104
CMS105	MSB105, RSET10, SUB105
CMS106	MSB106, RSET10, SUB106
CMS111	MSB111, RSET11, SUB111
CMS112	MSB112, RSET11, SUB112
CMS113	ACQIRE, MSB113, RSET11, SUB113
CMS121	FUN12, MCFN12, MSB121, RSET12
CMS122	FUN12, MCFN12, MSB122, RSET12
CMS131	MCFN13, RSET13
CMS132	MCFN13, RSET13
CMS133	MCFN13, RSET13
CMS134	MCFN13, RSET13
CMS135	MCFN13, RSET13
CMS161	MSB161, RSET16
CMS162	MSB162, RSET16
CMS163	MSB163, RSET16
CMS171	MSB171, RSET17
CMS172	MSB172, RSET17

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
COMM	COMNAV, LINKL
COMPT	SETCON
CONSTS	COMBLK, CONTRL, CRUISE, DERAC, FLY, MSB047, ONETWO, PRTMC, PRTST, RAYLGH, READAT, RSET04, RSET07, RSET08, RSET09, RSET10, RSET11, RSET12, RSET13, RSET16, RSET17, SETCON, SETST
DEBUG	MCARLO, READ, WRITE
DELTIM	COMBLK, MSB041, MSB051, NOMINL, SETCON, WAITCK
DETECT	ACQIRE, MCFN11, MSB111, MSB112, MSB113
EQFAIL	ACUPDT, COMBLK, FAIL, MCFAIL, MCINTL, MSB041, MSB045, MSB047, RESULT, SETCON
EVENTS	ABRT03, ABRT04, ABRT09, ABRT12, ABRT18, ACABRT, ACLOST, ACQIRE, ACUPDT, CANCEL, CLKOFF, CLKON, COMBLK, COMNAV, DAMAGE, FABT03, FABT04, FABT07, FABT09, FABT10, FABT11, FABT12, FABT16, FABT17, FABT18, FAIL, FNABRT, FUNCHK, FUNON, FUN09, FUN10, FUN11, FUN12, MCARLO, MCFAIL, MCFN01, MCFN02, MCFN03, MCFN04, MCFN05, MCFN07, MCFN08, MCFN09, MCFN10 MCFN11, MCFN12, MCFN13, MCFN16, MCFN17, MCFN18, MCINTL, MISABT, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB031, MSB032, MSB033, MSB041, MSB045, MSB046, MSB047, MSB051, MSB052, MSB071, MSB072, MSB081, MSB082, MSB083, MSB084, MSB091, MSB092, MSB093, MSB094, MSB095, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB161, MSB162, MSB163, MSB171, MSB172, MSB181, MSB182, MSB183, MSB184, MSB185, MSB186, MSB187, MSB188, MSB189, NAVUPD, NEWAC, NOMINL, ONETWO, PRTMC, PUTALL, PUT, SAMAA, SENSOR, SUB101, SUB102,

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
EVENTS (Continued)	SUB103, SUB104, SUB105, SUB106, SUB111, SUB112, SUB113, TAKE, TALLY, UMAINT, XTRACK
FETS	CLSFLE, COMBLK, GENFLE, NEWFLE, READ, WRITE
FETZZ	CLSFLE, COMBLK, GENFLE, NEWFLE, READ, WRITE
FILES	ACUPDT, CLSFLE, COMBLK, CONTRL, EDIT, ENDJOB, FLY, GENFLE, MCARLO, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, NEWFLE, NOMINL, ONEONE, ONE, PRTST, PUT, READAT, READ, RESULT, SAVEST, SETCON, SETLAB, TAKE, THREE, WRITE
FNDATA	ABRT12, ACLOST, ACQIRE, ACUPDT, COMBLK, FABT07, FABT11, FABT12, FUNCHK, FUNON, FUN12, GETFND, GETMD, MCARLO, MCFNON, MCFN02, MCFN03, MCFN08, MCFN09, MCFN10, MCFN11, MCFN12, MCFN13, MCFN16, MCFN17, MCINTL, MISABT, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB031, MSB041, MSB042, MSB045, MSB046, MSB047, MSB052, MSB084, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB181, MSB182, MSB183, MSB184, MSB185, MSB186, MSB187, MSB188, MSB189, NAVUPD, NOMINL, PUTALL, READAT, REPAIR, RESULT, RSET12, SAMAAA, SETCON, SETST, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106, SUB111, SUB112, SUB113, TALLY, UMAINT, USE, WAITCK
FOV	SAVEST, SUB111, SUB112, SUB113
FUEL	ACUPDT, COMBLK, MCARLO, MSB031, MSB033, MSB045, MSB047, READAT, SETCON
GAINS	LINKL, REDJAM

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
JAMMER	COMNAV, LINKL, LINKR, REDJAM
JLINK1	COMNAV, LINKL, REDJAM
KEYS	ABRT04, ACQIRE, ACUPDT, COMBLK, FABT04, FABT17, FUNCHK, MCARLO, MCFN11, MCINTL, MISABT, MSB041, MSB046, MSB084, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB171, MSB172
LABELS	ONEONE, ONE, READAT
LINK1	COMNAV, GEOMTY2, LINKG, LINK1, LINKL, LINKR, REDRPV
LINK4	LINKG, LINKL, LINKR
LINK5	GEOMTY2, LINK1
LINK6	COMNAV, LINKL
LOCFOV	ACUPDT, COMBLK, FUN11, MSB111, MSB112, MSB113, SAVEST, SETCON, SUB111, SUB112
MCACFT	ABRT04, ACLOST, ACQIRE, ACUPDT, ALLOFF, COMBLK, DAMAGE, FABT12, FAIL, FUNCHK, GETMD, MCFAIL, MCFNON, MCFN13, MCINTL, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB032, MSB033, MSB041, MSB042, MSB045, MSB047, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB121, MSB122, NEWAC, ONOFF, REPAIR, UMAINT, USE, WAITCK
MCACST	ABRT12, ACLOST, ACQIRE, ACUPDT, COMBLK, FABT07, FABT11, FABT12, FUNCHK, FUNON, FUN12, GETFND, GETMD, MCARLO, MCFNON, MCFN02, MCFN03, MCFN08, MCFN09, MCFN10, MCFN11, MCFN12, MCFN13, MCFN16, MCFN17, MCINTL, MISABT, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB031, MSB041, MSB042, MSB045, MSB046, MSB047, MSB052, MSB084, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB181, MSB182, MSB183, MSB184, MSB185, MSB186, MSB187, MSB188, MSB189, NAVUPD,

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
MCACST (Continued)	NOMINL, PUTALL, READAT, REPAIR, RESULT, RSET12, SAMAAA, SETCON, SETST, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106, SUB111, SUB112, SUB113, TALLY, UMAINT, USE, WITICK
MCFLGT	ACQIRE, ACUPDT, MCARLO, MSB033, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB181, MSB182, MSB183, MSB184, MSB185, MSB186, MSB187, MSB188, MSB189, READAT
MCOUT	COMBLK, MCARLO, ONE, RESULT, SETCON, SETEVT, SETLAB, SETVAR
MCOUT2	COMBLK, MCARLO, ONE, RESULT, SETCON, SETEVT, SETLAB, SETVAR
MCSYS	ABRT04, ACLOST, ACQIRE, ACUPDT, ALLOFF, COMBLK, DAMAGE, FABT12, FAIL, FUNCHK, GETMD, MCFAIL, MCFNON, MCFN13, MCINTL, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB032, MSB033, MSB041, MSB042, MSB045, MSB047, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB121, MSB122, NEWAC, ONOFF, REPAIR, UMAINT, USE, WAITCK
MDATA	ABRT12, ACLOST, ACQIRE, ACUPDT, COMBLK, FABT07, FABT11, FABT12, FUNCHK, FUNON, FUN12, GETFND, GETMD, MCARLO, MCFNON, MCFN02, MCFN03, MCFN08, MCFN09, MCFN10, MCFN11, MCFN12, MCFN13, MCFN16, MCFN17, MCINTL, MISABT, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB031, MSB041, MSB042, MSB045, MSB046, MSB047, MSB052, MSB084, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB181, MSB182, MSB183, MSB184, MSB185 MSB186, MSB187, MSB188, MSB189, NAVUPD, NOMINL, PUTALL, READAT, REAPIR, RESULT, RSET12, SAMAAA, SETCON, SETST, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106, SUB111, SUB112, SUB113, TALLY, UMAINT, USE, WAITCK

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
MTIME	MCINTL, MSB011, MSB012, MSB013, MSB031
NAVERR	ACQIRE, ACUPDT, MCFN12, MSB047, MSB071, MSB072, MSB084, MSB111, MSB112, MSB113, NAVPOS, NAVUPD, XTRACK
NOMSNS	COMBLK, DERAC, FABT17, FLY, MCARLO, MCINTL, MSB051, MSB052, MSB171, MSB172, NOMINL, ONEONE, ONE, ONOFF, PRTMC, PRTST, SETCON, THREE
ORDLD	MCFN02, MSB021, MSB022, MSB023, MSB024, MSB025, MSB121, MSB122, MSB161, MSB162, MSB163, NEWAC
PCOM	ACQIRE, COMBLK, EDIT, MSB084, SETCON
PROB	COMNAV, EDIT, LINKL
PROCES	ACUPDT, MSB181, MSB182, MSB183, MSB184, MSB185, MSB186, MSB187, MSB188, MSB189, TALLY
PROFLE	CMBLK1, CONTRL, FLY, FUNON, NOMINL, ONETWO, READAT, SAMAAA, SAVEST,
RPV	COMNAV, ONETWO, REDRPV
SORTIE	ACQIRE, MCARLO, MCINTL, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB041, MSB045, MSB046, MSB047, MSB051, MSB052, MSB084, MSB121, MSB122, NEWAC, REPAIR
SRVIVE	ACUPDT, COMBLK, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, READAT, SAMAA, SAVEST, SETCON, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106
STADOT	CMBLK1, CONTRL, DERAC, FLY, FUNON, NOMINL, PRTST, READAT, SAVEST, SETST

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
STATES	ACQIRE, ACUPDT, ALLOFF, CLKOFF, CLKON, COMBLK, FABT12, FUNCHK, FUN12, GETMD, MCARLO, MCFNON, MCFN11, MCFN12, MCFN13, MCINTL, MSB011, MSB012, MSB013, MSB031, MSB032, MSB033, MSB042, MSB045, MSB047, MSB052, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB161, MSB162, MSB163, MSB171, MSB172, NAVUPD, ONOFF, PRTMC, READAT, RESULT, RSET12, SAMAAA, SAVEST, SENSOR, SETCON, SETST, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106, USE
STOP CM	COMBLK, MCARLO, ONE, SETCON
STRTCM	COMBLK, MCARLO, ONE, SETCON
SUBDAT	ABRT12, ACLOST, ACQIRE, ACUPDT, COMBLK, FABT07, FABT11, FABT12, FUNCHK, FUNON, FUN12, GETFND, GETMD, MCARLO, MCFNON, MCFN02, MCFN03, MCFN08, MCFN09, MCFN10, MCFN11, MCFN12, MCFN13, MCFN16, MCFN17, MCINTL, MISABT, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB031, MSB041, MSB042, MSB045, MSB046, MSB047, MSB052, MSB084, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB181, MSB182, MSB183. MSB184, MSB185, MSB186, MSB187, MSB188, MSB189, NAVUPD, NOMINL, PUTALL, READAT, REPAIR, RESULT, RSET12, SAMAAA, SETCON, SETST, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106, SUB111, SUB112, SUB113, TALLY, UMAINT, USE, WAITCK
SYSDAT	ACUPDT, ALLOFF, CLKOFF, COMBLK, DAMAGE, FAIL, MCARLO, MCFAIL, MCINTL, MSB052, NEWAC, ONOFF, READAT, REPAIR, RESULT SETCON, USE, WAITCK

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
SYSLAB	ONEONE, ONE, READAT
TARGET	ABRT12, ACQIRE, ACUPDT, COMBLK, FUN12, MCFN11, MCFN12, MCFN13, MSB111, MSB112, MSB113, READAT, RESULT, RSET13, SETCON
TFAIL	ACLOST, CLKOFF, CLKON, DAMAGE, FAIL, MCFAIL MCINTL, NEWAC, REPAIR, USE
TIME	COMNAV, REDRPV
WDELIV	MCFN12, MCFN13, MSB121, MSB122
WDMODE	ABRT12, ACLOST, ACQIRE, ACUPDT, COMBLK, FABT07, FABT11, FABT12, FUNCHK, FUNON, FUN12, GETFND, GETMD, MCARLO, MCFNON, MCFN02, MCFN03, MCFN08, MCFN09, MCFN10, MCFN11, MCFN12, MCFN13, MCFN16, MCFN17, MCINTL, MISABT, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB031, MSB041, MSB042, MSB045, MSB046, MSB047, MSB052, MSB084, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB181, MSB182, MSB183, MSB184, MSB185, MSB186, MSB187, MSB188, MSB189, NAVUPD, NOMINL, PUTALL, READAT, REPAIR, RESULT, RSET12, SAMAAA, SETCON, SETST, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106, SUB111, SUB112, SUB113, TALLY, UMAINT, USE, WAITCK
WDSUB	ABRT12, ACLOST, ACQIRE, ACUPDT, COMBLK, FABT07, FABT11, FABT12, FUNCHK, FUNON, FUN12, GETFND, GETMD, MCARLO, MCFNON, MCFN02, MCFN03, MCFN08, MCFN09, MCFN10, MCFN11, MCFN12, MCFN13, MCFN16, MCFN17, MCINTL, MISABT, MSB011, MSB012, MSB013, MSB021, MSB022, MSB023, MSB024, MSB025, MSB026, MSB031, MSB041, MSB042, MSB045, MSB046, MSB047, MSB052, MSB084, MSB101, MSB102, MSB103, MSB104, MSB105, MSB106, MSB111, MSB112, MSB113, MSB121, MSB122, MSB181, MSB182, MSB183, MSB184, MSB185, MSB186, MSB187, MSB188, MSB189,

TABLE B-2. AEP COMMON BLOCKS

COMMON BLOCK	ROUTINES USING BLOCK
WDSUB (Continued)	NAVUPD, NOMINL, PUTALL, READAT, REPAIR, RESULT, RSET12, SAMAAA, SETCON, SETST, SUB101, SUB102, SUB103, SUB104, SUB105, SUB106, SUB111, SUB112, SUB113, TALLY, UMAINT, USE, WAITCK
WEATH	GEOMTY2, REDRPV
XYZ	ANGLE, COMNAV, LINKL, LINKR

APPENDIX C

SAMPLE EXECUTION OF THE AAA SURVIVABILITY PROGRAM

This appendix shows the line printer output of the IPRF file when printed using the PRINT command in the output processor. Figure C-1 shows the printout of the flight profile. Figure C-2 shows the input data for gun site 1 and Figure C-3 contains the results of site 1. Figures C-4 and C-5 show the input data and results for gun site 2. A summary table is printed at the end of this simulation as shown in Figure C-6. Finally, the total Pk for Density Class 1 as a Function of Aircraft Aspect Sector and Impact Velocity is tabulated as shown in Figure C-7.

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 1

TIME	X	Y	Z	SPEED	XDOT	YDOT	ZDOT	CLIMB	ROLL	HEADING
0.00	-10001.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
5.00	-9000.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
10.00	-8000.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
15.00	-6999.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
20.00	-5998.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
25.00	-4998.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
30.00	-3997.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
35.00	-2997.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
40.00	-1996.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
45.00	-995.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
50.00	5.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
55.00	1006.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
60.00	2006.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
65.00	3007.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
70.00	4008.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
75.00	5008.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
80.00	6009.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
85.00	7009.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
90.00	8010.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
95.00	9010.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00
99.80	9971.	0.	500.	200.1	200.1	0.0	0.0	0.00	0.00	0.00

XP= 0.0 YP= 0.0 XT= 0.0 YT= 0.0 ZT= 0.0 PSI= 0.0

FIGURE C-1. FLIGHT PROFILE

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AAASIM ---- TEST SIMULATION FOR DOCUMENTATION                                              13.43.03  05/05/77    PAGE   2

>>>  GUN SITE DESCRIPTION
          ISL  IGT  IEM  ICH  ISB  IGL  CIRCLE      XGUN       YGUN       ZGUN     TREACT    TRACK1    TRACK2
           1    3    4    2    1    1      0.0   -1000.0     1500.0       0.0      0.000     2.500     6.000

G  TIME/  GUN ELEVATION  MAX SLEW RT  A/C VELOC.  RANGE OF GUN  SMOOTH  MAX TRK ERROR  MAX PROJ T-O-F  MUZZLE  BALLISTIC SLOWDOWN
T  ROUND     MIN    MAX   AZIM  ELEV   MIN   MAX    MIN    MAX    CONST    AZIM  ELEV   MODE=1  MODE>1  VELOC.   COEFF-A    COEFF-B
3   .300  -10.00  89.99  72.00 59.00   0.0 300.0   500.  3300.     1.33   5.730 5.730      3.8     7.5   930.0  .2299800 -.0068900

   MODE SWITCHING RANGE =    400.0        BALLISTIC DISPERSION COEFF. =  .00310

DENSITY CLASSES FOR PK ACCUMULATION (4 CLASSES)

  1.0000000    .7500000    .5000000    .2500000
        # INTERPOLATED VALUES FOR AC1: GT3  (A/H)  SABRE TIGER #
 VULNERABLE AREA AS A FUNCTION OF IMPACT SPEED (METER/SEC) AND AIRCRAFT VIEW
```

	0	152	305	457	610	762	914	1067	1219
1	0.00	2.21	4.42	4.42	4.42	4.42	4.42	4.42	4.42
2	0.00	1.56	3.13	3.13	3.13	3.13	3.13	3.13	3.13
3	0.00	3.44	6.89	6.89	6.89	6.89	6.89	6.89	6.89
4	0.00	4.22	8.45	8.45	8.45	8.45	8.45	8.45	8.45
5	0.00	3.56	7.12	7.12	7.12	7.12	7.12	7.12	7.12
6	0.00	1.73	3.45	3.45	3.45	3.45	3.45	3.45	3.45
7	0.00	3.56	7.12	7.12	7.12	7.12	7.12	7.12	7.12
8	0.00	4.22	8.45	8.45	8.45	8.45	8.45	8.45	8.45
9	0.00	3.44	6.89	6.89	6.89	6.89	6.89	6.89	6.89
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	2.66	5.32	5.32	5.32	5.32	5.32	5.32	5.32
12	0.00	3.76	7.53	7.53	7.53	7.53	7.53	7.53	7.53
13	0.00	2.82	5.65	5.65	5.65	5.65	5.65	5.65	5.65
14	0.00	.23	.46	.46	.46	.46	.46	.46	.46
15	0.00	2.82	5.65	5.65	5.65	5.65	5.65	5.65	5.65
16	0.00	3.76	7.53	7.53	7.53	7.53	7.53	7.53	7.53
17	0.00	2.66	5.32	5.32	5.32	5.32	5.32	5.32	5.32
18	0.00	1.72	3.44	3.44	3.44	3.44	3.44	3.44	3.44
19	0.00	3.60	7.20	7.20	7.20	7.20	7.20	7.20	7.20
20	0.00	4.38	8.76	8.76	8.76	8.76	8.76	8.76	8.76
21	0.00	3.71	7.43	7.43	7.43	7.43	7.43	7.43	7.43
22	0.00	1.88	3.76	3.76	3.76	3.76	3.76	3.76	3.76
23	0.00	3.71	7.43	7.43	7.43	7.43	7.43	7.43	7.43
24	0.00	4.38	8.76	8.76	8.76	8.76	8.76	8.76	8.76
25	0.00	3.60	7.20	7.20	7.20	7.20	7.20	7.20	7.20
26	0.00	2.43	4.86	4.86	4.86	4.86	4.86	4.86	4.86

FIGURE C-2. GUN SITE 1 INPUT DATA

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 3

LOCATION 1 GUN TYPE 3 TRACK MODE 4 POSITION = (-1000.0, 1500.0, 0.0) RADIUS = 0.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	24.96	7.45	32.41	4307.	2971.	27.2	25.5	.1	1.0	419.8	.94	.29	.01	.01	2.67	.00061	.00061
1	4	25.09	7.39	32.48	4283.	2959.	27.2	25.4	.1	1.0	420.1	.95	.29	.01	.01	2.68	.00062	.00123
1	4	25.22	7.34	32.55	4259.	2946.	27.0	25.2	.1	1.0	420.4	.96	.29	.01	.01	2.69	.00063	.00186
1	4	25.41	7.26	32.67	4223.	2927.	26.8	25.0	.0	1.0	420.9	.97	.30	.01	.01	2.71	.00064	.00250
1	4	25.54	7.21	32.74	4200.	2914.	26.6	24.9	.2	1.0	421.2	.99	.30	.01	.01	2.73	.00065	.00315
1	4	25.66	7.16	32.82	4176.	2902.	26.5	24.8	.4	1.0	421.5	1.00	.30	.01	.01	2.74	.00066	.00381
1	4	25.86	7.08	32.93	4140.	2883.	26.3	24.6	.2	1.0	422.0	1.01	.31	.01	.01	2.76	.00068	.00449
1	4	25.98	7.02	33.01	4117.	2870.	26.1	24.4	.3	1.0	422.3	1.03	.31	.01	.01	2.77	.00069	.00517
1	4	26.11	6.97	33.08	4093.	2858.	26.1	24.3	.0	1.0	422.7	1.04	.32	.01	.01	2.79	.00070	.00587
1	4	26.30	6.89	33.20	4058.	2839.	25.9	24.1	.2	1.0	423.3	1.06	.32	.01	.01	2.81	.00072	.00658
1	4	26.43	6.84	33.27	4034.	2826.	25.7	24.0	.3	1.0	423.7	1.07	.32	.01	.01	2.82	.00073	.00730
1	4	26.56	6.79	33.35	4010.	2813.	25.6	23.8	.3	1.0	424.1	1.08	.33	.01	.02	2.84	.00074	.00803
1	4	26.75	6.71	33.46	3975.	2795.	25.5	23.7	.0	1.0	424.8	1.10	.33	.01	.02	2.86	.00075	.00878
1	4	26.88	6.66	33.54	3952.	2782.	25.3	23.5	.0	1.0	425.2	1.12	.34	.01	.02	2.87	.00077	.00954
1	4	27.01	6.61	33.61	3928.	2770.	25.2	23.4	.0	1.0	425.7	1.13	.34	.01	.02	2.89	.00078	.01031
1	4	27.20	6.53	33.73	3893.	2751.	25.0	23.2	.0	1.1	426.4	1.15	.35	.01	.02	2.91	.00080	.01110
1	4	27.33	6.48	33.81	3870.	2738.	24.9	23.1	.0	1.1	426.9	1.16	.35	.01	.02	2.93	.00081	.01190
1	4	27.46	6.43	33.89	3846.	2725.	24.7	22.9	.4	1.1	427.3	1.18	.35	.01	.02	2.94	.00083	.01272
1	4	27.65	6.35	34.00	3811.	2706.	24.5	22.7	.2	1.1	428.1	1.20	.36	.01	.02	2.97	.00085	.01355
1	4	27.78	6.30	34.08	3788.	2694.	24.4	22.6	.1	1.1	428.7	1.22	.36	.01	.02	2.98	.00086	.01440
1	4	27.90	6.25	34.16	3765.	2681.	24.3	22.5	.0	1.1	429.2	1.23	.37	.01	.02	3.00	.00087	.01526
1	4	28.10	6.18	34.27	3730.	2662.	24.1	22.3	.2	1.1	430.0	1.25	.37	.01	.02	3.03	.00090	.01614
1	4	28.22	6.13	34.35	3707.	2650.	24.0	22.2	.0	1.1	430.6	1.27	.38	.01	.02	3.05	.00091	.01703
1	4	28.35	6.08	34.43	3684.	2637.	23.8	22.0	.3	1.1	431.2	1.29	.38	.01	.02	3.06	.00093	.01794
1	4	28.54	6.01	34.55	3649.	2618.	23.6	21.8	.4	1.1	432.0	1.31	.39	.01	.02	3.09	.00095	.01888
1	4	28.67	5.95	34.63	3626.	2606.	23.6	21.7	.1	1.1	432.7	1.33	.39	.01	.02	3.11	.00096	.01982
1	4	28.86	5.88	34.75	3591.	2587.	23.4	21.5	.1	1.1	433.6	1.35	.40	.01	.02	3.14	.00099	.02079
1	4	28.99	5.83	34.83	3568.	2574.	23.2	21.4	.2	1.1	434.3	1.37	.40	.01	.02	3.16	.00101	.02178
1	4	29.12	5.79	34.91	3545.	2562.	23.1	21.3	.3	1.1	434.9	1.39	.41	.01	.02	3.18	.00103	.02279
1	4	29.31	5.71	35.02	3511.	2543.	22.9	21.1	.2	1.1	435.9	1.42	.42	.01	.02	3.21	.00105	.02382
1	4	29.44	5.67	35.11	3488.	2530.	22.8	21.0	.3	1.1	436.6	1.44	.42	.01	.02	3.23	.00107	.02486
1	4	29.57	5.62	35.19	3465.	2518.	22.7	20.8	.3	1.2	437.3	1.46	.43	.01	.02	3.25	.00109	.02593
1	4	29.76	5.54	35.30	3431.	2499.	22.6	20.7	.0	1.1	438.4	1.49	.43	.01	.02	3.28	.00112	.02701
1	4	29.89	5.50	35.38	3409.	2487.	22.5	20.5	.0	1.2	439.1	1.51	.44	.01	.02	3.30	.00114	.02812
1	4	30.02	5.45	35.47	3386.	2475.	22.4	20.4	.1	1.2	439.9	1.53	.44	.01	.02	3.32	.00115	.02924
1	4	30.21	5.38	35.59	3352.	2455.	22.0	20.2	.4	1.2	440.9	1.56	.45	.01	.02	3.35	.00120	.03040
1	4	30.34	5.34	35.67	3329.	2443.	22.0	20.1	.2	1.2	441.7	1.58	.46	.01	.02	3.38	.00121	.03158
1	4	30.46	5.29	35.75	3307.	2431.	21.9	20.0	.0	1.2	442.5	1.60	.46	.01	.02	3.40	.00123	.03277
1	4	30.66	5.22	35.88	3273.	2412.	21.6	19.8	.4	1.2	443.6	1.64	.47	.01	.02	3.44	.00127	.03401
1	4	30.78	5.17	35.96	3251.	2399.	21.6	19.7	.1	1.2	444.4	1.66	.48	.01	.02	3.46	.00129	.03526
1	4	30.91	5.13	36.04	3228.	2387.	21.6	19.6	.2	1.2	445.3	1.68	.48	.01	.02	3.48	.00131	.03652
1	4	31.10	5.06	36.17	3195.	2368.	21.3	19.4	.0	1.2	446.5	1.72	.49	.01	.02	3.52	.00135	.03782
1	4	31.23	5.02	36.25	3173.	2356.	21.2	19.2	.1	1.2	447.3	1.74	.50	.01	.02	3.55	.00138	.03915
1	4	31.36	4.97	36.33	3151.	2344.	21.0	19.1	.2	1.2	448.1	1.77	.50	.01	.02	3.57	.00141	.04050
1	4	31.55	4.91	36.46	3117.	2325.	20.9	19.0	.2	1.2	449.3	1.81	.51	.01	.02	3.61	.00145	.04189
1	4	31.68	4.86	36.54	3095.	2313.	20.8	18.8	.2	1.2	450.2	1.84	.52	.01	.02	3.64	.00148	.04331
1	4	31.81	4.82	36.63	3073.	2300.	20.7	18.7	.1	1.2	451.1	1.86	.52	.01	.02	3.66	.00150	.04474
1	4	32.00	4.75	36.75	3040.	2282.	20.6	18.5	.1	1.2	452.4	1.90	.53	.01	.02	3.71	.00154	.04621
1	4	32.13	4.71	36.84	3019.	2270.	20.3	18.4	.3	1.2	453.2	1.93	.54	.01	.02	3.73	.00158	.04772

FIGURE C-3. RESULTS OF GUN SITE 1 SIMULATION

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 4

LOCATION 1 GUN TYPE 3 TRACK MODE 4 POSITION = (-1000.0, 1500.0, 0.0) RADIUS = 0.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	32.26	4.67	36.93	2997.	2258.	20.3	18.3	.1	1.2	454.1	1.96	.55	.01	.03	3.76	.00161	.04925
1	4	32.45	4.61	37.05	2964.	2239.	20.1	18.1	.2	1.2	455.4	2.01	.56	.01	.03	3.80	.00166	.05083
1	4	32.58	4.55	37.14	2943.	2227.	20.1	18.0	.1	1.2	456.4	2.04	.56	.01	.03	3.83	.00168	.05242
1	4	32.70	4.52	37.23	2921.	2215.	19.9	17.9	.1	1.2	457.2	2.07	.57	.01	.03	3.86	.00172	.05405
1	4	32.90	4.46	37.36	2889.	2197.	19.8	17.7	.0	1.2	458.6	2.12	.58	.01	.03	3.91	.00177	.05572
1	4	33.02	4.42	37.44	2867.	2185.	19.7	17.6	.0	1.2	459.5	2.15	.59	.01	.03	3.94	.00180	.05742
1	4	33.15	4.38	37.53	2846.	2173.	19.5	17.5	.0	1.3	460.4	2.18	.59	.01	.03	3.97	.00184	.05915
1	4	33.34	4.32	37.67	2814.	2154.	19.3	17.3	.2	1.3	461.7	2.23	.60	.01	.03	4.02	.00190	.06094
1	4	33.47	4.28	37.75	2793.	2142.	19.2	17.2	.1	1.3	462.6	2.27	.61	.01	.03	4.05	.00194	.06276
1	4	33.66	4.22	37.89	2761.	2124.	19.1	17.1	.2	1.3	463.9	2.32	.62	.02	.03	4.10	.00200	.06463
1	4	33.79	4.18	37.97	2740.	2113.	19.1	17.0	.0	1.3	464.9	2.36	.63	.02	.03	4.14	.00203	.06653
1	4	33.92	4.15	38.07	2720.	2101.	18.9	16.8	.2	1.3	465.7	2.40	.64	.02	.03	4.17	.00208	.06847
1	4	34.11	4.09	38.20	2688.	2083.	18.8	16.7	.0	1.3	467.1	2.45	.65	.02	.03	4.23	.00213	.07046
1	4	34.24	4.05	38.29	2668.	2071.	18.6	16.6	.1	1.3	468.0	2.49	.66	.02	.03	4.26	.00218	.07249
1	4	34.37	4.01	38.38	2647.	2060.	18.5	16.5	.2	1.3	468.8	2.53	.66	.02	.03	4.30	.00223	.07456
1	4	34.56	3.96	38.52	2616.	2042.	18.4	16.3	.3	1.3	470.1	2.60	.68	.02	.03	4.35	.00230	.07669
1	4	34.69	3.92	38.61	2596.	2031.	18.3	16.2	.6	1.3	471.0	2.64	.68	.02	.03	4.39	.00235	.07886
1	4	34.82	3.89	38.70	2576.	2019.	18.2	16.1	.5	1.3	471.9	2.68	.69	.02	.03	4.43	.00239	.08106
1	4	35.01	3.83	38.84	2546.	2002.	18.2	15.9	.2	1.3	473.2	2.75	.70	.02	.03	4.49	.00245	.08331
1	4	35.14	3.80	38.93	2526.	1991.	18.0	15.8	.6	1.3	473.9	2.79	.71	.02	.03	4.53	.00252	.08562
1	4	35.26	3.76	39.03	2506.	1979.	17.8	15.7	.8	1.3	474.7	2.84	.72	.02	.03	4.57	.00258	.08798
1	4	35.46	3.71	39.17	2476.	1962.	17.6	15.6	.9	1.3	475.9	2.91	.73	.02	.03	4.63	.00266	.09041
1	4	35.58	3.68	39.26	2456.	1952.	17.7	15.5	.4	1.2	476.8	2.96	.74	.02	.03	4.67	.00269	.09286
1	4	35.71	3.64	39.36	2437.	1940.	17.6	15.4	.4	1.2	477.5	3.01	.75	.02	.03	4.72	.00275	.09535
1	4	35.90	3.60	39.50	2408.	1924.	17.4	15.2	.7	1.2	478.5	3.09	.76	.02	.03	4.78	.00285	.09793
1	4	36.03	3.56	39.60	2388.	1913.	17.4	15.1	.6	1.2	479.3	3.14	.77	.02	.03	4.83	.00290	.10055
1	4	36.16	3.53	39.69	2369.	1902.	17.4	15.1	.4	1.2	480.0	3.19	.77	.02	.04	4.87	.00295	.10320
1	4	36.35	3.48	39.83	2341.	1887.	17.3	14.9	.3	1.2	481.0	3.27	.79	.02	.04	4.94	.00303	.10592
1	4	36.48	3.45	39.93	2322.	1876.	17.1	14.8	.6	1.2	481.6	3.33	.79	.02	.04	4.99	.00311	.10870
1	4	36.61	3.42	40.03	2303.	1865.	17.0	14.7	.8	1.2	482.1	3.39	.80	.02	.04	5.04	.00319	.11154
1	4	36.80	3.38	40.18	2275.	1850.	17.1	14.6	.3	1.2	483.1	3.47	.81	.02	.04	5.11	.00325	.11443
1	4	36.93	3.35	40.28	2257.	1840.	17.0	14.5	.3	1.1	483.7	3.53	.82	.02	.04	5.16	.00331	.11736
1	4	37.06	3.32	40.38	2239.	1830.	16.7	14.4	.8	1.2	484.0	3.59	.83	.02	.04	5.21	.00342	.12037
1	4	37.25	3.28	40.53	2212.	1815.	16.7	14.3	.5	1.1	484.7	3.69	.84	.02	.04	5.29	.00349	.12344
1	4	37.38	3.25	40.63	2194.	1805.	16.5	14.2	.9	1.1	485.0	3.75	.84	.02	.04	5.34	.00359	.12659
1	4	37.50	3.22	40.73	2176.	1795.	16.6	14.1	.5	1.1	485.5	3.81	.85	.02	.04	5.39	.00363	.12976
1	4	37.70	3.18	40.88	2150.	1781.	16.6	14.0	.4	1.0	486.0	3.91	.86	.02	.04	5.47	.00372	.13300
1	4	37.82	3.16	40.98	2133.	1772.	16.5	13.9	.5	1.0	486.2	3.98	.87	.02	.04	5.53	.00380	.13629
1	4	37.95	3.13	41.08	2116.	1763.	16.5	13.8	.4	1.0	486.4	4.05	.87	.02	.04	5.58	.00386	.13963
1	4	38.14	3.09	41.24	2090.	1749.	16.4	13.7	.5	1.0	486.6	4.15	.88	.02	.04	5.67	.00398	.14305
1	4	38.27	3.07	41.34	2074.	1740.	16.2	13.6	.9	1.0	486.5	4.22	.89	.02	.04	5.72	.00409	.14655
1	4	38.46	3.04	41.50	2049.	1727.	16.3	13.5	.6	.9	486.6	4.33	.89	.03	.04	5.81	.00417	.15011
1	4	38.59	3.01	41.61	2033.	1719.	16.2	13.5	.8	.9	486.5	4.41	.90	.03	.04	5.87	.00425	.15372
1	4	38.72	2.99	41.71	2017.	1711.	16.2	13.4	.8	.9	486.3	4.48	.90	.03	.04	5.93	.00433	.15739
1	4	38.91	2.96	41.87	1993.	1699.	16.2	13.3	.7	.8	486.0	4.60	.91	.03	.04	6.02	.00442	.16111
1	4	39.04	2.94	41.98	1978.	1691.	16.0	13.2	1.1	.8	485.6	4.67	.91	.03	.04	6.08	.00454	.16492
1	4	39.17	2.92	42.09	1962.	1684.	16.1	13.2	.8	.7	485.3	4.75	.91	.03	.04	6.11	.00455	.16872
1	4	39.36	2.89	42.25	1940.	1673.	16.1	13.1	.7	.7	484.7	4.87	.91	.03	.04	6.15	.00460	.17254
1	4	39.49	2.87	42.36	1925.	1666.	16.1	13.0	.8	.6	484.1	4.95	.92	.03	.04	6.17	.00465	.17639

FIGURE C-3. RESULTS OF GUN SITE 1 SIMULATION (Continued)

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AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 5

LOCATION 1 GUN TYPE 3 TRACK MODE 4 POSITION = (-1000.0, 1500.0, 0.0) RADIUS = 0.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	39.62	2.86	42.47	1911.	1659.	15.9	13.0	1.4	.6	483.2	5.03	.92	.03	.04	6.20	.00475	.18030
1	4	39.81	2.83	42.64	1889.	1649.	16.2	12.9	.7	.5	482.4	5.15	.91	.03	.04	6.24	.00473	.18419
1	4	39.94	2.81	42.75	1876.	1643.	16.1	12.8	1.1	.5	481.4	5.23	.91	.03	.04	6.27	.00481	.18811
1	4	40.06	2.80	42.86	1862.	1637.	16.0	12.8	1.3	.5	480.4	5.32	.91	.03	.04	6.30	.00486	.19205
1	4	40.26	2.78	43.03	1842.	1628.	16.0	12.7	1.3	.4	478.9	5.44	.91	.04	.04	6.34	.00491	.19601
1	4	40.38	2.76	43.15	1829.	1623.	16.1	12.7	1.2	.3	477.8	5.53	.90	.04	.04	6.37	.00492	.19997
1	4	40.51	2.75	43.26	1816.	1618.	16.0	12.6	1.6	.3	476.4	5.61	.90	.04	.03	6.40	.00499	.20396
1	4	40.70	2.73	43.44	1798.	1611.	16.1	12.6	1.6	.2	474.3	5.74	.89	.04	.03	6.44	.00502	.20795
1	4	40.83	2.72	43.55	1785.	1607.	16.1	12.5	1.7	.1	472.8	5.82	.88	.04	.03	6.47	.00504	.21194
1	4	40.96	2.71	43.67	1774.	1603.	16.2	12.5	1.6	.1	471.3	5.91	.87	.04	.03	6.50	.00504	.21592
1	4	41.15	2.70	43.85	1757.	1597.	16.4	12.5	1.6	.0	468.7	6.03	.85	.04	.03	6.54	.00505	.21987
1	4	41.28	2.69	43.97	1746.	1594.	16.4	12.4	1.8	.1	466.8	6.11	.84	.05	.03	6.57	.00508	.22384
1	4	41.41	2.68	44.09	1735.	1591.	16.4	12.4	1.9	.2	464.8	6.20	.83	.05	.03	6.60	.00509	.22779
1	4	41.60	2.67	44.27	1719.	1587.	16.4	12.4	2.4	.3	461.4	6.32	.81	.05	.03	6.65	.00513	.23175
1	4	41.73	2.67	44.39	1710.	1585.	16.7	12.4	2.0	.3	459.3	6.40	.79	.05	.03	6.68	.00509	.23566
1	4	41.86	2.66	44.52	1700.	1584.	16.7	12.4	2.2	.4	456.9	6.48	.78	.05	.03	6.71	.00510	.23956
1	4	42.05	2.66	44.71	1686.	1582.	16.8	12.3	2.5	.5	453.1	6.60	.75	.06	.02	6.76	.00510	.24344
1	4	42.18	2.66	44.83	1678.	1581.	16.7	12.3	3.0	.6	450.2	6.67	.73	.06	.02	6.79	.00512	.24731
1	4	42.30	2.66	44.96	1669.	1581.	17.1	12.3	2.5	.7	447.7	6.75	.71	.06	.02	6.82	.00505	.25111
1	4	42.50	2.66	45.15	1657.	1581.	17.0	12.4	3.2	.8	443.0	6.85	.67	.06	.02	6.87	.00507	.25491
1	4	42.62	2.66	45.28	1650.	1582.	17.3	12.4	3.0	.9	440.1	6.92	.65	.07	.02	6.90	.00501	.25864
1	4	42.75	2.66	45.41	1643.	1584.	17.4	12.4	2.7	1.0	436.7	6.99	.62	.07	.02	6.93	.00502	.26237
1	4	42.94	2.67	45.61	1633.	1586.	17.5	12.4	3.0	1.1	431.6	7.08	.58	.07	.01	6.98	.00499	.26604
1	4	43.07	2.67	45.75	1626.	1589.	17.9	12.4	2.7	1.1	428.3	7.14	.55	.07	.01	7.01	.00492	.26965
1	4	43.26	2.69	45.95	1618.	1593.	17.8	12.5	3.6	1.3	422.5	7.23	.51	.08	.01	7.06	.00491	.27324
1	4	43.39	2.70	46.09	1613.	1597.	18.1	12.5	3.4	1.4	418.8	7.28	.48	.08	.01	7.09	.00485	.27676
1	4	43.52	2.70	46.22	1608.	1601.	18.6	12.5	3.0	1.4	415.0	7.33	.45	.08	.01	7.12	.00476	.28021
1	4	43.71	2.72	46.44	1601.	1608.	18.4	12.6	4.0	1.6	408.6	7.40	.39	.09	.00	7.17	.00474	.28362
1	4	43.84	2.74	46.58	1597.	1613.	18.5	12.6	4.3	1.7	404.2	7.44	.36	.09	.00	7.20	.00470	.28698
1	4	43.97	2.75	46.72	1594.	1619.	18.8	12.7	4.4	1.7	399.9	7.48	.32	.09	-.00	7.23	.00464	.29029
1	4	44.16	2.78	46.94	1590.	1629.	19.4	12.8	4.0	1.8	393.4	7.52	.27	.10	-.00	7.28	.00452	.29350
1	4	44.29	2.80	47.09	1587.	1636.	19.3	12.8	4.8	1.9	388.5	7.55	.23	.10	-.00	7.31	.00449	.29667
1	4	44.42	2.82	47.23	1585.	1644.	19.7	12.9	4.5	2.0	383.9	7.57	.19	.10	-.01	7.34	.00441	.29977
1	4	44.61	2.85	47.46	1583.	1657.	20.1	13.0	4.7	2.1	376.6	7.60	.14	.11	-.01	7.38	.00431	.30279
1	4	44.74	2.87	47.61	1582.	1667.	20.2	13.1	5.1	2.1	371.6	7.61	.10	.11	-.01	7.41	.00425	.30575
1	4	44.86	2.90	47.76	1581.	1677.	20.5	13.2	5.1	2.2	366.5	7.62	.06	.11	-.01	7.44	.00418	.30865
1	4	45.06	2.94	48.00	1581.	1693.	20.8	13.3	5.6	2.3	358.6	7.62	-.00	.11	-.02	7.49	.00407	.31147
1	4	45.18	2.97	48.16	1582.	1704.	21.2	13.4	5.5	2.3	353.3	7.62	-.04	.12	-.02	7.51	.00399	.31421
1	4	45.31	3.01	48.32	1583.	1717.	21.1	13.6	6.4	2.4	347.7	7.61	-.08	.12	-.02	7.54	.00393	.31691
1	4	45.50	3.06	48.57	1585.	1737.	21.7	13.7	6.3	2.5	339.5	7.59	-.14	.12	-.02	7.58	.00380	.31951
1	4	45.63	3.10	48.73	1587.	1750.	22.1	13.9	6.2	2.5	333.9	7.57	-.18	.13	-.02	7.61	.00372	.32204
1	4	45.76	3.14	48.90	1589.	1765.	22.1	14.0	7.0	2.6	328.0	7.55	-.22	.13	-.02	7.63	.00365	.32451
1	4	45.95	3.21	49.16	1593.	1789.	22.5	14.2	7.5	2.7	319.3	7.51	-.27	.13	-.03	7.67	.00353	.32690
1	4	46.08	3.25	49.33	1596.	1805.	23.1	14.4	7.2	2.6	313.6	7.48	-.31	.13	-.03	7.70	.00344	.32921
1	4	46.21	3.30	49.51	1600.	1823.	23.2	14.6	7.8	2.7	307.5	7.44	-.34	.13	-.03	7.72	.00336	.33146
1	4	46.40	3.38	49.78	1607.	1850.	24.3	14.8	7.2	2.6	298.8	7.38	-.40	.14	-.03	7.60	.00315	.33357
1	4	46.53	3.44	49.96	1611.	1870.	24.4	15.0	7.9	2.7	292.6	7.33	-.43	.14	-.03	7.46	.00301	.33558
1	4	46.66	3.49	50.15	1616.	1890.	24.9	15.2	8.0	2.7	286.5	7.28	-.46	.14	-.03	7.33	.00287	.33748
1	4	46.85	3.59	50.44	1625.	1922.	25.5	15.5	8.5	2.7	277.3	7.20	-.51	.14	-.03	7.12	.00266	.33924

FIGURE C-3. RESULTS OF GUN SITE 1 SIMULATION (Continued)

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 6

LOCATION 1 GUN TYPE 3 TRACK MODE 4 POSITION = (-1000.0, 1500.0, 0.0) RADIUS = 0.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	46.98	3.65	50.63	1631.	1944.	26.1	15.7	8.5	2.7	271.1	7.15	-.54	.14	-.03	6.98	.00251	.34091
1	4	47.10	3.73	50.83	1637.	1968.	26.4	16.0	9.1	2.8	264.8	7.09	-.57	.14	-.03	6.83	.00238	.34247
1	4	47.30	3.84	51.13	1648.	2004.	27.5	16.3	8.8	2.7	255.6	6.99	-.61	.14	-.04	6.61	.00218	.34391
1	4	47.42	3.93	51.35	1655.	2031.	27.6	16.6	10.2	2.8	249.1	6.92	-.64	.14	-.04	6.45	.00206	.34526
1	4	47.55	4.01	51.56	1663.	2058.	28.7	16.9	9.7	2.7	243.0	6.85	-.66	.14	-.04	6.30	.00193	.34652
1	4	47.74	4.15	51.89	1675.	2101.	29.6	17.3	10.5	2.8	233.5	6.75	-.70	.14	-.04	6.04	.00174	.34765
1	4	47.87	4.24	52.11	1684.	2130.	30.6	17.6	10.4	2.7	227.3	6.67	-.72	.14	-.04	5.87	.00161	.34871
1	4	48.06	4.39	52.46	1697.	2177.	32.2	18.1	10.4	2.6	218.1	6.56	-.75	.14	-.04	5.62	.00144	.34964
1	4	48.19	4.51	52.70	1707.	2211.	32.8	18.4	11.4	2.7	211.7	6.48	-.77	.14	-.04	5.45	.00133	.35051
1	4	48.32	4.63	52.95	1717.	2246.	34.0	18.8	11.5	2.7	205.6	6.40	-.79	.14	-.04	5.29	.00123	.35131
1	4	48.51	4.82	53.33	1732.	2301.	35.9	19.4	11.9	2.6	196.4	6.28	-.81	.14	-.04	5.05	.00108	.35201
1	4	48.64	4.97	53.61	1743.	2341.	36.5	19.8	13.5	2.7	190.2	6.20	-.82	.14	-.04	4.89	.00099	.35265
1	4	48.77	5.11	53.88	1754.	2382.	38.0	20.2	14.0	2.7	184.2	6.12	-.84	.14	-.04	4.73	.00091	.35324
1	4	48.96	5.35	54.31	1771.	2447.	40.8	20.9	14.3	2.6	175.4	5.99	-.85	.14	-.04	4.51	.00078	.35375
1	4	49.09	5.52	54.61	1782.	2493.	42.4	21.5	15.4	2.7	169.5	5.91	-.87	.13	-.04	4.36	.00071	.35420
1	4	49.22	5.71	54.93	1794.	2543.	44.0	22.0	16.8	2.7	163.7	5.82	-.87	.13	-.04	4.21	.00064	.35462
1	4	49.41	6.01	55.41	1813.	2620.	48.3	22.9	15.4	2.5	155.3	5.70	-.89	.13	-.04	4.00	.00054	.35497
1	4	49.54	6.24	55.78	1825.	2678.	49.8	23.6	17.7	2.7	149.7	5.61	-.89	.13	-.04	3.86	.00049	.35528
1	4	49.66	6.47	56.14	1838.	2737.	53.0	24.3	18.1	2.6	144.4	5.53	-.90	.13	-.04	3.73	.00043	.35556
1	4	49.86	6.86	56.71	1858.	2831.	58.8	25.4	18.0	2.5	136.8	5.40	-.91	.13	-.04	3.54	.00036	.35579
1	4	49.98	7.15	57.13	1872.	2901.	62.0	26.3	19.4	2.5	131.8	5.32	-.91	.13	-.04	3.41	.00032	.35599
1	4	50.11	7.47	57.58	1886.	2977.	65.0	27.2	21.6	2.6	127.0	5.24	-.91	.12	-.04	3.29	.00028	.35617

FIGURE C-3. RESULTS OF GUN SITE 1 SIMULATION (Continued)

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 7

LOCATION 1 GUN TYPE 3 TRACK MODE 4 POSITION = (0 -1000.0, 1500.0, 0.0) RADIUS = 0.0 M

PK AS A FUNCTION OF ASPECT SECTOR AND IMPACT SPEED

SECT	0-152	152-305	305-457	457-610	610-762	762-914	914-1067	1067-1219	TOTAL PK
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
10	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
12	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
13	0.0000000	0.0000000	.0524192	.1147048	0.0000000	0.0000000	0.0000000	0.0000000	.1611113
14	.0005951	.0206305	.1253407	.0888674	0.0000000	0.0000000	0.0000000	0.0000000	.2199750
15	.0012784	.0148307	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0160901
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
17	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
18	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
19	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
20	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
21	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
22	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
23	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
24	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
25	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
26	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
27	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
28	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
29	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
30	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
31	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
32	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
TOT.	.0018727	.0351553	.1711897	.1933787	0.0000000	0.0000000	0.0000000	0.0000000	

ROUNDS = 169 CPK = .3561745 F.TIME = 25.35

FIGURE C-3. RESULTS OF GUN SITE 1 SIMULATION (Continued)

>>> GUN SITE DESCRIPTION

ISL	IGT	IEM	ICB	ISB	IGL	CIRCLE	XGUN	YGUN	ZGUN	TREACT	TRACK1	TRACK2
2	5	4	2	1	2	50.0	1000.0	-500.0	0.0	0.000	2.500	6.000

G T	TIME/ ROUND	GUN ELEVATION MIN	GUN ELEVATION MAX	MAX SLEW RT AZIM	MAX SLEW RT ELEV	A/C VELOC. MIN	A/C VELOC. MAX	RANGE OF GUN MIN	RANGE OF GUN MAX	SMOOTH CONST	MAX TRK ERROR AZIM	MAX TRK ERROR ELEV	MAX PROJ T-O-F MODE=1	MAX PROJ T-O-F MODE>1	MUZZLE VELOC.	BALLISTIC SLOWDOWN COEFF-A	BALLISTIC SLOWDOWN COEFF-B
5	.857	-4.00	87.00	30.00	18.00	0.0	300.0	0.	5500.	1.33	5.730	5.730	6.2	11.6	960.0	.0784500	-.0004210

MODE SWITCHING RANGE = 1500.0 BALLISTIC DISPERSION COEFF. = .00113

DENSITY CLASSES FOR PK ACCUMULATION (4 CLASSES)

1.0000000 .7500000 .5000000 .2500000

\# INTERPOLATED VALUES FOR AC1: GTS (H) SABRE TIGER #

VULNERABLE AREA AS A FUNCTION OF IMPACT SPEED (METER/SEC) AND AIRCRAFT VIEW

	0	152	305	457	610	762	914	1067	1219
1	0.00	7.79	15.59	15.59	15.59	15.59	15.59	15.59	15.59
2	0.00	5.51	11.02	11.02	11.02	11.02	11.02	11.02	11.02
3	0.00	8.83	17.67	17.67	17.67	17.67	17.67	17.67	17.67
4	0.00	10.20	20.42	20.42	20.42	20.42	20.42	20.42	20.42
5	0.00	9.06	18.13	18.13	18.13	18.13	18.13	18.13	18.13
6	0.00	5.83	11.68	11.68	11.68	11.68	11.68	11.68	11.68
7	0.00	9.06	18.13	18.13	18.13	18.13	18.13	18.13	18.13
8	0.00	10.20	20.42	20.42	20.42	20.42	20.42	20.42	20.42
9	0.00	8.83	17.67	17.67	17.67	17.67	17.67	17.67	17.67
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	4.70	9.40	9.40	9.40	9.40	9.40	9.40	9.40
12	0.00	6.64	13.29	13.29	13.29	13.29	13.29	13.29	13.29
13	0.00	5.02	10.06	10.06	10.06	10.06	10.06	10.06	10.06
14	0.00	.46	.93	.93	.93	.93	.93	.93	.93
15	0.00	5.02	10.06	10.06	10.06	10.06	10.06	10.06	10.06
16	0.00	6.64	13.29	13.29	13.29	13.29	13.29	13.29	13.29
17	0.00	4.70	9.40	9.40	9.40	9.40	9.40	9.40	9.40
18	0.00	6.26	12.18	12.18	12.18	12.18	12.18	12.18	12.18
19	0.00	9.58	18.82	18.82	18.82	18.82	18.82	18.82	18.82
20	0.00	10.96	21.57	21.57	21.57	21.57	21.57	21.57	21.57
21	0.00	9.81	19.29	19.29	19.29	19.29	19.29	19.29	19.29
22	0.00	6.59	12.83	12.83	12.83	12.83	12.83	12.83	12.83
23	0.00	9.81	19.29	19.29	19.29	19.29	19.29	19.29	19.29
24	0.00	10.96	21.57	21.57	21.57	21.57	21.57	21.57	21.57
25	0.00	9.58	18.82	18.82	18.82	18.82	18.82	18.82	18.82
26	0.00	8.86	17.22	17.22	17.22	17.22	17.22	17.22	17.22

FIGURE C-4. GUN SITE 2 INPUT DATA

BEST AVAILABLE COPY

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 9

LOCATION 2 GUN TYPE 5 TRACK MODE 4 POSITION = (1000.0, -500.0, 0.0) RADIUS = 50.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	13.31	11.60	24.91	8367.	6008.	45.0	44.5	2.8	2.7	494.7	-.08	.08	-.00	.00	2.17	.00017	.0001
1	4	13.76	11.42	25.18	8277.	5954.	44.6	44.0	2.8	2.8	498.1	-.08	.08	-.00	.00	2.19	.00018	.0003
2	4	13.95	11.54	25.49	8239.	5991.	44.9	44.4	2.7	1.7	495.7	-.08	.08	-.00	.00	2.19	.00017	.0005
1	4	14.14	11.27	25.41	8201.	5908.	44.2	43.6	2.9	2.8	501.1	-.09	.08	-.00	.00	2.20	.00018	.0007
2	4	14.40	11.36	25.76	8150.	5938.	44.4	43.9	2.7	1.7	499.2	-.09	.09	-.00	.00	2.21	.00018	.0008
1	4	14.59	11.09	25.68	8112.	5855.	43.7	43.1	2.9	2.8	504.7	-.09	.09	-.00	.00	2.22	.00019	.0010
2	4	14.85	11.18	26.03	8061.	5884.	43.9	43.4	2.8	1.8	502.7	-.09	.09	-.00	.00	2.22	.00019	.0012
1	4	15.04	10.91	25.95	8022.	5801.	43.2	42.7	3.0	2.9	508.3	-.09	.09	-.00	.00	2.24	.00019	.0014
2	4	15.23	11.03	26.27	7984.	5838.	43.5	43.0	2.8	1.8	505.8	-.09	.09	-.00	.00	2.24	.00019	.00164
1	4	15.49	10.74	26.23	7933.	5746.	42.7	42.2	3.0	2.9	512.0	-.09	.09	-.00	.00	2.26	.00020	.0018
2	4	15.68	10.86	26.54	7895.	5783.	43.0	42.5	2.8	1.8	509.4	-.09	.09	-.00	.00	2.26	.00020	.0020
1	4	15.87	10.59	26.46	7856.	5699.	42.3	41.8	3.0	2.9	515.2	-.09	.09	-.00	.00	2.27	.00020	.00223
2	4	16.13	10.68	26.81	7805.	5729.	42.6	42.0	2.9	1.8	513.2	-.09	.09	-.00	.00	2.28	.00020	.00243
1	4	16.32	10.42	26.74	7767.	5645.	41.8	41.3	3.1	3.0	519.0	-.10	.09	-.00	.00	2.29	.00021	.00264
2	4	16.51	10.54	27.05	7729.	5682.	42.1	41.6	2.9	1.8	516.4	-.10	.10	-.00	.00	2.29	.00021	.00285
1	4	16.77	10.25	27.01	7678.	5590.	41.3	40.8	3.1	3.0	522.9	-.10	.10	-.00	.00	2.31	.00022	.00307
2	4	16.96	10.36	27.32	7640.	5628.	41.7	41.2	3.0	1.9	520.2	-.10	.10	-.00	.00	2.31	.00021	.00328
1	4	17.15	10.10	27.25	7601.	5543.	40.9	40.4	3.2	3.0	526.3	-.10	.10	-.00	.00	2.33	.00022	.00350
2	4	17.41	10.19	27.60	7550.	5572.	41.2	40.7	3.0	1.9	524.1	-.10	.10	-.00	.00	2.33	.00022	.00372
1	4	17.60	9.93	27.53	7512.	5487.	40.5	40.0	3.2	3.1	530.2	-.10	.10	-.00	.00	2.35	.00023	.00395
2	4	17.79	10.05	27.84	7474.	5525.	40.8	40.3	3.0	1.9	527.5	-.10	.10	-.00	.00	2.35	.00023	.00418
1	4	18.05	9.76	27.81	7423.	5431.	40.0	39.5	3.3	3.2	534.3	-.10	.10	-.00	.00	2.37	.00024	.00441
2	4	18.24	9.88	28.12	7385.	5470.	40.3	39.8	3.1	1.9	531.5	-.11	.10	-.00	.00	2.37	.00023	.00465
1	4	18.43	9.62	28.06	7346.	5383.	39.6	39.1	3.3	3.2	537.8	-.11	.11	-.00	.00	2.39	.00024	.00489
2	4	18.69	9.71	28.40	7295.	5413.	39.8	39.3	3.1	1.9	535.5	-.11	.11	-.00	.00	2.39	.00024	.00513
1	4	18.88	9.46	28.34	7257.	5327.	39.1	38.6	3.4	3.2	542.0	-.11	.11	-.00	.00	2.41	.00025	.00538
2	4	19.07	9.57	28.64	7219.	5366.	39.4	38.9	3.2	2.0	539.1	-.11	.11	-.00	.00	2.41	.00025	.00563
1	4	19.33	9.29	28.62	7168.	5270.	38.6	38.1	3.4	3.3	546.2	-.11	.11	-.00	.00	2.43	.00026	.00589
2	4	19.52	9.41	28.93	7130.	5310.	38.9	38.5	3.2	2.0	543.3	-.11	.11	-.00	.00	2.43	.00026	.00614
1	4	19.78	9.13	28.91	7079.	5214.	38.1	37.7	3.5	3.3	550.5	-.11	.11	-.00	.01	2.46	.00027	.00641
2	4	19.97	9.24	29.21	7040.	5253.	38.5	38.0	3.2	2.0	547.5	-.12	.11	-.00	.01	2.46	.00027	.00668
1	4	20.16	8.99	29.15	7002.	5165.	37.7	37.3	3.6	3.4	554.2	-.12	.12	-.00	.01	2.48	.00028	.00695
2	4	20.42	9.08	29.50	6951.	5197.	38.0	37.5	3.3	2.0	551.9	-.12	.12	-.00	.01	2.48	.00028	.00723
1	4	20.61	8.83	29.44	6913.	5108.	37.3	36.8	3.6	3.4	558.7	-.12	.12	-.00	.01	2.50	.00029	.00751
2	4	20.80	8.94	29.74	6875.	5147.	37.6	37.1	3.3	2.1	555.6	-.12	.12	-.00	.01	2.50	.00028	.00779
1	4	21.06	8.67	29.73	6824.	5051.	36.8	36.3	3.7	3.5	563.2	-.12	.12	-.00	.01	2.52	.00030	.00809
2	4	21.25	8.78	30.03	6786.	5090.	37.1	36.7	3.4	2.1	560.0	-.12	.12	-.00	.01	2.53	.00029	.00838
1	4	21.44	8.54	29.98	6747.	5001.	36.4	35.9	3.8	3.5	567.0	-.13	.12	-.00	.01	2.55	.00031	.00868
2	4	21.70	8.63	30.32	6696.	5033.	36.6	36.2	3.4	2.1	564.5	-.13	.13	-.00	.01	2.55	.00030	.00899
1	4	21.89	8.38	30.27	6658.	4944.	35.9	35.5	3.8	3.5	571.7	-.13	.13	-.00	.01	2.57	.00032	.00930
2	4	22.08	8.49	30.57	6620.	4983.	36.2	35.8	3.5	2.2	568.5	-.13	.13	-.00	.01	2.57	.00031	.00961
1	4	22.34	8.23	30.57	6569.	4885.	35.4	35.0	3.9	3.6	576.3	-.13	.13	-.00	.01	2.60	.00033	.00994
2	4	22.53	8.33	30.86	6531.	4926.	35.7	35.3	3.6	2.2	573.1	-.13	.13	-.00	.01	2.60	.00033	.01026
1	4	22.72	8.10	30.82	6493.	4836.	35.0	34.6	3.9	3.6	580.4	-.14	.13	-.00	.01	2.62	.00034	.01060
2	4	22.98	8.18	31.16	6442.	4867.	35.3	34.8	3.6	2.2	577.8	-.14	.14	-.00	.01	2.63	.00034	.01093
1	4	23.17	7.95	31.11	6404.	4777.	34.5	34.1	4.0	3.8	585.2	-.14	.14	-.00	.01	2.65	.00035	.01128
2	4	23.36	8.05	31.41	6365.	4817.	34.9	34.4	3.7	2.3	581.9	-.14	.14	-.00	.01	2.65	.00035	.01163
1	4	23.62	7.79	31.41	6314.	4718.	34.1	33.7	4.1	3.8	590.1	-.14	.14	-.00	.01	2.68	.00037	.01199
2	4	23.81	7.90	31.71	6276.	4759.	34.4	34.0	3.7	2.3	586.7	-.15	.14	-.00	.01	2.68	.00036	.01235

FIGURE C-5. RESULTS OF GUN SITE 2 SIMULATION

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 10

LOCATION 2 GUN TYPE 5 TRACK MODE 4 POSITION = (1000.0, -500.0, 0.0) RADIUS = 50.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	24.00	7.67	31.67	6238.	4668.	33.6	33.3	4.1	3.8	594.3	-.15	.15	-.00	.01	2.70	.00038	.01272
2	4	24.26	7.75	32.00	6187.	4700.	33.9	33.5	3.8	2.3	591.6	-.15	.15	-.00	.01	2.71	.00038	.01309
1	4	24.45	7.52	31.96	6149.	4609.	33.2	32.8	4.2	3.8	599.4	-.15	.15	-.00	.01	2.73	.00039	.01348
2	4	24.64	7.62	32.26	6111.	4649.	33.5	33.1	3.9	2.3	595.9	-.15	.15	-.00	.01	2.74	.00039	.01386
1	4	24.90	7.37	32.26	6060.	4549.	32.7	32.3	4.3	3.9	604.5	-.16	.15	-.00	.01	2.76	.00041	.01427
2	4	25.09	7.47	32.56	6022.	4590.	33.0	32.6	4.0	2.4	600.9	-.16	.16	-.00	.01	2.77	.00040	.01467
1	4	25.34	7.22	32.57	5971.	4489.	32.2	31.8	4.4	4.0	609.6	-.16	.16	-.00	.01	2.80	.00043	.01509
2	4	25.54	7.32	32.86	5933.	4530.	32.6	32.2	4.0	2.4	606.0	-.16	.16	-.00	.01	2.80	.00042	.01550
1	4	25.73	7.10	32.83	5895.	4438.	31.8	31.4	4.4	4.1	614.1	-.17	.16	-.00	.01	2.82	.00044	.01594
2	4	25.98	7.18	33.16	5844.	4470.	32.1	31.7	4.1	2.4	611.2	-.17	.17	-.00	.01	2.83	.00044	.01637
1	4	26.18	6.96	33.13	5806.	4378.	31.3	31.0	4.5	4.1	619.4	-.17	.17	-.00	.01	2.86	.00046	.01682
2	4	26.37	7.05	33.42	5768.	4419.	31.7	31.3	4.2	2.5	615.7	-.17	.17	-.00	.01	2.86	.00045	.01726
1	4	26.62	6.81	33.44	5717.	4318.	30.9	30.5	4.6	4.2	624.7	-.18	.17	-.00	.01	2.89	.00049	.01773
2	4	26.82	6.91	33.73	5679.	4359.	31.2	30.8	4.3	2.5	621.0	-.18	.18	-.00	.01	2.90	.00047	.01820
1	4	27.01	6.69	33.70	5640.	4266.	30.5	30.1	4.7	4.2	629.4	-.18	.18	-.00	.01	2.92	.00050	.01869
2	4	27.26	6.77	34.03	5590.	4299.	30.7	30.4	4.4	2.6	626.4	-.18	.18	-.00	.01	2.93	.00049	.01917
1	4	27.46	6.55	34.01	5552.	4205.	30.0	29.6	4.8	4.3	634.9	-.19	.18	-.00	.01	2.96	.00052	.01968
2	4	27.65	6.65	34.30	5513.	4246.	30.3	30.0	4.4	2.6	631.0	-.19	.19	-.00	.01	2.96	.00051	.02018
1	4	27.90	6.41	34.32	5463.	4144.	29.5	29.2	4.9	4.4	640.5	-.19	.19	-.00	.01	3.00	.00054	.02071
2	4	28.10	6.51	34.60	5425.	4186.	29.8	29.5	4.5	2.6	636.6	-.20	.19	-.00	.01	3.00	.00053	.02123
1	4	28.29	6.30	34.58	5386.	4092.	29.1	28.8	5.0	4.4	645.4	-.20	.20	-.00	.01	3.03	.00056	.02178
2	4	28.54	6.37	34.92	5336.	4124.	29.4	29.0	4.5	2.7	642.1	-.20	.20	-.00	.01	3.04	.00056	.02233
1	4	28.74	6.16	34.90	5298.	4030.	28.6	28.3	5.1	4.5	651.1	-.21	.20	-.00	.01	3.07	.00059	.02290
2	4	28.93	6.25	35.18	5259.	4072.	29.0	28.6	4.7	2.7	647.0	-.21	.21	-.00	.01	3.08	.00058	.02347
1	4	29.18	6.02	35.21	5209.	3969.	28.2	27.8	5.2	4.5	656.9	-.21	.21	-.00	.01	3.11	.00061	.02406
2	4	29.38	6.12	35.49	5171.	4011.	28.5	28.2	4.8	2.7	652.8	-.22	.21	-.00	.01	3.12	.00061	.02466
1	4	29.57	5.91	35.48	5133.	3915.	27.8	27.4	5.3	4.7	661.8	-.22	.22	-.00	.01	3.15	.00064	.02528
2	4	29.82	5.98	35.81	5082.	3949.	28.0	27.7	4.9	2.8	658.6	-.22	.22	-.00	.01	3.16	.00063	.02589
1	4	30.02	5.78	35.79	5044.	3853.	27.3	27.0	5.4	4.7	667.8	-.23	.22	-.00	.01	3.19	.00067	.02654
2	4	30.27	5.85	36.12	4993.	3887.	27.5	27.2	5.0	2.8	664.5	-.23	.23	-.00	.01	3.21	.00067	.02719
1	4	30.46	5.64	36.11	4955.	3791.	26.8	26.5	5.5	4.8	673.9	-.24	.23	-.00	.01	3.24	.00070	.02787
2	4	30.66	5.73	36.39	4917.	3834.	27.1	26.8	5.1	2.8	669.6	-.24	.23	-.00	.01	3.25	.00069	.02854
1	4	30.91	5.51	36.43	4866.	3729.	26.3	26.0	5.7	4.8	679.9	-.24	.24	-.00	.01	3.28	.00073	.02925
2	4	31.10	5.60	36.71	4828.	3772.	26.7	26.4	5.2	2.9	675.6	-.25	.24	-.00	.01	3.29	.00073	.02996
1	4	31.30	5.40	36.70	4790.	3675.	25.9	25.6	5.8	4.9	685.2	-.25	.25	-.00	.01	3.32	.00076	.03070
2	4	31.55	5.47	37.03	4740.	3709.	26.2	25.9	5.3	2.9	681.7	-.26	.25	-.00	.01	3.34	.00076	.03144
1	4	31.74	5.28	37.02	4702.	3612.	25.5	25.2	5.9	5.0	691.4	-.26	.26	-.00	.01	3.37	.00080	.03221
2	4	31.94	5.36	37.30	4664.	3655.	25.8	25.5	5.4	3.0	687.0	-.27	.26	-.00	.01	3.39	.00080	.03298
1	4	32.19	5.15	37.34	4613.	3549.	25.0	24.7	6.1	5.1	697.7	-.27	.27	-.00	.01	3.43	.00084	.03379
2	4	32.38	5.24	37.62	4575.	3592.	25.3	25.0	5.6	3.0	693.3	-.28	.27	-.00	.01	3.44	.00084	.03460
1	4	32.58	5.04	37.62	4537.	3495.	24.6	24.3	6.2	5.2	703.2	-.28	.27	-.00	.01	3.47	.00088	.03544
2	4	32.83	5.11	37.94	4487.	3530.	24.8	24.6	5.7	3.0	699.6	-.29	.28	-.00	.01	3.49	.00088	.03629
1	4	33.02	4.92	37.94	4449.	3432.	24.1	23.8	6.3	5.2	709.6	-.29	.29	-.00	.01	3.53	.00092	.03718
2	4	33.22	5.00	38.22	4411.	3475.	24.4	24.2	5.9	3.1	705.1	-.30	.29	-.00	.01	3.54	.00092	.03806
1	4	33.47	4.79	38.27	4360.	3368.	23.6	23.4	6.5	5.4	716.1	-.30	.30	-.00	.01	3.58	.00097	.03900
2	4	33.66	4.88	38.54	4322.	3412.	24.0	23.7	5.9	3.1	711.4	-.31	.30	-.00	.01	3.60	.00097	.03993
1	4	33.86	4.69	38.55	4284.	3313.	23.2	23.0	6.7	5.5	721.7	-.32	.31	-.00	.01	3.64	.00101	.04090
2	4	34.11	4.75	38.87	4234.	3348.	23.5	23.2	6.2	3.2	718.1	-.32	.32	-.00	.01	3.66	.00102	.04188
1	4	34.30	4.57	38.87	4196.	3250.	22.8	22.5	6.8	5.5	728.4	-.33	.32	-.00	.01	3.70	.00106	.04290

FIGURE C-5. RESULTS OF GUN SITE 2 SIMULATION (Continued)

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AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 11

LOCATION 2 GUN TYPE 5 TRACK MODE 4 POSITION = (1000.0, -500.0, 0.0) RADIUS = 50.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
2	4	34.50	4.65	39.15	4158.	3294.	23.1	22.8	6.3	3.2	723.7	-.34	.33	-.00	.02	3.71	.00107	.04392
1	4	34.75	4.45	39.20	4108.	3185.	22.3	22.0	7.0	5.7	735.1	-.34	.33	-.00	.02	3.76	.00112	.04499
2	4	34.94	4.53	39.48	4070.	3229.	22.6	22.4	6.4	3.3	730.3	-.35	.34	-.00	.02	3.78	.00113	.04607
1	4	35.20	4.33	39.53	4019.	3121.	21.8	21.6	7.2	5.7	741.9	-.36	.35	-.00	.02	3.83	.00118	.04720
2	4	35.39	4.41	39.80	3981.	3165.	22.1	21.9	6.5	3.3	737.0	-.37	.36	-.00	.02	3.85	.00119	.04834
1	4	35.58	4.23	39.81	3944.	3066.	21.4	21.2	7.4	5.7	747.9	-.37	.36	-.00	.02	3.89	.00124	.04951
2	4	35.84	4.29	40.13	3893.	3101.	21.7	21.4	6.8	3.3	743.9	-.38	.37	-.00	.02	3.92	.00126	.05071
1	4	36.03	4.11	40.14	3855.	3002.	20.9	20.7	7.6	5.8	754.8	-.39	.38	-.00	.02	3.96	.00131	.05195
2	4	36.22	4.19	40.42	3818.	3046.	21.3	21.0	7.0	3.4	749.8	-.40	.39	-.00	.02	3.98	.00132	.05321
1	4	36.48	4.00	40.48	3767.	2937.	20.5	20.2	7.8	6.1	761.7	-.41	.40	-.00	.02	4.04	.00138	.05451
2	4	36.67	4.08	40.75	3730.	2981.	20.8	20.6	7.1	3.4	756.6	-.42	.40	-.00	.02	4.06	.00140	.05584
1	4	36.86	3.90	40.76	3692.	2881.	20.1	19.8	8.1	6.1	767.8	-.43	.41	-.00	.02	4.11	.00144	.05720
2	4	37.12	3.96	41.08	3642.	2917.	20.3	20.1	7.4	3.4	763.7	-.44	.42	-.00	.02	4.14	.00149	.05861
1	4	37.31	3.79	41.10	3604.	2816.	19.6	19.4	8.3	6.1	774.9	-.45	.43	-.00	.02	4.19	.00152	.06004
2	4	37.50	3.87	41.37	3566.	2861.	19.9	19.7	7.5	3.5	769.7	-.46	.44	-.00	.02	4.21	.00156	.06151
1	4	37.76	3.68	41.44	3516.	2751.	19.1	18.9	8.6	6.3	782.0	-.47	.45	-.00	.02	4.28	.00161	.06302
2	4	37.95	3.75	41.70	3478.	2796.	19.5	19.2	7.8	3.5	776.9	-.48	.46	-.00	.02	4.30	.00166	.06457
1	4	38.14	3.58	41.73	3441.	2695.	18.7	18.5	8.8	6.4	788.2	-.49	.47	-.00	.02	4.35	.00168	.06615
2	4	38.40	3.64	42.04	3391.	2731.	19.0	18.8	8.0	3.6	784.0	-.51	.49	-.00	.02	4.40	.00176	.06779
1	4	38.59	3.47	42.06	3353.	2630.	18.3	18.0	9.1	6.6	795.5	-.52	.50	-.00	.02	4.45	.00177	.06944
2	4	38.78	3.55	42.33	3316.	2675.	18.6	18.4	8.4	3.5	790.3	-.53	.51	-.00	.02	4.48	.00185	.07117
1	4	39.04	3.36	42.40	3266.	2564.	17.8	17.6	9.4	6.8	802.8	-.55	.53	-.00	.02	4.55	.00187	.07290
2	4	39.23	3.44	42.67	3228.	2609.	18.1	17.9	8.5	3.6	797.5	-.56	.54	-.00	.03	4.58	.00197	.07472
1	4	39.42	3.27	42.69	3191.	2508.	17.4	17.2	9.7	6.6	809.3	-.57	.55	-.00	.03	4.64	.00196	.07653
2	4	39.68	3.33	43.01	3141.	2544.	17.6	17.4	8.8	3.7	804.8	-.59	.57	-.00	.03	4.69	.00209	.07846
1	4	39.87	3.17	43.04	3103.	2443.	16.9	16.7	10.0	6.9	816.6	-.61	.58	-.00	.03	4.75	.00205	.08035
2	4	40.13	3.22	43.35	3053.	2478.	17.2	17.0	9.2	3.6	812.2	-.63	.60	-.00	.03	4.80	.00221	.08239
1	4	40.32	3.06	43.38	3016.	2377.	16.4	16.3	10.4	7.1	824.1	-.65	.61	-.00	.03	4.86	.00215	.08437
2	4	40.51	3.13	43.64	2979.	2422.	16.8	16.6	9.5	3.6	818.6	-.66	.63	-.00	.03	4.90	.00233	.08650
1	4	40.77	2.96	43.72	2929.	2311.	16.0	15.8	10.8	7.0	831.7	-.69	.65	-.00	.03	4.99	.00226	.08856
2	4	40.96	3.03	43.99	2892.	2357.	16.3	16.1	9.9	3.5	826.1	-.70	.67	-.00	.03	5.03	.00246	.09081
1	4	41.15	2.87	44.02	2854.	2255.	15.6	15.4	11.2	7.1	838.2	-.72	.68	-.00	.03	5.10	.00234	.09294
2	4	41.41	2.93	44.33	2805.	2291.	15.8	15.7	10.1	3.7	833.5	-.75	.71	-.00	.03	5.16	.00262	.09531
1	4	41.60	2.77	44.37	2768.	2189.	15.1	14.9	11.6	7.3	845.7	-.77	.73	-.00	.04	5.23	.00243	.09751
2	4	41.79	2.84	44.63	2731.	2234.	15.5	15.3	10.5	3.7	840.0	-.79	.75	-.00	.04	5.28	.00274	.09999
1	4	42.05	2.67	44.72	2681.	2123.	14.7	14.5	12.1	7.4	853.4	-.82	.77	-.00	.04	5.38	.00252	.10225
2	4	42.24	2.74	44.98	2644.	2159.	15.0	14.8	11.0	3.5	847.6	-.85	.79	-.00	.04	5.43	.00288	.10484
1	4	42.43	2.58	45.01	2607.	2067.	14.3	14.1	12.5	7.4	859.9	-.87	.82	-.00	.04	5.51	.00258	.10714
2	4	42.69	2.64	45.32	2558.	2103.	14.5	14.3	11.4	3.6	855.1	-.91	.85	-.00	.04	5.59	.00303	.10985
1	4	42.88	2.49	45.37	2521.	2001.	13.8	13.6	12.9	7.9	867.4	-.93	.87	-.00	.04	5.67	.00261	.11217
2	4	43.07	2.55	45.62	2484.	2047.	14.1	14.0	11.9	3.5	861.6	-.96	.90	-.00	.04	5.73	.00314	.11495
1	4	43.33	2.39	45.72	2435.	1935.	13.3	13.2	13.4	8.2	875.0	-1.00	.93	-.00	.05	5.85	.00263	.11728
2	4	43.52	2.46	45.98	2398.	1981.	13.7	13.5	12.3	3.7	869.1	-1.04	.96	-.00	.05	5.91	.00327	.12017
1	4	43.71	2.31	46.02	2362.	1879.	13.0	12.8	14.0	8.2	881.5	-1.07	.99	-.00	.05	6.01	.00263	.12248
2	4	43.97	2.36	46.33	2313.	1915.	13.2	13.0	12.8	3.7	876.6	-1.12	1.03	-.00	.05	6.10	.00337	.12544
1	4	44.16	2.21	46.37	2276.	1814.	12.5	12.3	14.5	8.6	889.0	-1.16	1.06	-.00	.05	6.20	.00257	.12769
2	4	44.35	2.28	46.63	2240.	1859.	12.8	12.7	13.2	3.8	882.9	-1.20	1.10	-.00	.05	6.28	.00345	.13069
1	4	44.61	2.12	46.73	2191.	1749.	12.1	11.9	15.2	8.5	896.6	-1.25	1.14	-.00	.06	6.42	.00249	.13286
2	4	44.80	2.18	46.98	2155.	1793.	12.4	12.2	13.8	3.9	890.3	-1.30	1.18	-.00	.06	6.50	.00348	.13588

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FIGURE C-5. RESULTS OF GUN SITE 2 SIMULATION (Continued)

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 12

LOCATION 2 GUN TYPE 5 TRACK MODE 4 POSITION = (1000.0, -500.0, 0.0) RADIUS = 50.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	45.06	2.03	47.09	2106.	1684.	11.6	11.4	15.8	9.0	903.9	-1.36	1.23	-.00	.06	6.64	.00232	.13788
2	4	45.25	2.09	47.34	2070.	1728.	11.9	11.7	14.4	4.0	897.7	-1.41	1.28	-.00	.06	6.73	.00346	.14086
1	4	45.44	1.95	47.39	2034.	1628.	11.2	11.1	16.3	9.5	910.1	-1.47	1.32	-.00	.07	6.86	.00212	.14268
2	4	45.70	2.00	47.70	1986.	1663.	11.5	11.3	15.1	4.2	904.9	-1.54	1.38	-.00	.07	6.99	.00337	.14557
1	4	45.89	1.86	47.75	1950.	1564.	10.8	10.6	17.1	9.6	917.4	-1.60	1.43	-.00	.07	7.12	.00188	.14717
2	4	46.08	1.93	48.01	1915.	1608.	11.1	10.9	15.7	4.4	910.9	-1.67	1.48	-.00	.08	7.22	.00322	.14992
1	4	46.34	1.78	48.11	1867.	1499.	10.4	10.2	17.8	10.3	924.4	-1.76	1.55	-.00	.08	7.41	.00155	.15124
2	4	46.53	1.84	48.37	1832.	1543.	10.7	10.5	16.4	4.7	917.8	-1.84	1.61	-.00	.08	7.52	.00296	.15375
1	4	46.72	1.70	48.42	1796.	1445.	10.0	9.8	18.5	10.6	930.2	-1.92	1.67	.00	.09	7.67	.00127	.15483
2	4	46.98	1.75	48.73	1749.	1480.	10.3	10.0	17.6	4.4	924.6	-2.03	1.76	.00	.09	7.84	.00255	.15698
1	4	47.17	1.62	48.79	1714.	1382.	9.6	9.4	19.6	10.5	936.9	-2.12	1.83	.00	.09	8.01	.00096	.15780
2	4	47.36	1.68	49.04	1679.	1425.	9.9	9.7	18.3	4.9	930.1	-2.22	1.90	.00	.10	8.14	.00219	.15964
1	4	47.62	1.54	49.16	1633.	1319.	9.2	8.9	20.2	11.9	943.0	-2.36	2.00	.00	.10	8.38	.00062	.16016
2	4	47.81	1.59	49.40	1598.	1362.	9.5	9.2	19.3	5.2	936.2	-2.47	2.08	.01	.11	8.53	.00169	.16158
1	4	48.00	1.47	49.47	1564.	1267.	8.8	8.6	21.1	12.2	948.1	-2.60	2.17	.01	.11	8.72	.00041	.16192
2	4	48.26	1.51	49.77	1519.	1300.	9.1	8.8	20.3	6.0	941.9	-2.77	2.29	.01	.12	8.95	.00120	.16292
1	1	48.45	1.39	49.84	1485.	1206.	41.3	34.3	31.1	14.7	948.7	-3.83	2.99	.06	.09	9.79	.00076	.16356
2	1	48.64	1.45	50.09	1451.	1247.	43.3	35.9	39.4	20.5	944.6	-3.81	2.95	.22	-.02	9.56	.00055	.16402
1	1	48.90	1.32	50.21	1406.	1146.	40.7	33.3	33.8	15.2	952.5	-2.97	2.34	.23	.01	10.36	.00078	.16466
2	1	49.09	1.37	50.46	1373.	1187.	42.7	34.9	37.0	17.7	949.5	-3.30	2.60	.18	.06	10.03	.00065	.16520
1	1	49.28	1.25	50.53	1341.	1096.	40.2	32.4	31.6	13.1	955.5	-3.90	3.04	.20	.05	10.83	.00089	.16595
2	1	49.54	1.29	50.83	1297.	1128.	42.2	33.9	37.4	17.3	953.1	-4.16	3.11	.26	.02	10.58	.00070	.16653
1	1	49.73	1.18	50.91	1265.	1040.	39.6	31.4	31.4	11.8	957.9	-4.24	3.11	.27	.03	11.47	.00100	.16736
2	1	49.98	1.22	51.20	1223.	1070.	41.7	32.9	36.6	15.4	956.3	-4.66	3.39	.28	.05	11.18	.00079	.16802
1	1	50.18	1.12	51.29	1192.	985.	39.2	30.4	30.3	9.9	959.2	-5.03	3.59	.31	.04	12.16	.00114	.16897
2	1	50.37	1.16	51.53	1161.	1023.	41.4	32.0	36.2	14.1	957.9	-5.35	3.71	.34	.04	11.75	.00087	.16970
1	1	50.62	1.05	51.68	1121.	933.	38.8	29.4	29.4	7.9	958.8	-5.80	3.90	.38	.04	12.95	.00130	.17078
2	1	50.82	1.10	51.91	1091.	969.	41.0	30.9	35.4	12.0	958.4	-6.22	4.10	.41	.04	12.48	.00100	.17161
1	1	51.01	1.00	52.01	1063.	891.	38.4	28.6	28.4	6.0	957.0	-6.69	4.29	.44	.04	13.69	.00147	.17283
2	1	51.26	1.03	52.30	1025.	918.	40.7	29.8	34.8	9.9	957.3	-7.35	4.51	.49	.03	13.30	.00114	.17377
1	1	51.46	.95	52.40	997.	846.	37.9	27.7	27.3	3.7	952.9	-7.90	4.69	.54	.03	14.65	.00169	.17517
2	1	51.65	.98	52.63	971.	877.	40.3	28.9	34.4	8.0	955.0	-8.51	4.87	.58	.03	14.08	.00128	.17623
1	1	51.90	.90	52.80	936.	805.	37.3	26.8	25.9	1.2	945.9	-9.41	5.10	.65	.01	15.73	.00196	.17785
2	1	52.10	.93	53.03	912.	832.	39.2	27.8	33.4	5.4	949.7	-10.15	5.26	.71	-.00	15.09	.00150	.17909
1	1	52.29	.86	53.15	888.	774.	35.3	25.9	24.8	.9	937.5	-10.96	5.40	.77	-.02	16.54	.00224	.18093
2	1	52.54	.88	53.43	858.	793.	36.3	26.4	32.3	2.8	941.6	-12.13	5.55	.86	-.05	16.21	.00180	.18240
1	1	52.74	.82	53.56	83[illegible]	744.	33.1	24.7	23.5	3.1	924.7	-13.08	5.62	.92	-.08	17.27	.00258	.18451
2	1	52.93	.85	53.78	817.	764.	34.3	25.2	31.1	.8	932.3	-14.08	5.64	.99	-.11	16.83	.00205	.18618
1	1	53.18	.80	53.98	792.	722.	31.5	23.5	21.5	4.6	907.8	-15.48	5.57	1.07	-.17	18.04	.00301	.18863
2	1	53.38	.82	54.19	776.	736.	32.5	23.6	28.6	1.0	918.2	-16.54	5.43	1.12	-.21	17.58	.00246	.19063
1	1	53.57	.79	54.35	761.	711.	30.7	22.4	19.4	5.0	890.4	-17.59	5.19	1.16	-.27	18.70	.00345	.19342
2	1	53.82	.79	54.62	743.	717.	31.4	22.1	24.8	1.5	900.6	-18.89	4.71	1.18	-.35	18.35	.00306	.19589
1	1	54.02	.78	54.80	732.	707.	30.2	21.3	16.4	3.8	867.3	-19.75	4.22	1.17	-.41	19.45	.00406	.19915
2	1	54.21	.78	54.99	723.	709.	30.9	21.0	20.0	.4	883.0	-20.47	3.59	1.12	-.46	19.01	.00376	.20216
1	1	54.46	.79	55.25	714.	715.	30.1	20.8	13.0	.6	841.9	-21.15	2.58	.99	-.53	20.13	.00464	.20587
2	1	54.66	.78	55.44	710.	708.	30.5	20.2	13.1	2.7	860.2	-21.43	1.70	.86	-.56	19.72	.00458	.20950
1	1	54.91	.82	55.73	707.	735.	30.2	20.8	8.9	4.2	814.9	-21.50	.42	.62	-.57	20.13	.00476	.21327
2	1	55.10	.80	55.90	708.	720.	30.4	20.3	6.0	7.1	835.6	-21.36	-.57	.42	-.56	20.19	.00477	.21702
1	1	55.30	.85	56.14	710.	762.	30.7	22.2	6.3	7.4	791.4	-21.07	-1.53	.21	-.53	19.66	.00425	.22034

FIGURE C-5. RESULTS OF GUN SITE 2 SIMULATION (Continued)

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AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 13

LOCATION 2 GUN TYPE 5 TRACK MODE 4 POSITION = (1000.0, -500.0, 0.0) RADIUS = 50.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
2	1	55.55	.82	56.38	717.	744.	30.5	21.9	.1	9.6	809.0	-20.49	-2.72	-.06	-.45	19.99	.00430	.22370
1	1	55.74	.90	56.64	724.	805.	31.7	24.4	4.2	7.8	763.5	-19.93	-3.49	-.23	-.39	18.89	.00365	.22653
2	1	55.94	.86	56.80	733.	774.	31.0	23.6	3.2	9.4	784.9	-19.25	-4.15	-.37	-.31	19.50	.00388	.22953
1	1	56.19	.96	57.15	748.	858.	33.4	27.0	4.6	4.6	736.0	-18.21	-4.82	-.50	-.21	18.00	.00309	.23191
2	1	56.38	.91	57.30	761.	820.	32.2	26.0	3.4	6.8	756.5	-17.32	-5.18	-.55	-.14	18.65	.00340	.23452
1	1	56.58	1.03	57.60	777.	912.	35.6	29.4	6.5	.3	713.0	-16.37	-5.43	-.58	-.07	17.20	.00257	.23649
2	1	56.83	.98	57.81	799.	877.	34.4	28.5	1.1	2.7	728.6	-15.06	-5.62	-.58	.01	17.73	.00286	.23867
1	1	57.02	1.11	58.14	818.	983.	38.9	32.3	10.0	5.2	687.4	-14.07	-5.66	-.56	.05	16.30	.00197	.24017
2	1	57.22	1.05	58.27	838.	934.	36.9	30.6	1.8	.9	705.5	-13.10	-5.65	-.53	.09	16.94	.00237	.24197
1	1	57.47	1.21	58.68	866.	1062.	43.1	35.1	14.1	10.5	663.4	-11.88	-5.55	-.48	.13	15.19	.00145	.24307
2	1	57.66	1.14	58.81	889.	1008.	40.8	33.1	6.2	5.4	680.3	-11.02	-5.43	-.44	.15	16.06	.00184	.24447
1	1	57.86	1.30	59.16	913.	1135.	47.3	37.5	18.1	14.8	644.3	-10.22	-5.29	-.41	.17	14.14	.00109	.24529
2	1	58.11	1.24	59.36	946.	1088.	44.5	35.6	11.0	9.6	657.1	-9.24	-5.08	-.36	.18	14.88	.00140	.24634
1	1	58.30	1.42	59.72	972.	1225.	50.2	40.2	22.6	19.1	623.4	-8.57	-4.90	-.32	.18	13.05	.00083	.24697
2	1	58.50	1.34	59.83	999.	1163.	46.5	37.7	15.1	13.1	638.3	-7.96	-4.72	-.29	.19	13.87	.00112	.24781
1	1	58.75	1.54	60.29	1036.	1320.	52.3	42.7	26.6	22.6	603.3	-7.23	-4.48	-.26	.19	12.09	.00066	.24831
2	1	58.94	1.46	60.40	1064.	1255.	48.6	40.1	19.4	16.4	617.4	-6.73	-4.30	-.23	.18	12.83	.00089	.24898
1	1	59.14	1.65	60.79	1093.	1405.	53.9	44.9	30.0	25.2	587.1	-6.28	-4.12	-.21	.18	11.35	.00055	.24939
2	1	59.39	1.58	60.97	1132.	1351.	50.5	42.5	23.6	19.4	597.9	-5.73	-3.89	-.18	.17	11.90	.00071	.24992
1	1	59.58	1.79	61.37	1163.	1507.	55.8	47.4	33.6	27.8	568.8	-5.36	-3.72	-.16	.17	10.59	.00045	.25026
2	1	59.84	1.71	61.55	1204.	1451.	52.3	44.9	27.4	22.1	579.0	-4.92	-3.51	-.14	.16	11.08	.00058	.25069
1	1	60.03	1.93	61.96	1235.	1613.	57.6	49.9	36.9	30.1	550.9	-4.62	-3.36	-.13	.15	9.92	.00037	.25097
2	1	60.22	1.83	62.06	1267.	1540.	53.9	46.9	30.5	24.2	563.5	-4.34	-3.22	-.12	.14	10.46	.00049	.25134
1	1	60.48	2.08	62.56	1310.	1721.	59.4	52.3	40.0	32.1	533.7	-4.01	-3.03	-.10	.14	9.33	.00032	.25158
2	1	60.67	1.98	62.65	1342.	1646.	55.8	49.2	33.9	26.4	546.0	-3.78	-2.90	-.09	.13	9.80	.00041	.25188
1	1	60.86	2.22	63.08	1375.	1816.	61.1	54.3	42.3	33.5	519.0	-3.58	-2.78	-.08	.12	8.87	.00028	.25209
2	1	61.12	2.13	63.25	1419.	1755.	57.8	51.6	36.9	28.4	528.7	-3.32	-2.63	-.07	.12	9.23	.00035	.25235
1	1	61.31	2.38	63.69	1453.	1929.	63.1	56.7	45.1	35.2	502.5	-3.15	-2.52	-.07	.11	8.39	.00024	.25253
2	1	61.50	2.27	63.77	1486.	1851.	59.5	53.5	39.3	30.0	514.2	-2.99	-2.41	-.06	.11	8.78	.00030	.25275
1	4	61.76	2.55	64.31	1532.	2045.	14.3	13.9	27.6	9.5	490.1	-2.56	-1.24	-.08	-.04	8.94	.00089	.25342
2	4	61.95	2.43	64.38	1566.	1965.	13.7	13.3	13.5	8.5	499.4	-2.57	-1.89	-.11	-.17	8.78	.00384	.25628
1	4	62.14	2.70	64.85	1600.	2146.	15.0	14.6	30.2	10.8	475.9	-2.63	-2.71	-.09	-.10	8.53	.00063	.25675
2	4	62.40	2.61	65.01	1646.	2082.	14.5	14.1	22.4	1.8	482.4	-2.40	-2.08	-.07	-.01	8.25	.00193	.25819
1	4	62.59	2.89	65.48	1681.	2266.	15.8	15.4	25.6	7.4	459.4	-2.21	-1.64	-.07	-.06	8.21	.00129	.25915
2	4	62.78	2.76	65.54	1716.	2183.	15.2	14.9	17.2	3.2	468.8	-2.14	-1.80	-.07	-.09	8.00	.00289	.26129
1	4	63.04	3.08	66.12	1763.	2387.	16.7	16.3	24.1	5.7	443.3	-2.07	-1.94	-.06	-.05	7.86	.00152	.26241
2	4	63.23	2.95	66.18	1798.	2304.	16.0	15.7	19.8	.4	452.5	-1.96	-1.72	-.06	-.04	7.63	.00225	.26407
1	4	63.42	3.25	66.67	1833.	2494.	17.4	17.0	23.3	5.4	429.4	-1.86	-1.57	-.06	-.05	7.60	.00159	.26524
2	4	63.68	3.14	66.82	1881.	2426.	16.9	16.5	17.9	1.0	436.8	-1.77	-1.59	-.05	-.06	7.35	.00238	.26698
1	4	63.87	3.46	67.33	1916.	2620.	18.3	17.9	22.1	4.4	413.5	-1.71	-1.56	-.05	-.05	7.31	.00166	.26820
2	4	64.06	3.31	67.38	1952.	2533.	17.6	17.3	18.2	.3	423.0	-1.63	-1.46	-.05	-.04	7.11	.00217	.2697[illegible]
1	4	64.32	3.67	67.99	2000.	2748.	19.2	18.8	21.4	4.1	397.8	-1.55	-1.38	-.04	-.05	7.06	.00163	.2709[illegible]
2	4	64.51	3.52	68.04	2036.	2660.	18.5	18.2	17.2	.0	407.3	-1.49	-1.36	-.04	-.05	6.87	.00210	.27251
1	4	64.77	3.90	68.66	2084.	2879.	20.2	19.8	20.5	3.4	382.0	-1.42	-1.30	-.04	-.04	6.83	.00160	.2736[illegible]
2	4	64.96	3.74	68.70	2120.	2788.	19.5	19.1	17.1	.2	391.9	-1.37	-1.25	-.04	-.04	6.64	.00193	.2750[illegible]
1	4	65.15	4.10	69.25	2157.	2992.	21.0	20.6	20.0	3.1	368.9	-1.32	-1.20	-.04	-.04	6.65	.00154	.2761[illegible]
2	4	65.41	3.96	69.37	2205.	2919.	20.4	20.0	16.6	.2	376.5	-1.26	-1.16	-.03	-.04	6.44	.00180	.2774[illegible]
1	4	65.60	4.34	69.94	2241.	3126.	22.0	21.5	19.3	2.7	353.4	-1.22	-1.12	-.03	-.04	6.46	.00146	.2785[illegible]
2	4	65.79	4.17	69.96	2278.	3033.	21.3	20.9	16.2	.3	363.3	-1.17	-1.09	-.03	-.04	6.28	.00168	.2797[illegible]

FIGURE C-5. RESULTS OF GUN SITE 2 SIMULATION (Continued)

AAASIM ---- TEST SIMULATION FOR DOCUMENTATION 13.43.03 05/05/77 PAGE 14

LOCATION 2 GUN TYPE 5 TRACK MODE 4 POSITION = (1000.0, -500.0, 0.0) RADIUS = 50.0 M

L N	OEM	FIRE TIME	FLT. TIME	INTCP TIME	FIRE RANGE	INTCP RANGE	SIG1	SIG2	BIAS1	BIAS2	CLOSE VEL.	AZIM. RATE	ELEV. RATE	MEAN AZ.ERR	MEAN EL.ERR	VULN AREA	SHOT PK	CUM. PK
1	4	66.05	4.59	70.64	2327.	3263.	23.0	22.5	18.9	2.5	338.1	-1.12	-1.04	-.03	-.04	6.29	.00137	.28074
2	4	66.24	4.42	70.66	2363.	3169.	22.3	21.8	15.7	.4	347.8	-1.09	-1.01	-.03	-.03	6.12	.00156	.28186
1	4	66.43	4.83	71.26	2400.	3384.	23.9	23.4	18.6	2.4	324.8	-1.05	-.98	-.03	-.03	6.16	.00128	.28278
2	4	66.69	4.68	71.37	2449.	3307.	23.3	22.8	15.3	.5	332.5	-1.01	-.94	-.03	-.03	5.96	.00144	.28381
1	4	66.88	5.10	71.98	2486.	3526.	25.0	24.5	18.1	2.1	309.7	-.98	-.92	-.03	-.03	6.02	.00120	.28467
2	4	67.07	4.91	71.98	2523.	3428.	24.2	23.7	15.0	.5	319.4	-.95	-.89	-.02	-.03	5.85	.00134	.28563
1	4	67.33	5.40	72.73	2572.	3672.	26.1	25.5	17.7	2.0	294.4	-.91	-.86	-.02	-.03	5.70	.00108	.28640
2	4	67.52	5.19	72.71	2609.	3571.	25.3	24.8	14.7	.5	304.3	-.88	-.83	-.02	-.03	5.72	.00122	.28727
1	4	67.71	5.66	73.38	2646.	3799.	27.0	26.5	17.5	1.9	281.4	-.86	-.81	-.02	-.03	5.36	.00096	.28796
2	4	67.97	5.49	73.46	2695.	3718.	26.4	25.9	14.3	.5	289.1	-.83	-.78	-.02	-.03	5.33	.00107	.28872
1	4	68.16	5.99	74.15	2732.	3951.	28.2	27.6	17.2	1.7	266.4	-.80	-.76	-.02	-.03	4.99	.00084	.28932
2	4	68.35	5.76	74.11	2769.	3846.	27.4	26.8	14.2	.4	276.3	-.78	-.74	-.02	-.03	5.02	.00095	.28999
1	4	68.61	6.33	74.94	2819.	4107.	29.5	28.8	17.1	1.6	251.2	-.75	-.72	-.02	-.03	4.65	.00074	.29051
2	4	68.80	6.09	74.89	2856.	4000.	28.6	28.0	13.9	.4	261.1	-.73	-.70	-.02	-.02	4.67	.00083	.29110
1	4	68.99	6.64	75.64	2894.	4245.	30.6	29.9	16.9	1.5	238.3	-.71	-.68	-.02	-.02	4.37	.00065	.29156
2	4	69.25	6.45	75.69	2943.	4157.	29.8	29.2	13.7	.4	246.0	-.69	-.66	-.02	-.02	4.35	.00072	.29207
1	4	69.44	7.03	76.47	2981.	4410.	31.9	31.1	16.9	1.4	223.1	-.67	-.64	-.02	-.02	4.06	.00056	.29247
2	4	69.70	6.82	76.52	3030.	4320.	31.1	30.4	13.6	.4	230.9	-.65	-.62	-.02	-.02	4.05	.00062	.29291
1	4	69.89	7.44	77.33	3068.	4579.	33.4	32.5	16.6	1.2	208.2	-.63	-.61	-.02	-.02	3.77	.00049	.29325
2	4	70.08	7.16	77.24	3105.	4463.	32.3	31.5	13.5	.3	218.0	-.62	-.59	-.01	-.02	3.80	.00054	.29364
1	4	70.34	7.90	78.23	3155.	4758.	34.9	33.9	16.9	1.2	192.8	-.60	-.57	-.01	-.02	3.49	.00042	.29393
2	4	70.53	7.58	78.11	3192.	4635.	33.7	32.9	13.4	.3	202.9	-.58	-.56	-.01	-.02	3.53	.00047	.29426
1	4	70.72	8.31	79.03	3230.	4917.	36.2	35.1	17.1	1.1	179.5	-.57	-.55	-.01	-.02	3.27	.00036	.29452
2	4	70.98	8.04	79.02	3280.	4815.	35.3	34.3	13.4	.2	187.6	-.55	-.53	-.01	-.02	3.27	.00040	.29480
1	4	71.17	8.84	80.00	3317.	5109.	38.0	36.7	17.3	1.0	164.1	-.54	-.52	-.01	-.02	3.02	.00031	.29502
2	4	71.36	8.47	79.83	3355.	4976.	36.7	35.6	13.3	.2	174.3	-.52	-.51	-.01	-.02	3.05	.00035	.29527
1	4	71.62	9.41	81.03	3405.	5312.	39.9	38.4	17.7	.9	148.4	-.51	-.49	-.01	-.02	2.78	.00026	.29545
2	4	71.81	9.01	80.81	3443.	5170.	38.5	37.2	13.6	.1	158.9	-.50	-.48	-.01	-.02	2.82	.00029	.29566
1	4	72.00	9.97	81.97	3480.	5498.	41.7	40.0	18.3	.9	134.5	-.49	-.47	-.01	-.02	2.58	.00022	.29582
2	4	72.26	9.61	81.86	3531.	5378.	40.4	38.9	13.7	.1	143.1	-.47	-.46	-.01	-.02	2.59	.00025	.29599
1	4	72.45	10.68	83.13	3568.	5729.	44.1	41.9	19.1	.7	118.3	-.46	-.45	-.01	-.02	2.35	.00018	.29612
2	4	72.64	10.17	82.81	3606.	5567.	42.3	40.5	14.3	.0	129.3	-.45	-.44	-.01	-.02	2.40	.00021	.29627
1	4	72.90	11.51	84.41	3656.	5982.	47.1	44.2	19.9	.6	101.4	-.44	-.43	-.01	-.02	2.14	.00015	.29637
2	4	73.09	10.92	84.01	3694.	5804.	44.8	42.6	15.0	.0	112.8	-.43	-.42	-.01	-.02	2.18	.00017	.29649

FIGURE C-5. RESULTS OF GUN SITE 2 SIMULATION (Continued)

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LOCATION 2 GUN TYPE 5 TRACK MODE 4 POSITION = (1000.0, -500.0, 0.0) RADIUS = 50.0 M

PK AS A FUNCTION OF ASPECT SECTOR AND IMPACT SPEED

SECT	0-152	152-305	305-457	457-610	610-762	762-914	914-1067	1067-1219	TOTAL PK
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0132472	0.0000000	0.0000000	.0132472
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0047702	0.0000000	0.0000000	.0047702
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	.0014463	.0137825	.0329494	.0170368	.0067575	0.0000000	0.0000000	0.0000000	.0702078
10	0.0000000	0.0000000	0.0000000	0.0000000	.0179650	.0075153	0.0000000	0.0000000	.0253453
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0262579	.0093070	0.0000000	.0353204
12	0.0000000	0.0000000	0.0000000	.0155011	.0409758	.0979498	.0378524	0.0000000	.1805599
13	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
14	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
15	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
17	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
18	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
19	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
20	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
21	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
22	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
23	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
24	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
25	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
26	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
27	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
28	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
29	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
30	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
31	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
32	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
OT.	.0014463	.0137825	.0329494	.0322738	.0645689	.1438887	.0468070	0.0000000	

ROUNDS = 279 CPK = .2964925 F.TIME = 59.78

FIGURE C-5. RESULTS OF GUN SITE 2 SIMULATION (Continued)

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LOC	IGT	IEM	ICB	ISB	IGL	RADIUS	XGUN	YGUN	ZGUN	ROUNDS	F.TIME	PK
1	3	4	2	1	1	0.0	-1000.0	1500.0	0.0	169	25.35	.3561745
2	5	4	2	1	2	50.0	1000.0	-500.0	0.0	279	59.78	.2964925

FIGURE C-6. SIMULATION SUMMARY TABLE

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TOTAL PK FOR DENSITY CLASS 1 AS A FUNCTION OF ASPECT SECTOR AND IMPACT SPEED

SECT	0-152	152-305	305-457	457-610	610-762	762-914	914-1067	1067-1219	TOTAL PK
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0132472	0.0000000	0.0000000	.0132472
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0047702	0.0000000	0.0000000	.0047702
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	.0014463	.0137825	.0329494	.0170368	.0067575	0.0000000	0.0000000	0.0000000	.0702078
10	0.0000000	0.0000000	0.0000000	0.0000000	.0179650	.0075153	0.0000000	0.0000000	.0253453
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0262579	.0093070	0.0000000	.0353204
12	0.0000000	0.0000000	0.0000000	.0155011	.0409758	.0979498	.0378524	0.0000000	.1805599
13	0.0000000	0.0000000	.0524192	.1147048	0.0000000	0.0000000	0.0000000	0.0000000	.1611113
14	.0005951	.0206305	.1253407	.0888674	0.0000000	0.0000000	0.0000000	0.0000000	.2199750
15	.0012784	.0148307	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	.0160901
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
17	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
18	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
19	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
20	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
21	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
22	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
23	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
24	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
25	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
26	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
27	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
28	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
29	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
30	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
31	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
32	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
TOT.	.0033163	.0484533	.1984984	.2194114	.0645689	.1438887	.0468070	0.0000000	

FIGURE C-7. TOTAL Pk TABLE FOR DENSITY CLASS 1 (ALL SITES)

APPENDIX D

PROGRAMMER'S GUIDE FOR AAA SURVIVABILITY PROGRAM

The purpose of this programmer's guide is to provide a description of the routines necessary to set up, perform, and review output of a AAA simulation run. The following references may be consulted for a review of the complete AEP:

(1) "Avionics Evaluation Program User's Manual", Battelle-Columbus Laboratories (most recent version).

(2) "Application of Interactive Graphics to the Avionics Evaluation Program", Battelle-Columbus Laboratories, Programmer's Manual (most recent version).

The first reference is the user's manual which resides in the computer and is accessible from a terminal. The second describes the interactive graphics processor from which the AEP is operated.

Figure D-1 shows the organization of the portions of AEP necessary for a AAA simulation run. The interactive input processor for AAA is a new major overlay in the AEP which contains two minor overlays, one to add, modify, view and store gun and vulnerability data; and one to setup the input data deck and initiate execution of the AAA program. The AAA simulation and its output processor are contained in a separate program. When the user is finished viewing the output, he is transferred back to the AAA input portion of AEP. None of this transferral from one program to the other is visible to the user.

Table D-1 contains a brief description of each of the subroutines required for the AAA simulation itself. In order to fit the program into the allowable computer field length and to facilitate modifications for use with interactive processing, the extensive P001 main routine was divided into several smaller routines. Table D-2 lists the common blocks used and the routines which call each block. Most of the code documentation exists in the programs themselves. At the beginning of each routine is a description of its purpose and a definition of each variable in the argument list. Further comments are spread throughout each routine to aid in following the code. All variables in common blocks are also described in each routine where they are used.

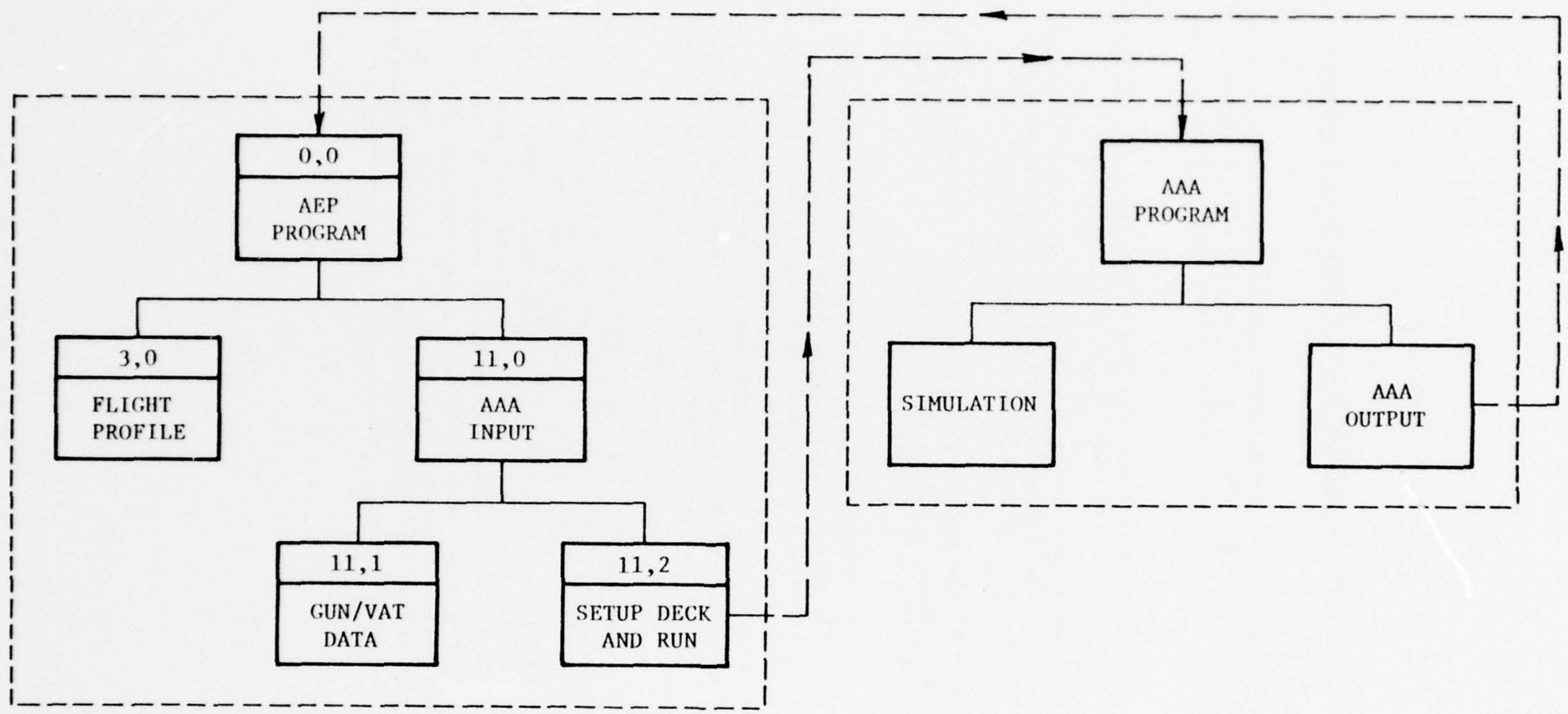

FIGURE D-1. ORGANIZATION OF AEP AND AAA

TABLE D-1. DESCRIPTION OF ROUTINES FOR AAA SIMULATION

Routine Name	Category	Description
AAA	EXECUTION	Main Program; links simulation with output processor
BATCH	EXECUTION	Links data reading and setup routines with simulation routines
FIRST	EXECUTION	Initialize new simulation and read input data
SETUP	EXECUTION	Variable initialization for each new gun site
TRACK	EXECUTION	Simulates gun tracking aircraft between firing attempts
FIRE	EXECUTION	Computes error analysis and probability of kill and writes output
OUTPUT	DATA	Writes output to summarize simulation of gun site
HEADER	DATA	Prints header information at top of each new page
NPAGE	DATA	Counts lines printed on output page
PRSEGS	UTILITY	Prints Pk as a function of impact aspect and velocity
ANGLIM	UTILITY	Limits angles to within range between $-\pi$ and π
GETVAL	UTILITY	Performs two-point, linear interpolation of array
INTERP	UTILITY	Computes indexes for interpolation in GETVAL
RPLANE	UTILITY	Computes position of aircraft at time = t
RSHELL	UTILITY	Computes range of shell from gun at time = t
VSHELL	UTILITY	Computes velocity of shell at time = t
AAADAT	DATA	Sets default values for simulation variables
READ	DATA	Read data from random-access file
WRITE	DATA	Write data to random-access file
READDK	DATA	Read random-access file header PRU

TABLE D-1. DESCRIPTION OF ROUTINES FOR AAA SIMULATION (Continued)

Routine Name	Category	Description
WRITDK	DATA	Write random-access file header PRU
INDXSEQ	DATA	Machine language routine to access files
CLSFLE	DATA	Routine to close a random-access file
MESAGE	UTILITY	Routine to send message to user's terminal

TABLE D-2. AAA COMMON BLOCKS

COMMON BLOCK	ROUTINES USING THE COMMON BLOCK
(blank)	BATCH, FIRST, TRACK, FIRE, RPLANE
BLOCK1	AAA, FIRST, SETUP, TRACK, FIRE, OUTPUT, RPLANE
BLOCK2	AAA, FIRST, SETUP, TRACK, FIRE, RPLANE
BLOCK3	BATCH, FIRST, SETUP, AAADAT
BLOCK4	BATCH, FIRST, SETUP, AAADAT
BLOCK5	AAA, FIRST, SETUP, OUTPUT
BLOCK7	BATCH, FIRST, FIRE, AAADAT
BLOCK8	BATCH, FIRST, SETUP, TRACK, AAADAT
BLOCK9	BATCH, SETUP, TRACK, FIRE, OUTPUT, RSHELL, VSHELL
BLOCKF	BATCH, SETUP, TRACK, FIRE
BLOCKO	AAA, FIRST, SETUP, FIRE, OUTPUT
CONSTS	BATCH, FIRST, FIRE, ANGLIM, AAADAT
HEADFO	AAA, FIRST, SETUP, FIRE, OUTPUT, HEADER, NPAGE
NFPARM	BATCH, FIRE, RPLANE
MAGIC	BATCH, FIRE, GETVAL, INTERP
FILZ	AAA, FIRST, SETUP, FIRE, OUTPUT, HEADER, PRSEGS
INPUT	AAA, FIRE, OUTPUT
FILES	AAA, FIRE, OUTPUT
SCREEN	AAA, FIRE, OUTPUT
IFPTR	AAA, FIRE, OUTPUT

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