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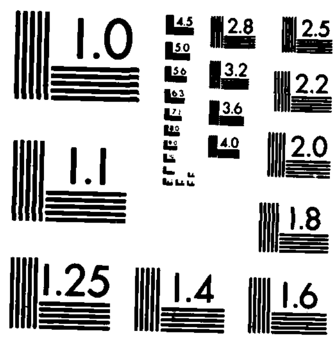

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AIR COMBAT MANEUVER

A Computer-Operated Simulation Model

of

A Strike Group, its Escorts, and Enemy Interceptors

ANALYST'S/USER'S MANUAL

CACI REPORT NO. D5332-1983-001

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The Air Combat Maneuver Model (ACM) was designed by CAPT. James Wilson USN, (Ret) under the sponsorship of the Directorate of Systems Analysis (OP-962) of the Office of the Chief on Naval Operations.

Programming was carried out by CAPT. Wilson and Janice Fain.

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CHAPTER 1 - INTRODUCTION AND SUMMARY

1.1 INTRODUCTION - GENERAL: This manual is intended to acquaint the prospective user/analyst with the AIR COMBAT MANEUVER Model and to provide sufficient qualitative descriptive and input instructions to permit him to run and use the model.

1.2 BASIC CAPABILITIES AND LIMITATIONS: The AIR COMBAT MANEUVER Model is a computer-operated logic model which simulates dynamically a many-vs-many engagement of interceptors with a tactical strike group which includes escorting fighters. It is a large-scale model written in the SIMSCRIPT II.5 simulation programming language, and is intended to run in any large computing system which possesses a SIMSCRIPT II.5 compiler. Currently operating on the Federal CSS System, it could be transferred relatively easily with a few input-output program changes to other computer installations.

The model is intended to analyze the effectiveness of various interceptor approach geometries, the strike group's disposition of its escorts, the engage/parry strategy of the escorts, clear-to-fire inhibitions on interceptors and escorts, sensor parameters, AIM weapon parameters and tell-tale reporting by AEW/AWACS in support of the strike group.

Detail and complexity of the ACM Model design have been deliberately held to the minimum commensurate with its objectives, in order to provide run-time simplicity and speed. The model carries the action through the first-pass firing attempts of the interceptors, but does not proceed to analyze any "dog-fighting" evolutions beyond the first pass. Curvilinear flight paths and relative motion are followed in detail during maneuver, but not to the level of aerodynamic energy transfer.

1.3 SYSTEM FUNCTIONAL OVERVIEW: The model is designed as a hybrid timestep/event-sequence simulation, with a two-stage time-step interval (long cycle until first attack turn starts, then shifting to short cycle).

Geography is represented as a plane surface, with all aircraft positions in x-y coordinates. Differential aircraft altitudes are used in evaluating target signatures and sensor "swept volumes" for detection purposes, but not otherwise. Aircraft speed changes are rendered instantaneously, but flight paths are represented as "true" curves with resultant dynamic relative motion changes. (Because of the time-stepping, "curves" are really a series of short, straight-line segments).

The strike group, escorts and interceptors are all treated as individual aircraft with identifying "tail numbers." Each aircraft starts from a specific x-y location with its own heading and speed. Each escort is assigned a formation station on the basis of an offsetting relative range and bearing from the strike lead. Each interceptor has an "activate time" in the simulation, at which time his intercept starts toward his specifically assigned target (most likely a member of the bomber group). Interceptors are aimed initially at ranges and bearing offset relative to their targets. All starting positions, speeds, activate times and interception targets are set by user input.

An interceptor proceeds via collision intercept path to the initial aiming point, offset relative to his target, and then converts to a pursuit attack path. By choice of the offset specification, the user may make the intercept virtually pure collision, round-house up-the-tail, all pursuit, etc..

All aircraft conduct both visual and electronic search throughout. The presence (input) of jamming inhibits detection range to that input for "burn-through". (No firing attempt can be made without individually-acquired contact, nor will an interceptor convert to pursuit attack without contact. Interceptors lacking contact at the pursuit start point commence a search-orbit pattern). Contact once gained may be lost, when a target's relative motion carries it out of the swept volume of the observer's sensors.

When anyone makes a detection, he attempts to notify (transmit "knowledge" to) his fellows. Such attempts may not be completely successful, dependent upon input communication reliability. "Knowledge" of a target's presence heightens detection probability and lack of "knowledge" inhibits an escort from partaking in a parry maneuver.

Upon detection of an interceptor (visual or electronic), escorts are committed to parrying attacks in accordance with input doctrine and numbers. If an interceptor individually detects an escort turning toward him, the interceptor shifts his attack to a pursuit aimed at the escort.

Pursuits are pressed until within the firing envelope of the available AIM weapons. Repeated firing attempts are made (at the time-step interval) until the target is killed or the attacker overruns his target of the AIMs are exhausted. When any of the foregoing results, a "resume" takes place. Resume for an interceptor causes him to be re-committed - always against the bomber group. He turns onto a pursuit path toward that group and will attempt to fire when within appropriate parameter constraints. Resume for an escort sets up a return to his assigned formation station, during which he continues to search and may be re-committed at any time against another target (interceptor).

The model run ends at an input stop time or when all bombers have been killed or when all interceptors have either been killed or neutralized, whichever comes first.

1.4 USE OF THIS MANUAL: It is strongly urged that prospective users of the AIR COMBAT MANEUVER Model familiarize themselves thoroughly with the qualitative descriptions of the various systems and phenomena as set forth in this manual before attempting to run the model. It is urged further that repeated refresher reading of these sections be undertaken during use of the model in order that the user/analyst may retain a clear overall grasp of the model features, effects, and their interactions.

CHAPTER 2 - THE MODEL DESCRIPTION

2.1 INTRODUCTION - GENERAL: This chapter describes the logical functions of the AIR COMBAT MANEUVER Model. It sets forth the physical systems simulated, the key inputs which describe those systems, and the manner in which the systems interact. System assumptions and limitations are addressed at appropriate locations in the narrative.

Succeeding paragraphs address major subsystems and logical functions as follows:

2.2 The Strike Group
2.3 The Escorts
2.4 The Interceptors
2.5 The Sensors
2.6 The Missiles
2.7 The Aircraft Types

2.2 THE STRIKE FORCE:

2.2.1 General: The Strike Group is simulated as an aircraft following a preassigned path. Upon detecting an interceptor within a specified distance, the strike group takes evasive action, returning as soon as possible to its assigned heading.

The number of bombers comprising the strike group is input. Bombers killed by interceptors are subtracted from this number.

2.2.2 Detection and Communication by the Strike Group: The strike group has the detection and communication capabilities of its aircraft type. It carries out the same detection and communication functions as the interceptors and escorts (which, see below).

2.2.3 Evasive Action by the Strike Group: If a visually-detected interceptor is within the pre-set "break-distance," the strike group will attempt to communicate this information within the group. A random number compared with the communication reliability for this aircraft type determines if communication is successful. If so, the strike group will turn toward the attacker through a turn equal D (1.5 x the relative bearing to the interceptor) up to a maximum of 120°. On completion of the turn, a second turn back to the original heading is scheduled in the same time required for the original turn.

2.3 THE ESCORTS:

Initial location of each escort is specified by a distance and relative bearing from the strike group. The escorts occupy these relative positions until attacking interceptors are detected.

2.3.1 General: The function of the escort is to protect the strike group by engaging the attacking interceptors. Their initial locations are specified by distance and relative bearing from the strike group. The escorts will follow the heading of the strike group until attacking interceptors are detected. When an individual engagement is ended, either by killing or losing the interceptor, the escort returns to his assigned position relative to the strike group.

2.3.2 Detection and Communication: These functions are the same for all aircraft, although the effectiveness with which they can be carried out depends on the capabilities of the sensors and aircraft communication equipment.

Upon detecting an interceptor, an escort will attempt to pass this information to his fellow escorts. A random number compared with the communication reliability of the escort aircraft type determines the success of the attempt.

2.3.3 Commitment: The ACM Model may be run in one of three (input) modes:

- Assign all uncommitted escorts whenever an interceptor is detected, or
- Assign "x" uncommitted escorts from the formation side opposite the interceptor, or
- Assign "x" uncommitted escorts from the formation side nearest the interceptor.

An escort committed to an interceptor will turn toward the interceptor in an attempt to reach a position from which its missiles may be fired.

2.3.4 Engagement: When the escort is sufficiently close to its target and within the firing parameters of its missile, a random number is compared with the missile's kill probability to determine if a kill is achieved.

2.3.5 Return to Station: An escort that has been committed to a target returns to its assigned place in the strike group formation under the following conditions:

- Its target is killed,
- It has overrun,
- It has been out-turned; or
- It has run out of missiles.

2.4 THE INTERCEPTORS:

2.4.1 General: A starting time and a starting position are specified for each interceptor. At the starting time an intercept course with the strike group is computed and the interceptor is started along that course. An input offset requires the user to specify a point outside the strike group for this first intercept point.

On arriving at the computed intercept point, the interceptor searches for his target and fires as soon as it is in a position to do so.

2.4.2 Commitment: An interceptor is committed by input to a specific target (side no.). However, it will drop the assignment and commit to an escort that is detected turning toward it.

2.4.3 Engagement: An interceptor will fire at its target when in the firing position required by its missiles. A random number is compared with its kill probability to determine if a kill is achieved.

2.4.4 Recommittment: After a firing, an interceptor will turn toward the strike group in attempt to pick it up again as a target.

2.4.5 Retirement: An interceptor will retire from the game when it runs out of missiles.

2.4.6 Rules of Engagement: The user may select one of two rules of engagement for the interceptors:

- A firing is allowed only if the target has been identified visually, or
- Global clear-to-fire after x (input) positive identifications, or
- Clear-to-fire allowed on any radar detection.

2.5 THE SENSORS:

2.5.1 General: Each aircraft type is given two sensors. The sensor characteristics are part of the user-provided input, but it is generally considered that one of the sensors is visual and one is radar.

2.5.2 Sensor Attributes: The sensors are described by the following attributes: Maximum and 90-pct detection ranges, target signature for 90-pct detection, sweep rate and width, upper and lower sweep limits, and maximum and 90-pct ranges when jamming is present.

2.5.3 Search and Detection: During each model time-step, each aircraft is checked for detection by each aircraft on the other side. A target signature is computed from the input target signatures of the target aircraft and the relative positions of the sensing and target aircraft.

From the target signature, a detection probability is computed and compared with a random number to determine if a detection takes place. An initial check of relative positions rules out target aircraft too distant or outside the angular limits for detection.

When a detection is made, the detecting aircraft makes an attempt to communicate the target information to its colleagues.

2.6 THE MISSILES:

2.6.1 General: Each aircraft may have a pre-specified number of i iles belonging to each of two missile types. The missile types are descr by their maximum and minimum head-on and tail-on ranges, maximur e off from the target's tail and SSPK for each aircraft type. An aircraft will attempt to use its first input missile type first, switching to the second input type only if unable to fire a missile of the first type - either because of being out of envelop or because of having used them all.

2.7 THE AIRCRAFT TYPES:

2.7.1 General: The strike group is made up of a single aircraft type. Its escorts may be the same or different types. Interceptor types are assigned as the user wishes.

2.7.2 Aircraft Type Attributes: Aircraft types are described by their sensor and missile types, three speeds and their associated turn rates and bank angles, numbers of each type missiles, reliability of its communication, and numbers of targets engageable simultaneously, and target signatures for radar and visual sensors.

2.8 CREW EFFECTIVENESS AND RELIABILITY:

2.8.1 General: The probability of target detection is the product of two terms - one representing the physical characteristics of the target aircraft and sensor, and the second, depending on the attentiveness of the pilot and crew.

2.8.2 Pilot and Crew Attentiveness: The user specifies input numbers for crew and pilot between 1 (perfect attentiveness) and 0 (complete inattention). If this number is 1 for either pilot or crew, then the detection term itself is set to 1, leaving the detection probability a function solely of the target-sensor combination. If the number for either the pilot or the crew is set to 0, then detection depends on the other. Only if the factors for both pilot and crew are set to 0 will detection always fail. If the pilot and crew have been told about the potential target, the attentiveness term is set to the square root of the computed value.

CHAPTER 3 - INPUT DATA REQUIREMENTS

3.1 INTRODUCTION - GENERAL: This chapter describes the required and the optional data inputs necessary to perform a model run of the OP-962 ACM Model. By following these instructions, the analyst will be able to construct a complete data file to run the model.

3.2 INPUT CONVENTIONS: The OP-962 ACM Model is written in the SIMSCRIPT II.5 programming language. That fact, plus the form and format of the model sections which process the input data files, determine some constraints as well as allowing some options to the analyst in preparing the input data. The significant factors are discussed below.

a. Input data reading is essentially free of format restrictions, except as noted below for specific data items. This means that data items on a single line need only be in the proper order - there are no specific spacing requirements. The analyst is free to format data lines to suit his own preferences.

b. Certain data items are specified to be either integer or alpha (alpha-numeric characters). Unless so specified, all input data are real numbers and may have decimal points and fractional parts. Those designated as integer must have no decimal point or fractional part; otherwise a reading error will be declared. A free-form read of a designated alpha input will begin with the first non-blank character and will continue until the first blank space or until the machine-dependent work size is reached. (For the current IBM installation, that word size is 4 characters). Successive free-form read attempts (after a free-form alpha) will begin either in the first blank after the alpha or in the fifth character of the alpha input, if the alpha continues. This may be the source of some input errors, if the notations below are not followed closely.

c. In reading a string of data items across a data line, the program will continue until it has read the required number of items - continuing if necessary on the next line. Thus, if a line calls for 5 items and the analyst erroneously supplies only 4 items, the program will attempt to pick up the 5th item on the next line. This may be the source of some input errors.

3.3 THE INPUT DATA FILE:

3.3.1 General: Before running the model, the input data must be prepared and stored on a disk file. Normally, the text editor residing on the computer system on which the model will be run is used for data entry, modification, and storage.

For convenience in describing the input data file, it will be divided into the following sections:

- General Information Section
- Sensor Data
- Missile Data
- Aircraft Type Data
- Data for the Individual Aircraft
- Attrition Rates
- Seeds for the Random Number Generators

Figure 1 shows a sample data file with sections marked. The data file description below will give, for each section, the names of the input variables, their definitions and units (if any).

3.3.2 General Information Section: This section contains the title and various codes to designate policy decisions.

TITLE 72 alpha characters to identify the run
PRINTR Code to control the program output

STP Simulation end time (minutes)

General Information

```
ACMSIM DEMONSTRATION - BASIC DATA (2 TOMS VS 5 FITR) - FEBRUARY 1?8.
 1  0  18  2 1 1 8 3 1
```

Sensor Data

```
3 SENSOR TYPES
 1
  1   1  75   60   10    9    5  60 60   30   20 0
 2
  1   0 50 45 10 9 5 60 60 30 20 0
 3
   2  1  10    6  10    6    5    2  135   90 90 0
```

Missile Data

```
 3 MISSILE TYPES
   1 TURKEY
 50    4    5    1   180
  2   SEEKER
 20 3 2 1 60
  3 CANNON
 .6   .3   .01   .01   180
```

Aircraft Type Data

```
 2 ACFT TYPES
  1 FITTER
  1  5    2  3   .8   .8  0   0   .9
250   25   90
420   30   45   60  110  180  360
650   30   45   60   85  120  180
 2    2    3    4
 20   20    3    3    5   20   10
 2 TOMCAT
 4  5    1   3    .55 .85 .85 .55   .9
250   25   90
375   30   45   60  120  240  480
650   30   45   60   85  120  240
 1   2    2   2
 20   20    3    3    5    20   10
```

Data for Individual Aircraft

```
 8 ACFT
  2    1 1    45    10   90 15000  200  200    0    0
  2    2 1   210   2    0 15000    0    0    0    0
  2    2 1   150   2    0 15000    0    0    0    0
  1    3 14  315    14   0 18000  310  210   .5    1
  1    3 14  315    14   0 18000  350  240  1.5    1
  1    3 14  295   45    0 18000  250  275  2.5    1
  1    3 14   65   45    0 18000  255  125  3.5    1
  1    3 14    45    14   0 18000  325  160  4.5    1
```

Attrition Rates

```
.8   .8
.9   .9
.33  .33
```

Initialization Information

```
 10  1.000
  5 12345 23456 34567 45678 56789
```

Figure 1. Sample Data for the ACM Model

PARRY	Parry strategy code:	1; Use escorts from same side; 2; Use escorts from opposite side; 3: Use any excort available.
ROEE	Clear-to-fire code for escorts:	Number of visual identifications required before global clear-to-fire.
ROEI	Clear-to-fire code for interceptors:	Number of visual identifications required before global clear-to-fire.

BRKDS — Minimum approach distance before strike group turns to evade interceptor (miles)

CMTDS — Maximum distance at which escorts will be committed to parries (miles).

MXCMT — Maximum number of escorts committed against an identified hostile

3.3.3 Sensor Type Data: The first card of this section must specify the number of sensor types in the data base. Data for each sensor type starts with a card containing the sensor identification number and one or more cards containing the sensor attributes.

N.TYP.SNSR — Number of sensor types. (Plus optional alpha characters identifying the card)

J — The sensor idenification number (J must not be greater than N.TYP.SNSR)

MODE — Code to control sensor operation:

0, sensor may not detect a second target while engaged in tracking

1, sensor may hold any number of targets

MXRNG — Maximum range for this sensor type (miles)

RNG90 — Range for 90-pct detection (miles)

BRNGM — Maximum range in the presence of jamming (miles)

BRN90	90-pct range under jamming (miles)
SR	Sweep rate (number per minute)
SW	Sweep width (degrees)
UP	Upper sweep limit (degrees)
LW	Lower sweep limit (degrees)
JAM	Code to indicate jamming: 1, this sensor is being jammed; 0, no jamming of this sensor.

(Note: The program converts minutes to hours and degrees to radians)

3.3.4 Missile Data: This section starts with a card specifying the number of missile types. It is followed by a card with the missile identification number and "name" (up to 8 alpha characters to be used on reports) and one or more cards with the missile attributes.

N.TYP.MSL	Number of missile types (Plus optional alpha characters identifying the card)
J	Identification number (J must not be greater than N.TYP.MSL)
NAM1	Up to 4 alpha characters
NAM2	Up to 4 alpha characters
MXHD	Maximum head-on range (miles)
MXTL	Maximum tail-on range (miles)
MNHD	Minimum head-on range (miles)
MNTL	Minimum tail-on range (miles)
CO	Maximum angle off from tail (degrees)

3.3.5 Aircraft Type Data: This section starts with a card specifying the number of aircraft types. It is followed by a card with the aircraft identification number and "name" (up to 8 alpha characters to be used on reports) and one or more cards with the aircraft type data.

N.TYP.ACFT	Number of aircraft types (Plus optional alpha characters identifying the card)

J	Identification number (J must not be greater than N.TYP.ACFT)
ANAM1,2	Aircraft type name (Up to 8 alpha characters)
MXTGTS	Maximum number of targets this aircraft can engage simultaneously
RADAR	Radar sensor type identification number
VIZ	Visual sensor type identification number
PLOTR	Efficiency of pilot in radar search (0. - 1.)
PLOTV	Efficiency of pilot in visual search (0. - 1.)
CREWR	Efficiency of crew in radar search (0. - 1.)
CREWV	Efficiency of crew in visual serch (0. - 1.)

Note: No degradation of detection if either pilot or crew code is set to 1; no detection if both are 0.

COMREL	Probability that the aircraft can communicate successfully
SAUNT	Aircraft speed (miles per hour)
BA	Bank angle at speed SAUNT (degrees)
TU	Turn rate at speed SAUNT (degrees per minute)

Note: Miles may be either statute miles or nautical miles as long as the unit is used consistently

3.3.6 Aircraft Data: This section starts with a card specifying the number of individual aircraft (escorts + interceptors + 1). It is followed by one card for each aircraft with the aircraft attributes.

TYPE	Aircraft type
ROLE	Code to indicate the role of the aircraft: 1, the strike group; 2, escorts, and 3, interceptors
STAT	Code to indicate the aircraft status.
	For escorts: 1, active; 2, passive; 3, killed; 4, not in game

	For interceptors: 11, active; 12, passive; 13, killed; 14, not in game.
	Initial values should be: 1, strike group; 1, escorts; 14, interceptors
FB	Relative bearing from the strike group (degrees) (used to compute initial positions with the escorts)
FDIST	Distance from the strike group (Used to compute initial positions with the escorts)(miles)
HD	Initial heading (degrees)
AT	Altitude (feet)
XLOC & YLOC	Initial coordinates (Strike group and interceptors) (miles)
TM	Starting time for the interceptors (minutes)
TG	Initial target for the interceptors (Set to 1 to indicate the strike group)

3.3.7 Attrition Rates

KILL (I,J)	Kill rate for missile type I against aircraft type J

3.3.8 Initialization Information

NOB	Initial number of bombers
REPT	Interval between status reports (hours)
NUMR	Number of random number generator seeds provided
SEED	Seeds for the random number generator

CHAPTER 4 - THE MODEL OUTPUT

4.1 INTRODUCTION - GENERAL: The AIR COMBAT MANEUVER MODEL outputs are produced on-line during program execution and, hence, do not require a Post-Processor or Report Generator separate from the model. Virtually all output reports are straight-forward and require no decoding or interpretation. Figure 2 shows a sample output report.

4.2 THE INPUT SUMMARY REPORTS:

4.2.1 General: The following information is printed for all runs:

-Program name, developer and sponsor
-Run title (user input)
-Values of the control codes (User input)
-Values of the random number generator seeds (User input)
-Values of the "long" and "short" time steps (computed by the program for the maximum aircraft turn rates)
-Summary of the strike force composition and initial direction

If the control code PRINTR is set to 1, a listing of the input file is produced.

4.3 THE CHRONOLOGICAL REPORTS:

4.3.1 General: The Chronological Reports are one-liners which report significant events as they occur during the simulation run. These reports aid the analyst in "debugging" his input data - that is, in determining that the system is behaving in an "intuitively reasonable manner." Each line contains the time of the event, the identities of the aircraft involved, and a brief description of the event.

Events noted are:

Commitment to a target
Detection of a target (visual)
Detection of a target (radar)
Firing of a missile at a target
An interceptor starts a new intercept
An aircraft begins an attack
A detected target is lost
The strike group takes evasive action
An attack is broken off
An interceptor searches for the strike group
An escort resumes its station

4.4 STATUS REPORTS:

4.4.1 General: While the chronological reports provide a running history of the important occurrences during a run, the status reports provide snapshots of the location and status of each aircraft at periodic intervals. The initial status report is printed before action starts and additional reports are printed at intervals specified by the user.

4.4.2 Status Report Contents: The first line of a status report provides the current time (in minutes and seconds) and the number of bombers remaining in the game. Then the following information for each aircraft in the game is given ("Killed" aircraft are included in the report immediately following the kill event, and are dropped from later reports.)

Aircraft identification number
Type
Status
Time
Current location (X, Y coordinates) (miles)
Current velocity (miles/hour)
Current heading (degrees)
Current turn rate (degrees per minute)

Direction of turn
Current target
Number of targets held
Number of first choice missiles
Number of second choice missiles
After-burner time remaining (minutes)

CNO FORCE PROJECTION SYSTEM ANALYSIS
MANY-VERSUS-MANY ACM SIMULATION MODEL (ACMSIM)

DEVELOPED BY: CACI,INC-FEDERAL ARLINGTON VA OFFICES
(CAPT JAMES WILSON USN(RET) AND
DR. JANICE B. FAIN)

SPONSORED BY: OP-962 (MR. GEORGE HAERING)

VERSION DATED: 9 FEBRUARY, 1982

ACMSIM DEMONSTRATION - BASIC DATA (2 TOMS VS 5 FITR) - FEBRUARY 1982

- TIME STEPS CALCULATED AS: 48.6 SECS (LONG), AND 1.3 SECS (SHORT).

STRIKE ADVANCES ON CUS 90.0 WITH 10 ATTACK AND 2 ESCORTS

TIME 0: 0 STATUS REPORT ----- (10 BOMBERS REMAINING).

NO	TY	ST	XLOC	YLOC	VEL	HDG	TM	D	TGT	MSLA	MSLB	TGTS
1	2	1	200.0	200.0	320.	90.0	0.	0	0	2	2	0
2	2	1	198.3	201.0	320.	90.0	0.	0	0	2	2	0
3	2	1	198.3	199.0	320.	90.0	0.	0	0	2	2	0
4	1	14	310.0	210.0	0.	0.	0.	0	0	2	4	0
5	1	14	350.0	240.0	0.	0.	0.	0	0	2	4	0
6	1	14	250.0	275.0	0.	0.	0.	0	0	2	4	0
7	1	14	255.0	125.0	0.	0.	0.	0	0	2	4	0
8	1	14	325.0	160.0	0.	0.	0.	0	0	2	4	0

0:30 FITTER 4 STARTS NEW INTERCEPT FROM BRG 5L/107.8
1:30 FITTER 5 STARTS NEW INTERCEPT FROM BRG 16L/147.5

TIME 1:37 STATUS REPORT ----- (10 BOMBERS REMAINING).

NO	TY	ST	XLOC	YLOC	VEL	HDG	TM	D	TGT	MSLA	MSLB	TGTS
1	2	1	208.6	200.0	320.	90.0	0.	0	0	2	2	0
2	2	1	206.9	201.0	320.	90.0	0.	0	0	2	2	0
3	2	1	206.9	199.0	320.	90.0	0.	0	0	2	2	0
4	1	12	3[illegible]1	210.0	420.	269.9	0.	0	0	2	4	0
5	1	12	3[illegible].2	239.7	420.	247.4	0.	0	0	2	4	0

TIME 2:26 STATUS REPORT ----- (10 BOMBERS REMAINING).

NO	TY	ST	XLOC	YLOC	VEL	HDG	TM	D	TGT	MSLA	MSLB	TGTS
1	2	1	213.0	200.0	320.	90.0	0.	0	0	2	2	0
2	2	1	211.2	201.0	320.	90.0	0.	0	0	2	2	0
3	2	1	211.2	199.0	320.	90.0	0.	0	0	2	2	0
4	1	12	296.3	210.0	420.	269.9	0.	0	0	2	4	0
5	1	12	344.0	237.5	420.	247.4	0.	0	0	2	4	0

Figure 2. Sample of ACM Model Output

```
5:15 CONTACT. FITTER      4 DETECTS BOMBER GROUP BRG  11L/ 49.8
5:15 CONTACT. FITTER      6 DETECTS TOMCAT      2 BRG  26R/ 49.9
5:16 CONTACT. FITTER      6 DETECTS BOMBER GROUP BRG  24R/ 49.8
5:22 CONTACT. FITTER      4 DETECTS TOMCAT      2 BRG  10L/ 49.8
5:23 CONTACT. FITTER      4 DETECTS TOMCAT      3 BRG  12L/ 49.8
5:23 CONTACT. FITTER      6 DETECTS TOMCAT      3 BRG  25R/ 49.7

5:25 TOMCAT      3 FIRES A TURKEY    AT FITTER      4
---- NO JOY ----

5:26 TOMCAT      3 FIRES A TURKEY    AT FITTER      4
---- KILL ONE ----

     ( 1 NOW HOLDS  0 TGTS).
     ( 2 NOW HOLDS  0 TGTS).
5:26 TOMCAT      3 DROPS IT  (TGT GONE).       BEGINS REJOIN.
     ( 3 NOW HOLDS  0 TGTS).
5:33 CONTACT. TOMCAT      3 DETECTS FITTER      7 BRG  51R/ 58.0
5:33 TOMCAT      2 COMMITS AGAINST FITTER     7, BRG  63R/ 60.0
     ( 2 NOW HOLDS  1 TGTS).
     TOMCAT      2 AFFIRMS FITTER      7 FOR ATTACK.
5:35 CONTACT. TOMCAT      2 DETECTS FITTER      7 BRG  59R/ 59.7
5:40 PUNCH. FITTER      6 BEGINS ATTACK.
5:40 FITTER      6 COMMITS AGAINST BOMBER GROUP, BRG  24R/ 45.0
     FITTER      6 AFFIRMS BOMBER GROUP FOR ATTACK.
5:56 TOMCAT      3 RESUMES STATION.
5:57 LOST CONTACT. TOMCAT      3 LOSES FITTER      7

TIME     6: 1  STATUS REPORT  -----  (  10 BOMBERS REMAINING).
NO TY ST  XLOC   YLOC  VEL     HDG    TN   B  TGT  MSLA MSLB   TGTS
 1  2  1 232.1 200.0 320.    90.0    0.   0   0     2    2     0
 2  2  1 229.6 199.3 320.   145.0    0.   0   7     2    2     1
 3  2  1 [illegible] 199.0 320.    90.0    0.   0   0     0    2     0
 4  1 13 [illegible] 209.9 420.   269.9    0.   0   0     2    4     0
 5  1 12 320.8 227.9 420.   247.4    0.   0   0     2    4     0
 6  1 11 248.5 238.4 420.   196.6    0.   0   1     2    4     1
 7  1 12 254.6 152.2 650.   359.2    0.   0   0     2    4     0
 8  1 12 316.0 165.6 420.   302.1    0.   0   0     2    4     0

6:15 CONTACT. FITTER      7 DETECTS TOMCAT      2 BRG  28L/ 49.9
6:15 CONTACT. FITTER      7 DETECTS TOMCAT      3 BRG  27L/ 49.9
6:16 CONTACT. FITTER      7 DETECTS BOMBER GROUP BRG  24L/ 49.8

6:21 TOMCAT      2 FIRES A TURKEY    AT FITTER      7
---- KILL ONE ----

     ( 1 NOW HOLDS  0 TGTS).
     ( 3 NOW HOLDS  0 TGTS).
6:21 TOMCAT      2 DROPS IT  (TGT GONE).       BEGINS REJOIN.
     ( 2 NOW HOLDS  0 TGTS).
6:52 CONTACT. TOMCAT      2 DETECTS FITTER      6 BRG  17L/ 38.6
6:52 TOMCAT      2 COMMITS AGAINST FITTER     6, BRG  17L/ 38.6
     ( 2 NOW HOLDS  1 TGTS).
     TOMCAT      2 AFFIRMS FITTER      6 FOR ATTACK.

6:53 TOMCAT      2 FIRES A TURKEY    AT FITTER      6
---- NO JOY ----
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Figure 2. Sample of ACM Model Output (continued)

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7:21 CONTACT. BOMBER GROUP DETECTS FITTER      8 BRG  23R/ 74.9
  SCRAPING ESCORT PARRY BARREL
7:21 TOMCAT      3 COMMITS AGAINST FITTER     8, BRG  22R/ 76.1
    ( 3 NOW HOLDS  1 TGTS).
    TOMCAT      3 AFFIRMS FITTER      8 FOR ATTACK.
7:27 CONTACT. TOMCAT      3 DETECTS FITTER      8 BRG   7R/ 74.7
7:31 CONTACT. BOMBER GROUP DETECTS FITTER      5 BRG  19L/ 74.9
7:31 TOMCAT      2 COMMITS AGAINST FITTER     5, BRG  52R/ 78.4
    ( 2 NOW HOLDS  2 TGTS).
    TOMCAT      2 AFFIRMS FITTER      6 FOR ATTACK.

  7:41 CONTACT. TOMCAT      3 DETECTS FITTER      5 BRG  34L/ 74.9
  7:51 CONTACT. TOMCAT      2 DETECTS FITTER      5 BRG  54R/ 75.0

TIME     8: 1  STATUS REPORT  -----  (  10 BOMBERS REMAINING).
NO TY ST  XLOC  YLOC  VEL     HDG     TM    D  TGT  MSLA MSLB   TGTS
 1  2  1 242.8 200.0 320.    90.0    0.    0   0     2    2     0
 2  2  1 237.6 201.7 320.    19.2    0.    0   6     0    2     2
 3  2  1 241.0 198.1 320.   105.0    0.    0   8     0    2     1
 5  1 12 307.9 222.5 420.   247.4    0.    0   0     2    4     0
 6  1 11 244.6 224.9 420.   194.3  110.0 -1   1     2    4     1
 8  1 12 304.1 173.1 420.   302.1    0.    0   0     2    4     0


TIME     9: 1  STATUS REPORT  -----  (  10 BOMBERS REMAINING).
NO TY ST  XLOC  YLOC  VEL     HDG     TM    D  TGT  MSLA MSLB   TGTS
 1  2  1 248.1 200.0 320.    90.0    0.    0   0     2    2     0
 2  2  1 239.3 206.7 320.    19.2    0.    0   6     0    2     2
 3  2  1 246.2 196.7 320.   105.0    0.    0   8     0    2     1
 5  1 12 301.4 219.8 420.   247.4    0.    0   0     2    4     0
 6  1 11 243.9 218.0 420.   176.0    0.    0   1     2    4     1
 8  1 12 298.2 176.8 420.   302.1    0.    0   0     2    4     0


  9:13 LOST CONTACT. TOMCAT      2 LOSES FITTER      5
      ( 2 NOW HOLDS  1 TGTS).
      TOMCAT      2 AFFIRMS FITTER      6 FOR ATTACK.
  9:20 CONTACT. TOMCAT      2 DETECTS FITTER      5 BRG  56R/ 60.4
  9:20 TOMCAT      3 COMMITS AGAINST FITTER     5, BRG  39L/ 56.3
      ( 3 NOW HOLDS  2 TGTS).
      TOMCAT      3 AFFIRMS FITTER      8 FOR ATTACK.
  9:28 CONTACT. FITTER      8 DETECTS BOMBER GROUP BRG   7L/ 49.8
  9:28 CONTACT. FITTER      8 DETECTS TOMCAT      3 BRG  12L/ 50.0
  9:36 CONTACT. FITTER      5 DETECTS BOMBER GROUP BRG   1R/ 49.9
  9:37 TALLYHO. FITTER      6 SEES TOMCAT      2 BRG  60R/  5.7
  9:46 TALLYHO. TOMCAT      2 SEES FITTER      6 BRG   8R/  4.5
  9:56 CONTACT. TOMCAT      2 DETECTS FITTER      8 BRG  58R/ 59.2

  10: 2 TOMCAT      2 FIRES A SEEKER   AT FITTER      6
   ---- KILL ONE ----

       ( 1 NOW HOLDS  0 TGTS).
       ( 3 NOW HOLDS  2 TGTS).
  10: 2 TOMCAT      2 DROPS IT  (TGT GONE).      BEGINS REJOIN.
       ( 2 NOW HOLDS  0 TGTS).
  10:10 CONTACT. FITTER      5 DETECTS TOMCAT      2 BRG  16R/ 49.7
  10:30 CONTACT. FITTER      8 DETECTS TOMCAT      2 BRG   1R/ 49.9

  TIME    18: 1  STATUS REPORT  -----  (   8 BOMBERS REMAINING).
  NO TY ST  XLOC  YLOC  VEL     HDG     TM    D  TGT  MSLA MSLB   TGTS
   1  2  1 286.3 201.8 320.    90.0    0.    0   0     2    2     0
   3  2  1 284.6 200.8 320.    90.0    0.    0   0     0    1     0


   18: 1  SIMULATION ENDS NORMALLY
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Figure 2. Sample of ACM Model Output (continued)

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