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AFATL-TR-76-84 VOLUME I

SYNERGISTIC EFFECTS OF MINEFIELDS AND COVERING FIRE (SEMAC) COMPUTER MODEL

VOLUME I. USER'S MANUAL

BOOZ, ALLEN & HAMILTON INC.
362 BEAL PARKWAY N.W.
FORT WALTON BEACH, FLORIDA 32548

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AIR FORCE ARMAMENT LABORATORY
AIR FORCE SYSTEMS COMMAND • UNITED STATES AIR FORCE
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This computer simulation model, referred to as SEMAC, provides the methodology and analytical techniques required for evaluating the synergistic effects of minefields and covering fire. The model was specifically designed to consider mixed minefields, armored vehicle tactics, and the employment of combinations of different types of direct and indirect fire. Methodology is included to evaluate the effectiveness of rollers and plows, as well as line charges

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and fuel air explosive devices employed in a minesweeping role. SEMAC is an event-oriented model which used Monte Carlo techniques to simulate the passage of up to 100 intruder targets of up to five types through an engagement area. The model can evaluate the effectiveness of up to 20 direct fire defenders and up to 10 indirect fire volley aimpoints. The computer program was specifically designed for the Control Data Corporation 6600 computer system at Eglin Air Force Base, Florida.

PREFACE

This report documents work accomplished during the period 10 June 1975 through 10 April 1976 by Booz, Allen & Hamilton Inc., 362 Beal Parkway, N.W., Fort Walton Beach, Florida 32548, under Contract F08635-75-C-0151 with the Air Force Armament Laboratory, Armament Development and Test Center, Eglin Air Force Base, Florida. The program manager for the Armament Laboratory was Mr. Charles A. Reynolds (DLYW).

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

J.R. MURRAY
Chief, Weapon Systems Analysis Division

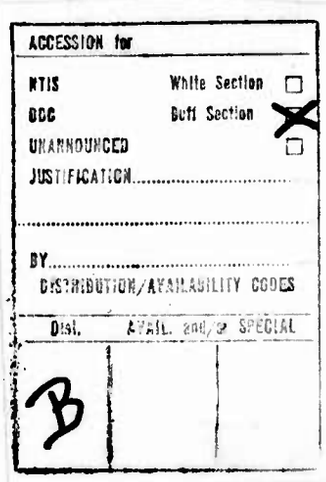

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION I

INTRODUCTION

This computer simulation model, referred to as SEMAC, provides the methodology and analytical techniques required for evaluating the synergistic effects of minefields and covering fire. The program was designed to allow mixed minefields, various armored vehicle tactics, and employment of combinations of different types of direct and indirect fire. SEMAC determines, on a time history basis, the damage and the breach times for the engagement area consisting of mines and covering fire. The intruder force travels along multisegmented travel paths through the engagement area, with one of two tactics employed by the formation of targets. These tactic options are:

- The targets traverse the engagement area with no sweeping and no evasive action taken.
- The engagement area is swept by selected targets traversing the engagement area.

SEMAC is an event-oriented simulation model which uses Monte Carlo techniques to obtain measures of effectiveness. The minefield is defined by randomly applying aiming errors to each sortie and ballistic errors to each mine in the sortie. The aiming range and deflection errors are independent of each sortie of mines delivered, and the ballistic range and deflection errors are independent of each mine in the pattern. The formation of targets proceeds through the minefield, and damage is assessed for every encounter of a mine by a target. A mine which detonates is evaluated against all targets. Inputs specify the locations of covering fire weapons, their time of commencing fire, and other items pertaining to weapon employment, target acquisition, system accuracies, and return fire parameters. The effects of the covering fire on the targets attempting the minefield breach is evaluated in time sequence. The simulation ends when all targets have either passed through the minefield and/or all targets have been damaged. The minefield is redefined using random aiming and ballistic errors, and another iteration is evaluated. At the end of a selected number of iterations, statistical output is computed and presented.

The targets which are engaged in the minefield breach attempt are capable of utilizing several tactics for minesweeping. Visual detection of mines by selected target

elements is provided. In addition, methodology for the employment of armored plows and rollers, explosive line charges, and fuel air explosives (FAE) is incorporated. Explosive line charges and FAE mine clearing provides minefield degradation within a rectangular area around line charges and within a circular area around FAE.

The "in minefield" targets receive direct and indirect covering fire from defending forces according to an input time schedule, and are capable of returning fire. The indirect fire methodology is based upon the development of Tri-Service approved methodology for the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) Methodology Working Group. These techniques are used to compute the effectiveness of single or multiple releases of unguided weapons (including cluster munitions) against various types of targets. Up to ten volley aimpoints are permitted with up to ten rounds fired per volley. The effectiveness index can be expressed in the following terms:

- Mean area of effectiveness for fragmentation (MAE_f)
- Vulnerable area (VA_N)
- Mean area of effectiveness for blast (MAE_b)
- Effective miss distance (EMD).

The direct covering fire methodology considers the effects of terrain masking on target acquisition and line of fire. The extent of terrain masking is described by inputs pertaining to location and size of natural obstacles. A direct fire area is a portion of the travel path not masked by terrain.

SEMAC will simulate the passage of up to 100 intruder targets of up to five different types passing through an engagement area. The program can consider up to 50 aimpoints for mines and up to seven different mine types. A maximum of 32,767 mines can be dispensed, and up to 4,998 mines can be located within the range of influence on either side of a travel path segment. The width of the range of influence is the maximum distance at which a mine can detonate or be detected by a target. (A mine which is outside this region cannot affect the outcome of the simulation.) The computer program can evaluate the effectiveness of up to 20 defenders of up to five direct fire defender weapon types. Each of the five defender weapon types is capable of direct covering fire against the five target types of the intruder and each of the

five target types of the intruder is capable of return fire against the target types of the defender.

This volume contains:

- A detailed description of the input variables required to properly execute SEMAC.
- Instructions for placing the input variables on punch cards.
- Instructions for arranging the punch cards in proper order.
- Descriptions and definitions of the output available from SEMAC.
- A description of a sample case which can be used to verify that the program is operating properly.

Detailed discussions of the simulation model and the mathematical relationships which were utilized to develop SEMAC (including flowcharts and definitions of variables) are contained in Volume II, the Analyst's Manual, of this report.

SECTION II

INPUT

INPUT DESCRIPTION

The number of input parameters required for each case to be investigated with SEMAC varies depending upon the options of the model which are being exercised. A Header Card and Card Type 99 must be present as the first and last card, respectively, of each data deck. In addition, a Card Type 999 must be placed at the end of the last data deck to signify the end-of-job. In stacking data decks, any of the card types mentioned below may be omitted from a deck if all the variables described on the card are to retain the same values specified in the previous run.

Card Types 1 and 2 contain general information required to run the case. Card Types 3 and 4 contain data related to intruder target number and intruder target type. Up to five intruder target types are permitted. Card Types 5, 6, and 7 contain data related to indirect fire volley aimpoints and volley patterns if any are to be employed. Card Types 8 and 8a contain data related to the travel path segments. Card Types 9, 10, 11, and 11a contain data which is a function of sortie aimpoint. Card Types 12, 13, 14, and 15 may be required depending on the value of several input variables. Card Type 16 contains data related to each defender while Card Type 17 contains data for the direct fire attack areas (areas of the travel path segment not shielded by terrain and in which direct fire weapons may be employed). Card Type 18 contains the probability of damage given a hit for each indirect fire weapon type/intruder target type combination. Card Type 19 contains data related to the effectiveness index and its value for indirect attack munitions. Card Type 20 contains data which defines defender target type parameters. Card Types 21, 22, and 23 contain direct fire and return fire parameters. Card Type 24 contains data related to the employment of line charges or fuel air explosives as sweeping devices.

A number of tables of probability versus range must be entered to properly exercise the minefield effectiveness portion of SEMAC. These consist of two types of functions, entered as tabular data to specify:

- The probability that a mine will function when a target reached the point of closest approach.

- The probability that a mine which detonates will damage a target.

The tables are entered on pairs of cards with the card type greater than 1000. The first card of each pair specifies up to eight probability values, and the second card of each pair specifies up to eight corresponding range values. Each tabular function must be in order of increasing range, and a data point must be included describing the range at which the probability is equal to zero.

The data card formats are presented in Table 1. The column entitled CARD denotes the title (for the Header Card) or an identification number which is to be punched in the first five columns of the card. (Alpha characters are permitted only in the Header Card, and notations other than numerals which are shown in this column should not be punched. They are provided only to show the position of the card in the data deck or to indicate that the card is required only when a particular option is employed.) The column entitled VARIABLE denotes the parameter or function which is to be defined on the card. The column entitled COLUMN refers to the field of the card in which the data values are to be entered. The column entitled FORMAT designates the format which must be used for punching the data values in the cards. The column entitled DESCRIPTION contains a brief explanation or definition of the variable. Finally, the column entitled UNITS designates the unit of measurement that must be used for the variable.

DATA DECK SETUP

Figure 1 depicts the order in which the data cards must be arranged to insure proper execution of the computer program.

PROGRAM DECK SETUP

Figure 2 displays the program deck setup that must be used to properly execute SEMAC on the Control Data Corporation 6600 computer system at Eglin Air Force Base, Florida.

TABLE 1. DATA CARD FORMATS

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
HDR	Title	1-80	8A10	Contains any combination of alphanumeric characters needed to identify the run. The card is not identified by any punched code and is recognized only by its position as the first card for each run in the deck. A title card is required at the beginning of each run, even if it is blank.	none
1	---	1-5	I5	The card identifier.	none
	NAP	6-10	I5	The number of sortie aimpoints for mines (must be less than or equal to 50).	none
	NTGO	11-15	I5	The total number of intruder targets (must be less than or equal to 100).	none
	NTGTP	16-20	I5	The number of intruder target types (must be less than or equal to 5).	none
	NOIT	21-25	I5	The number of iterations desired.	none
	NOSTAT	26-30	I5	The number of iterations desired between each statistical summary.	none
	IPRINT	31-35	I5	The detailed output option flag. Detailed information concerning each event is printed for the iteration specified by the value. Set to zero if no detailed information is desired.	none
	SEED	36-45	F10.2	Any number to start the random number generator.	none
	NMT	46-50	I5	The number of mine types (must be less than or equal to 7).	none
	MODE	51-55	I5	The tactical mode to be employed by intruders: 1 = bull through at normal speed with no sweeping. 3 = allow some intruders to sweep the minefield.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	NVAP	56-60	15	The number of indirect fire volley aimpoints (must be less than or equal to 10).	none
	NDFAA	61-65	15	The total number of direct fire attack areas (must be less than or equal to 15).	none
	NDFWD	66-70	15	The number of direct fire elements in the defender force (must be less than or equal to 20).	none
	NRBA	71-75	15	The number of rounds the intruder targets will observe before acquiring the defender target and beginning return fire.	none
2	---	1-5	15	The card identifier.	none
	LCFOPT	6-10	15	The option for employing line charge or fuel air explosive (FAE) devices for sweeping: 0 = neither used. 1 = line charges are employed. 2 = FAE are employed.	none
	YLENGTH	11-20	F10.2	The length of the engagement area through which the targets are passing.	feet
	XWIDTH	21-30	F10.2	The width of the engagement area through which the targets are passing.	feet
	THETA	31-35	F5.2	The angle defining the direction of travel of the mine delivery aircraft (measured clockwise from the positive Y axis).	degrees
	D3DEL	36-40	F5.2	The time required to remove a travel path blockage caused by a damaged target on the travel path flanked by two targets which were damaged while diverting.	minutes

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	ISYMP(1)	41-45	I5	The sympathetic detonation option for mines: 0 = sympathetic detonations are not evaluated. 1 = sympathetic detonations are evaluated (optional Card Type 12 must be input).	none
	ISYMP(2)	46-50	I5	The sympathetic detonation option for direct fire munition: 0 = sympathetic detonations are not evaluated. 1 = sympathetic detonations are evaluated (optional Card Type 13 must be input).	none
	ISYMP(3)	51-55	I5	The sympathetic detonation option for indirect fire munition explosion: 0 = sympathetic detonations are not evaluated. 1 = sympathetic detonations are evaluated (optional Card Type 14 must be input).	none
	ISBL	56-60	I5	An option describing the disposition of swept mines: 0 = swept mines are neutralized. 1 = swept mines are blown in place.	none
	ITEROP	61-62	I2	An option describing the disposition of the iteration data: 0 = data for each iteration is not output. 1 = data for each iteration is output.	none
	IDISOP	63-65	I3	An option describing the disposition of the distribution data: 0 = distributions for output variables are not printed. 1 = distributions for output variables are calculated and printed.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
3	---	1-5	I5	The card identifier. This card type provides data for each intruder being considered. Two intruders can be entered on each card.	none
	NTN	6-10 46-50	I5	The sequential target number. There may be a maximum of 100 intruder targets.	none
	NTGTYP(NTN)	11 51	I1	The type of the NTN^{th} intruder target.	none
	NCTAW(NTN)	12-15 52-55	I4	The number of the intruder leading the column with which the NTN^{th} intruder is associated.	none
	NGTAW(NTN)	16-20 56-60	I5	The number of another intruder target with which the NTN^{th} intruder is associated as a group.	none
	TGTXOL(NTN)	21-30 61-70	F10.2	The original X coordinate for the NTN^{th} intruder relative to the starting point of the first travel path segment.	feet
	TGTYOL(NTN)	31-40 71-80	F10.2	The original Y coordinate for the NTN^{th} intruder relative to the starting point of the first travel path segment.	feet
4	---	1-5	I5	The card identifier.	none
	ITYP	6-10	I5	The intruder target type for data described on the remainder of this card.	none
	TARL(ITYP)	11-20	F10.2	The intruder target length.	feet
	TARW(ITYP)	21-30	F10.2	The intruder target width.	feet
	TARRAD(ITYP)	31-40	F10.2	The intruder target radius.	feet
	TARHT(ITYP)	41-50	F10.2	The intruder target height.	feet
	TMBRI(ITYP)	51-55	F5.2	The time required to reload and aim for return fire.	minutes
	NRAI(ITYP)	56-60	I5	The number of rounds available for return fire.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	LDFDPR(ITYP,I) (I=1,5)	61-65	5I1	The list of defender weapon types in the order in which this intruder type will return fire.	none
	NTTTCS(ITYP)	66-70	I5	A flag describing the sweeping capability of this intruder target type: 0 = the target type has no sweeping capability. 1 = the target type is capable of sweeping at least one mine type.	none
	NTTTMD(ITYP)	71-75	I5	A flag describing this intruder target type as one which must be diverted around by subsequent intruders in the same column: 0 = the target type need not be diverted around. 1 = the target type must be diverted around.	none
	NTTTRP(ITYP)	76-80	I5	A flag describing this intruder target type as a roller or plow: 0 = this target type is not a roller or plow. 1 = this target type is a roller. 2 = this target type is a plow.	none
5	---	1-5	I5	The card identifier.	none
	IVAP	11-15	I5	The sequential indirect fire volley aimpoint number (must be less than or equal to 10).	none
	IROAD	16-20	I5	The travel path segment that this aimpoint is located on.	none
	XOVP(IVAP)	21-30	F10.2	The X coordinate of the origin of the indirect fire volley pattern in the map coordinate system.	feet
	YOVP(IVAP)	31-40	F10.2	The Y coordinate of the origin of the indirect fire volley pattern in the map coordinate system.	feet

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	AYYVP(IVAP)	41-50	F10.2	The direction of attack for this indirect fire volley aimpoint measured clockwise from the positive Ẏ axis in the map coordinate system.	degrees
	NVFAEA(IVAP)	51-55	I5	The number of indirect fire volleys fired at this aimpoint.	none
	NWEPV(IVAP)	56-60	I5	The number of rounds per volley employed at this aimpoint.	none
	IWTVAP(IVAP)	61-65	I5	The weapon type employed at this indirect fire volley aimpoint.	none
	NTLCIF(IVAP)	66-70	I5	The number of the target leading the column of intruders that initiates the indirect fire volley aimpoint.	none
	TDBIFV(IVAP)	71-80	F10.2	The time delay between each volley fired at this indirect fire volley aimpoint.	minutes
6	---	1-5	I5	The card identifier.	none
	IVAP	11-15	I5	The sequential indirect fire volley aimpoint number.	none
	IWEPV	16-20	I5	The sequential number of the round in this volley (must be less than or equal to 10).	none
	DMPIIX(IVAP,IWEPV)	21-30	F10.2	The X coordinate of the desired mean point of impact with respect to the origin of the volley pattern for this aimpoint and round.	feet
	DMPIIY(IVAP,IWEPV)	31-40	F10.2	The Y coordinate of the desired mean point of impact with respect to the origin of the volley pattern for this aimpoint and round.	feet
7	---	1-5	I5	The card identifier.	none
	IVAP	6-10	I5	The sequential indirect fire volley aimpoint number.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	IWT	11-15	I5	The weapon type employed at this volley aimpoint.	none
	ANGIMP(IVAP)	16-20	F5.2	The angle of fall for each round at impact for this volley aimpoint.	degrees
	REP(IVAP)	21-30	F10.2	The range error probable for the round delivered at this volley aimpoint.	feet
	DEP(IVAP)	31-40	F10.2	The deflection error probable for the round delivered at this volley aimpoint.	feet
	NSUB(IWT)	41-45	I5	The number of submunitions for the improved conventional munition (ICM) delivered at this aimpoint for this weapon type (enter a zero for high explosive rounds).	none
	RELSUB(IWT)	46-55	F10.2	The reliability of the submunition for ICMs (not required for high explosive rounds).	none
	PATRAD(IWT)	56-65	F10.2	The radius of the ICM pattern.	feet
	RELRND(IWT)	66-75	F10.2	The reliability of the round.	none
8	---	1-5	I5	The card identifier.	none
	NRS	11-15	I5	The number of travel path segments (must be less than or equal to 10).	none
	TGTOVL	16-25	F10.2	The normal speed of the targets.	miles per hour
	TGTVL2	26-35	F10.2	The sweep rate.	miles per hour
8a	XROAD(I), I=1,NRS+1	1-10 21-30 41-50 61-70	F10.2	The X coordinates (in the map coordinate system) of the NRS+1 ends of the travel path segments. Up to 10 segments (11 X coordinates) can be input.	feet

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	YROAD(I) I=1,NRS+1	11-20 31-40 51-60 71-80	F10.2	The Y coordinates (in the map coordinate system) of the NRS+1 ends of the travel path segments. Up to 10 segments (11 Y coordinates) can be input.	feet
9	---	1-5	I5	The card identifier.	none
	IAP	6-10	I5	The sequential mine aimpoint number. One Card Type 9 is required for each aimpoint.	none
	MTFA(IAP)	11-15	I5	The type of mine dispensed at the aimpoint.	none
	NSTICK(IAP)	16-20	I5	The number of mines dispensed at the aimpoint.	none
	AIMPTX(IAP)	21-30	F10.2	The X coordinate of the aimpoint in the map coordinate system.	feet
	AIMPTY(IAP)	31-40	F10.2	The Y coordinate of the aimpoint in the map coordinate system.	feet
	YSWATH(IAP)	41-50	F10.2	The mine pattern length (in the range direction) for uniform distributions of mines. For mines which are normally distributed, this variable is six times the standard deviation which describes the normal distribution of mines in range.	feet
	XSWATH(IAP)	51-60	F10.2	The mine pattern width (in the deflection direction) for uniform distributions of mines. For mines which are normally distributed, this variable is six times the standard deviation which describes the normal distribution of mines in deflection.	feet
10	---	1-5	I5	The card identifier.	none
	IAP	6-10	I5	The sequential mine aimpoint number. One Card Type 10 is required for each aimpoint.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	SIGAR(IAP)	11-20	F10.2	The aiming error standard deviation in range describing the normal distribution.	feet
	SIGAD(IAP)	21-30	F10.2	The aiming error standard deviation in deflection describing the normal distribution.	feet
	SIGBR(IAP)	31-40	F10.2	The ballistic error standard deviation in range describing the normal distribution.	feet
	SIGBD(IAP)	41-50	F10.2	The ballistic error standard deviation in deflection describing the normal distribution.	feet
11	---	1-5	I5	The card identifier.	none
	MT	11-15	I5	The mine type number for data described on the remainder of the card.	none
	JSELDS(MT)	16-20	I5	The type of mine pattern distribution for the mine type: 0 = mine pattern is read in from cards (must be followed by Card Type 11a). 1 = range and deflection values selected from random normal distribution. 2 = range and deflection values selected from random uniform distribution. 3 = range value selected from random normal distribution and deflection value selected from random uniform distribution. 4 = range value selected from random uniform distribution and deflection value selected from random normal distribution.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	TMSWP(MT)	21-30	F10.2	The time required to remove or neutralize the mine type.	minutes
	DUDPRB(MT)	31-40	F10.2	Probability that the mine type will be a dud (must be less than or equal to 1.0).	none
	PPEAF(MT)	41-50	F10.2	Probability that a plowed mine will function (must be less than or equal to 1.0).	none
11a[a]	ORX(I), ORY(I), I=1, NSTICK(IAP)	1-80	NF10.2	The X and Y coordinates of the nominal mine locations about the sortie aimpoint [required if JSELDS(MT)=0]. Up to four mine locations can be specified on each card.	feet
12[a]	---	1-5	I5	The card identifier [this card type is required if ISYMP(1)=1].	none
	MT	11-15	I5	The mine type number for data described on the remainder of card.	none
	SYMDIS(MT,J) J=1,7	16-50	7F5.2	The maximum distance at which the mine type can cause another mine type to detonate sympathetically. The first data point is the range for Mine Type MT detonating Mine Type 1, the second data point is the range for Mine Type MT detonating Mine Type 2, etc.	feet
13[a]	---	1-5	I5	The card identifier [this card type is required if ISYMP(2)=1].	none
	IWT	11-15	I5	The direct fire weapon type for the data described on the remainder of this card.	none

[a] Optional

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	SYMDDF(IWT,J) J=1,7	16-50	7F5.2	The maximum distance at which the direct fire weapon type can cause a mine type to detonate sympathetically. The first data point is the range for Weapon Type IWT detonating Mine Type 1, the second data point is the range for Weapon Type IWT detonating Mine Type 2, etc.	feet
14[a]	---	1-5	I5	The card identifier [this card type is required if ISYMP(3)=1].	none
	IWT	11-15	I5	The indirect fire weapon type for the data described on the remainder of this card.	none
	SYMDIF(IWT,J) J=1,7	16-50	7F5.2	The maximum distance at which the indirect fire weapon type can cause a mine type to detonate sympathetically. The first data point is the range for Weapon Type IWT detonating Mine Type 1, the second data point is the range for Weapon Type IWT detonating Mine Type 2, etc.	feet
15[a]	---	1-5	I5	The card identifier (this card type is required if the mine type has an ON/OFF timing cycle or target counting capability).	none
	MT	11-15	I5	The mine type number for data described on the remainder of card.	none
	SECON(MT)	16-20	F5.2	The duration of the active portion of the fuze timing cycle for the mine type [SECON(MT) + SECOFF(MT) must be less than 256 seconds].	seconds

[a] Optional

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	SECOFF(MT)	21-25	F5.2	The duration of the inactive portion of the fuze timing cycle for the mine type.	seconds
	KOUNT(MT)	26-30	I5	The target count at which Mine Type MT will arm and detonate.	none
	IRNK(MT)	31-35	I5	A flag controlling the target counting option for mines: 0 = mine will arm and detonate after sensing KOUNT(MT) number of targets. 1 = mine will arm and detonate after sensing a uniform random number of targets varying from one up to KOUNT(MT).	none
16	---	1-5	I5	The card identifier.	none
	NUMDEF	6-10	I5	The defender number.	none
	IWTDEF(NUMDEF)	11-15	I5	The type of this defender.	none
	XODEF(NUMDEF)	16-25	F10.2	The X coordinate in the map coordinate system of the location of this defender.	feet
	YODEF(NUMDEF)	26-35	F10.2	The Y coordinate in the map coordinate system of the location of this defender.	feet
	NDEFEA(J,NUMDEF)	36-65	15I2	The direct fire areas that this defender may fire into. For the J^{th} direct fire area that the defender may fire into, the J^{th} position of the array must be nonzero.	none
17	---	1-5	I5	The card identifier.	none
	NDF	6-10	I5	The number of the direct fire area accessible to defender and intruder direct fire.	none
	IROAD.	11-15	I5	The travel path segment on which the direct fire area is located. Each direct fire area must be within a travel path segment and must not overlap travel path segment end points.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	XYMS(1)	16-25	F10.2	The X coordinate in the map coordinate system of the beginning of the NDFth direct fire area.	feet
	XYMS(2)	26-35	F10.2	The Y coordinate in the map coordinate system of the beginning of the NDFth direct fire area.	feet
	XYMS(3)	36-45	F10.2	The X coordinate in the map coordinate system of the end of the NDFth direct fire area.	feet
	XYMS(4)	46-55	F10.2	The Y coordinate in the map coordinate system of the end of the NDFth direct fire area.	feet
18	---	1-5	I5	The card identifier.	none
	I	6-10 21-25 36-40 51-55 66-70	I5	The indirect fire weapon type.	none
	J	11-15 26-30 41-45 56-60 71-75	I5	The intruder target type.	none
	PHD(I,J)	16-20 31-35 46-50 61-65 76-80	F5.2	The probability of damage given a hit for the Ith indirect fire weapon type and the Jth intruder target type. Up to five values can be input on each card. Required for HE rounds only.	none
19	---	1-5	I5	The card identifier.	none
	I	6-10 31-35 56-60	I5	The indirect fire weapon type.	none
	J	11-15 36-40 61-65	I5	The intruder target type.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	N	16-20 41-45 66-70	I5	A number specifying the type of effectiveness index entered. 1 = mean area of effectiveness for fragmentation in the ground plane in square feet (MAE_f). 2 = vulnerable area in the normal plane in square feet (VA_N). 3 = mean area of effectiveness for blast in the ground plane in square feet (MAE_b). 4 = effectiveness miss distance in the ground plane in feet (EMD).	none
	EV	21-30 46-55 71-80	F10.2	The value of the effectiveness index for the I^{th} weapon type and the J^{th} target type as described by the value of N.	various
20	---	1-5	I5	The card identifier.	none
	NDFTYP	6-10	I5	The defender type for data described on the remainder of this card. Data in columns 11 through 50 required only if the defender type damage criterion is probability of damage given a hit as input on Card Type 22.	none
	DEFL(NDFTYP)	11-20	F10.2	The defender target length.	feet
	DEFW(NDFTYP)	21-30	F10.2	The defender target width.	feet
	DEFRAD(NDFTYP)	31-40	F10.2	The defender target radius.	feet
	DEFHT(NDFTYP)	41-50	F10.2	The defender target height.	feet
	TMBRD(NDFTYP)	51-55	F5.2	The time required to reload and aim this weapon type.	minutes
	NRAD(NDFTYP)	56-60	I5	The number of rounds available for this defender type.	none
	ITGTPR(NDFTYP,I)	61-65	5I1	The list of intruder target types in the order in which the defender type will fire.	none
21	---	1-5	I5	The card identifier.	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	I	6-10 46-50	I5	The sequential number by which the remainder of the data on one-half of this card will be referenced. Up to 20 sets of values are permitted describing weapon delivery parameters. Parameters of this type are required only when an intruder or defender type have a damage criterion in terms of MAE_f as input on Card Type 22.	none
	AI(I)	11-20 51-60	F10.2	The angle of fall at weapon impact.	degrees
	AREP(I)	21-30 61-70	F10.2	The range error probable for the round.	feet
	ADEP(I)	31-40 71-80	F10.2	The deflection error probable for the round.	feet
22	---	1-5	I5	The card identifier.	none
	I	6-10	I5	The defender target type.	none
	J	11-15	I5	The intruder target type.	none
	K	16-20	I5	A flag indicating which target (defender or intruder) the effectiveness index is applied to: 1 = effectiveness index is for attack by defender against intruder. 2 = effectiveness index is for attack by intruder against defender.	none
	N	21-25	I5	A number specifying the type of effectiveness index entered. 1 = mean area of effectiveness for fragmentation in the ground plane in square feet (MAE_f). 2 = probability of damage given a hit (P_{HD}).	none

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	AEV	26-35	F10.2	The value of the effectiveness index for an attack described by the values of I, J, and K.	various
	AREL	36-40	F5.2	The reliability of the round fired by either defender or intruder as specified by the value of K.	none
	ACEP	41-50	F10.2	The circular error probable in the normal plane. This value required only when the value of N is 2. If input is in mils, the value must be negative.	feet or mils
23	---	1-5	I5	The card identifier.	none
	I	6-10 31-35 56-60	I5	The defender number.	none
	J	11-15 36-40 61-65	I5	The direct fire area number.	none
	K	16-20 41-45 66-70	I5	A flag indicating the direction of fire: 1 = defender I firing into direct fire area J. 2 = an intruder in direct fire area J firing at defender I.	none
	IDP	21-25 46-50 71-75	I5	A number specifying the set of delivery parameters input on Card Type 21 which are to be used for the attack conditions I, J, and K. This variable is required only when the effectiveness index is given in terms of MAE_f on Card Type 22.	none
24	---	1-5	I5	The card identifier.	none
	LCFTT	6-10	I5	The intruder target type which deploys the line charge or fuel air explosive sweeping device.	none
	DBFAE	11-20	F10.2	The distance between fuel air explosive munition aimpoints.	feet

TABLE 1. DATA CARD FORMATS (CONTINUED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
	DFTFAE	21-30	F10.2	The intended impact distance in front of the intruder which deploys the fuel air explosive sweeping device.	feet
	RADFAE	31-40	F10.2	The radius of the fuel air explosive effects.	feet
	ALNGLC	41-50	F10.2	The length of the line charge effects.	feet
	AWIDLC	51-60	F10.2	The width of the line charge effects.	feet
	TMDLCF	61-70	F10.2	The time delay for deployment of the line charge or fuel air explosive sweeping device.	minutes
	PDLCF	71-80	F10.2	The probability of mine detonation within the line charge or fuel air explosive pattern.	none
b	---	-----	-----	Cards with numbers greater than 1000 are used to input probability versus range functions for the three types of tabular data required. Two cards are required for each function, with the first containing probability values and the second containing range values. (The Card Type number is composed of the values punched in Columns 2 through 5.)	
	NT	2	I1	The target type for data described on card.	none
	NM	3-4	I2	The mine type for data described on card.	none
	NTB	5	I1	The number of the table type described on the card: 1 = function describing probability that a target of Type NT will detect a mine of Type NM versus range.	none

[b] Greater than 1000.

TABLE 1. DATA CARD FORMATS (CONCLUDED)

CARD	VARIABLE	COLUMN	FORMAT	DESCRIPTION	UNITS
				2 = function describing probability that a mine of Type NM which detonates will damage a target of Type NT versus range. 3 = function describing probability that a mine of Type NM will be detonated by a target of Type NT when the target has reached its point of closest approach versus range.	
	PROBTP(I) or RANGTP(I)	6-80	F5.2 7F10.2	These fields on the card contain up to eight probability or range values describing the tabular function denoted by the value of NTB. The first card of each pair contains the probability values associated with the increasing range values on the second card of the pair. For each tabular function, a data point must be included identifying the range at which the associated probability is zero.	none
99	---	1-5	I5	The card identifier (this card signals the end of the case).	none
999	---	1-5	I5	The card identifier (this card signals the end-of-job).	none

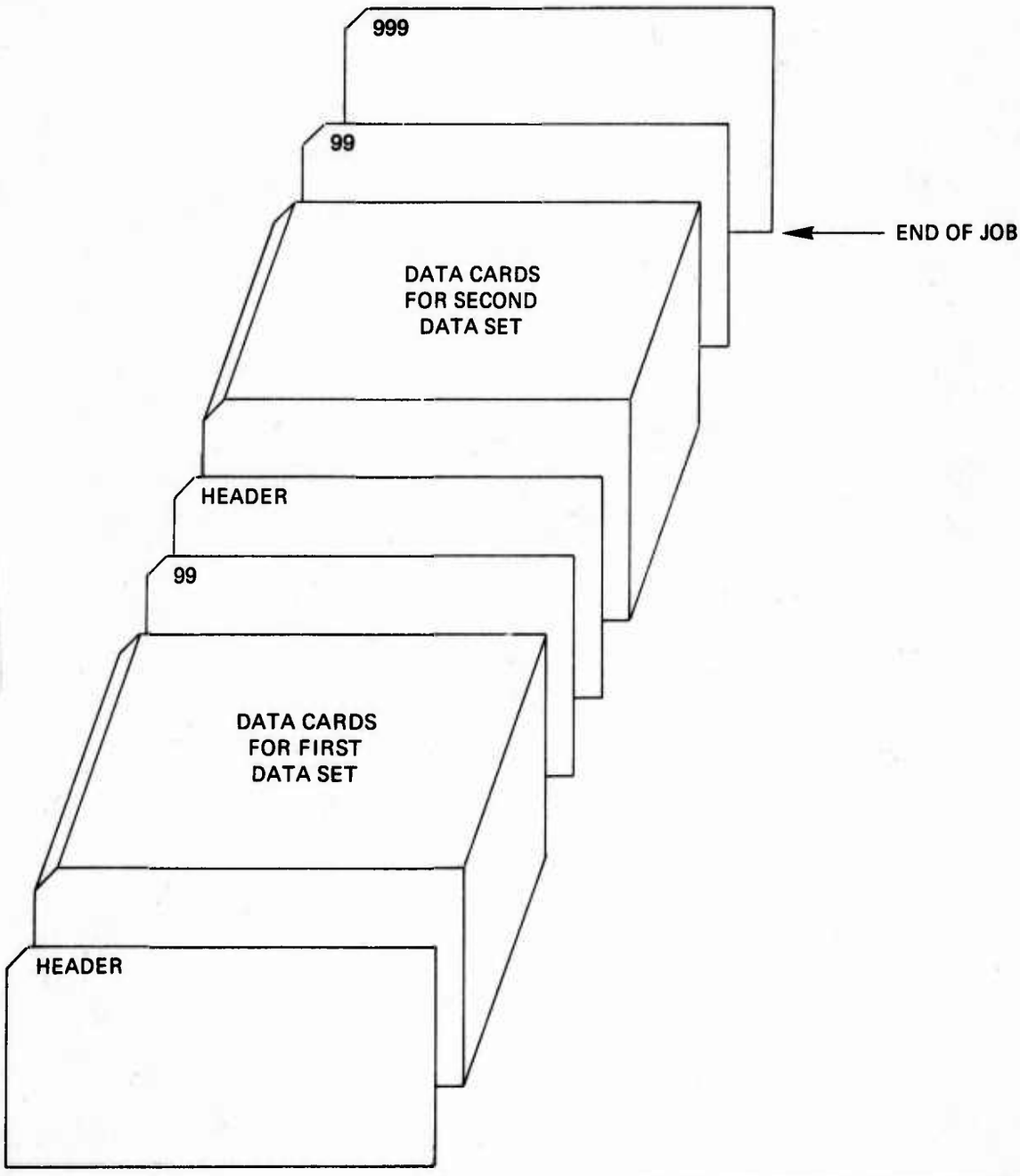

Figure 1. Typical Data Deck Setup

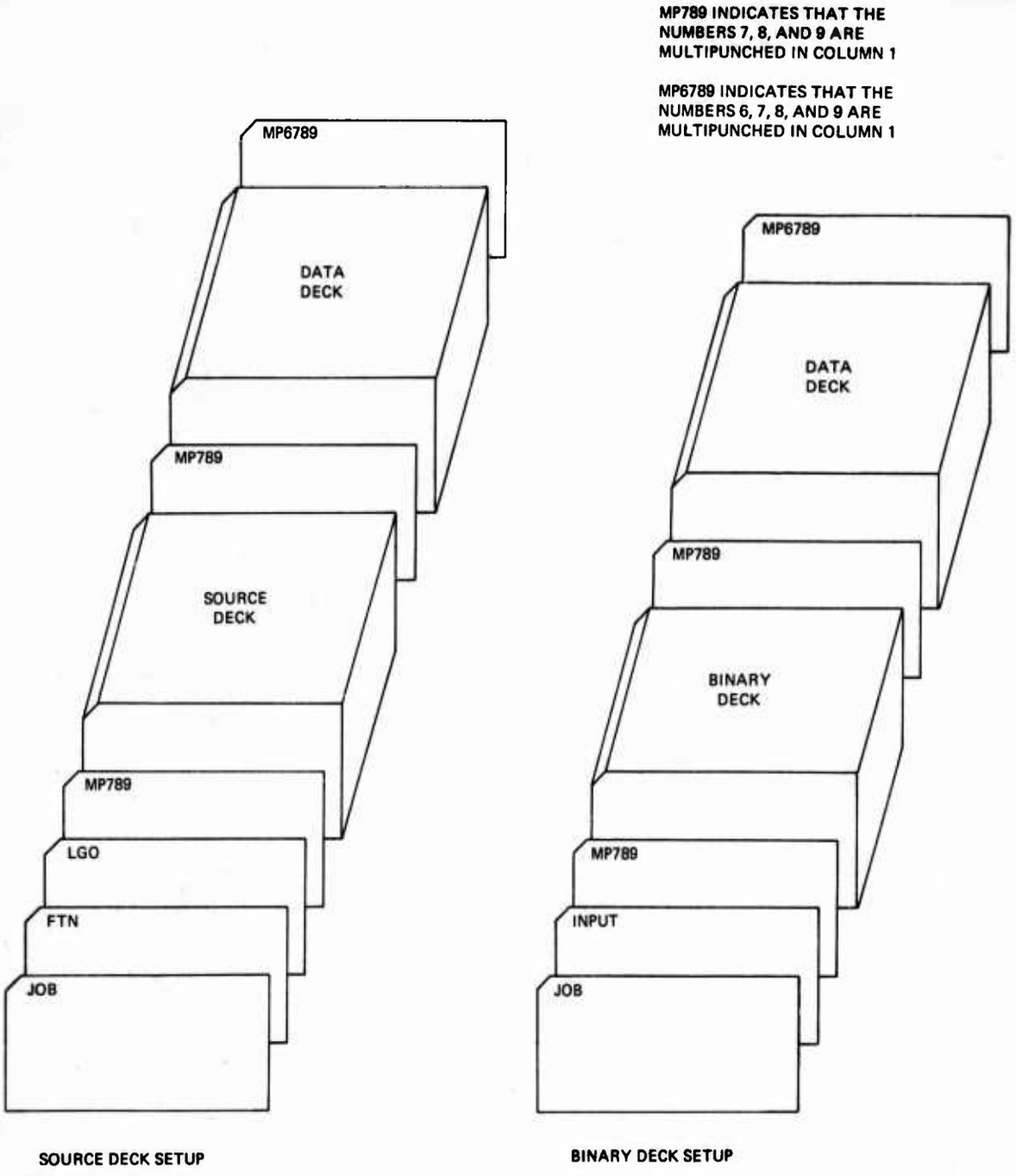

Figure 2. Program Deck Setup—Control Data Corporation 6600 Computer System

SECTION III

OUTPUT

Computer printout is provided with several user options. When the input variable ITEROP is set to 1, a summary of the results of each iteration and a statistical summary controlled by the value of the input variable NOSTAT is output. Additional output is provided when the value of IDISOP is set to 1. This output consists of the distributions for each intruder type damaged by mines, direct fire, and indirect fire. Additionally, distributions for the defender types damaged, the rounds fired by the intruder and defenders by type, mines swept, mines detonated, and mines in field by type, and breach time are output. Supplementary output is available, and one iteration only, when the value of IPRINT is set to N, where N is the iteration number for which the additional output is desired. This additional output consists of the results of each event in the iteration. At the beginning of the run, all input data card images are printed.

PRINTOUT NOMENCLATURE

Descriptions of the nomenclature for the output options (excluding the printout of the input data card images) are given in Tables 2 and 3. Output produced when the input variable IDISOP is set to 1 consists of frequency distributions for the output variables which are presented in the Statistical Summary. The printout nomenclature for this information is presented in Table 2. The frequency distribution tabular output is for the zero value plus 20 classes with a class interval specified for each column of output.

SAMPLE OUTPUT

Sample output for displaying card images read at the start of the run is shown in Figure 3. Figure 4 displays sample output when ITEROP = 1. The additional output obtained when IPRINT = N is shown in Figure 5. Sample distribution output is displayed in Figure 6.

TABLE 2. DEFINITIONS FOR SEMAC PRINTOUT NOMENCLATURE (ITEROP = 1)

NOMENCLATURE	DEFINITION
RUN NUMBER	The run number for this group of iterations.
TACTIC NUMBER	The type of tactic used to breach the engagement area during this group of iterations.
INITIAL NUMBER OF INTRUDERS BY TYPE	The initial number of intruders of each type for this group of iterations.
INITIAL NUMBER OF DEFENDERS BY TYPE	The initial number of defenders of each type for this group of iterations.
NUMBER OF MINES DISPENSED BY TYPE	The total number of mines of each mine type dispensed for this group of iterations.
ITER NUM	The sequential number of this iteration.
INTRUDERS DAMAGED BY MINES	The total number of intruders of each type damaged by mines.
INTRUDERS DAMAGED BY DIR FIRE	The total number of intruders of each type damaged by direct fire.
INTRUDERS DAMAGED BY IND FIRE	The total number of intruders of each type damaged by indirect fire.
DEFENDERS DAMAGED	The total number of defenders of each type damaged by return fire from the intruders.
ROUNDS FIRED BY INT	The total number of rounds fired by the intruders of each type.
ROUNDS FIRED BY DEF	The total number of rounds fired by the defenders of each type.
MINES DETONATED	The total number of mines of each mine type detonated or neutralized by a target.

TABLE 2. DEFINITIONS FOR SEMAC PRINTOUT NOMENCLATURE (ITEROP = 1) (CONCLUDED)

NOMENCLATURE	DEFINITION
MINES IN FIELD	The number of mines of each mine type which were within the range of influence of the target formation.
MINES SWEPT	The number of mines of each mine type detected and neutralized by a target.
TGTS LOST	The number of targets which were associated with other targets as a group, lost their lead target, and were unable to find another lead target in the same column. (Lost targets are not included in TARGETS DAMAGED.)
RMVL TIME	The time each target was delayed due to the removal of a travel path blockage.
SWEEP TIME	The time required to remove or neutralize mines.
TRAVEL TIME	The accumulated time that the target moved during the engagement breach attempt.
BREACH TIME	The sum of RMVL TIME, SWEEP TIME, and TRAVEL TIME.

TABLE 3. DEFINITIONS FOR SEMAC PRINTOUT NOMENCLATURE (IPRINT=N)

NOMENCLATURE	DEFINITION
TARGET	A tabulation of the target identification numbers.
OBSTACLE	A tabulation of the identification numbers for the mines, minefield boundaries, direct fire boundaries, or volley aimpoints that will be encountered next by each of the targets.
DISTANCE	The distance in feet between each target and its point of closest approach to the next mine, minefield boundary, direct fire boundary, or volley aimpoint. (The value 99999.00 indicates that the target has been damaged or has exited the engagement area.)
EVENT TGT	The identification number of the event target.
TGT TYPE	The type of the event target.
TGT Y	The Y coordinate of the event target at its point of closest approach to the event mine, minefield boundary, direct fire boundary, or volley aimpoint.
TGT X	The X coordinate of the event target at its point of closest approach to the event mine, minefield boundary, direct fire boundary, or volley aimpoint.
TGT VEL	The velocity of the event target.
TOTAL TRAV TIME	The total time that the targets have been moving during the breach attempt.
BREACH TIME	The total breach time.
EVENT OBS	The identification number of the event mine, minefield boundary, direct fire boundary, or volley aimpoint.

TABLE 3. DEFINITIONS FOR SEMAC PRINTOUT NOMENCLATURE (IPRINT=N) (CONTINUED)

NOMENCLATURE	DEFINITION
OBS TYPE	The type of event obstacle (1 through 7 = active mine; 8 = minefield boundary; 9 through 15 = dud mine; 16 = indirect fire volley aimpoint; 17 = direct fire entry boundary; 18 = direct fire exit boundary; and 19 = point of deployment of line charge or FAE).
OBX	The X coordinate of the event mine, minefield boundary, direct fire boundary, or volley aimpoint.
OBY	The Y coordinate of the event mine or minefield boundary, direct fire boundary, or volley aimpoint.
PROB	The probability from the last call to Subroutine TABINT.
RN	The last uniform random number chosen for comparison with PROB.
TGT TYPE	The target type for each target in the simulation.
TGT Y	The Y coordinate for each target at the completion of the event.
TGT X	The X coordinate for each target at the completion of the event.
TGT VEL	The velocity of each target at the completion of the event.
TRAV TIME	The total travel time for each target at the completion of the event.
DEL TIME	The delay time remaining due to the removal of a travel path blockage and mine sweeping activities for each target.
INT NO	The intruder target number involved in this event.

TABLE 3. DEFINITIONS FOR SEMAC PRINTOUT NOMENCLATURE (IPRINT=N) (CONCLUDED)

NOMENCLATURE	DEFINITION
TYPE	The type of the event target.
FIRED AT DEF NO	The defender target number fired at by a target of the intruder force.
FIRED AT INT NO	The intruder target number fired at by a defender.
DEF NO	The defender target number.
AND MISSED	An indicator showing that the target was not damaged by this direct fire round.
AND HIT HIM	An indicator showing that the target was damaged by this direct fire round.
AIMPOINT NO	The aimpoint number for the indirect fire volley.
INDIRECT FIRE WEAPON TYPE	The weapon type for the indirect fire volley.
VOLLEY NO	The number of the indirect fire volley.
TRAVEL PATH BOUNDARY	Alpha information indicating that an intruder has entered or exited a travel path segment.
DIRECT FIRE AREA ENTRANCE NUMBER	Alpha information indicating that an intruder has entered an area not shielded by terrain and in which direct fire may be employed.
DIRECT FIRE AREA EXIT NUMBER	Alpha information indicating that an intruder has exited an area not shielded by terrain and in which direct fire may be employed.
SWEPT	Alpha information indicating a mine was swept.
DETONATED	Alpha information indicating a mine was detonated.

```
INPUT DATA --------
CARD NO.     1        10        20        30        40        50        60        70        80

      1                 SEMAC SAMPLE TEST CASE
      2          1    2   10    3   30   15   17  0.0         2    3    2    4    4    2
      3          2    1     4800.     5000.  30.  50.    0    0    0    0 1  1
      4          3    11   1           100.        0.         21   2             0.        0.
      5          3    33   2             0.      -50.         43   2             0.     -100.
      6          3    53   2             0.     -150.         63   2             0.     -200.
      7          3    73   2             0.     -250.         82   1    1       90.      -30.
      8          3    92   1    1      110.      -30.        102   1    1       90.      -50.
      9          4    1       30.       12.                  6.   .5   2500        1    1    0
     10          4    2       13.        8.                  4.   .5    423        0    0    0
     11          4    3       30.       12.                  6.   .5   2513        1    1    0
     12          5         1    1    -1800.     -850.        0.    4    4    1    2         .3
     13          5         2    1    -1000.     -600.        0.    4    4    2    2         .3
     14          6         1    1        0.       50.
     15          6         1    2       50.        0.
     16          6         1    3      -50.        0.
     17          6         1    4        0.      -50.
     18          6         2    1        0.       50.
     19          6         2    2       50.        0.
     20          6         2    3      -50.        0.
     21          6         2    4        0.      -50.
     22          7    1    1  45.      100.       50.                                .95
     23          7    2    2  45.      100.       50.                                .95
     24          8         2        5.        1.
     25          -2500.    -1100.     -400.     -400.     1200.     2400.
     26          9    1    1   90    - 400.     -200.     1100.      500.
     27          9    2    2   90    - 400.     -200.     1100.      500.
     28         10    1       50.       50.
     29         10    2       50.       50.
     30         11         1    2       20.       .05
     31         11         2    2       20.       .05
     32         16    1    1    -1700.    -1500. 1
     33         16    2    1    -1100.     -200.   2
     34         16    3    2      400.      200.     3
     35         16    4    3     1400.     1400.       4
     36         17    1    1    -2100.     -980.    -1500.     -780.
     37         17    2    1    -1300.     -700.     -800.     -540.
     38         17    3    2     -200.     -100.      180.      580.
     39         17    4    2      590.     1270.      950.     1900.
     40         18    1    1   1.    2    1   1.    1    2   1.    2    2   1.
     41         18    1    3   1.    2    3   1.
     42         19    1    1    4        2.    2    1    4       3.
     43         19    1    2    4       20.    2    2    4      20.
     44         19    1    3    4        2.    2    3    4       3.
     45         20    1       30.       12.        0.       6.0  0.9   2013
     46         20    2        0.        0.       1.5       5.0  0.6    302
     47         20    3        0.        0.       1.0       4.0  1.4    103
     48         21    1       30.       60.       20.         2       25.       50.       20.
     49         21    3       15.       20.       10.
     50         22    1    1    1    2       0.9 0.95       30.
     51         22    1    3    1    2       0.8 0.95       30.
     52         22    2    2    1    1     1000. 0.95        0.
     53         22    3    3    1    2       0.8  0.8       15.
     54         22    2    2    2    1      100. 0.95        0.
     55         22    3    2    2    1      100. 0.95        0.
     56         22    1    3    2    2       0.9 0.95       30.
     57         22    3    3    2    1     1500. 0.95        0.
     58         23    3    3    1    1         4    4    2    2         3    3    2    3
     59         23    4    4    2    3
     60         24    1        0.        0.        0.       40.       20.        1.       0.9
     61       1  11   0.
     62       1  11   0.
     63       1  12   1.        1.        0.
     64       1  12   0.       10.     10.01
     65       1  13   1.        1.        0.
     66       1  13   0.       10.     10.01
     67       1  21   0.
     68       1  21   0.
     69       1  22   0.
     70       1  22   0.
     71       1  23   0.
```

Figure 3. Sample Output of All Input Data Card Images

```
INPUT DATA --------
CARD NO.   1         10        20        30        40        50        60        70        80

   72      1 23    0.
   73      2 11    0.
   74      2 11    0.
   75      2 12    0.
   76      2 12    0.
   77      2 13    0.
   78      2 13    0.
   79      2 21    0.
   80      2 21    0.
   81      2 22    .3          0.
   82      2 22    0.         30.
   83      2 23    1.          0.
   84      2 23    0.         30.
   85      3 11    0.
   86      3 11    0.
   87      3 12    1.          1.         0.
   88      3 12    0.         10.      10.01
   89      3 13    1.          1.         0.
   90      3 13    0.         10.      10.01
   91      3 21    0.
   92      3 21    0.
   93      3 22    0.
   94      3 22    0.
   95      3 23    0.
   96      3 23    0.
   97        99
   98       999
```

Figure 3. Sample Output of All Input Data Card Images (Concluded)

RUN NUMBER 1 TACTIC NUMBER 3
INITIAL NUMBER OF INTRUDERS BY TYPE 2 3 5
INITIAL NUMBER OF DEFENDERS BY TYPE 2 1 1
NUMBER OF MINES DISPENSED BY TYPE 90 90

ITER NUM.	TYPE	INTRUDERS DAMAGED BY MINES	DIR. FIRE	IND. FIRE	DEFENDERS DAMAGED	ROUNDS FIRED BY INT.	ROUNDS FIRED BY DEF.	MINES DETONATED	MINES IN FIELD	MINES SWEPT	TGTS LOST	RMVL TIME	SWEEP TIME	TRAVEL TIME	BREACH TIME
1	1	1	0	1	2	0	19	5	39	3	0	0.0	19.0	64.6	83.6
	2	1	1	1	0	2	3	5	47	1					
	3	1	0	1	1	95	2								
2	1	0	0	0	2	0	11	8	34	8	0	0.0	30.0	64.6	94.6
	2	2	1	0	0	8	15	15	42	11					
	3	0	1	0	1	46	3								
3	1	2	0	0	1	0	16	10	43	7	1	0.0	13.0	64.6	77.5
	2	1	0	1	0	0	0	6	36	4					
	3	1	1	0	1	75	4								
4	1	1	0	0	2	0	10	4	22	2	0	0.0	29.0	49.7	77.7
	2	0	1	2	0	0	2	10	46	10					
	3	1	0	1	1	19	2								
5	1	0	0	0	1	0	16	12	45	12	0	0.0	31.0	64.6	95.6
	2	0	1	2	0	4	5	14	35	13					
	3	0	1	2	1	55	4								
6	1	1	0	0	2	0	18	6	44	5	1	0.0	33.0	64.6	97.6
	2	0	0	2	0	0	0	8	38	8					
	3	0	0	2	1	59	4								
7	1	0	0	0	2	0	12	14	43	14	0	0.0	31.0	64.2	95.2
	2	0	1	2	0	4	5	10	36	8					
	3	0	1	0	1	42	3								
8	1	0	2	0	0	0	22	3	37	0	3	0.0	0.0	64.6	64.6
	2	0	0	0	0	0	0	0	41	0					
	3	3	0	1	1	35	2								
9	1	0	0	1	2	0	11	11	38	11	0	0.0	32.0	64.6	96.6
	2	1	0	2	0	0	0	8	42	7					
	3	0	0	1	1	34	2								
10	1	0	0	1	2	0	6	9	34	9	0	0.0	30.0	64.6	94.6
	2	1	1	1	0	8	6	14	43	7					
	3	0	1	0	1	12	4								
11	1	1	0	0	2	0	11	15	44	14	2	0.0	31.0	64.6	95.6
	2	1	0	0	0	0	0	11	42	9					
	3	0	1	0	1	37	3								
12	1	1	0	0	2	0	12	13	41	10	0	0.0	32.0	59.3	91.3
	2	1	1	1	0	4	5	14	41	12					
	3	2	0	0	1	44	2								
13	1	0	0	0	2	0	10	7	31	7	0	0.0	31.0	64.6	95.6
	2	0	1	2	0	4	29	10	35	10					
	3	0	0	1	1	28	2								
14	1	0	1	0	2	0	14	4	38	4	3	0.0	30.0	64.6	94.6
	2	0	0	0	0	0	0	7	43	7					
	3	0	0	0	1	59	2								
15	1	1	1	0	1	0	23	5	45	0	2	0.0	4.0	33.2	37.2
	2	0	0	1	0	0	0	0	42	0					
	3	4	0	1	0	108	0								

Figure 4. Sample Output for Printout Option ITEROP = 1

STATISTICAL SUMMARY	MEAN	VARIANCE	STD. DEV.
INTRUDERS DAMAGED			
BY MINES	.367	.309	.556
	.367	.378	.615
	1.333	3.126	1.768
BY DIRECT FIRE	.467	.464	.681
	.400	.248	.498
	.233	.185	.430
BY INDIRECT FIRE	.300	.286	.535
	1.000	.621	.788
	.467	.395	.629
DEFENDERS DAMAGED	1.733	.271	.521
	.033	.033	.183
	.800	.166	.407
ROUNDS FIRED			
BY INTRUDERS	0.000	0.000	0.000
	1.733	7.099	2.664
	58.100	898.231	29.971
BY DEFENDERS	14.167	19.040	4.364
	3.900	52.359	7.237
	2.100	1.748	1.322
MINES DETONATED	7.600	14.938	3.865
	7.533	21.232	4.614
MINES IN FIELD	37.967	38.447	6.201
	41.700	29.941	5.472
MINES SWEPT	5.900	22.231	4.715
	6.300	17.045	4.129
BREACH TIME (MINUTES)	86.505	204.523	14.301

Figure 4. Sample Output for Printout Option ITEROP = 1 (Concluded)

```
TARGET          1       2       3       4       5       6       7       8       9       10
OBSTACLE        8      55      47      42      32      26      19       7       7        7
DISTANCE 99999.00     .00   10.00   20.00    4.90   20.10   10.00 99999.00 99999.00 99999.00

EVENT TGT=   2  TGT TYPE=  1  TGT Y=  2134.7  TGT X=     0.0
TGT VEL=    0.0  TOTAL TRAV TIME=   24.258  BREACH TIME=   34.258

EVENT OBS=  55  OBS TYPE= 19  OB X=    0.0  OB Y=  2134.7  PROB= 0.00  RN=  .46

TGT TYPE     TGT Y     TGT X  TGT VEL  TRAV TIME  DEL TIME      TGT TYPE     TGT Y     TGT X  TGT VEL  TRAV TIME  DEL TIME

  1    1   99999.00   100.00     0.00      18.87      0.00        6    3    1934.70      0.00     0.00      24.26      1.00
  2    1    2134.70     0.00     0.00      24.26      1.00        7    3    1884.70      0.00     0.00      24.26      1.00
  3    3    2084.70     0.00     0.00      24.26      1.00        8    2   99995.00     90.00     0.00      18.87      0.00
  4    3    2034.70     0.00     0.00      24.26      1.00        9    2   99995.00    110.00     0.00      18.87      0.00
  5    3    1984.70     0.00     0.00      24.26      1.00       10    2   99995.00     90.00     0.00      18.87      0.00
THE EXPLOSIVE SWEEP ROUTINE HAS REMOVED THE FOLLOWING MINES

TARGET          1       2       3       4       5       6       7       8       9       10
OBSTACLE        8      61      53      47      42      32      24       7       7        7
DISTANCE 99999.00     .00     .10   20.00   30.00   14.90   10.00 99999.00 99999.00 99999.00

EVENT TGT=   2  TGT TYPE=  1  TGT Y=  2174.7  TGT X=     0.0
TGT VEL=    0.0  TOTAL TRAV TIME=   24.713  BREACH TIME=   35.713

EVENT OBS=  61  OBS TYPE= 19  OB X=    0.0  OB Y=  2174.7  PROB= 0.00  RN=  .46

TGT TYPE     TGT Y     TGT X  TGT VEL  TRAV TIME  DEL TIME      TGT TYPE     TGT Y     TGT X  TGT VEL  TRAV TIME  DEL TIME

  1    1   99999.00   100.00     0.00      18.87      0.00        6    3    1974.70      0.00     0.00      24.71      1.00
  2    1    2174.70     0.00     0.00      24.71      1.00        7    3    1924.70      0.00     0.00      24.71      1.00
  3    3    2124.70     0.00     0.00      24.71      1.00        8    2   99995.00     90.00     0.00      18.87      0.00
  4    3    2074.70     0.00     0.00      24.71      1.00        9    2   99995.00    110.00     0.00      18.87      0.00
  5    3    2024.70     0.00     0.00      24.71      1.00       10    2   99995.00     90.00     0.00      18.87      0.00
********* TRAVEL PATH BOUNDARY  EVENT TGT =   2  OB Y=  2213.5  BREACH TIME=  36.153*********
********* TRAVEL PATH BOUNDARY  EVENT TGT =   3  OB Y=  2213.5  BREACH TIME=  36.722*********
********* TRAVEL PATH BOUNDARY  EVENT TGT =   4  OB Y=  2213.5  BREACH TIME=  37.290*********
********* TRAVEL PATH BOUNDARY  EVENT TGT =   5  OB Y=  2213.5  BREACH TIME=  37.858*********
********* TRAVEL PATH BOUNDARY  EVENT TGT =   6  OB Y=  2213.5  BREACH TIME=  38.426*********
********* TRAVEL PATH BOUNDARY  EVENT TGT =   7  OB Y=  2213.5  BREACH TIME=  38.994*********
********* TRAVEL PATH BOUNDARY  EVENT TGT =   2  OB Y=     0.0  BREACH TIME=  36.153*********
THE EXPLOSIVE SWEEP ROUTINE HAS REMOVED THE FOLLOWING MINES

TARGET          1       2       3       4       5       6       7       8       9       10
OBSTACLE        1       5       5       5       5       5       5       1       1        1
DISTANCE 99999.00    40.00   90.00  140.00  190.00  240.00  290.00 99999.00 99999.00 99999.00

EVENT TGT=   2  TGT TYPE=  1  TGT Y=    40.0  TGT X=     0.0
TGT VEL=    0.0  TOTAL TRAV TIME=   25.608  BREACH TIME=   37.608

EVENT OBS=   5  OBS TYPE= 19  OB X=    0.0  OB Y=    40.0  PROB= 0.00  RN=  .46

TGT TYPE     TGT Y     TGT X  TGT VEL  TRAV TIME  DEL TIME      TGT TYPE     TGT Y     TGT X  TGT VEL  TRAV TIME  DEL TIME

  1    1   99999.00   100.00     0.00      18.87      0.00        6    3    -160.00      0.00     0.00      25.61      1.00
  2    1     40.00     0.00     0.00      25.61      1.00        7    3    -210.00      0.00     0.00      25.61      1.00
  3    3    -10.00     0.00     0.00      25.61      1.00        8    2   99995.00     90.00     0.00      18.87      0.00
  4    3    -60.00     0.00     0.00      25.61      1.00        9    2   99995.00    110.00     0.00      18.87      0.00
  5    3   -110.00     0.00     0.00      25.61      1.00       10    2   99995.00     90.00     0.00      18.87      0.00
THE EXPLOSIVE SWEEP ROUTINE HAS REMOVED THE FOLLOWING MINES

TARGET          1       2       3       4       5       6       7       8       9       10
OBSTACLE        1      10       6       6       6       6       6       1       1        1
DISTANCE 99999.00    31.50   41.50   91.50  141.50  191.50  241.50 99999.00 99999.00 99999.00

EVENT TGT=   2  TGT TYPE=  1  TGT Y=    80.0  TGT X=     0.0
TGT VEL=    0.0  TOTAL TRAV TIME=   26.063  BREACH TIME=   39.063

EVENT OBS=  10  OBS TYPE= 19  OB X=    0.0  OB Y=    80.0  PROB= 0.00  RN=  .46
```

Figure 5. Sample Output for Printout Option IPRINT = N

DISTRIBUTIONS FOR

INTERVAL CLASS	INTRUDERS DAMAGED BY MINES 1	1	1	INTRUDERS DAMAGED BY DIRECT FIRE 1	1	1	INTRUDERS DAMAGED BY INDIRECT FIRE 1	1	1
0	.667	.700	.533	.633	.600	.767	.733	.300	.600
1	.300	.233	.133	.267	.400	.233	.233	.400	.333
2	.033	.067	.067	.100	0.000	0.000	.033	.300	.067
3	0.000	0.000	.067	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	.133	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	.067	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

INTERVAL CLASS	DEFENDERS DAMAGED 1	1	1	ROUNDS FIRED BY INTRUDERS 1	1	5	ROUNDS FIRED BY DEFENDERS 2	2	1
0	.033	.967	.200	1.000	.633	0.000	0.000	.500	.200
1	.200	.033	.800	0.000	0.000	0.000	0.000	.033	.033
2	.767	0.000	0.000	0.000	.067	.067	0.000	.067	.400
3	0.000	0.000	0.000	0.000	0.000	.033	.033	.167	.200
4	0.000	0.000	0.000	0.000	.200	.067	.033	0.000	.167
5	0.000	0.000	0.000	0.000	0.000	.067	.167	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	.033	.200	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	.067	.067	0.000	0.000
8	0.000	0.000	0.000	0.000	.100	.100	.200	.067	0.000
9	0.000	0.000	0.000	0.000	0.000	.033	.133	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	.100	.100	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	.033	.033	.033	0.000
12	0.000	0.000	0.000	0.000	0.000	.033	.033	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	.067	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	.133	0.000	.033	0.000
16	0.000	0.000	0.000	0.000	0.000	.100	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	.067	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure 6. Sample Output for Printout Option IDISOP = 1

DISTRIBUTIONS FOR

INTERVAL CLASS	MINES DETONATED 1	1	MINES IN FIELD 3	3
0	0.000	.133	0.000	0.000
1	0.000	.033	0.000	0.000
2	.033	.033	0.000	0.000
3	.100	0.000	0.000	0.000
4	.100	0.000	0.000	0.000
5	.167	.100	0.000	0.000
6	.067	.067	0.000	0.000
7	.100	.133	0.000	0.000
8	.067	.100	.067	0.000
9	.067	0.000	0.000	0.000
10	.033	.167	.067	0.000
11	.100	.067	.033	0.000
12	.033	0.000	.200	.267
13	.033	0.000	.167	.067
14	.033	.100	.133	.267
15	.033	.067	.300	.167
16	.033	0.000	.033	.133
17	0.000	0.000	0.000	.067
18	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	.033
20	0.000	0.000	0.000	0.000

INTERVAL CLASS	MINES SWEPT 1	1	BREACH TIME 5
0	.200	.167	0.000
1	.033	.067	0.000
2	.033	.033	0.000
3	.100	0.000	0.000
4	.033	.033	0.100
5	.133	.033	0.100
6	.033	.067	0.000
7	.067	.200	0.000
8	.100	.100	.033
9	.033	.033	0.000
10	.033	.100	0.000
11	.067	.067	0.000
12	.033	.067	0.100
13	0.000	.033	.067
14	.067	0.000	.067
15	0.000	0.000	0.000
16	.033	0.000	.100
17	0.000	0.000	.033
18	0.000	0.000	.033
19	0.000	0.000	.367
20	0.000	0.000	.300

Figure 6. Sample Output for Printout Option IDISOP = 1 (Concluded)

SECTION IV

SAMPLE CASE

DESCRIPTION OF CASE

For this sample case, it is assumed that a formation of ten intruder targets is traversing a two-segment travel path which has been mined with 90 aerially delivered antitank mines and 90 aerially delivered antivehicular mines. The target formation consists of two armored vehicles which are capable of deploying line charge clearing devices, five tanks, and three armed jeeps. The travel paths are terrain shielded in all but four areas, and four direct fire weapons (one for each direct fire area) can fire at the intruders. There are also two volley aimpoints into which four volleys are fired. Two aircraft deliver 90 mines each, and the angle between the nominal delivery path and the positive Y axis in the map coordinate system is 30 degrees.

DATA DECK SETUP

Figure 7 shows the card image output of the data cards that were used to run this sample case. Note that the Card Type 99 signals the end of data for the case, and the Card Type 999 signals the end of job.

OUTPUT LISTING

Figure 8 presents the output resulting from the sample case using the output options ITEROP=1, IDISOP=0, but excluding the card image output.

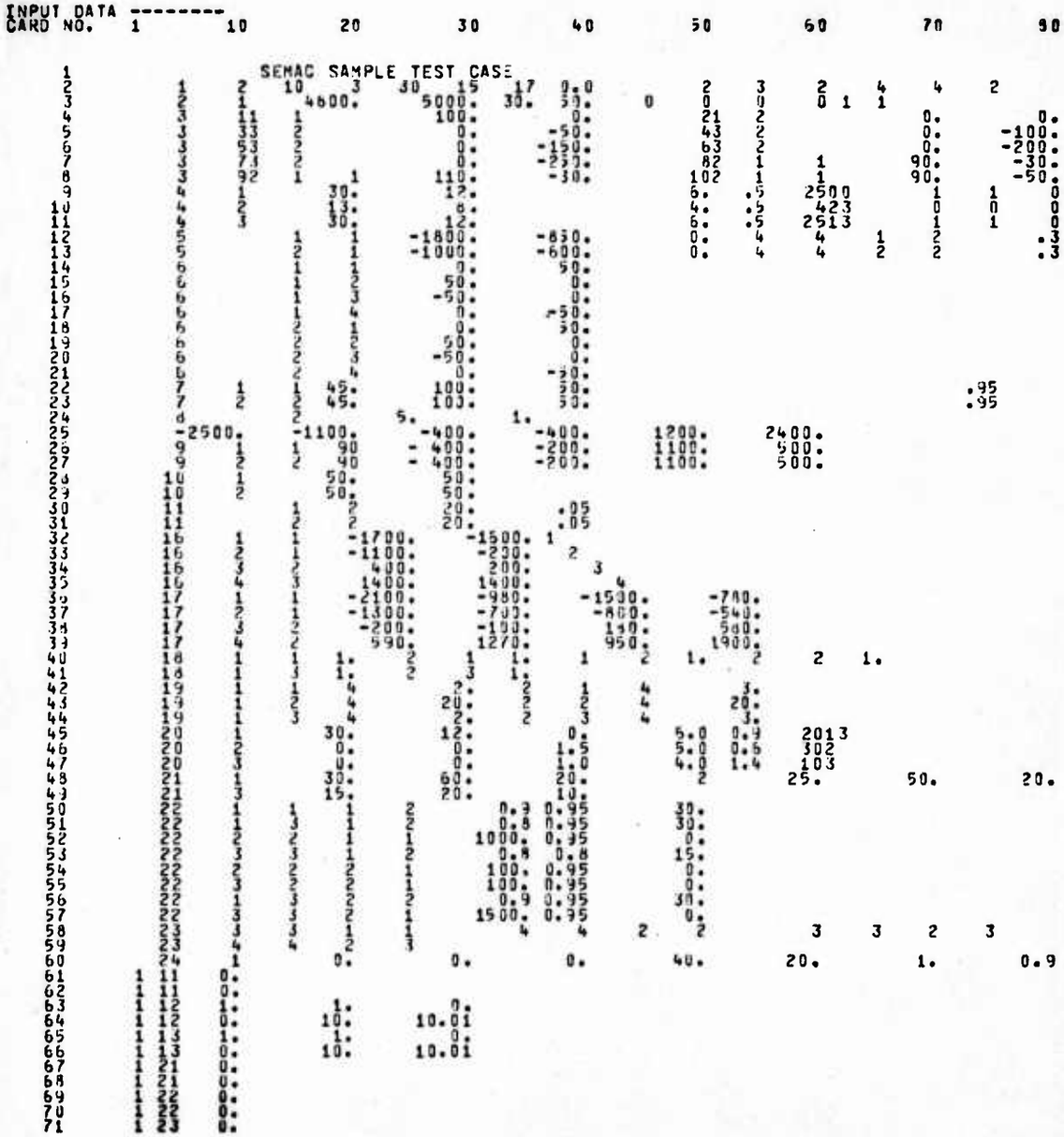

Figure 7. Sample Case Card Image Output

```
INPUT DATA --------
CARD NO.   1         10        20        30        40        50        60        70        80

   72       1 23    0.
   73       2 11    0.
   74       2 11    0.
   75       2 12    0.
   76       2 12    0.
   77       2 13    0.
   78       2 13    0.
   79       2 21    0.
   80       2 21    0.
   81       2 22    .3         0.
   82       2 22    0.        30.
   83       2 23    1.         0.
   84       2 23    0.        30.
   85       3 11    0.
   86       3 11    0.
   87       3 12    1.         1.         0.
   88       3 12    0.        10.        10.01
   89       3 13    1.         1.         0.
   90       3 13    0.        10.        10.01
   91       3 21    0.
   92       3 21    0.
   93       3 22    0.
   94       3 22    0.
   95       3 23    0.
   96       3 23    0.
   97         99
   98        999
```

Figure 7. Sample Case Card Image Output
(Concluded)

RUN NUMBER 1 TACTIC NUMBER 3
INITIAL NUMBER OF INTRUDERS BY TYPE 2 3 5
INITIAL NUMBER OF DEFENDERS BY TYPE 2 1 1
NUMBER OF MINES DISPENSED BY TYPE 90 90

ITER NUM.	TYPE	INTRUDERS DAMAGED BY MINES	DIR. FIRE	IND. FIRE	DEFENDERS DAMAGED	ROUNDS FIRED BY INT.	DEF.	MINES DETONATED	MINES IN FIELD	MINES SWEPT	TGTS LOST	RMVL TIME	SWEEP TIME	TRAVEL TIME	BREACH TIME
1	1	1	0	1	2	0	19	5	39	3	0	0.0	19.0	64.6	83.6
	2	1	1	1	0	2	3	5	47	1					
	3	1	0	1	1	55	2								
2	1	0	0	0	2	0	11	8	34	8	0	0.0	30.0	64.6	94.6
	2	2	1	0	0	8	15	15	42	11					
	3	0	1	0	1	46	3								
3	1	2	0	0	1	0	16	10	43	7	1	0.0	13.0	64.6	77.6
	2	1	0	1	0	0	0	6	36	4					
	3	1	1	0	1	75	4								
4	1	1	0	0	2	0	10	4	22	2	0	0.0	29.0	48.7	77.7
	2	0	1	2	0	0	2	10	48	10					
	3	1	0	1	1	19	2								
5	1	0	0	0	1	0	16	12	43	12	0	0.0	31.0	64.6	95.6
	2	0	1	2	0	4	3	14	35	13					
	3	0	1	2	1	55	4								
6	1	1	0	0	2	0	18	6	44	5	1	0.0	33.0	64.6	97.6
	2	0	0	2	0	0	0	8	38	8					
	3	0	0	2	1	59	4								
7	1	0	0	0	2	0	12	14	43	14	0	0.0	31.0	64.2	95.2
	2	0	1	2	0	4	5	10	36	8					
	3	0	1	0	1	42	3								
8	1	0	2	0	0	0	22	3	37	0	3	0.0	0.0	64.6	64.6
	2	0	0	0	0	0	0	0	41	0					
	3	3	0	1	1	35	2								
9	1	0	0	1	2	0	11	11	38	11	0	0.0	32.0	64.6	96.6
	2	1	0	2	0	0	0	8	42	7					
	3	0	0	1	1	34	2								
10	1	0	0	1	2	0	6	9	34	9	0	0.0	30.0	64.6	94.6
	2	1	1	1	0	8	5	14	43	7					
	3	0	1	0	1	12	4								
11	1	1	0	0	2	0	11	15	44	14	2	0.0	31.0	64.6	95.6
	2	1	0	0	0	0	0	11	42	9					
	3	0	1	0	1	37	3								
12	1	1	0	0	2	0	12	13	41	10	0	0.0	32.0	59.3	91.3
	2	1	1	1	0	4	5	14	41	12					
	3	2	0	0	1	44	2								
13	1	0	0	0	2	0	10	7	31	7	0	0.0	31.0	64.6	95.6
	2	0	1	2	0	4	29	10	35	10					
	3	0	0	1	1	28	2								
14	1	0	1	0	2	0	14	4	38	4	3	0.0	30.0	64.6	94.6
	2	0	0	0	0	0	0	7	43	7					
	3	0	0	0	1	59	2								
15	1	1	1	0	1	0	23	5	45	0	2	0.0	4.0	33.2	37.2
	2	0	0	1	0	0	0	0	42	0					
	3	4	0	1	0	108	0								

Figure 8. Sample Case Output for ITEROP = 1

STATISTICAL SUMMARY	MEAN	VARIANCE	STD. DEV.
INTRUDERS DAMAGED			
BY MINES	.367	.303	.556
	.367	.378	.615
	1.333	3.126	1.768
BY DIRECT FIRE	.467	.464	.681
	.400	.248	.498
	.233	.185	.430
BY INDIRECT FIRE	.300	.286	.535
	1.000	.621	.788
	.467	.395	.629
DEFENDERS DAMAGED	1.733	.271	.521
	.033	.033	.183
	.800	.166	.407
ROUNDS FIRED			
BY INTRUDERS	0.000	0.000	0.000
	1.733	7.099	2.664
	58.100	898.231	29.971
BY DEFENDERS	14.167	19.040	4.364
	3.900	52.359	7.237
	2.100	1.748	1.322
MINES DETONATED	7.600	14.938	3.865
	7.533	21.292	4.614
MINES IN FIELD	37.967	38.447	6.201
	41.700	29.941	5.472
MINES SWEPT	5.900	22.231	4.715
	6.300	17.045	4.129
BREACH TIME (MINUTES)	86.506	204.523	14.301

Figure 8. Sample Case Output for ITEROP - 1
(Concluded)

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INITIAL DISTRIBUTION

DDC	2
DRXSY/GB	3
SMUPA/DW	2
DRC PM-SA-CP	1
USN Weapons Cntr/Code 317	1
USAMERDC/DRXFB-O	1
Nav Coastal Sys Lab/Code 722	1
TFWC/SA	1
AFAITC/TINAT	1
USACAA/MOCA-SA-1	1
Nav Surface Wpn Cntr/DL	1
Air Force Sys Comd/SDW	1
USA Training and Doctrine Comd/ ATCD-CM	1
TAC/DRA	1
AFATL/DLOSL	9
AFATL/DLYW	10
ADTC/XRO	1
AFATL/DL	1
AUL (AUL-LSE-70-239)	1
ASD/ENFEA	1
TAWC/TRADOCLO	1
Hq USAF/SAMI	1
Ogden ALC/MMWM	2
AFIS/INTA	1
Hq USAFE/DOQ	1
Hq PACAF/DOO	1

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