

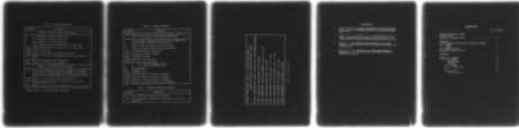
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ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND REDSTO--ETC F/G 15/3
AGGREGATED SHORADS ATTRITION WEAPON DECK.(U)
FEB 77 K J TARAS, J C RICHARDSON
DRDMI-C-77-1

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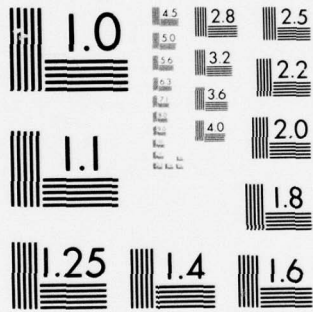
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TECHNICAL REPORT C-77-1

AGGREGATED SHORADS
ATTRITION WEAPON DECK

Advanced Systems Concepts Office

2 February 1977

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4. TITLE (and Subtitle) AGGREGATED SHORADS ATTRITION WEAPON DECK.	5. TYPE OF REPORT & PERIOD COVERED Technical Report.	6. PERFORMING ORG. REPORT NUMBER C-77-1
7. AUTHOR(s) Kosta John Taras J. C. Richardson, Jr.	8. CONTRACT OR GRANT NUMBER(s)	9. PERFORMING ORGANIZATION NAME AND ADDRESS Commander US Army Missile Research and Development Command Attn: DRDMI-C Redstone Arsenal, Alabama 35809
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	11. CONTROLLING OFFICE NAME AND ADDRESS Commander US Army Missile Research and Development Command Attn: DRDMI-TI Redstone Arsenal, Alabama 35809	12. REPORT DATE 2 February 1977
13. NUMBER OF PAGES 16	14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) DRDMI-C-77-1	15. SECURITY CLASS. (of this report) Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.	17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
18. SUPPLEMENTARY NOTES	19. KEY WORDS (Continue on reverse side if necessary and identify by block number) COMO III Project successor High/medium air defense systems	20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The aggregated short range air defense system's attrition weapon deck was developed to provide dynamic interaction between the short range air defense systems deployed in the division area and the high/medium air defense systems. The weapon deck is intended for use with the COMO III system simulation system in the high/medium air defense systems effectiveness studies. It was developed in conjunction with Project Successor and currently exists as a part of the COMO III weapon deck library.

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1. Introduction

The aggregated short range air defense system's (SHORADS) attrition weapon deck was developed for Project Successor to provide dynamic interaction between the SHORADS and the high/medium air defense systems (HIMADS) which were being evaluated in the study. The approach of aggregating the SHORAD systems rather than playing each unit as a discrete and independent entity in the COMO III simulation was chosen based on computer runtime and storage considerations. A detailed "precursor analysis" of the SHORAD [1] was conducted using the COMO III simulation and weapon decks representing ROLAND, STINGER, FLAK 20 mm, and the Advanced US Gun to develop parametric data on overall SHORADS contribution to air defense effectiveness. The results of this study were combined with the detailed HIMAD analysis through the SHORADS attrition weapon deck to evaluate the overall effectiveness of the air defense deployment mix.

The attrition weapon deck currently exists as a part of the COMO III weapon deck library which represents opposing or friendly forces. These weapon decks, when integrated with the COMO III simulation software, form a critical event Monte Carlo simulation of the dynamically interacting systems. The COMO III simulation software was developed by SHAPE Technical Center (STC), the Hague, Netherlands, and is fully described in STC reports [2,3,4]. This report assumes a basic familiarity with COMO III simulations. Any potential user should be familiar with the COMO Input Language (COMIL) [2]. Section 2 of this report describes the modeling approach for aggregating the SHORADS in the division area; Section 3 describes the weapon deck structure and support routines. Model input and output is described in Section 4 along with definitions of pertinent parameters.

2. Modeling Approach

The SHORADS attrition weapon deck design allows all SHORAD systems in the division area to be represented in the COMO III simulation by a single combat unit. A division area in rough terrain would be represented by a single entity with specific attrition characteristics; a division area in smooth terrain would be represented by another combat unit with different characteristics. For each attrition combat unit in the game, the weapon deck periodically interrogates all aircraft formations to determine which formations are currently in the zone and which ones should be considered for attrition.

The attrition zone was defined for a raid structure with essentially parallel aircraft tracks through the division area. It is modeled as a simple rectangular parallelepiped oriented such that the aircraft fly along the primary target line (PTL) of the zone (Figure 1). The formation penetration depth, DPEN, can be approximated by subtracting the projection of its current position on the PTL from the length of the zone.

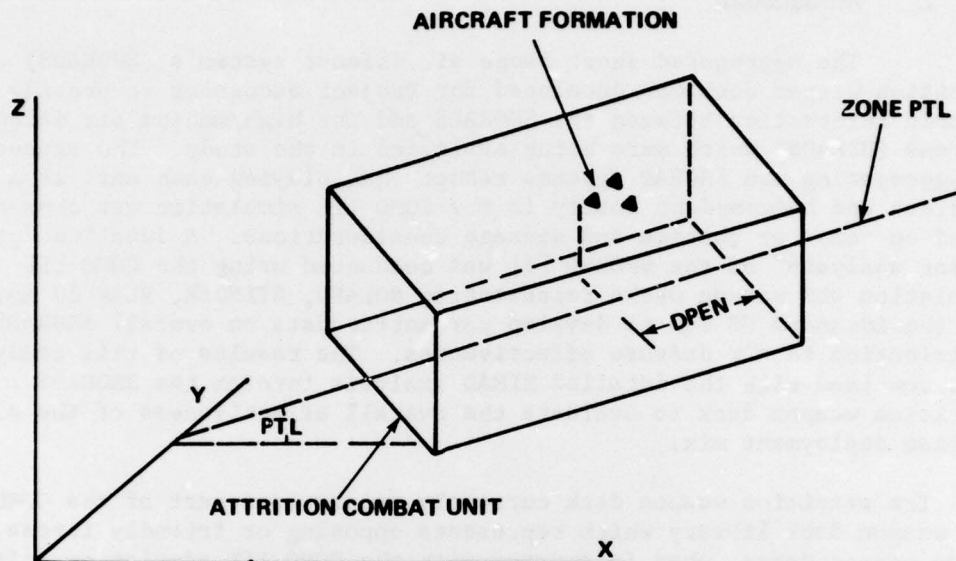


Figure 1. Attrition zone.

The parametric data representing SHORADS effectiveness in the division area can be input in either a deterministic or stochastic form. In the deterministic form, the average number of aircraft lost per formation (Figure 2) is used to remove a prescribed number of aircraft from each formation. The data shown in Figure 2 are not typical of actual SHORAD attrition but shows the independent variables modeled. In the stochastic form, a pseudo probability of kill (P) (Figure 3) is used to remove aircraft from formations. In this formulation, a scale factor (F) is used to correct P for initial formation size and is input versus formation size. A second scale factor (G) is used to correct the P to account for closely-spaced formations and pseudoformations which result from modeling limitations in the aircraft weapon deck. Pseudoformations must be defined in the raid structure for aircraft that fly through the attrition zone as a formation then break formation to attack. For normal formations, G is input equal to one. For pseudoformations, G is set to the number of pseudoformations into which the original formation has been divided. G is further modified if closely-spaced formations exist by adding a factor W. W is defined for two overlapping formations, i and k, with an initial number of aircraft, I and K, respectively, as follows:

$$W_i = \frac{I}{I + K}$$

$$W_k = \frac{K}{I + K} \quad .$$

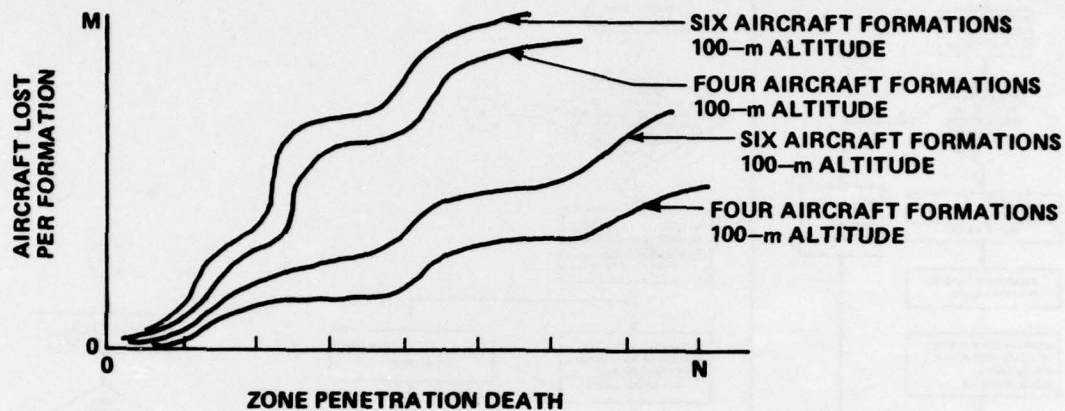


Figure 2. Aircraft lost per formation.

The procedure for constructing P using F, G, and W is shown in Figure 4.

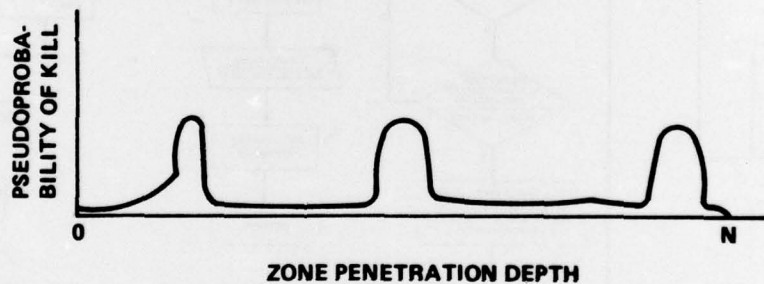


Figure 3. Pseudoprobability of kill.

The stochastic form of input for the attrition model presents a more realistic interaction among the raid structure, the HIMADS, and the SHORADS in the division area. This form correctly accounts for a SHORAD hop where most aircraft would at best enter the zone toward the rear. It allows definition of pseudoformations providing greater flexibility in the raid structure and accounts for closely-spaced or overlapping formations.

3. Weapon Deck Description

The SHORADS attrition weapon deck is relatively simple in comparison with other existing weapon decks. The deck consists of a single event routine, two support routines, and three complex identifiers or \$9 routines which allow the attrition model inputs to be a function of conditions detected dynamically by the model. An overview of the weapon deck structure is shown in Figure 4. The event routine,

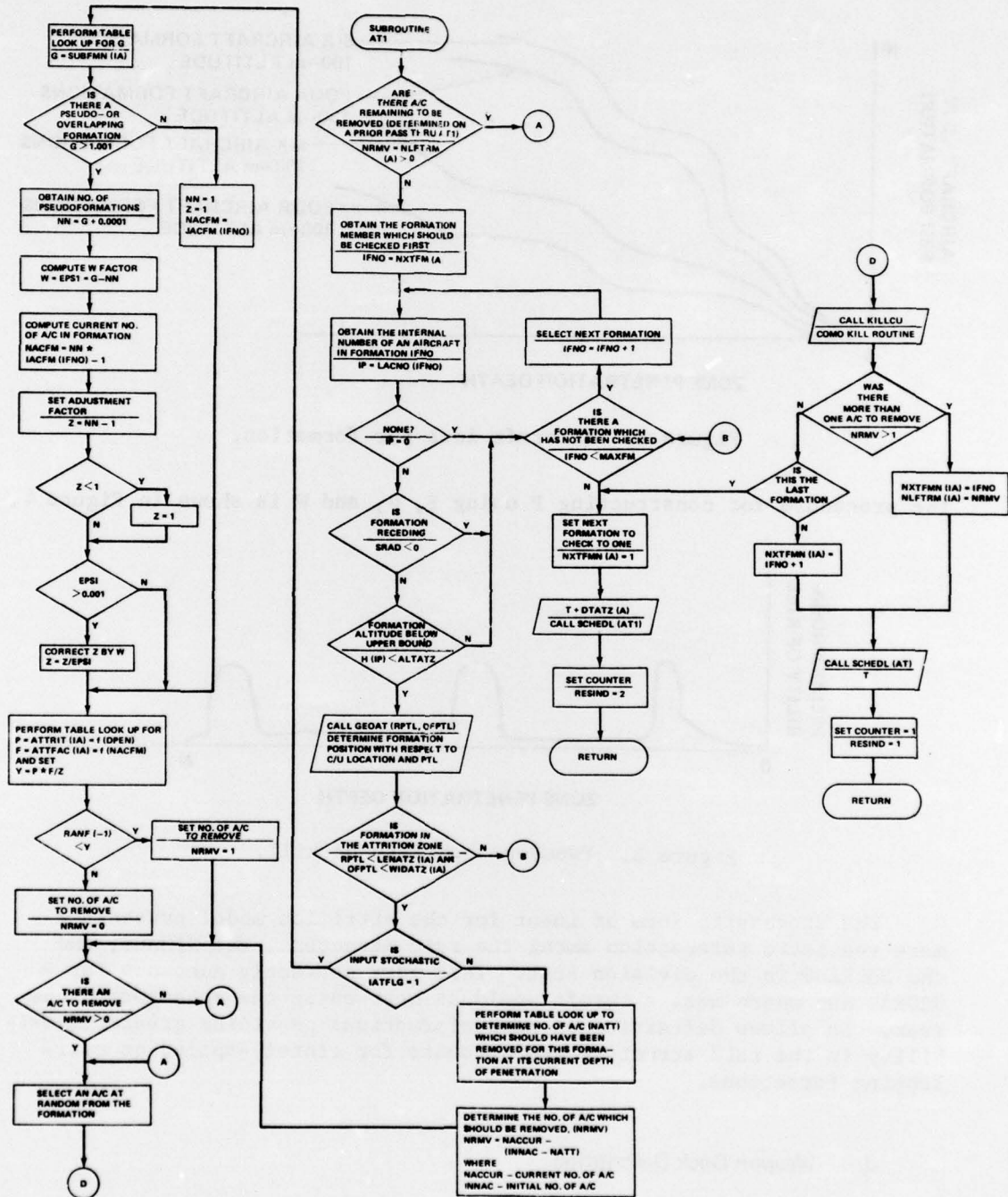


Figure 4. Attrition model overview.

AT1, is enabled periodically to determine if any aircraft should be removed from the game. A switch IATFLG is set at compile time, which indicates whether the deterministic or stochastic form of the attrition data will be input. In either case, the enablement frequency must be closely related to the attrition data (e.g., in the stochastic form the cumulative probability of removing an aircraft is a function of P and the frequency). At each time point, the event routine examines all formations to determine if an aircraft should be removed from any one of them.

Instead of calling routines SCHALL or SHTGT from the COMO frame to obtain a target, as do other weapon decks, the attrition model loops through the LACNO array which is defined and maintained by the aircraft weapon deck. The LACNO array contains an entry for each formation with aircraft which are currently in the game. For attrition model purposes, the spacing of the aircraft within a formation is assumed to be small so, on the basis of the location of one aircraft in the formation, the entire formation can be accepted as being in the zone or rejected. For each formation in the zone, the depth of penetration is determined, and the appropriate attrition data are retrieved from the input tables. If one or more aircraft are to be removed, the event routine calls the COMO frame routine KILLCU. To maintain the appropriate counters, the event routine must terminate after each kill and reenables itself at the same time with flags NLFRM and NXTFMN set to continue the search through the list of formations at the point where the last aircraft was removed. When all formations have been considered at one point in time, the event routine enables itself at a future time (T + DTATZ).

a. Subroutine ATO

Subroutine ATO is the routine called by the COMO frame when any attrition combat unit enters the game. This routine appropriately sets the flags NXTFMN and NLFFRM to one and zero, respectively. This subroutine also contains the entry point ATX which is called by the COMO frame when any attrition combat unit leaves the game. The ATX entry is a dummy because cleanup is required.

Input:

A Attrition combat unit number

Output:

NXTFMN Next formation number to consider
NLFFRM Number of aircraft left to remove from a formation.

b. Subroutine GEOAT

Subroutine GEOAT is called by the event routine to calculate the geometric properties of a formation relative to the attrition combat unit. The subroutine assumes that the attrition combat unit is defined at the rear of a rectangular parallelepiped so that

$$\begin{aligned} \text{RPTL} &= \text{RHOR}(A,P) * \text{COS}[\text{AZIM}(A,P) - \text{PTLATZ}(A)] \\ \text{OFPTL} &= \text{RHOR}(A,P) * \text{ABS}[\text{SIN}(\text{AZIM}[A,P] - \text{PTLATZ}[A])], \end{aligned}$$

where RHOR is the horizontal range from A to P, AZIM is the relative azimuth, and PTLATZ is the PTL of the attrition zone.

If RPTL is negative in the preceding example, then RPTL and OFPTL are set greater than the thresholds.

Input:

A Attrition combat unit
P Aircraft combat unit

Output:

RPTL Relative range projected on zone PTL
OFPTL Offset from zone PTL.

c. Real Function FORM

Real function FORM is a COMO complex identifier which allows attrition model inputs to be a function of formation number. Although any data may be input versus FORM, it was designed for the G factor described in Section 2.

Input:

IFNO Formation number being considered.

Output:

FORM Formation number.

d. Real Function NFORM

Real function NFORM is a COMO complex identifier which allows attrition model inputs to be a function of formation size. For deterministic attrition data, NFORM is defined to be the initial formation size. For the stochastic attrition data, it is defined to be the current formation size. For pseudoformations, it is defined as follows:

$$NFORM = (NN) * (IACFM - 1) ,$$

where NN is the number of pseudoformations (G - W) and IACFM is the initial number of aircraft for pseudoformation.

In the stochastic form of input, the F factor is input versus this independent variable.

Input:

NACFM Set to the value to be returned

Output:

NFORM Number of aircraft per formation.

e. Real Function DPEN

Real function DPEN is the complex identifier used to input the attrition data (either P in the stochastic form or average number of aircraft removed in the deterministic form). DPEN is set to the length of the zone less the projection of the aircraft relative range on the PTL of the zone.

Input:

LENATZ Length of the zone
RPTL Projection of relative range on PTL

Output:

DPEN Approximate depth of penetration.

4. Weapon Deck Variables

This section defines all variables in the weapon deck including input/output. Table 1 presents a list of the parameters which must be input to define an attrition combat unit. An example of the form of the input is shown in Figure 5. The input conventions are described in detail in an STC report [2]. Table 2 presents a list of other important variables in the model which would aid in understanding the code listing*. The model output consists primarily of counters presented in Table 3. Using the procedures described by Happel, et al. [2], tables of total occurrences and/or histograms of occurrences versus various independent variables may be constructed. More detailed data may be obtained through "TRACE" which prints internal parameters at the occurrence of each event.

*A list of the code may be obtained from the weapon deck library at MIRADCOM.

TABLE 1. ATTRITION MODEL INPUT

Variable	Definition
ATTRITON - Attrition Combat Unit Statement	
X	X coordinate of attrition combat unit
Y	Y coordinate of attrition combat unit
H	H coordinate of attrition combat unit
T	Game time when attrition combat unit is to enter game
TATZOT	Game time when attrition combat unit is to leave game
PTLATZ	Attrition zone PTL
LENATZ	Length of attrition zone (measured along PTL)
WIDATZ	Width of attrition zone (measured from and perpendicular to PTL)
ALTATZ	Upper band altitude of attrition zone
ATRTP	Pointer to attrition type statement
ATRITYP - Attrition Model Type Statement	
ATTRIT	For the deterministic form of input, ATTRIT is the number of aircraft to be removed from the formation. For the stochastic form of input, ATTRIT is the probability (P) of removing an aircraft from a formation at each time step $\leq P \leq 1$.
ATTFAC*	Factor to correct ATTRIT for formation size (F)
SUBFMN*	Factor to correct ATTRIT for overlapping formations and pseudoformations (G + W)
DTATZ	Time increment for periodic enablement of event routines AT1

*Required input = 0 for deterministic input form.

TABLE 2. INTERNAL VARIABLES

Variable	Definition
NXTFMN	When an aircraft is removed from a formation, NXTFMN is set to the next formation which should be considered.
NLFTRM	In the deterministic mode where more than one aircraft can be removed from a formation at a point in time, NLFTRM is set to the number of aircraft left to remove
IA	Set to attrition combat unit internal number
IP	Set to an aircraft combat unit internal number
IFNO	Formation number of aircraft IP
RPTL	Projection of RHOR on PTLATX
OFPTL	Offset from PTLATZ
NACFM	Aircraft in the formation
IATFLG	Attrition model input flag: = 0 input is deterministic form = 1 input is stochastic form
NN	$TRUNC(SUBFMN) \equiv G$
EPSI	$SUBFMN - NN \equiv W$
IACFM	Initial number of aircraft in formation
JACFM	Current number of aircraft in formation
LACNO	Pointer to a live aircraft in a formation
NRMV	Number of aircraft to remove from a formation

TABLE 3. ATTRITION WEAPON DECK COUNTERS

Counter	Definition
AT1C1	An aircraft was removed from a formation
AT1C2	AT1 was enabled, examined all formations, and removed no aircraft

```

ATRITON - ATRN (X = 200, Y = 100, H = 0, T = 0, TATZOT = 9000, LENATZ = 40,
          WIDATZ = 120, PTLATZ = 0, ALTATZ = 6000, ATRTP = ATRNT)$

ATRTYPE - ATRNT (DTATZ = 10, ATTRIT = TATRIT, ATTFAC = TATFAC, SUBFMN = TSUBFM)$

TABLE - TATRIT (H(PAS) = 180, 400, ATTRIT = ATRIT1, ATRIT2)$

TABLE - TSUBFM (FORM = 1, 20, 21, 22, 252, SUBFMN = 1.0, 1.0, 1.121, 1.0, 1.0)$

TABLE - TATF (H(PAS) = 80, 400, ATTFAC = TATF1, TATF2)$

TABLE - ATTRIT1 (DPEN = 0, 8, 10, 20, 22, ATTRIT = .1, .3, .1, .2, .1)$

TABLE - ATTRIT2 (DPEN = 0, 9, 11, 21, 23, ATTRIT = .05, .2, .1, .1, .1)$

TABLE - TATF1 (NFORM = 1, 2, 6, 10, ATTFAC = .5, .4, .2, .1)$

TABLE - TATF2 (NFORM = 1, 4, 8, ATTFAC = .4, .2, .05)$

```

Figure 5. Sample input.

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