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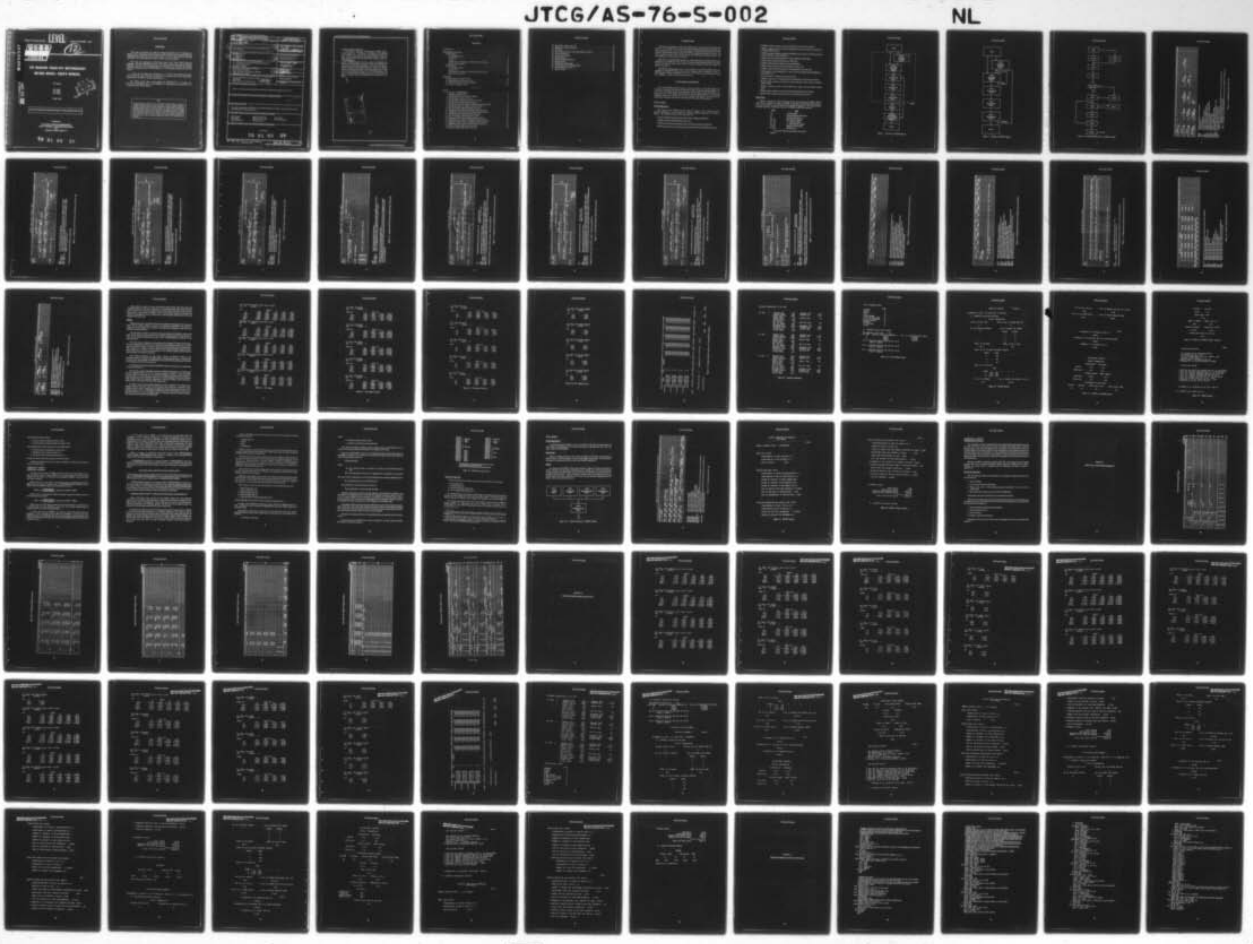

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THE MISSION TRADE-OFF METHODOLOGY (MTOM) MODEL: USER'S MANUAL

Final Report

W. J. Strauss
N. D. Bailey
M. W. Kasper

October 1978

Prepared for

THE JOINT LOGISTICS COMMANDERS
JOINT TECHNICAL COORDINATING GROUP
ON
AIRCRAFT SURVIVABILITY

FOREWORD

This report summarizes the results of research performed by A. T. Kearney, Inc., Chicago, IL, for Aeronautical Systems Division (AFSC), Deputy for Development Planning, Wright-Patterson AFB, OH, under contract F33615-74-C-5141. The work was performed from March 1974 to February 1975, and L. E. Boyd was project engineer.

The work was sponsored by JTCG/AS as part of the 3-year TEAS (Test and Evaluation, Aircraft Survivability) program. The TEAS program was funded by DDR&E/ ODDT&E. The effort was conducted under the direction of the JTCG/AS Survivability Assessment Subgroup as part of TEAS element 5.1.7.4, *Survivability Engineering Trade-Off Studies*.

A review of this report was conducted by J. L. Kemp, Naval Weapons Support Center, Crane, IN, under JTCG/AS task SA-6-02. As a result of that review, changes were made which are intended to enhance comprehension.

The authors would like to acknowledge the contributions of L. E. Boyd and R. K. Frick (ASD/XROL); also to their colleague M. A. Dloogatch for his contributions to the Mission Trade-Off Cost Model.

NOTE

This technical report was prepared by the Survivability Assessment Subgroup of the Joint Technical Coordinating Group on Aircraft Survivability in the Joint Logistics Commanders' organization. Because the Services' aircraft survivability development programs are dynamic and changing, this report represents the best data available to the subgroup at this time. It has been coordinated and approved at the JTCG subgroup level. The purpose of the report is to exchange data on all aircraft survivability programs, thereby promoting interservice awareness of the DOD aircraft survivability program under the cognizance of the Joint Logistics Commanders. By careful analysis of the data in this report, personnel with expertise in the aircraft survivability area should be better able to determine technical voids and areas of potential duplication or proliferation.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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18. SUPPLEMENTARY NOTES

For more information on MTOM, see JTCG/AS-76-S-001, *The Mission Trade-Off Methodology (MTOM) Model: Model Description*

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Trade studies	Effectiveness model	Cost model
Survivability	Mission effectiveness	Aircraft attrition
Trade-off models	Life cycle cost	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

See reverse.

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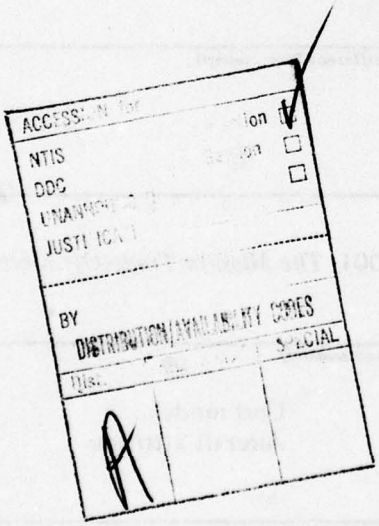
Aeronautical Systems Division

The Mission Trade-Off Methodology (MTOM) Model: User's Manual, by W. J. Strauss, N. D. Bailey, M. W. Kasper, A. T. Kearney, Inc., Chicago, IL. Wright-Patterson AFB, OH, ASD, for Joint Technical Coordinating Group/Aircraft Survivability, October 1978. 141 pp. (JTCG/AS-76-S-002, publication UNCLASSIFIED.)

The MTOM programs provide a means for evaluating the relative cost-effectiveness of proposed aircraft modifications for the purpose of enhancing survivability. There are two programs: MTO/E (mission trade-off/effectiveness) model and MTO/C (mission trade-off/cost) model. This report is designed to enable the user to prepare the inputs for the MTOM programs. The report explicitly explains formats, outputs, the relationships of inputs to outputs, and the limitations and restrictions on the inputs.



CONTENTS

INTRODUCTION

This report is intended to enable the prospective user to prepare inputs and interpret outputs of the MTOM (mission trade-off methodology) model computer programs. The report addresses itself to the overall organization of MTOM which includes the MTO/E (mission trade-off/effectiveness) model and MTO/C (mission trade-off/cost) model. The report explicitly explains input formats, outputs, the relationships of inputs to outputs, and the limitations and restrictions on the inputs.

The purpose of the MTOM programs is to evaluate alternate survivability enhancement programs on a cost-effective basis, as compared to the standard baseline aircraft. The model has the generality to treat a wide variety of mission scenarios in which the aircraft are expected to perform.

The MTOM complete input data set (card listing) for the sample problem is given in Appendix A; Appendix B shows the complete computer output. Appendix C shows the MTOM program written in FORTRAN IV for the CDC 6600 computer and uses card input only. A glossary of terms is presented in Appendix D.

MTOM MODEL DESCRIPTION

The overall MTOM model structure is shown in Figure 1. The figure depicts the interaction of MTO/E model which evaluates the number of aircraft required initially to do a fixed job and MTO/C model which calculates the life cycle cost for the aircraft, (i.e., shows how the various MTO/E submodels flow into the MTO/C model). The submodel sub-MOE (measures of effectivenss) has been grouped with MTO/C, since most of the submeasures computed are based on cost associated with modification programs.

MTO/E MODEL

Overall Organization

The concept of the MTO/E model is shown in Figure 2. For a baseline aircraft, proposed modification, and scenario, the computer program organization is shown in Figure 3. The principal functions of the subroutines are:

- Program MTOM model calls various subroutines in MTO/E and MTO/C
- JOBIN, MTODIN and MTOSIN provide inputs
- MTO/W model generates passes per target and targets per sortie information
- MTO/D model calls the subroutines which compute survival probabilities for events

- COMPT computes tentative survival probabilities for all events and all mods
- SURV1 computes tentative survival probabilities for each event and for each mod for a swingaround maneuver
- SURV2 computes tentative survival probabilities for each event and for each mod for all maneuvers except swingaround
- FIND1 performs single interpolation on PK (probability of kill) tables
- FIND2 performs double interpolation on PK tables
- COMPS computes diluted mission survival probabilities
- PSUR computes diluted survival probabilities for each event
- COMSC computes attrition allocation and scaling factors for each event
- GM computes a kill probability for a given event and updates kill probabilities for each defense zone
- SCAL computes a scaling factor for a given event
- COMPN computes scaled nondiluted survival probabilities for all events in mission
- MTO/P model computes the number of passes delivered and the number of aircraft killed on flight
- ACKILL computes number of aircraft killed for a single event and updates running totals
- MTO/S model computes a sortie rate and the damage-to-kill ratio for mods
- MTO/F model computes the number of aircraft required to do the job.

Input Forms

Figures 4 through 21 (input forms) specify the input formats for MTO/E. MTO/C input, which completes the input for MTOM, are discussed under *MTO/C Model* section. The inputs and their units are defined more thoroughly in Appendix D. The input forms are grouped, in general, according to their use in MTOM. The MTO/E inputs are:

Form	Input
1A	Job Parameters
2A	Weapon Delivery Parameters
3A	PK Table Dimensions
3B - 3E	PK Tables for Baseline
3F - 3I*	PK Tables for Mods
4A - 4C	Flightpath Characteristics
5A, 5B	Defensive Weapon Mix
6A, 6B	Maintenance

*Used only if PK for mod differs from PK for baseline.

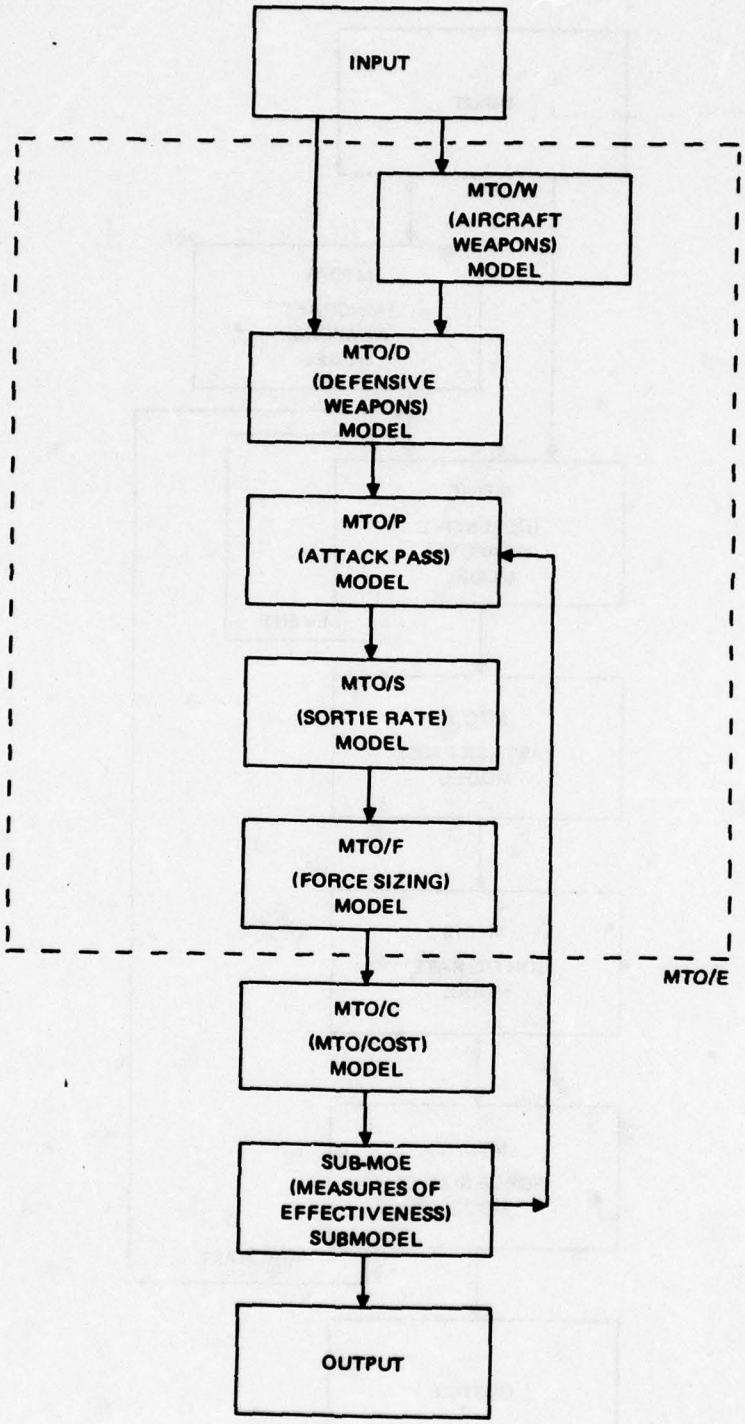


Figure 1. Structure of MTOM Model.

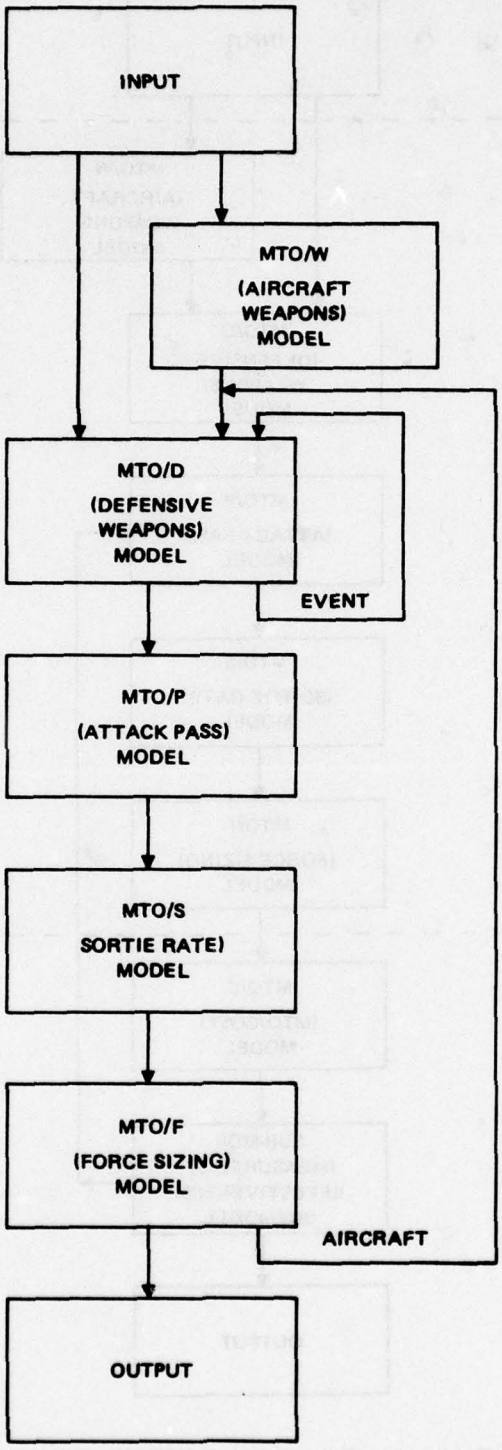


Figure 2. Diagram of MTO/E Model.

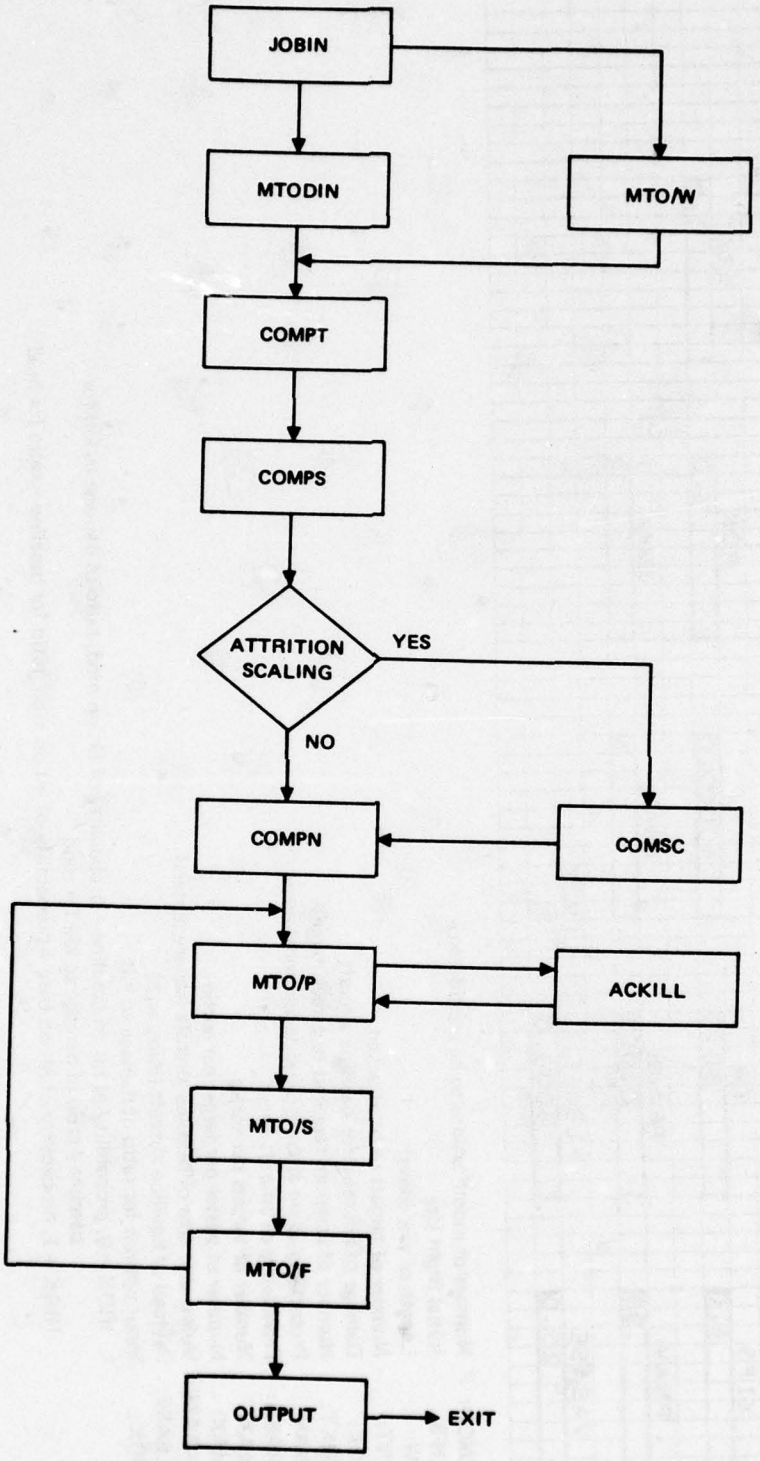
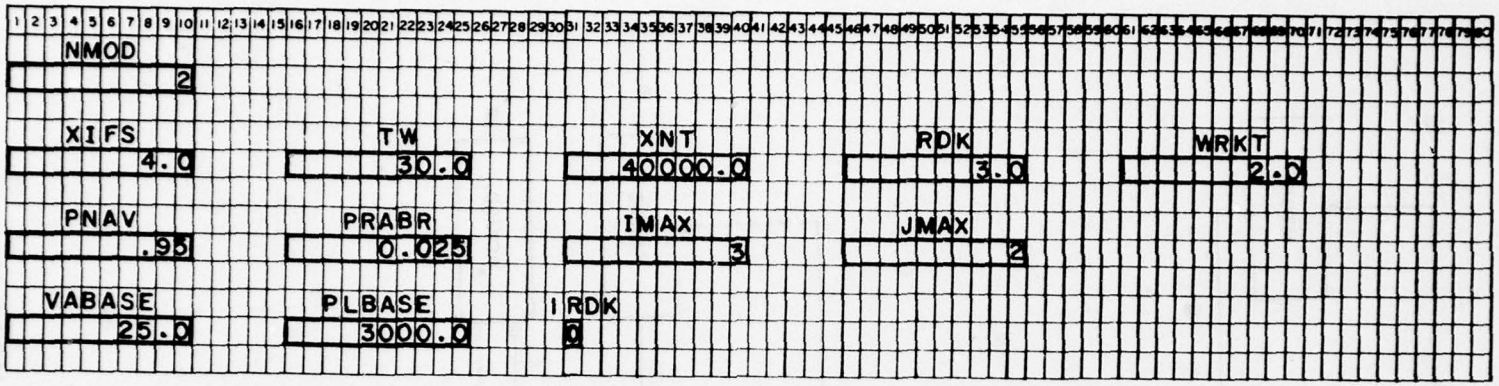


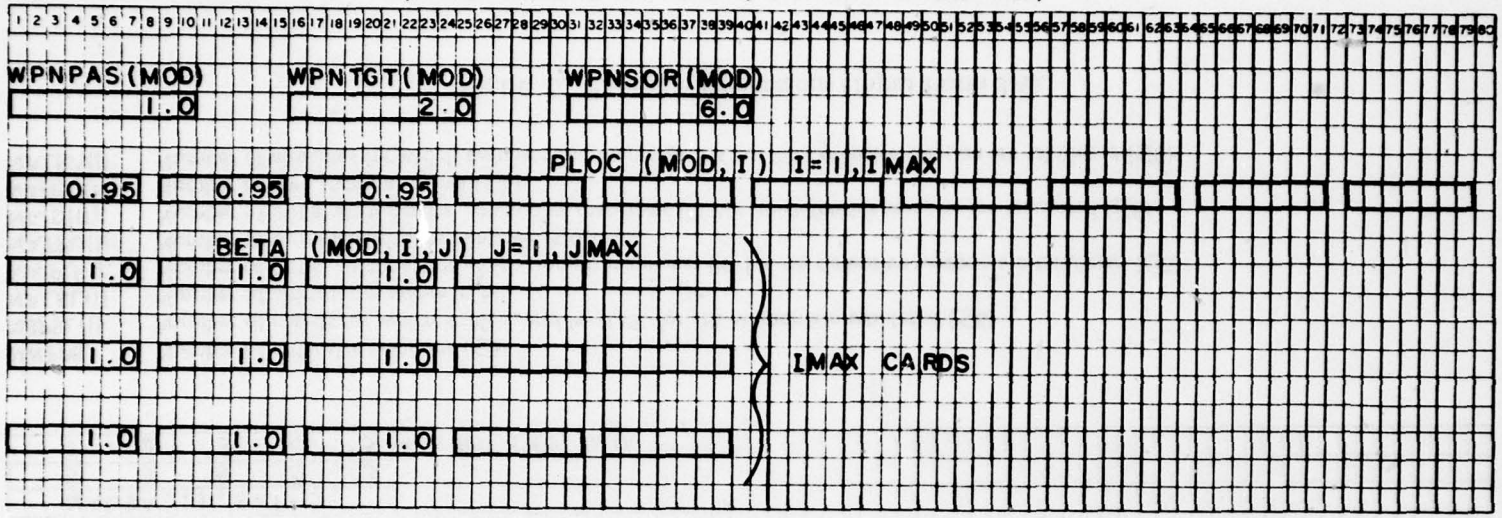
Figure 3. Overall Program Flow of MTO/E Model.



NMOD: Number of modifications to be considered
XIFS: Initial flight size
TW: Length of war (days)
XNT: Number of targets to be attacked
RDK: Damage to kill ratio for baseline aircraft
WRKT: Number of weapons required to attack target
PNAV: Probability of no aircraft gross navigational error
PRABR: Probability of aircraft abort
IMAX: Number of targets per sortie
JMAX: Number of passes per target per sortie
VABASE: Vulnerable area of baseline aircraft (square meters)
PLBASE: Payload of baseline aircraft (kilograms)
IRDK: Input options for ratio of damage to kill
IRDK = 0, probability of hit on baseline = probability of hit on mod, ratio of damage to kill for baseline ≠ ratio of damage to kill for mod
IRDK = 1, probability of hit on base ≠ probability of hit on mod, ratio for baseline = ratio for mod

Figure 4. Job Parameters (Input Form 1A).

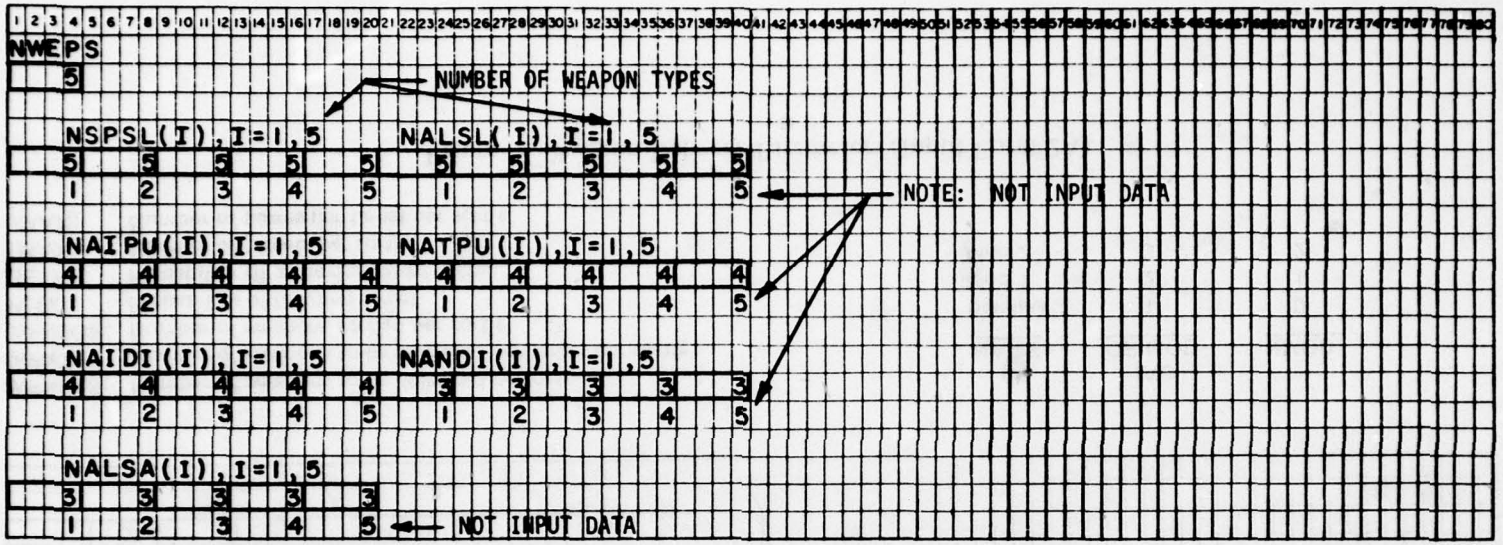
(SAMPLE BASELINE DATA SHOWN, ONE FORM FOR EACH MOD)



WPNPAS:	Number of weapons to be delivered per pass
WPNTGT:	Number of weapons to be delivered per target per sortie
WPNSOR:	Number of weapons carried per sortie
PLOC:	Probability of locating target
BETA:	Probability of achieving target lock-on
IMAX:	Number of targets per sortie
JMAX:	Number of passes per target per sortie

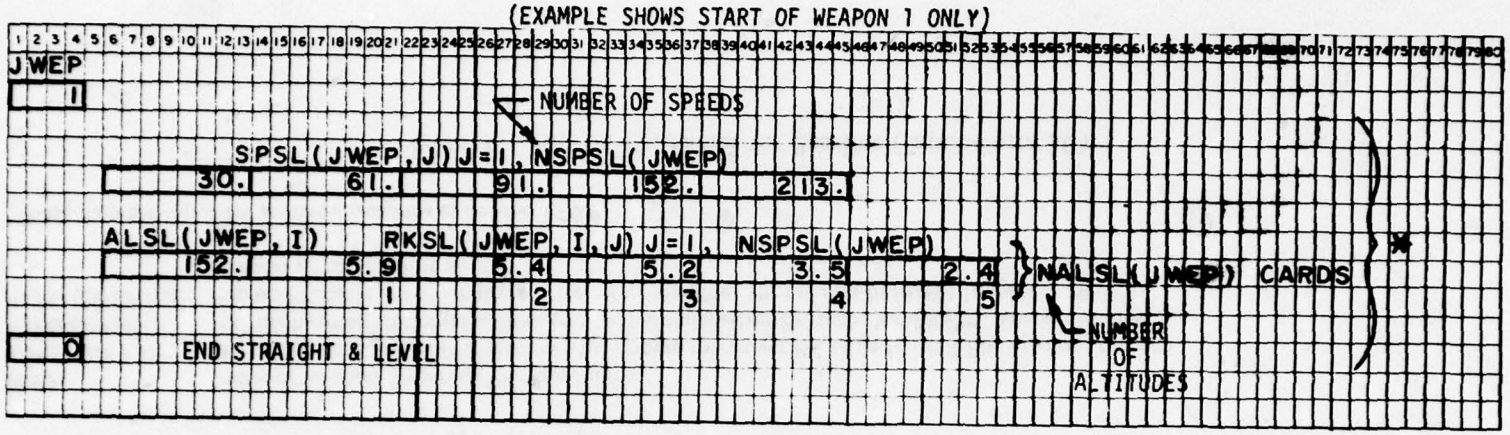
NAME	IAC OR MOD	NMOD
Baseline	1	0
Mod 1	2	1
Mod 2	3	2

Figure 5. Weapon Delivery Parameters (Input Form 2A).



NWEPS: Number of defensive weapons (≤5)
NSPSL(I): Number of speeds for which straight and level PK for ith weapon are tabulated (≤5)
NALSL(I): Number of altitudes as above (≤5)
NAIPU(I): Number of initial altitudes for which pop-up maneuver PK for ith defensive weapon are tabulated (≤5)
NATPU(I): Number of terminal altitudes as above (≤5)
NAIDI(I): Number of initial altitudes for which dive maneuver PK for ith defensive weapon are tabulated (≤5)
NANDI(I): Number of dive angles as above (≤5)
NALSA(I): Number of altitudes for which swingaround maneuver PK for ith defensive weapon are tabulated (≤5)

Figure 6. PK Table Dimensions (Input Form 3A).

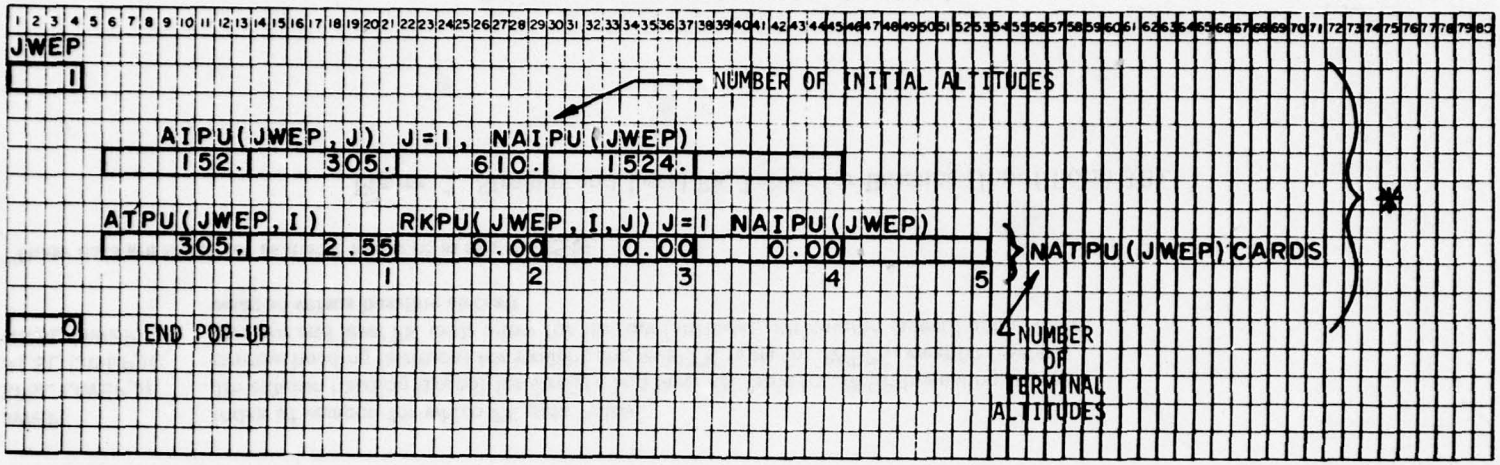


JWEP: Index of weapon for which PK data follow
SPSL (JWEP,J): Jth column heading (speed) for straight and level PK table for JWEPth weapon (m/sec)
ALSL (JWEP,I): Ith row heading (altitude) for straight and level PK table for JWEPth weapon (meters)
RKSL (JWEP,I,J): Straight and level PK table entry for ith row (altitude), jth column (speed) and JWEPth weapon versus baseline aircraft

*These data are input for as many weapons as desired (≤5).

Figure 7. Straight and Level PK Tables for Baseline (Input Form 3B).

(EXAMPLE SHOWS START OF WEAPON 1 ONLY)

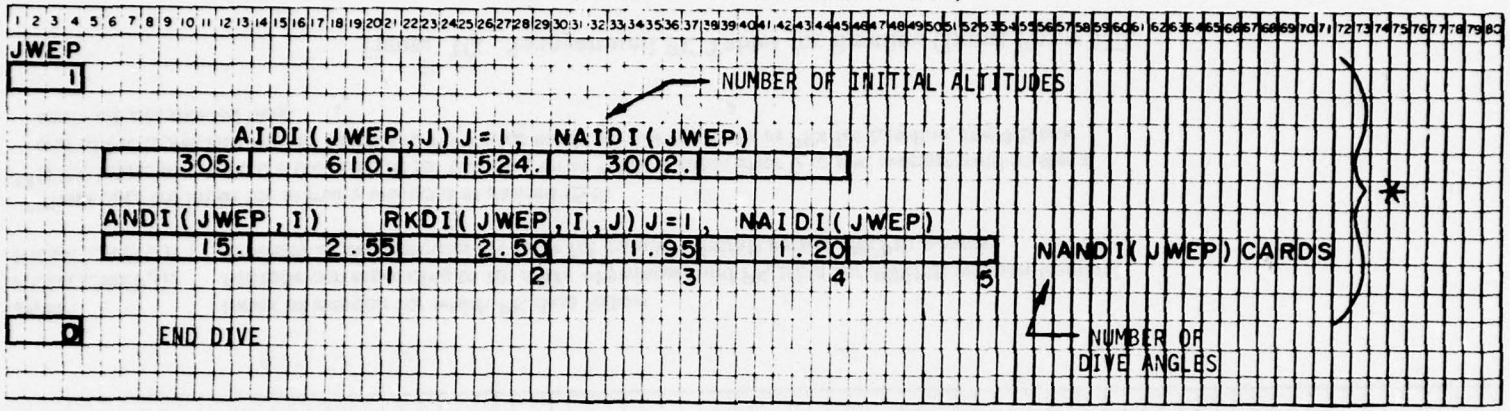


JWEP:	Index of weapon for which PK data follow
AIPU (JWEP,J):	Jth column heading (initial altitude) for pop-up maneuver PK table for JWEPth weapon (meters)
ATPU (JWEP,I):	Ith row heading (terminal altitude) for pop-up maneuver PK table for JWEPth weapon (meters)
RKPU (JWEP,I,J):	Pop-up PK table entry for ith row (terminal altitude) jth column (initial altitude) for JWEPth weapon versus baselline aircraft

*These data are input for as many weapons as desired (≤5).

Figure 8. Pop-Up PK Tables for Baseline (Input Form 3C).

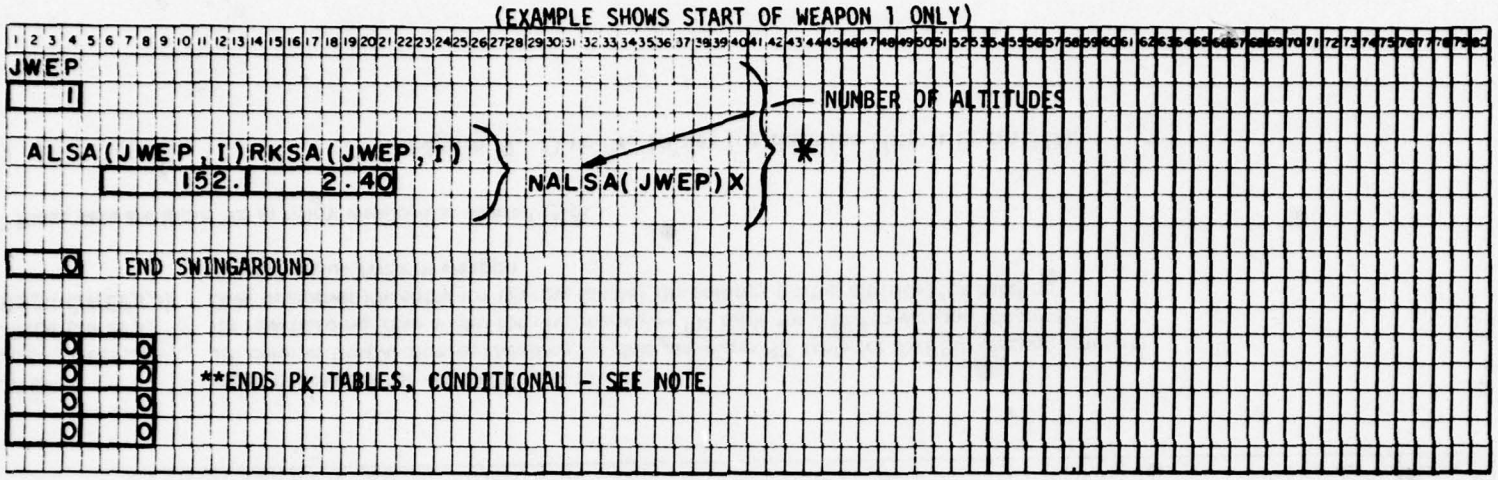
(EXAMPLE SHOWS START OF WEAPON 1 ONLY)



JWEP:	Index of weapon for which PK data follow
AIDI (JWEP,J):	Jth column (initial altitude) heading for dive maneuver PK table for JWEPth weapon (meters)
ANDI (JWEP,I):	Ith row heading (dive angle) for dive maneuver PK table for JWEPth weapon (degrees)
RKDI (JWEP,I,J):	Dive maneuver PK entry for ith row (angle) jth column (initial altitude) for baseline aircraft versus JWEPth weapon

*These data are input for as many weapons as desired (≤5).

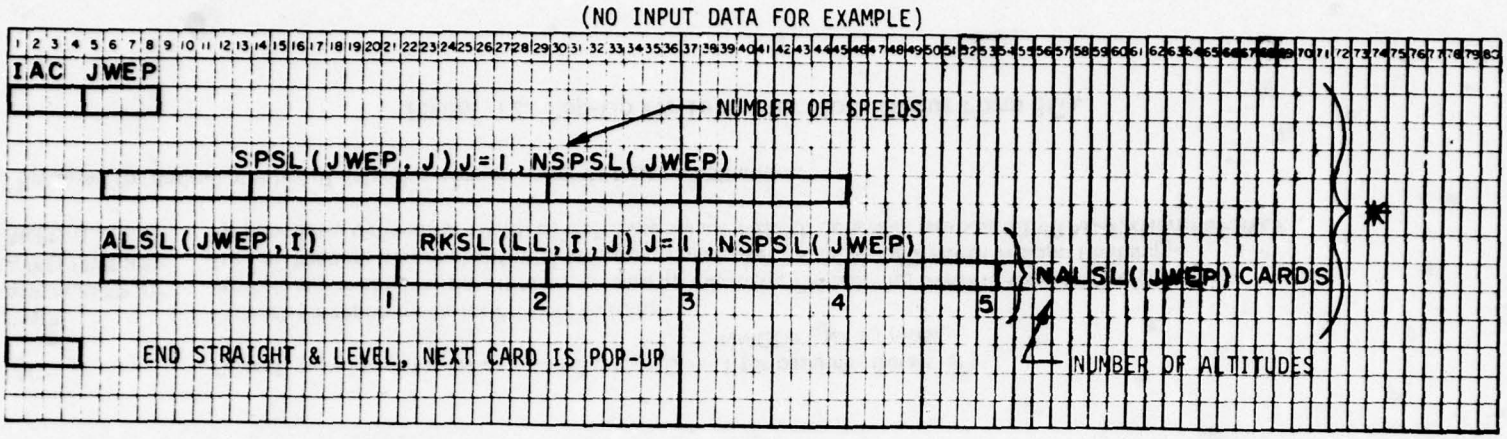
Figure 9. Dive PK Tables for Baseline (Input Form 3D).



JWEP: Index of weapon for which PK data follow
ALSA (JWEP,I): Altitude corresponding to ith entry of swingaround PK table for JWEPth weapon (meters)
RKSA (JWEP,I): Ith entry of swingaround PK table for baseline aircraft versus JWEPth weapon

*These data are input for as many weapons as desired (≤5).
**If PK tables for mods are the same as for baseline, enter 4 blank cards after 0 to end swingaround to signal end of PK tables and skip to Form 4A. If PKs for mods are not the same as PKs for baseline, the 4 blank cards are not needed here.

Figure 10. Swingaround PK Tables for Baseline (Input Form 3E).



IAC: Modification index for PK data to follow: IAC = 1 for baseline aircraft
NMOD+1 for aircraft mods

JWEP: Defensive weapon index for PK data to follow

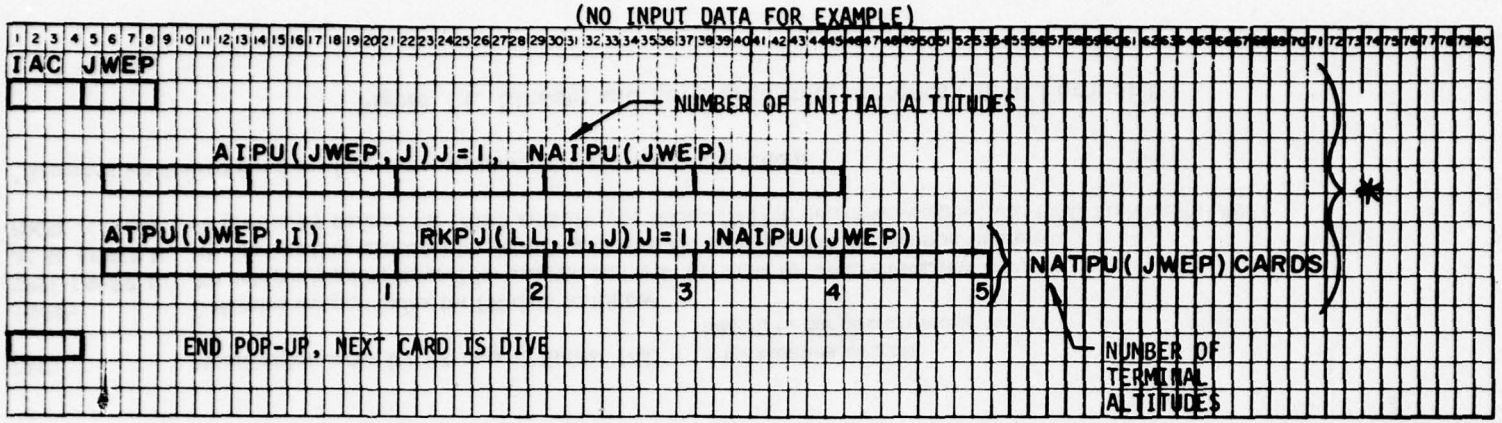
SPSL (JWEP,J): Jth column heading (speed) for straight and level PK table for JWEPth weapon (m/sec)

ALSL (JWEP,I): Ith row heading (altitude) for straight and level PK table for JWEPth weapon (meters)

RKSL (LL,I,J): As previously defined for IACth aircraft type versus JWEPth defensive weapon: LL=(IAC-1)xNWEPS+JWEP

*Repeated for desired number of defensive weapon - aircraft type combinations.

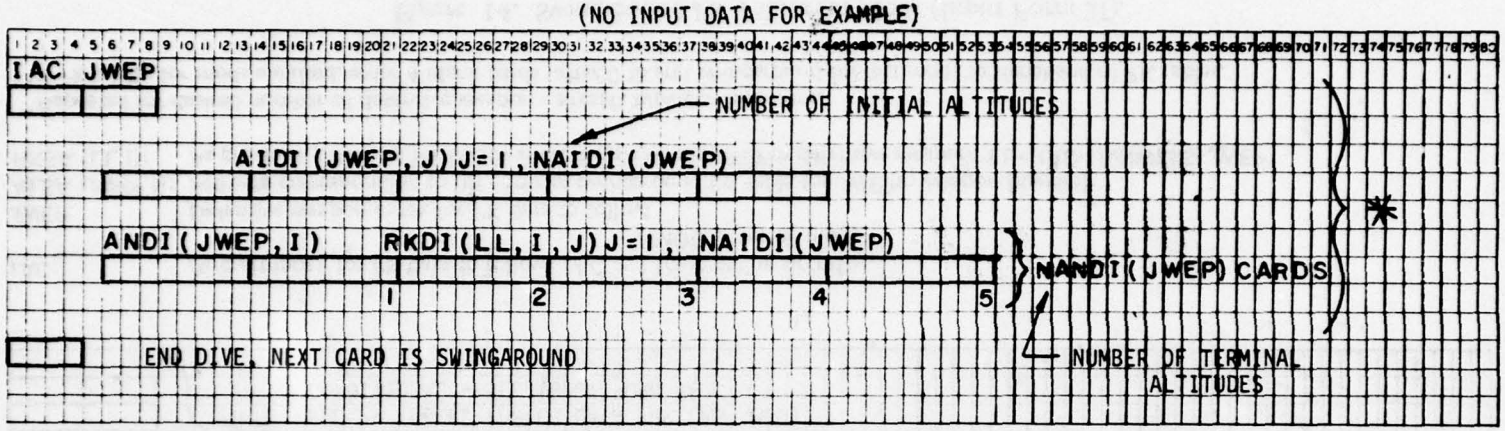
Figure 11. Straight and Level PK Tables for Mods (Input Form 3F).



IAC:	Aircraft type index for PK data to follow: IAC = 1 for baseline aircraft NMOD+1 for all mods
JWEP:	Defensive weapon index for PK data to follow
AIPU (JWEP,J):	Jth column heading (initial altitude) for pop-up maneuver PK table for JWEPth weapon (meters)
ATPU (JWEP,I):	Ith row heading (terminal altitude) for pop-up maneuver PK table for JWEPth weapon (meters)
RKPU (LL,I,J):	As previously defined for IACth aircraft type versus JWEPth defensive weapon: LL=(IAC-1)xNWEPS+JWEP

*Repeated for desired number of defensive weapon - aircraft type combinations.

Figure 12. Pop-Up PK Tables for Mods (Input Form 3G).



IAC: Aircraft modification index for PK data to follow: IAC = 1 for baseline aircraft
NMOD+1 for all mods

JWEP: Defensive weapon index for PK data to follow

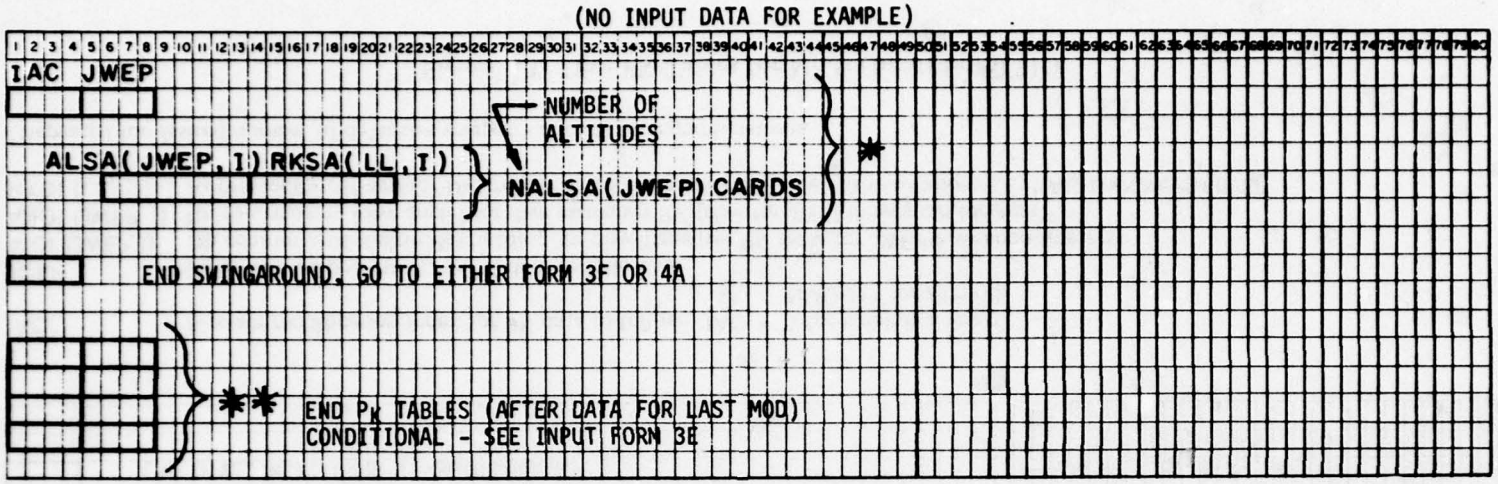
AIDI (JWEP,J): Jth column (initial altitude) heading for dive maneuver PK table for JWEPth weapon (meters)

ANDI (JWEP, I): Ith row heading (dive angle) for dive maneuver PK table for JWEPth weapon (degrees)

RKDI (LL,I,J): As previously defined for IACth aircraft type versus JWEPth defensive weapon: LL=(IAC-1)xNWEPS+JWEP

*Repeated for desired number of defensive weapon - aircraft type combinations.

Figure 13. Dive PK Tables for Mods (Input Form 3H).



IAC: Aircraft index for PK data to follow: IAC = 1 for baseline aircraft
NMOD+1 for all mods

JWEP: Defensive weapon index for PK data to follow

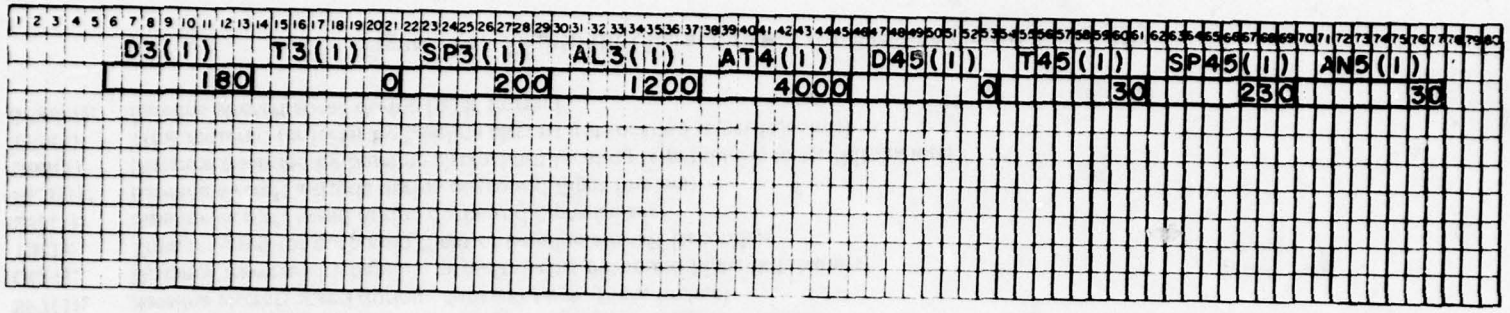
ALSA (JWEP,I): Altitude corresponding to ith entry of swingaround PK table for JWEPth weapon (meters)

RKSA (LL,I): As previously defined for IACth aircraft type versus JWEPth defensive weapon: LL=(IAC-1)xNWEPS+JWEP

*Repeated for desired number of defensive weapon - aircraft type combinations.

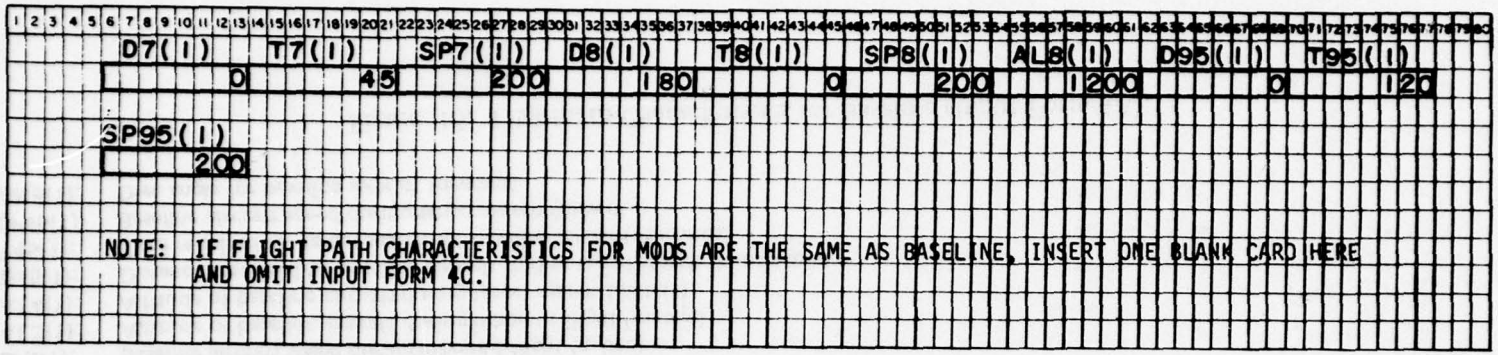
**If PK tables for mods are used, enter 4 blank cards (after 0 to end swingaround for last mod) to signal end of PK tables.

Figure 14. Swingaround PK Tables for Mods (Input Form 3I).



D3(1): Distance traversed by baseline aircraft during inbound flight (kilometers)
T3(1): Time required for inbound flight of baseline aircraft (seconds)
SP3(1): Baseline aircraft speed during inbound flight (m/sec)
AL3(1): Altitude of baseline aircraft during inbound flight (meters)
AT4(1): Altitude of baseline aircraft during target search (meters)
D45(1): Distance traversed by baseline aircraft during target search (kilometers)
T45(1): Time required for target search for baseline aircraft (seconds)
SP45(1): Baseline aircraft speed during target search (m/sec)
AN5(1): Dive angle for baseline aircraft (degrees)

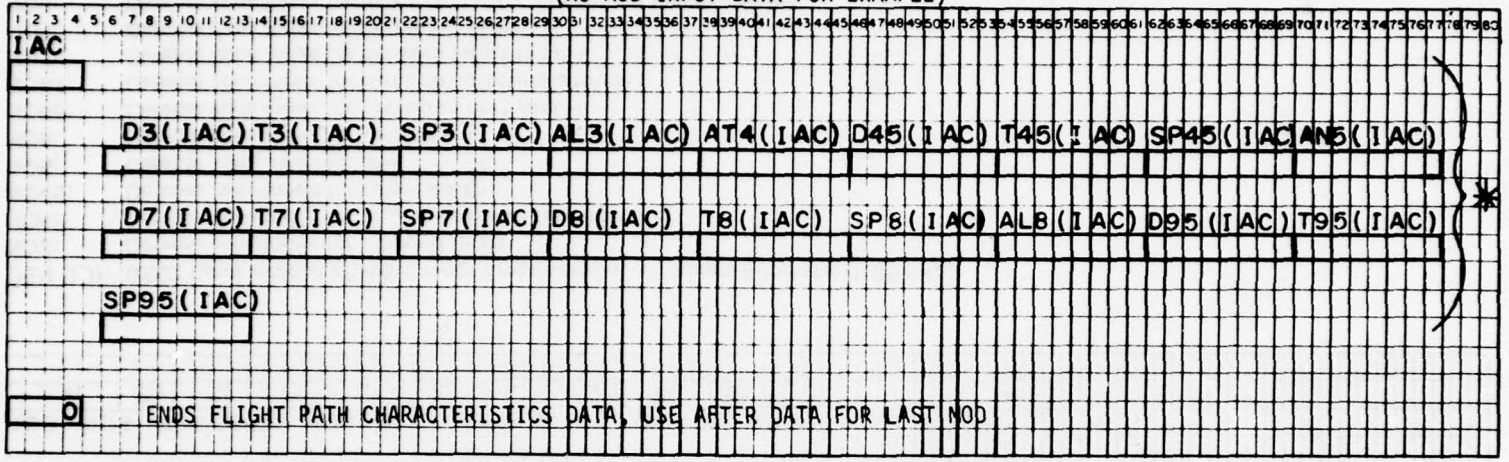
Figure 15. Flightpath Characteristics for Baseline (Input Form 4A).



D7(1): Between target distance for baseline aircraft (kilometers)
T7(1): Time required for between target flight for baseline aircraft (seconds)
SP7(1): Baseline aircraft speed during - between target flight (m/sec)
D8(1): Distance traversed by baseline aircraft during outbound flight (kilometers)
T8(1): Time required for outbound flight of baseline aircraft (seconds)
SP8(1): Baseline aircraft speed during outbound flight (m/sec)
AL8(1): Baseline aircraft altitude during outbound flight (meters)
D95(1): Distance traversed by baseline aircraft not locating target during loiter (kilometers)
T95(1): Time required for loiter by baseline aircraft not locating target (seconds)
SP95(1): Baseline aircraft speed during loiter (m/sec)

Figure 16. Flightpath Characteristics for Baseline (Input Form 4B).

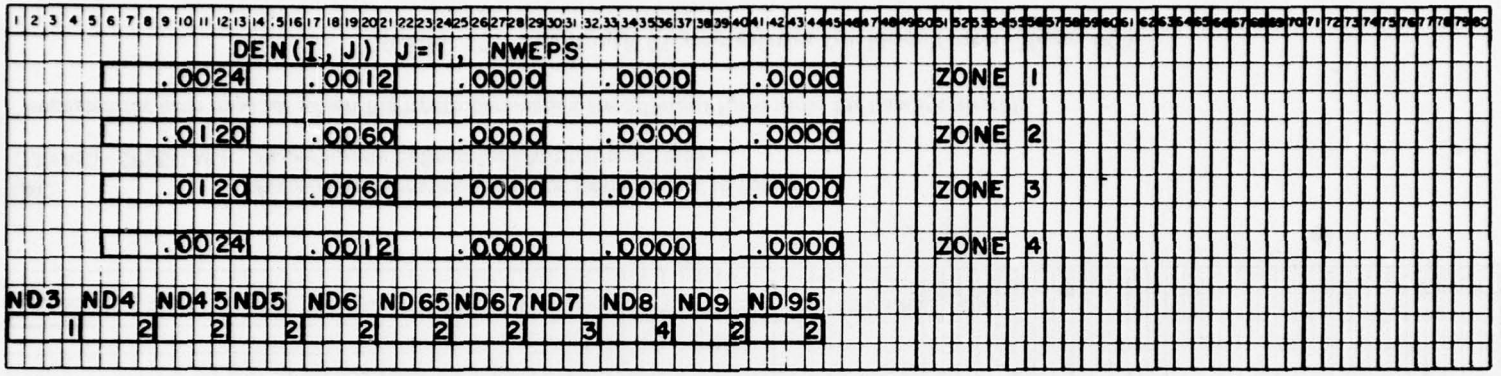
(NO MOD INPUT DATA FOR EXAMPLE)



IAC: Aircraft modification index for scenario data to follow
D3(IAC) - SP95(IAC): As previously defined for IACth aircraft type

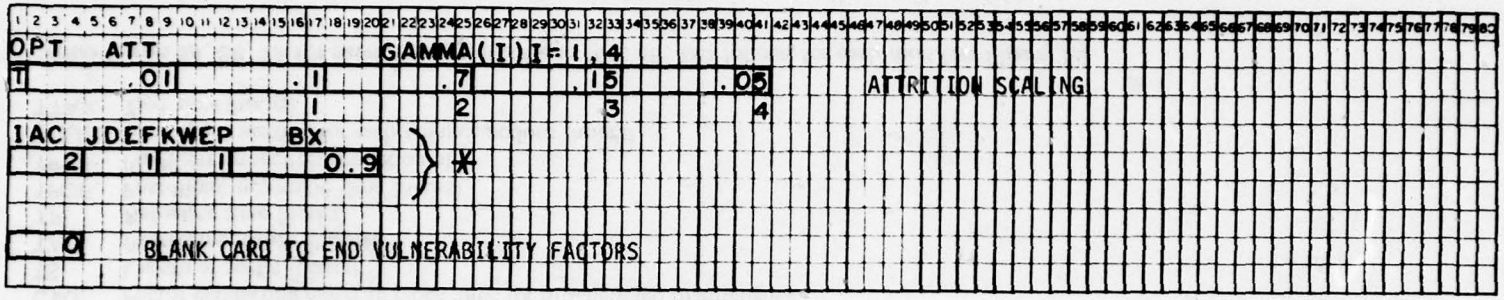
*Repeated for each mod for which flightpath parameters are different from those for baseline aircraft.

Figure 17. Flightpath Characteristics for Mods (Input Form 4C).



DEN (I,J): 0.002 times weapon effective range times weapons per square kilometer (0.002 Rρ)
ND3: Defense zone index for inbound flight
ND4: Defense zone index for pop-up to search for target
ND45: Defense zone index for target search
ND5: Defense zone index for dive
ND6: Defense zone index for swingaround
ND65: Defense zone index for pop-up to next pass
ND67: Defense zone index for climb to outbound altitude
ND7: Defense zone index for between target flight
ND8: Defense zone index for outbound flight
ND9: Defense zone index for dive to loiter for aircraft not locating target
ND95: Defense zone index for loiter for aircraft not locating target

Figure 18. Defensive Weapon Mix (Input Form 5A).

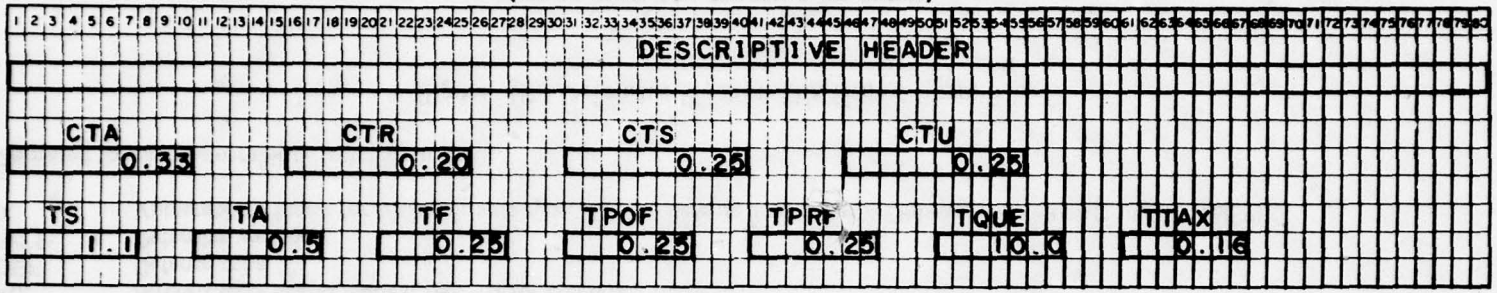


OPT:	Attrition scaling option: T = attrition scaling, F = no attrition scaling
ATT:	Input baseline attrition (required only if OPT=T)
GAMMA(I):	Allocation of attrition to ith defense zone (optional)
IAC:	Aircraft modification index: IAC = 1 for baseline
JDEF:	Defense zone
KWEP:	Defensive weapon
BX:	Vulnerability factor for IACth aircraft type, JDEFth defense zone and KWEPth weapon (=B(IAC, JDEF, KWEP))

*Repeated for each vulnerability factor to be input.

Figure 19. Defensive Weapon Mix (Input Form 5B).

(INPUT DATA FOR BASELINE IS SHOWN)*

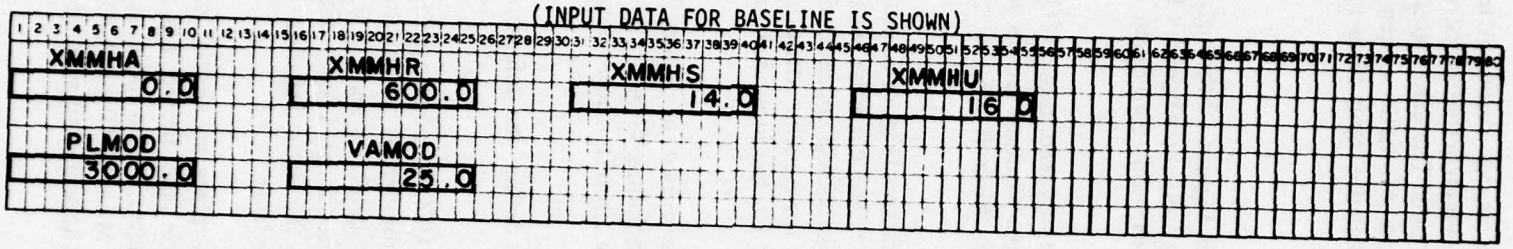


CTA: Factor converting MMH (maintenance manhours) to clock time for abort repair
CTR: Factor converting MMH to clock time for battle damage repair
CTS: Factor converting MMH to clock time for scheduled maintenance
CTU: Factor converting MMH to clock time for unscheduled maintenance
TS: Length of sortie (hours)
TA: Rearmament time (hours)
TF: Refueling time (hours)
TPOF: Post-flight inspection time (hours)
TPRF: Pre-flight inspection time (hours)
TQUE: Time spent waiting for maintenance actions (hours)
TTAX: Taxi time (hours)

*After Forms 6A, 6B, 7A for baseline, a set of 3 forms (6A, 6B, 7A) follows for each mod (see Figure 29).

Figure 20. Maintenance (Input Form 6A).

(INPUT DATA FOR BASELINE IS SHOWN)



XMMHA: Mean MMH (maintenance manhours) expended for abort repair
XMMHR: Mean MMH expended for battle damage repair task
XMMHS: Mean MMH per flight hour expended for scheduled maintenance
XMMHU: Mean MMH per flight hour expended for unscheduled maintenance
PLMOD: Payload of modified aircraft (kilograms)
VAMOD: Vulnerable area of modified aircraft (square meters)

NOTE: Figure 31 completes the MTOM input forms.

Figure 21. Maintenance (Input Form 6B).

These forms are meant to serve as keypunch layout forms. After they have been completely filled out, they can be submitted to a keypuncher with instructions to punch a card for every line on the form which has data entered. The cards which result from this process can be read directly by MTO/E. There is no automatic sequence checking of the inputs by the program so the user must take care that the input cards remain in the order implied by the input form.

Output

Sample output from the MTO/E model appear in Figures 22 through 28. The computer output for the sample problem is shown in its entirety in Appendix B. The amount of output per run will depend on the number of aircraft mods considered and the size of the defensive weapons population.

The first block of output is a printout of the inputs read in by MTODIN. First, the PK tables for all aircraft types, maneuvers and defensive weapons are shown. (See Figure 22; only the PK tables for MOD 0 are shown). Note: Aircraft MOD 0 corresponds to the baseline aircraft.

The input weapon densities and vulnerability factors (Figure 23) follow the PK tables. These are categorized by defense zone, aircraft mod, and defensive weapon type. If fewer than five defensive weapons are being considered, blanks will appear under the headings for which there are no weapons. Next the parameters for possible attrition scaling are listed. These include the code for the scaling option (T or F), the input baseline aircraft attrition and the defense zone attrition allocation.

The scenario parameters are then listed, as shown in Figure 24. These are the parameters required to describe the flight profile, including distance flown or elapsed time for those events with straight and level flight for the aircraft. These characteristics are listed for the baseline aircraft and for each mod.

The final section of output data from MTODIN defines the defense zone corresponding to each event (Figure 25).

The tentative survival probability results from MTO/D model appear next. Printed first are the nonaborted flight size or the expected number of aircraft to cross the FEBA (forward edge of battle area); then, the survival probabilities and the expected number or aircraft surviving, by mod. These are based on the nonaborted flight size and are calculated using unscaled survival probabilities, regardless of the input attrition option being used. Scaled results, if that option has been chosen, appear later.

In certain cases, the input flight profile may place an aircraft out of range of the defenses during a particular event. In this situation, the aircraft has a tentative survival probability equal to one, in which case a scaling factor has no meaning. If this occurs, the warning message, "PT=1. ATTRITION SCALING MAY NOT BE VALID" and the event identification will be printed immediately after the unscaled survival probability summary. The user should then reassess the flight profile.

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 1

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	.4920	.4500	.4330	.2920	.2000
305.	.4920	.4500	.4330	.3080	.2250
610.	.4670	.4330	.3830	.2920	.2170
1524.	.3830	.3250	.2670	.1750	.1080
3002.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 2

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4670	.2330	.1000	.0330	0.0000
305.	.4500	.1830	.0830	.0330	0.0000
610.	.4170	.1330	.0500	.0170	0.0000
1402.	0.0000	0.0000	0.0000	0.0000	0.0000
12192.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 3

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4500	.2000	.1000	.0400	.0050
305.	.6000	.2650	.1450	.0600	.0150
610.	.6000	.2650	.1500	.0650	.0200
1524.	.6000	.2650	.1500	.0650	.0200
3048.	.4500	.2000	.2550	.0400	.0100

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 4

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.7910	.6040	.4460	.2480	.1350
610.	.9430	.8190	.7220	.5540	.4190
1524.	.9760	.8930	.8070	.6780	.5590
3048.	.9870	.9040	.8350	.7060	.5930

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 5

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.2000	.1890	.1750	.1430	.1070
610.	.9460	.8930	.8180	.6430	.4790
1524.	.9680	.9360	.8930	.7960	.6860
3048.	.9680	.9360	.8930	.8180	.7180

Figure 22. PK Tables.

PK TABLE FOR POPUP
MOD 0 WEAPON 1

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.2130	0.0000	0.0000	0.0000
610.	.2080	.2210	0.0000	0.0000
1524.	.1630	.1670	.1630	0.0000
3002.	.1000	.1210	.1080	.0540

PK TABLE FOR POPUP
MOD 0 WEAPON 2

TERM ALT	INIT ALT			
	152.	305.	610.	1402.
305.	.0250	0.0000	0.0000	0.0000
610.	.0180	.0180	0.0000	0.0000
1402.	.0120	.0120	.0050	0.0000
12192.	.0120	.0120	.0050	0.0000

PK TABLE FOR POPUP
MOD 0 WEAPON 3

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.0380	0.0000	0.0000	0.0000
610.	.0400	.0520	0.0000	0.0000
1524.	.0400	.0520	.0540	0.0000
3048.	.0300	.0410	.0440	.0440

PK TABLE FOR POPUP
MOD 0 WEAPON 4

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.1110	0.0000	0.0000	0.0000
610.	.2600	.3700	0.0000	0.0000
1524.	.3240	.4340	.5840	0.0000
3048.	.3390	.4490	.5990	.6630

PK TABLE FOR POPUP
MOD 0 WEAPON 5

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.0680	0.0000	0.0000	0.0000
610.	.3000	.3680	0.0000	0.0000
1524.	.3840	.4510	.6850	0.0000
3048.	.3960	.4640	.6980	.7800

Figure 22. PK Tables. (Contd.)

PK TABLE FOR DIVE
MOD 0 WEAPON 1

ANGLE	INIT ALT 305.	610.	1524.	3002.
15.	.2130	.2080	.1630	.1000
45.	.2130	.2080	.1630	.1000
60.	.2130	.2080	.1630	.1000

PK TABLE FOR DIVE
MOD 0 WEAPON 2

ANGLE	INIT ALT 305.	610.	1402.	12192.
15.	.0250	.0180	.0120	.0120
45.	.0250	.0180	.0120	.0120
60.	.0250	.0180	.0120	.0120

PK TABLE FOR DIVE
MOD 0 WEAPON 3

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.0380	.0400	.0400	.0300
45.	.0380	.0400	.0400	.0300
60.	.0380	.0400	.0400	.0300

PK TABLE FOR DIVE
MOD 0 WEAPON 4

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.1110	.2600	.3240	.3390
45.	.1110	.2600	.3240	.3390
60.	.1110	.2600	.3240	.3390

PK TABLE FOR DIVE
MOD 0 WEAPON 5

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.0680	.3000	.3840	.3960
45.	.0680	.3000	.3840	.3960
60.	.0680	.3000	.3840	.3960

Figure 22. PK Tables. (Contd.)

```
PK TABLE FOR SWING AROUND
MOD   0     WEAPON   1

ALT
     152.          .2000
     305.          .2000
     610.          .2000


PK TABLE FOR SWING AROUND
MOD   0     WEAPON   2

ALT
     152.          .1250
     305.          .1250
     610.          .1250


PK TABLE FOR SWING AROUND
MOD   0     WEAPON   3

ALT
     152.          .0270
     305.          .0270
     610.          .0270


PK TABLE FOR SWING AROUND
MOD   0     WEAPON   4

ALT
     152.         0.0000
     305.          .6040
     610.          .8190


PK TABLE FOR SWING AROUND
MOD   0     WEAPON   5

ALT
     152.         0.0000
     305.          .1890
     610.          .8930
```

Figure 22. PK Tables. (Contd.)

WEAPON DENSITY FACTORS AND VULNERABILITY FRACTIONS BY ZONE, A/C MOD AND WEAPON

	ZONE	MOD	WEAPON	1	2	3	4	5
D-FACTOR	1			.0024	.0012	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000
D-FACTOR	2			.0120	.0060	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000
D-FACTOR	3			.0120	.0060	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000
D-FACTOR	4			.0024	.0012	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000

NOTE: D-FACTOR = .002 TIMES WEAPON EFFECTIVE RANGE (METERS) TIMES WEAPON DENSITY (QTY/SQ. KM)

ATTRITION OPTION = T BASELINE A/C ATTRITION .0100

	1	2	3	4
ZONE WEIGHTING	.1000	.7000	.1500	.0500

Figure 23. Weapon Density Factors and Vulnerability Fractions.

SCENARIO PARAMETERS BY A/C MOD

A/C MOD	0	INBOUND DIST	180.	INBOUND TIME	0.
		INBOUND SPEED	200.	INBOUND ALT	1200.
		POPUP TERM ALT	4000.		
		SEARCH DIST	0.	SEARCH TIME	30.
		SEARCH SPEED	230.		
		DIVE ANGLE	30.		
		BET TGT DIST	0.	BET TGT TIME	45.
		BET TGT SPEED	200.		
		OUTBOUND DIST	180.	OUTBOUND TIME	0.
		OUTBOUND SPEED	200.	OUTBOUND ALT	1200.
		LOITER DIST	0.	LOITER TIME	120.
		LOITER SPEED	200.		
A/C MOD	1	INBOUND DIST	180.	INBOUND TIME	0.
		INBOUND SPEED	200.	INBOUND ALT	1200.
		POPUP TERM ALT	4000.		
		SEARCH DIST	0.	SEARCH TIME	30.
		SEARCH SPEED	230.		
		DIVE ANGLE	30.		
		BET TGT DIST	0.	BET TGT TIME	45.
		BET TGT SPEED	200.		
		OUTBOUND DIST	180.	OUTBOUND TIME	0.
		OUTBOUND SPEED	200.	OUTBOUND ALT	1200.
		LOITER DIST	0.	LOITER TIME	120.
		LOITER SPEED	200.		
A/C MOD	2	INBOUND DIST	180.	INBOUND TIME	0.
		INBOUND SPEED	200.	INBOUND ALT	1200.
		POPUP TERM ALT	4000.		
		SEARCH DIST	0.	SEARCH TIME	30.
		SEARCH SPEED	230.		
		DIVE ANGLE	30.		
		BET TGT DIST	0.	BET TGT TIME	45.
		BET TGT SPEED	200.		
		OUTBOUND DIST	180.	OUTBOUND TIME	0.
		OUTBOUND SPEED	200.	OUTBOUND ALT	1200.
		LOITER DIST	0.	LOITER TIME	120.
		LOITER SPEED	200.		

Figure 24. Scenario Parameters.

```
EVENT DEFENSE ZONES

                        ZONE
INBOUND                    1
POP-UP                     2
SEARCH                     2
DIVE                       2
SWING-AROUND               2
CLIMB TO NEXT PASS         2
CLIMB FOR OUTBOUND         2
BETWEEN TARGET             3
OUTBOUND                   4
LOITER DIVE                2
LOITER                     2


(* - DENOTES CALCULATED VALUES)

NON-ABORTED FLIGHT SIZE    3.90
* A/C MOD   UNSCALED SURVIVAL PROBABILITY   NO. A/C SURVIVING PER FLIGHT
     0                    .86706                        3.38154
     1                    .88021                        3.43281
     2                    .89339                        3.48420
PT=1. ATTRITION SCALING MAY NOT BE VALID
        EVENT = SEARCH

PT=1. ATTRITION SCALING MAY NOT BE VALID
        EVENT = SEARCH

PT=1. ATTRITION SCALING MAY NOT BE VALID
        EVENT = SEARCH
```

Figure 25. Event Defense Zones.

BASELINE AIRCRAFT (MOD 0)

STANDARD F-4 MOD .01 ATTRITION 5 WEAPONS

(* - DENOTES CALCULATED VALUES)

FLIGHT INFORMATION

INITIAL FLIGHT SIZE

4.

INITIAL NO. OF PASSES PER A/C

6

NO. OF ASSIGNED TARGETS

3

NO. OF PASSES PER TARGET

TARGET	PASSES
1	2
2	2
3	2

PROB. OF NO ABORT

.975

PROB. OF NO A/C GNE

.95

PROB. OF A/C FINDING ASSIGNED TARGETS

TARGET	PROB.
1	.95
2	.95
3	.95

PROB. OF A/C LOCK-ON

	PASS				
TARGET	1	2	3	4	5
1	1.00	1.00			
2	1.00	1.00			
3	1.00	1.00			

NO. OF A/C ABORTS

.100

* NO. OF PASSES DELIVERED (ALL A/C)

21.012

Figure 26. MTO/P Output.

* NO. OF A/C KILLED	* NO. OF PASSES LOST ON A/C KILLED
.039	.120
* NO. OF A/C HOME SAFELY	* NO. OF PASSES BROUGHT HOME
3.961	2.868

MOD 0

* PROBABILITY OF SURVIVAL PER A/C

.99025

* PROBABILITY OF SURVIVAL PER A/C GIVEN NON-ABORT

.99000

* PROBABILITY OF DAMAGE PER A/C

.02925

MAINTENANCE SUMMARY

SORTIE INFORMATION

	UNSCHEDULED	SCHEDULED
MMH/FH	16.0	14.0
CONV.FACT.	.25	.25

	DAMAGE REPAIR	ABORT REPAIR
MMH/TASK	600.0	0.0
CONV.FACT.	.20	.33

TURNAROUND (CLOCK HOURS)

RE-ARM	RE-FUEL	PRE-FLIGHT INSP.	POST-FLIGHT INSP.
.50	.25	.25	.25

Figure 27. MTO/P and MTO/S Output.

```
WAITING     TAXIING
10.00         .16
TOTAL DELAY TIME
11.41
PROB. OF ABORT    * PROB. OF KILL
.025              .010
LENGTH OF SORTIE      DAMAGE/KILL RATIO
1.10 HRS.             3.00
* SORTIE RATE PER A/C PER DAY
1.00
```

Figure 27. MTO/P and MTO/S Output. (Contd.)

```
                                                    MOD 0
  JOB SCALING FACTORS


  NO. TARGETS TO BE ATTACKED=40000.0
  LENGTH OF WAR= 30.0 DAYS
  NO. PASSES REQUIRED TO ATTACK TARGET= 2.00
  INITIAL FLIGHT SIZE= 4.
* SORTIE RATE= 1.00 SORTIES PER DAY
* PROBABILITY OF SURVIVING SORTIE= .99025


  JOB SCALING OUTPUT


* MAXIMUM NO. SORTIES AVAILABLE PER A/C IN TW=30.0645
* EXP. NO. SORTIES AVAILABLE PER A/C IN TW=25.9137
* EXP. NO. SORTIES COMPLETED PER A/C IN TW=25.2659
* EXP. NO. TARGETS ATTACKED PER SORTIE=2.626
* EXP. NO. TARGETS ATTACKED PER A/C IN TW= 68.06
* EXP. NO. DAMAGES PER A/C IN TW=  .8794
* PROBABILITY OF A/C SURVIVING WAR=  .7449
* EXP. NO. A/C LOST IN TW= 149.95


* NUMBER OF A/C REQUIRED TO DO JOB=  587.70

(* - DENOTES CALCULATED VALUES)
```

Figure 28. MTO/F Output.

The remaining MTO/E and MTO/C output material is grouped by aircraft; i.e., for the baseline aircraft and for each mod, various inputs, MOE and related quantities are output. The first portion of each aircraft's output is concerned with flight information as displayed in Figures 26 and 27.

The flight information consists of the main inputs to MTO/P and the results of MTO/P including the survival probabilities. First the output of MTO/W (required input to MTO/P) is printed. This information consists of:

1. Initial number of passes per aircraft
2. Number of assigned targets
3. Number of passes assigned per target.

These assignments are the same for each of the aircraft in the initial flight size. Then, other inputs are printed, including:

1. The probabilities of no abort
2. No aircraft GNE (gross navigational error)
3. Finding assigned targets
4. The probability of the aircraft tracking and locking-on to the targets.

The results of MTO/P which are output include the number of:

1. Aircraft aborts
2. Aircraft killed
3. Aircraft which return home (including those which aborted)
4. Passes delivered
5. Passes lost on aircraft killed
6. Passes brought home.

These are followed by the probability of survival per aircraft, with and without aborts, and the probability of an aircraft being damaged on the sortie. If the scaling option is used, the probability of survival given nonabort for the baseline aircraft will be the complement of the input attrition.

The next section of the output is called the maintenance summary (Figure 27) which includes all the factors that contribute to the expected sortie rate. Almost all of these quantities are direct inputs to MTO/S, the exception being:

1. Total delay time (which is the sum of six of the direct inputs)
2. Probability of kill
3. Damage-to-kill ratio
4. Expected sortie rate.

The inputs displayed include:

1. The MMH (maintenance manhours) for scheduled
2. The MMH for unscheduled
3. Abort repair
4. Battle damage repair maintenance actions
5. The clock time conversion factors for each type of maintenance.

Following the MMH data are the components of the total delay time which are:

1. The clock hours required to rearm
2. Refuel
3. Conduct pre-flight and post-flight inspections
4. The time spent taxiing and waiting for maintenance actions.

Following the delay time parameters, the input probability of abort, the probability of kill from MTO/P, the input sortie length and the damage-to-kill ratio are printed. The damage-to-kill ratio is computed for all proposed aircraft modifications unless the option to use the input value throughout is exercised. Finally, the computed sortie rate per aircraft per day is output.

The next section of output contains the job scaling factors and the job scaling (MTO/F) output (Figure 28). The job scaling factors are the input parameters which describe the job to be done and the results from other submodels. The job to be done is defined as a number of targets to be attacked in a certain length of war. The number of passes required to attack a target and initial flight size of aircraft are also output. Next, the results from MTO/S and MTO/P are printed.

The job scaling output includes all the intermediate results and the final result (number of aircraft required to do the job). The intermediate results include:

1. Sortie related output
2. Target related output
3. Survivability output.

The sortie related output includes:

1. Maximum number of sorties available per aircraft in TW (time of war)
2. Expected number of sorties available per aircraft in TW (considering attrition)
3. Expected number of sorties completed per aircraft in TW (considering the abort rate).

The target related output includes:

1. Expected number of targets attacked per sortie
2. Expected number of targets attacked per aircraft in TW.

The remaining outputs which are related to survivability include:

1. Expected number of damages per aircraft in TW
2. Probability of an aircraft surviving the war
3. Expected number of aircraft lost during the war.

Finally, the number of aircraft required to do the job is printed.

Following the MTO/E results are the output of MTO/C. See *MTO/C* for a description of the cost model output.

Amplification, Limitations and Restrictions on Inputs

The range of input values for NMOD (Form 1A) is from zero to nine. When it is zero, only the baseline aircraft is analyzed. When it is nonzero and less than or equal to nine, the baseline and that number of modified aircraft are analyzed. NMOD+1 sets of mod inputs must then be prepared.

IMAX (Form 1A) is the number of targets per sortie for which input is provided. IMAX must be at least the largest value of WPNSOR(MOD)/WPNTGT(MOD) over all MOD's. (The index MOD=1 indicates the baseline aircraft.) That is,

$$\text{IMAX} = \max \frac{\text{WPNSOR(MOD)}}{\text{WPNTGT(MOD)}}, \text{ rounded up for MOD=1, NMOD}$$

JMAX (Form 1A) is analagous to IMAX, pertaining to passes per target per sortie for which input data are provided.

$$\text{JMAX} = \max \frac{\text{WPNTGT(MOD)}}{\text{WPNPAS(MOD)}}, \text{ rounded up for MOD=1, NMOD}$$

IRDK (Form 1A) is the indicator which informs the model whether to calculate a ratio of damage-to-kill for each modification type or to use the input baseline value of damage-to-kill for all aircraft types being analyzed.

1. If the input value of IRDK=0, the computer will use the option where the probability of hit for baseline aircraft equals the probability of hit for each of the modification types. Then RDKUSE (the ratio of damage to kill for each modification type) will be computed based on the probability of hit and the PKMOD (probability of kill for the modification type).

2. If the input value of IRDK=1, the computer will use the option where the probability of hit for baseline aircraft does *not* equal the probability of hit for each modification type. In this option, RDKUSE is set equal to RDK (the baseline value of damage-to-kill). The option of using the same ratio of damage-to-kill for all aircraft types should be used when modifications which affect certain sortie characteristics are being analyzed. Under certain circumstances (i.e., when the number of passes made or targets visited is altered) the probability of the modified aircraft being hit will not equal the probability of the baseline aircraft being hit. In these cases, use a value of one for IRDK.

There is a degree of consistency among the Form 2A inputs, WPNPAS(MOD), WPNTGT(MOD), WPNSOR(MOD), which should be explained. The submodel MTO/W checks on the following possibilities of inconsistency:

1. WPNSOR(MOD) should be an integer multiple of WPNPAS(MOD). This check ensures that WPNPAS(MOD) weapons will be delivered on each pass made, that is fractional passes will not be made. If the above condition is not met by the inputs, this message will be printed:

"WARNING-CHECK INPUTS FOR FRACTIONAL PASS"

In this case the passes made per target is taken to be the greatest integer less than the actual value of WPNSOR(MOD)/WPNPAS(MOD). The remaining weapons cannot be delivered, but will be added to the output of MTO/P under "PASSES BROUGHT HOME".

2. WPNTGT(MOD) should be an integer multiple of WPNPAS(MOD). A violation of this check results in an inefficient use of aircraft in the model. The number of passes made on a target is taken to be the smallest integer greater than WPNTGT(MOD)/WPNPAS(MOD) if the quotient is not an integer. In this case, the aircraft are forced to deliver more weapons than are actually required to attack a target, and printed is the message:

"WARNING-CHECK INPUTS - WPN/PASS INCOMPATIBLE WITH WPNS/TGT"

Tables of PK values must be input for the baseline aircraft. Up to five defensive weapons can be considered. The tables are to be input for four maneuvers; straight and level flight, pop-up, dive and swingaround. Tables of PK may be input for any mod-weapon-maneuver combination, but tables are optional. The PK input for the baseline aircraft are assumed for all mods unless specific PK are input for the mods.

The first item of PK input data are the dimensions of the PK data (Form 3A). NWEPS is the number of defensive weapons to be considered. NSPSL(I) is the number of aircraft speeds for which PK values for the ith weapon are tabulated. The number is the same for all aircraft types. Similar definitions hold for NALSL, NAIPU, NATPU, NAIDI, NANDI, and NALSA. This means that different PK tables can be used for different mods, but versus the same weapon they must have the same dimensions (number of rows and number of columns).

Data for PK tables for the baseline aircraft must be read in the following order (Input Forms 3B, 3C, and 3E):

1. Straight and level
2. Pop-up
3. Dive
4. Swingaround.

Within a maneuver any order for the weapons can be used (the only requirement is the card preceding the table which contains the weapon index). Sets of tables for different maneuvers are separated by one blank card.

If PK data for aircraft mods are not the same as for the baseline aircraft, the PK data for mods are input on Forms 3F, 3G, 3H, and 3I which are similar to Forms 3B, 3C, 3D, and 3E. The maneuver order is the same. Within a maneuver, modification-weapon combinations can be read in any order. Each table is preceded by a card giving the appropriate aircraft type index and defensive weapon index. Blank cards are also used to separate the data for different maneuvers.

After the PK data for the last modification, place four blank cards to signal the end of PK data. The four blank cards are in addition to the blank card needed to end the last maneuver (total of five blank cards).

Flightpath characteristics must be input for the baseline aircraft (Forms 4A and 4B). Different values of the flightpath parameters may be input for any mod (Form 4C), but are not necessary. If such values are not specifically input for a mod, the flightpath characteristics for the mod are assumed to be those of the baseline aircraft.

Either distance or time, but not necessarily both, must be specified for five events.

1. Inbound flight (D3, T3)
2. Target search (D45, T45)
3. Between targets (D7, T7)
4. Outbound flight (D8, T8)
5. Loiter (aircraft not locating target) (D95, T95).

All other flightpath characteristics must be specified for baseline aircraft.

A header card containing the aircraft type index precedes the flightpath data for a mod. A blank card is used to separate the flightpath data from the defensive weapon mix data which follow.

Four weapon density factor cards must be input (Form 5A). Each card contains D-FACTOR (density factor) of each weapon type for a particular zone. The density factor is defined as:

$$\text{D-FACTOR} = 0.002\ R(\rho)$$

where

R = Weapons effective range (meters)

ρ = Number of weapons per square kilometer

The computer program identifies weapon density factor as DEN (Figure 18). The output of the weapon density factors (Figure 23) is labeled D-FACTOR.

The use of D-FACTOR is shown in the following equations which approximate the probability of survival of an aircraft in an encounter with a given weapon type during an event. This probability is given by:

$$PS \simeq \exp\text{-}(M)\ (PK)$$

where

M = The expected number of weapons of a given type encountered during an event

PK = The probability of kill from an engagement of one weapon on one aircraft

The value of M is computed for an event which takes place over a distance d(kilometers) as:

$$M = [(0.002)\ (R)\ (\rho)]\ (d) = [\text{D-FACTOR}]\ (d)$$

The probability of survival can then be written as:

$$PS \simeq \exp\text{-}(M)\ (PK) = \exp\text{-}(\text{D-FACTOR})\ (d)\ (PK)$$

Attrition scaling inputs include a required indicator, and optionally an attrition value and defense zone weighting factors (Form 5B). The indicator (column 1) must be T or F. If it is F, no other attrition data are required. If the indicator is T, then the input attrition must be specified. The use of the zone weighting factors is completely optional. If they are not specified, the model will perform its own weighting for the defense zones.

Vulnerability factors (fractions) are automatically set to one by the computer program. They can be set to any other value through inputs (Form 5B). As many factors as desired can be read. The card from which the factor is read also contains the aircraft type, defense zone and defensive weapon indices for which the factor applies.

A blank card is required after the last vulnerability factor to signal the end of that type of data.

Typical sequencing of MTOM data is shown in Figure 29. For this example a baseline aircraft and two mods are being run.

FORM 1A		FORM 4A	BASELINE
FORM 2A	BASELINE	FORM 4B	
FORM 2A	MOD 1	FORM 4C*	MOD 1
FORM 2A	MOD 2	FORM 4C*	MOD 2
FORM 3A		FORM 5A	
FORM 3B	BASELINE	FORM 5B	
FORM 3C		FORM 6A	BASELINE
FORM 3D		FORM 6B	
FORM 3E		FORM 7A**	
FORM 3F*	MOD 1	FORM 6A	MOD 1
FORM 3F*	MOD 2	FORM 6B	
FORM 3G*	MOD 1	FORM 7A	
FORM 3G*	MOD 2	FORM 6A	MOD 2
FORM 3H*	MOD 1	FORM 6B	
FORM 3H*	MOD 2	FORM 7A	
FORM 3I*	MOD 1		
FORM 3I*	MOD 2		

*OPTIONAL INPUT. USE LAST CARD INDICATOR ONLY AFTER ALL DESIRED MODS HAVE BEEN INPUT.
**THESE INPUTS ARE DESCRIBED IN THE MTO/C SECTION.

Figure 29. MTOM Input Sequencing.

Sources for Input Data

There are several general categories of inputs required by MTO/E. These include:

1. Vulnerability data
2. Aircraft profile data
3. Aircraft maintenance related data
4. Aircraft combat damage repair data.

The vulnerability data, consisting of the PK tables, can be derived from aircraft-ground defense encounter models, such as the Air Force P001 model[1]. The aircraft profile data which are required by MTO/E consist of flight times, distances, dive and climb angles, etc.

The aircraft maintenance related data which MTO/E required consist of MMH for several categories of maintenance and may be obtained from documents such as AFFDL-TR-72-2[2]. The combat damage repair data may be obtained from documents such as AFFDL-TR-72-15[3].

---

[1]Naval Weapons Support Center. *Mission Scenarios for Survivability Assessment* (U), by D. N. Montgomery and N. L. Papke. Applied Sciences Department, Crane, IN, NWSC, September 1976, 136 pp. (JTCG/AS-75-S-003, publication CONFIDENTIAL.)

[2]Air Force Flight Dynamic Laboratory. *F-4D Field Experience Part IV Summary* (U), by The Boeing Co. Wright-Patterson AFB, OH, AFFDL, February 1972, (AFFDL-TR-72-2, publication (UNCLASSIFIED.)

[3]Air Force Flight Dynamic Laboratory. *Analysis of the USAF Fixed Wing Aircraft Losses and Aircrew Casualties in SEASIA Combat* (U), by Caywood-Schiller Division of A. T. Kearney and Compnay, Inc., Wright-Patterson AFB, OH, April 1971. (AFFDL-TR-72-15 (AD521-998L), publication SECRET.)

MTO/C MODEL

Overall Organization

A general flowchart of MTO/C is shown in Figure 30. The cost submodel requires an input value for discounting costs to their present value. If the discount rate is zero, the effect is that of no discounting.

Input Forms

Figure 31 displays the input form which specifies all of the input data required by MTO/C model. A brief description of these inputs appear on the form. A more complete description of these inputs and their units can be found in Appendix D.

Output

An example of the MTO/C model output appears in Figure 32. Much of this output is simply a listing of the input data. This listing can be valuable to the user for checking that the proper data has been entered. The actual output of MTO/C is presented under the heading, "Present Values–" after the listing of the input data. This output consists of the present values of the four components of the total cost of a particular modification and the present value of the total life cycle cost.

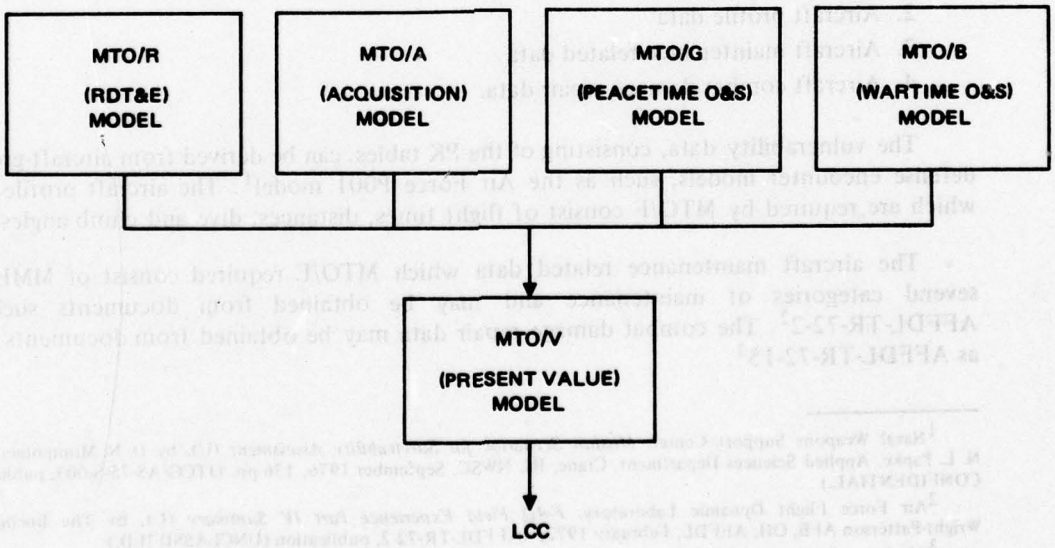


Figure 30. General Flowchart of MTO/C Model.

(INPUT DATA FOR BASELINE IS SHOWN; ONE FORM REQUIRED FOR EACH MOD)

DISCOUNT RATE
0.0

NRS	MRS	NRE	MRE	RDT&E COST
1	0	3	0	0.

NQS	MQS	NQE	MQE	NO. OF A/C	NO. MOD A/C	ACQ COST	RHA *	RLA *
2	6	5	0	1400.	700.	0.0		

NGS	MGS	NGE	MGE	A/C PER SQDONS	COST/SQD/YR
3	9	13	9	24.	17.492

NBS	MBS	LBS	RCBG	$/AIRCRAFT REPAIR $	$/WEAPON	RDAK	COST/CREW
10	0	0	0.5	4.0	.018398	.000195	.58	.4113

NRS,MRS: Years, months to start of RDT&E
NRE,MRE: Years, months to end of RDT&E
NQS,MQS: Years, months to start of acquisition
NQE,MQE: Years, months to end of acquisition
NGS,MGS: Years, months to start of operation and support
NGE,MGE: Years, months to end of operation and support
NBS,MBS,LBS: Years, months, days to start of wartime
*RHA,RLA: Ratio of cost of AGE to cost of modification, ratio of cost of initial spares to cost of modification: If blank or zero, program sets to 0.1
RCBG,RDAK: Ratio of wartime change in operation and support cost to peacetime operation and support cost, ratio of crews to lost aircraft killed

Figure 31. Cost Model (Input Form 7A).

```
MISSION TRADE-OFF METHODOLOGY
COST MODEL

                                                              MOD 0

ANNUAL DISCOUNT RATE=   0.00 PERCENT


RDTE COST INPUTS
     YEARS/MONTHS TO START OF RDTE= 1/ 0
     YEARS/MONTHS TO END OF RDTE= 3/ 0
     COST OF RDTE=$            0.00


ACQUISITION COST INPUTS
     YEARS/MONTHS TO START OF ACQUISITION= 2/ 6
     YEARS/MONTHS TO END OF ACQUISITION= 5/ 0
     NUMBER OF AIRCRAFT IN TOTAL FORCE=1400.
     NUMBER OF AIRCRAFT TO BE MODIFIED= 700.
     NUMBER OF AIRCRAFT IN WAR FORCE= 587.70
     COST OF MODIFICATION PER AIRCRAFT=$  0.00000
     COST OF AGE/COST OF MODIFICATION=   .1000
     COST OF SPARES/COST OF MODIFICATION=   .1000


PEACETIME OPERATION AND SUPPORT COST INPUTS
     YEARS/MONTHS TO START OF O+S= 3/ 9
     YEARS/MONTHS TO END OF O+S=13/ 9
     ANNUAL O+S COST PER SQUADRON=$     17.49200
     NUMBER OF AIRCRAFT PER SQUADRON= 24.
```

Figure 32. MTO/C Output.

```
                                                              MOD 0

WARTIME OPERATION AND SUPPORT COST INPUTS

    YEARS/MONTHS/DAYS TO START OF WAR=10/ 0/ 0

    DURATION OF WAR IN DAYS=  30

    CHANGE IN ANNUAL O+S COST/ANNUAL PEACETIME O+S COST=  .5000

    REPLACEMENT COST PER AIRCRAFT KILLED=$          4.00

    CREWS LOST PER AIRCRAFT KILLED=  .5800

    COST PER AIRCRAFT OF CREW REPLACEMENT=$   .41130

  * PROBABILITY AN AIRCRAFT WILL SURVIVE THE WAR= .74485

  * EXPECTED DAMAGED SORTIES FLOWN IN WAR PER AIRCRAFT=  .88

    REPAIR COST PER DAMAGED AIRCRAFT=$   .01840

  * EXPECTED SORTIES FLOWN IN WAR PER AIRCRAFT=  25.91

  * EXPECTED NUMBER OF WEAPONS USED PER SORTIE=  5.2529

    COST PER WEAPON=$  .000195


  * PRESENT VALUES--

                        ROTE COST=$          0.00
                 ACQUISITION COST=$          0.00
       OPERATION AND SUPPORT COST=$      10203.67
       CHANGE IN O+S COST FOR WAR=$        678.28
                                    ===============
            TOTAL LIFE CYCLE COST=$      10881.95


  (* - DENOTES CALCULATED VALUES)
```

Figure 32. MTO/C Output. (Contd.)

Amplifications, Limitations and Restrictions on Inputs

The assumption is made in calculating the discount factors that all payments are made as of the end of the year in which the costs are incurred. This means that if a nonzero discount rate is used, and if the length of time over which a cost occurs is short, there may be large changes in the present value of the cost depending on exactly when the start of the discount period occurs. For example, if a cost is incurred over a period of one week and is to be discounted, there would be a great difference in the present value if the one week period was input to be the last week in December as opposed to the first week in January of the following year.

Because the MTO/C calculations involved apart from discounting are quite straightforward, there are no strenuous limitations which need to be imposed on the inputs. However, the inputs must be consistent with the definitions and units, as given in Appendix D.

Sources for Input Data

The costs associated with each modification to be treated are required as input to the model. These are:

1. Cost of RDT&E
2. Cost per aircraft for the modification
3. Ratio of the cost of AGE (associated ground equipment) to the cost of the modification
4. Ratio of the cost of spares to the cost of the modifications.

These figures can best be estimated by the manufacturer involved.

Several of the remaining cost inputs and information about force size and structure can be obtained from Air Force Manual 173-10 *USAF Cost and Planning Factors*. Inputs which can be found in this manual are:

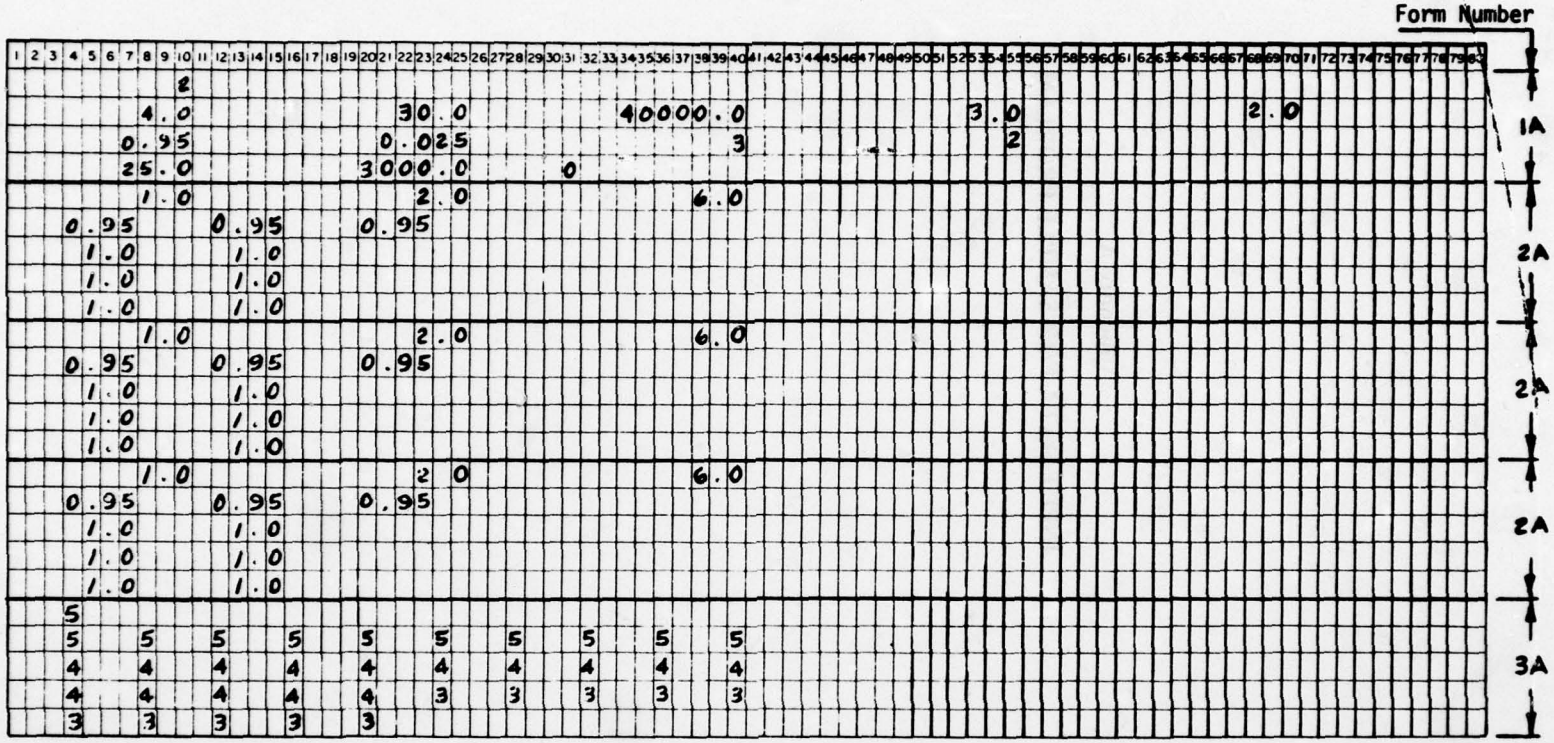
1. Annual peacetime operating cost per squadron
2. Aircraft replacement cost
3. Cost per weapon
4. Number of aircraft per squadron.

Information about the ratio of crews lost per damaged aircraft can be obtained from footnote 3.

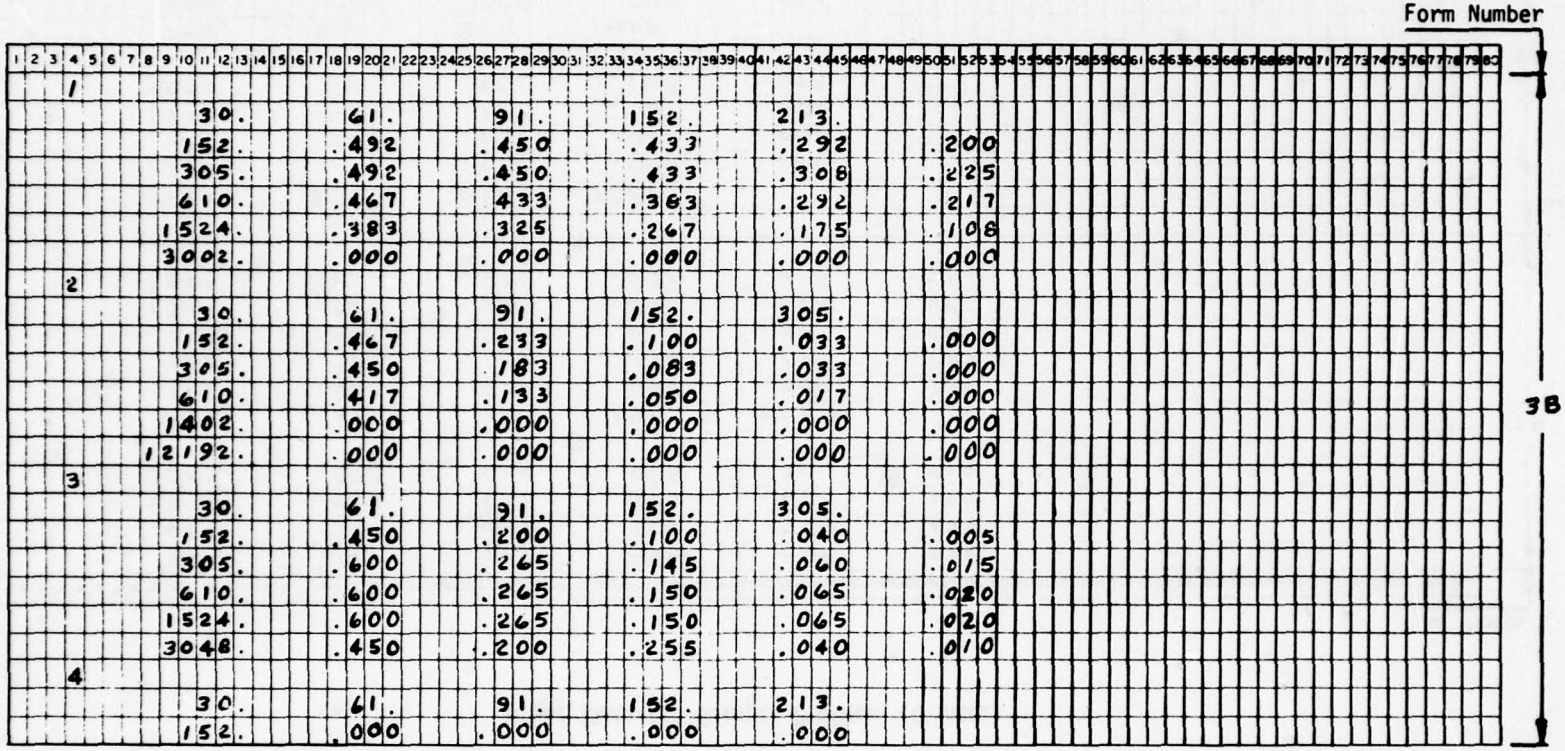
Appendix A

INPUT DATA FOR SAMPLE PROBLEM

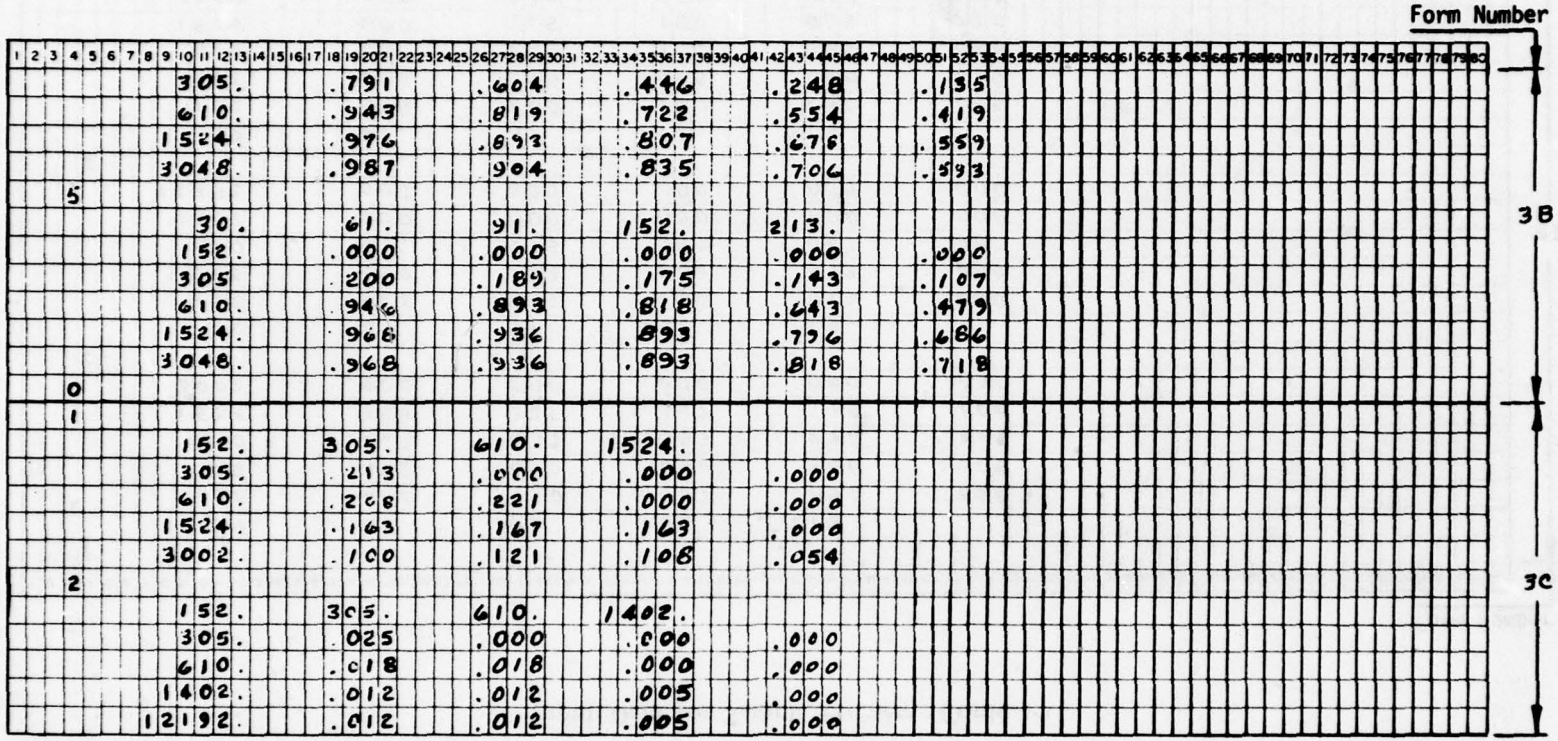
Input Data for Sample Problem



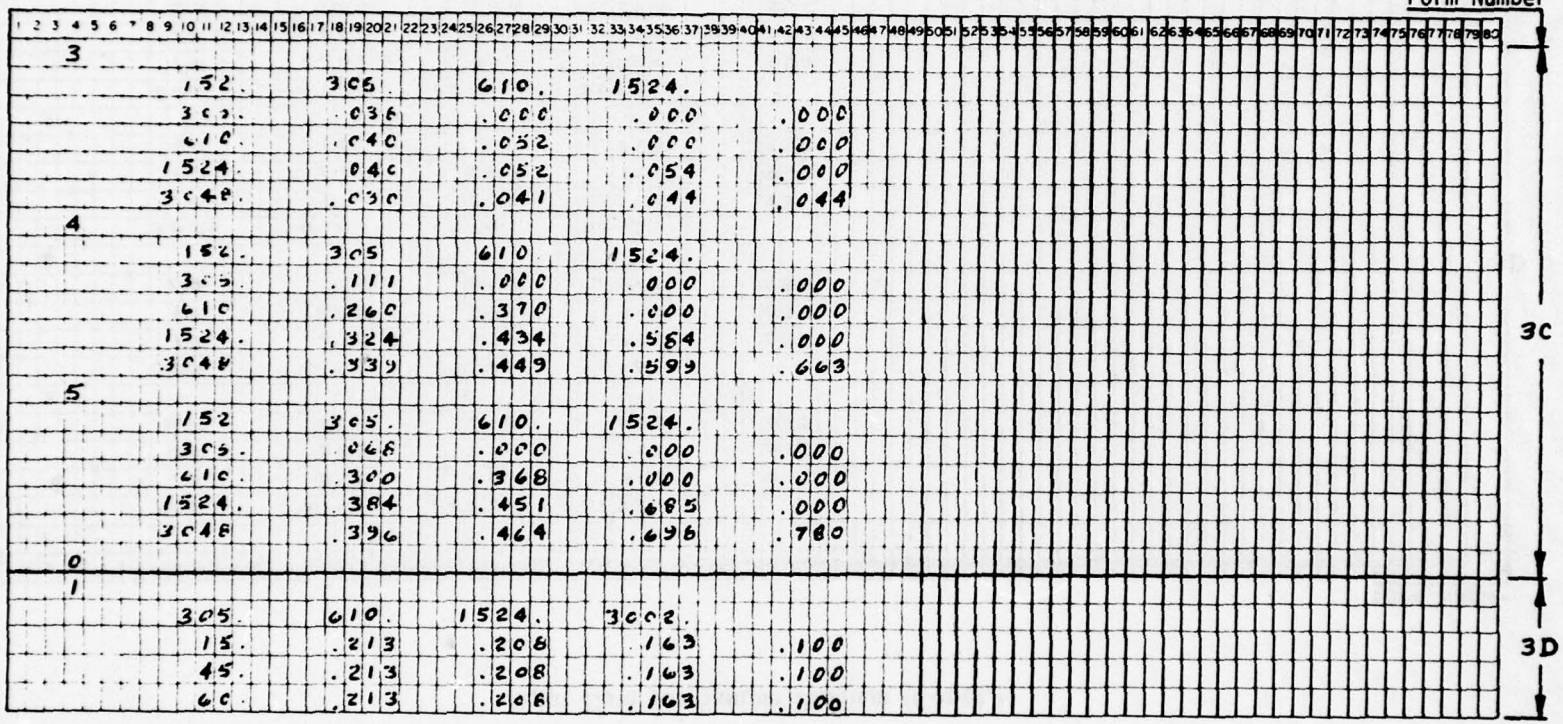
Input Data for Sample Problem (Contd.)



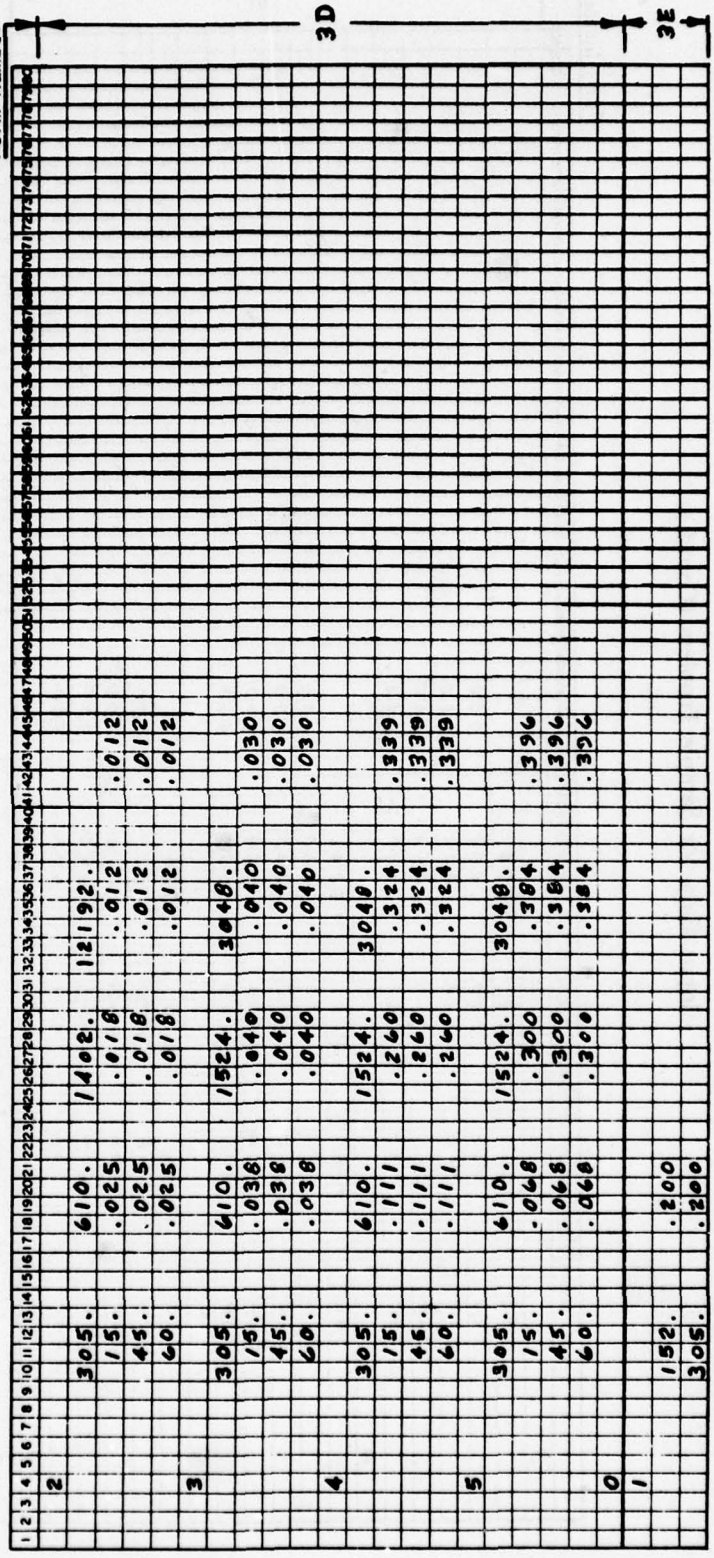
Input Data for Sample Problem (Contd.)



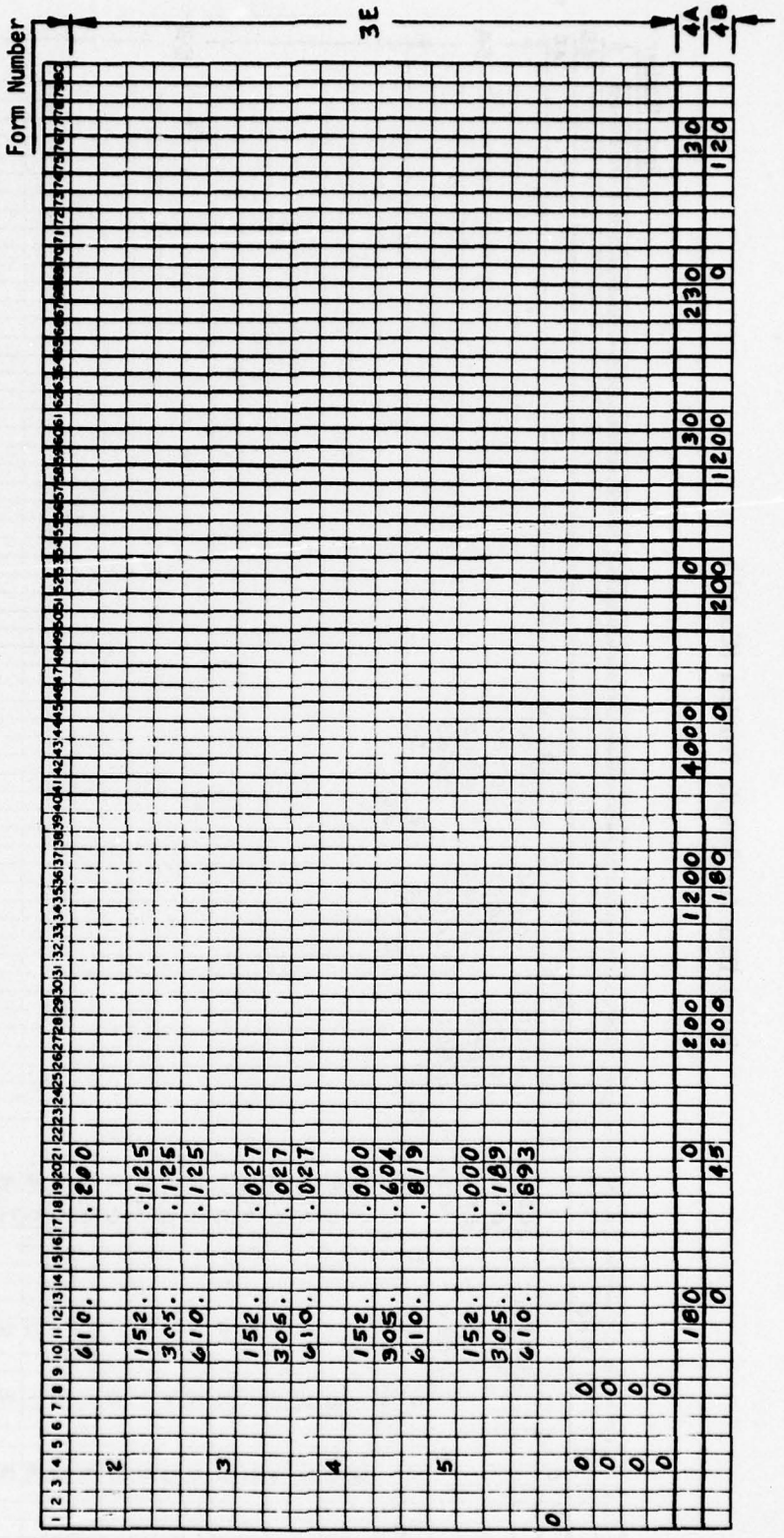
Input Data for Sample Problem (Contd.)



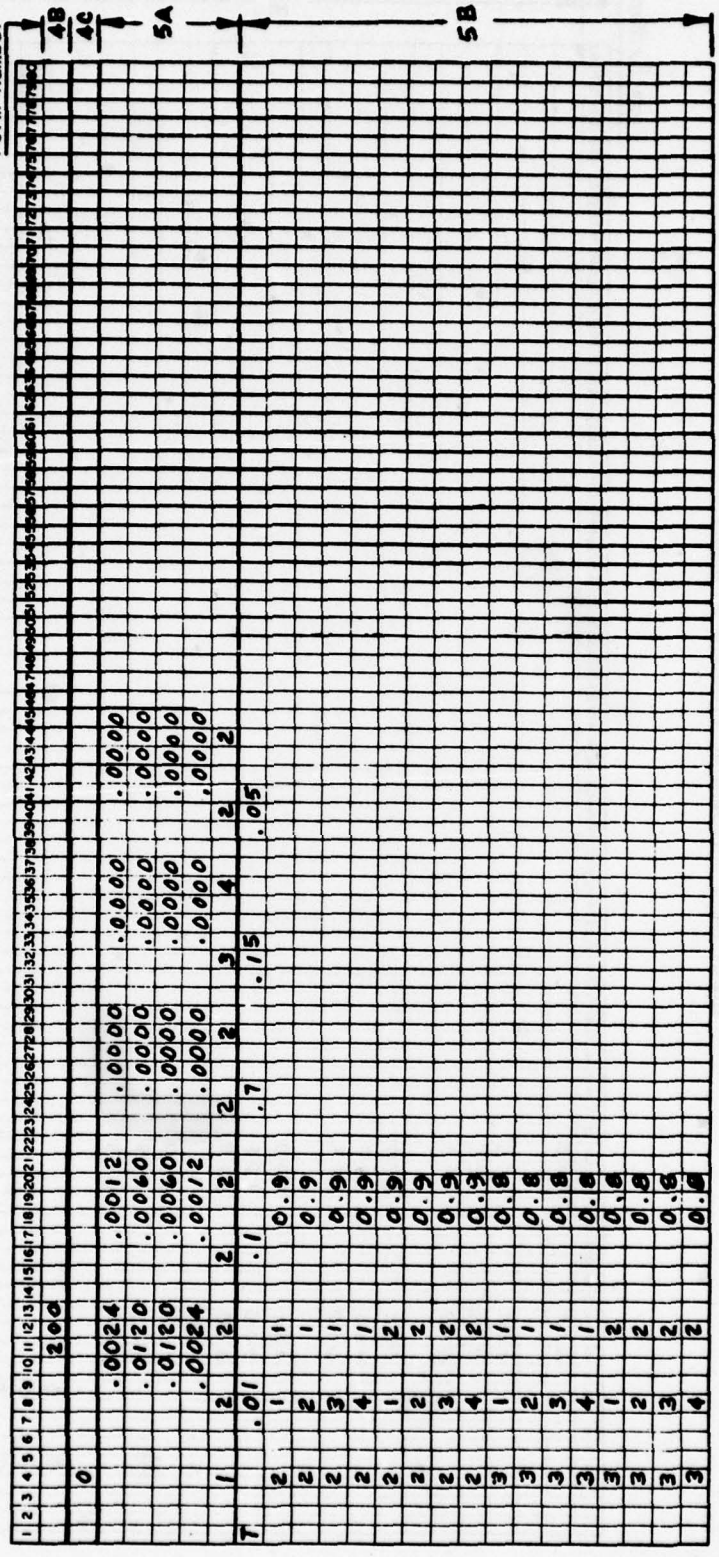
Input Data for Sample Problem (Contd.)



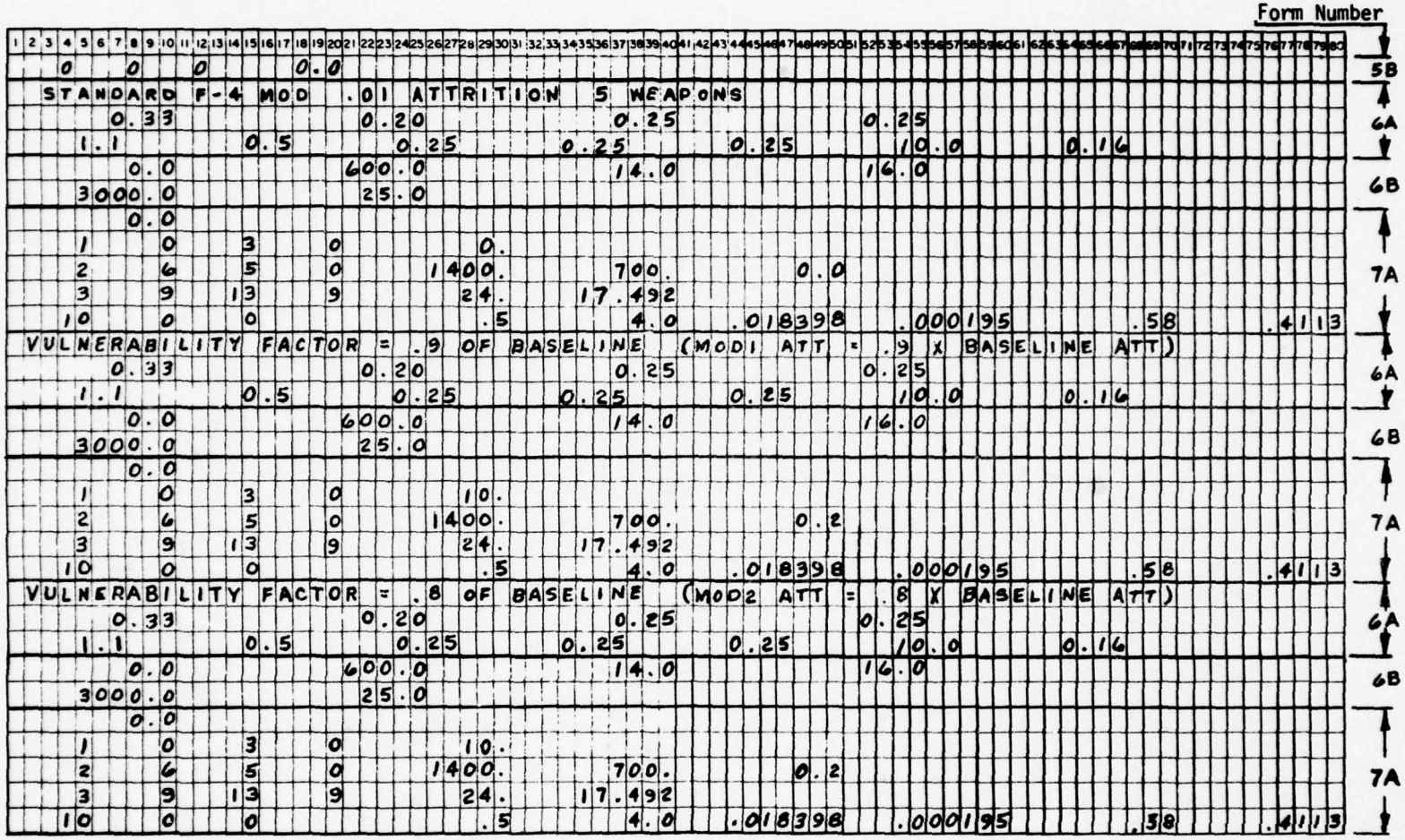
Input Data for Sample Problem (Contd.)



Input Data for Sample Problem (Contd.)



Input Data for Sample Problem (Contd.)



55/56 blank

Appendix B

SAMPLE PROBLEM COMPUTER OUTPUT

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 1

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	.4920	.4500	.4330	.2920	.2000
305.	.4920	.4500	.4330	.3080	.2250
610.	.4670	.4330	.3830	.2920	.2170
1524.	.3830	.3250	.2670	.1750	.1080
3002.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 2

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4670	.2330	.1000	.0330	0.0000
305.	.4500	.1830	.0830	.0330	0.0000
610.	.4170	.1330	.0500	.0170	0.0000
1402.	0.0000	0.0000	0.0000	0.0000	0.0000
12192.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 3

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4500	.2000	.1000	.0400	.0050
305.	.6000	.2650	.1450	.0600	.0150
610.	.6000	.2650	.1500	.0650	.0200
1524.	.6000	.2650	.1500	.0650	.0200
3048.	.4500	.2000	.2550	.0400	.0100

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 4

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.7910	.6040	.4460	.2480	.1350
610.	.9430	.8190	.7220	.5540	.4190
1524.	.9760	.8930	.8070	.6780	.5590
3048.	.9870	.9040	.8350	.7060	.5930

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 0 WEAPON 5

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.2000	.1890	.1750	.1430	.1070
610.	.9460	.8930	.8180	.6430	.4790
1524.	.9680	.9360	.8930	.7960	.6860
3048.	.9680	.9360	.8930	.8180	.7180

PK TABLE FOR POPUP
MOD 0 WEAPON 1

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.2130	0.0000	0.0000	0.0000
610.	.2080	.2210	0.0000	0.0000
1524.	.1630	.1670	.1630	0.0000
3002.	.1000	.1210	.1080	.0540

PK TABLE FOR POPUP
MOD 0 WEAPON 2

TERM ALT	INIT ALT			
	152.	305.	610.	1402.
305.	.0250	0.0000	0.0000	0.0000
610.	.0180	.0180	0.0000	0.0000
1402.	.0120	.0120	.0050	0.0000
12192.	.0120	.0120	.0050	0.0000

PK TABLE FOR POPUP
MOD 0 WEAPON 3

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.0380	0.0000	0.0000	0.0000
610.	.0400	.0520	0.0000	0.0000
1524.	.0400	.0520	.0540	0.0000
3048.	.0300	.0410	.0440	.0440

PK TABLE FOR POPUP
MOD 0 WEAPON 4

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.1110	0.0000	0.0000	0.0000
610.	.2600	.3700	0.0000	0.0000
1524.	.3240	.4340	.5840	0.0000
3048.	.3390	.4490	.5990	.6630

PK TABLE FOR POPUP
MOD 0 WEAPON 5

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.0680	0.0000	0.0000	0.0000
610.	.3000	.3680	0.0000	0.0000
1524.	.3840	.4510	.6850	0.0000
3048.	.3960	.4640	.6980	.7800

PK TABLE FOR DIVE
MOD 0 WEAPON 1

ANGLE	INIT ALT			
	305.	610.	1524.	3002.
15.	.2130	.2080	.1630	.1000
45.	.2130	.2080	.1630	.1000
60.	.2130	.2080	.1630	.1000

PK TABLE FOR DIVE
MOD 0 WEAPON 2

ANGLE	INIT ALT			
	305.	610.	1402.	12192.
15.	.0250	.0180	.0120	.0120
45.	.0250	.0180	.0120	.0120
60.	.0250	.0180	.0120	.0120

PK TABLE FOR DIVE
MOD 0 WEAPON 3

ANGLE	INIT ALT			
	305.	610.	1524.	3048.
15.	.0380	.0400	.0400	.0300
45.	.0380	.0400	.0400	.0300
60.	.0380	.0400	.0400	.0300

PK TABLE FOR DIVE
MOD 0 WEAPON 4

ANGLE	INIT ALT			
	305.	610.	1524.	3048.
15.	.1110	.2600	.3240	.3390
45.	.1110	.2600	.3240	.3390
60.	.1110	.2600	.3240	.3390

PK TABLE FOR DIVE
MOD 0 WEAPON 5

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.0680	.3000	.3840	.3960
45.	.0680	.3000	.3840	.3960
60.	.0680	.3000	.3840	.3960

PK TABLE FOR SWING AROUND
MOD 0 WEAPON 1

ALT	
152.	.2000
305.	.2000
610.	.2000

PK TABLE FOR SWING AROUND
MOD 0 WEAPON 2

ALT	
152.	.1250
305.	.1250
610.	.1250

PK TABLE FOR SWING AROUND
MOD 0 WEAPON 3

ALT	
152.	.0270
305.	.0270
610.	.0270

PK TABLE FOR SWING AROUND
MOD 0 WEAPON 4

ALT	
152.	0.0000
305.	.6040
610.	.8190

PK TABLE FOR SWING AROUND
MOD 0 WEAPON 5

ALT	
152.	0.0000
305.	.1890
610.	.8930

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 1 WEAPON 1

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	.4920	.4500	.4330	.2920	.2000
305.	.4920	.4500	.4330	.3080	.2250
610.	.4670	.4330	.3830	.2920	.2170
1524.	.3830	.3250	.2670	.1750	.1080
3002.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 1 WEAPON 2

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4670	.2330	.1000	.0330	0.0000
305.	.4500	.1830	.0830	.0330	0.0000
610.	.4170	.1330	.0500	.0170	0.0000
1402.	0.0000	0.0000	0.0000	0.0000	0.0000
12192.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 1 WEAPON 3

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4500	.2000	.1000	.0400	.0050
305.	.6000	.2650	.1450	.0600	.0150
610.	.6000	.2650	.1500	.0650	.0200
1524.	.6000	.2650	.1500	.0650	.0200
3048.	.4500	.2000	.2550	.0400	.0100

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 1 WEAPON 4

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.7910	.6040	.4460	.2480	.1350
610.	.9430	.8190	.7220	.5540	.4190
1524.	.9760	.8930	.8070	.6780	.5590
3048.	.9870	.9040	.8350	.7060	.5930

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 1 WEAPON 5

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.2000	.1890	.1750	.1430	.1070
610.	.9460	.8930	.8180	.6430	.4790
1524.	.9680	.9360	.8930	.7960	.6860
3048.	.9680	.9360	.8930	.8180	.7180

PK TABLE FOR POPUP
MOD 1 WEAPON 1

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.2130	0.0000	0.0000	0.0000
610.	.2080	.2210	0.0000	0.0000
1524.	.1630	.1670	.1630	0.0000
3002.	.1000	.1210	.1080	.0540

PK TABLE FOR POPUP
MOD 1 WEAPON 2

TERM ALT	INIT ALT			
	152.	305.	610.	1402.
305.	.0250	0.0000	0.0000	0.0000
610.	.0180	.0180	0.0000	0.0000
1402.	.0120	.0120	.0050	0.0000
12192.	.0120	.0120	.0050	0.0000

PK TABLE FOR POPUP
MOD 1 WEAPON 3

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.0380	0.0000	0.0000	0.0000
610.	.0400	.0520	0.0000	0.0000
1524.	.0400	.0520	.0540	0.0000
3048.	.0300	.0410	.0440	.0440

PK TABLE FOR POPUP
MOD 1 WEAPON 4

TERM ALT	INIT ALT 152.	305.	610.	1524.
305.	.1110	0.0000	0.0000	0.0000
610.	.2600	.3700	0.0000	0.0000
1524.	.3240	.4340	.5840	0.0000
3048.	.3390	.4490	.5990	.6630

PK TABLE FOR POPUP
MOD 1 WEAPON 5

TERM ALT	INIT ALT 152.	305.	610.	1524.
305.	.0680	0.0000	0.0000	0.0000
610.	.3000	.3680	0.0000	0.0000
1524.	.3840	.4510	.6850	0.0000
3048.	.3960	.4640	.6980	.7800

PK TABLE FOR DIVE
MOD 1 WEAPON 1

ANGLE	INIT ALT 305.	610.	1524.	3002.
15.	.2130	.2080	.1630	.1000
45.	.2130	.2080	.1630	.1000
60.	.2130	.2080	.1630	.1000

PK TABLE FOR DIVE
MOD 1 WEAPON 2

ANGLE	INIT ALT 305.	610.	1402.	12192.
15.	.0250	.0180	.0120	.0120
45.	.0250	.0180	.0120	.0120
60.	.0250	.0180	.0120	.0120

PK TABLE FOR DIVE
MOD 1 WEAPON 3

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.0380	.0400	.0400	.0300
45.	.0380	.0400	.0400	.0300
60.	.0380	.0400	.0400	.0300

PK TABLE FOR DIVE
MOD 1 WEAPON 4

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.1110	.2600	.3240	.3390
45.	.1110	.2600	.3240	.3390
60.	.1110	.2600	.3240	.3390

PK TABLE FOR DIVE
MOD 1 WEAPON 5

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.0680	.3000	.3840	.3960
45.	.0680	.3000	.3840	.3960
60.	.0680	.3000	.3840	.3960

PK TABLE FOR SWING AROUND
MOD 1 WEAPON 1

ALT	
152.	.2000
305.	.2000
610.	.2000

PK TABLE FOR SWING AROUND
MOD 1 WEAPON 2

ALT	
152.	.1250
305.	.1250
610.	.1250

PK TABLE FOR SWING AROUND
MOD 1 WEAPON 3

ALT	
152.	.0270
305.	.0270
610.	.0270

PK TABLE FOR SWING AROUND
MOD 1 WEAPON 4

ALT	
152.	0.0000
305.	.6040
610.	.8190

PK TABLE FOR SWING AROUND
MOD 1 WEAPON 5

ALT	
152.	0.0000
305.	.1890
610.	.8930

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 2 WEAPON 1

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	.4920	.4500	.4330	.2920	.2000
305.	.4920	.4500	.4330	.3080	.2250
610.	.4670	.4330	.3830	.2920	.2170
1524.	.3830	.3250	.2670	.1750	.1080
3002.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 2 WEAPON 2

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4670	.2330	.1000	.0330	0.0000
305.	.4500	.1830	.0830	.0330	0.0000
610.	.4170	.1330	.0500	.0170	0.0000
1402.	0.0000	0.0000	0.0000	0.0000	0.0000
12192.	0.0000	0.0000	0.0000	0.0000	0.0000

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 2 WEAPON 3

ALT	SPEED				
	30.	61.	91.	152.	305.
152.	.4500	.2000	.1000	.0400	.0050
305.	.6000	.2650	.1450	.0600	.0150
610.	.6000	.2650	.1500	.0650	.0200
1524.	.6000	.2650	.1500	.0650	.0200
3048.	.4500	.2000	.2550	.0400	.0100

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 2 WEAPON 4

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.7910	.6040	.4460	.2480	.1350
610.	.9430	.8190	.7220	.5540	.4190
1524.	.9760	.8930	.8070	.6780	.5590
3048.	.9870	.9040	.8350	.7060	.5930

PK TABLE FOR STRAIGHT AND LEVEL FLIGHT
MOD 2 WEAPON 5

ALT	SPEED				
	30.	61.	91.	152.	213.
152.	0.0000	0.0000	0.0000	0.0000	0.0000
305.	.2000	.1890	.1750	.1430	.1070
610.	.9460	.8930	.8180	.6430	.4790
1524.	.9680	.9360	.8930	.7960	.6860
3048.	.9680	.9360	.8930	.8180	.7180

PK TABLE FOR POPUP
MOD 2 WEAPON 1

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.2130	0.0000	0.0000	0.0000
610.	.2080	.2210	0.0000	0.0000
1524.	.1630	.1670	.1630	0.0000
3002.	.1000	.1210	.1080	.0540

PK TABLE FOR POPUP
MOD 2 WEAPON 2

TERM ALT	INIT ALT			
	152.	305.	610.	1402.
305.	.0250	0.0000	0.0000	0.0000
610.	.0180	.0180	0.0000	0.0000
1402.	.0120	.0120	.0050	0.0000
12192.	.0120	.0120	.0050	0.0000

PK TABLE FOR POPUP
MOD 2 WEAPON 3

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.0380	0.0000	0.0000	0.0000
610.	.0400	.0520	0.0000	0.0000
1524.	.0400	.0520	.0540	0.0000
3048.	.0300	.0410	.0440	.0440

PK TABLE FOR POPUP
MOD 2 WEAPON 4

TERM ALT	INIT ALT			
	152.	305.	610.	1524.
305.	.1110	0.0000	0.0000	0.0000
610.	.2600	.3700	0.0000	0.0000
1524.	.3240	.4340	.5840	0.0000
3048.	.3390	.4490	.5990	.6630

PK TABLE FOR POPUP
MOD 2 WEAPON 5

TERM ALT	INIT ALT 152.	305.	610.	1524.
305.	.0680	0.0000	0.0000	0.0000
610.	.3000	.3680	0.0000	0.0000
1524.	.3940	.4510	.6850	0.0000
3048.	.3960	.4640	.6980	.7800

PK TABLE FOR DIVE
MOD 2 WEAPON 1

ANGLE	INIT ALT 305.	610.	1524.	3002.
15.	.2130	.2080	.1630	.1000
45.	.2130	.2080	.1630	.1000
60.	.2130	.2080	.1630	.1000

PK TABLE FOR DIVE
MOD 2 WEAPON 2

ANGLE	INIT ALT 305.	610.	1402.	12192.
15.	.0250	.0180	.0120	.0120
45.	.0250	.0180	.0120	.0120
60.	.0250	.0180	.0120	.0120

PK TABLE FOR DIVE
MOD 2 WEAPON 3

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.0380	.0400	.0400	.0300
45.	.0380	.0400	.0400	.0300
60.	.0380	.0400	.0400	.0300

PK TABLE FOR DIVE
MOD 2 WEAPON 4

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.1110	.2600	.3240	.3390
45.	.1110	.2600	.3240	.3390
60.	.1110	.2600	.3240	.3390

Pk TABLE FOR DIVE
MOD 2 WEAPON 5

ANGLE	INIT ALT 305.	610.	1524.	3048.
15.	.0680	.3000	.3840	.3960
45.	.0680	.3000	.3840	.3960
60.	.0680	.3000	.3840	.3960

Pk TABLE FOR SWING AROUND
MOD 2 WEAPON 1

ALT	
152.	.2000
305.	.2000
610.	.2000

Pk TABLE FOR SWING AROUND
MOD 2 WEAPON 2

ALT	
152.	.1250
305.	.1250
610.	.1250

Pk TABLE FOR SWING AROUND
MOD 2 WEAPON 3

ALT	
152.	.0270
305.	.0270
610.	.0270

Pk TABLE FOR SWING AROUND
MOD 2 WEAPON 4

ALT	
152.	0.0000
305.	.6040
610.	.8190

Pk TABLE FOR SWING AROUND
MOD 2 WEAPON 5

ALT	
152.	0.0000
305.	.1890
610.	.8930

WEAPON DENSITY FACTORS AND VULNERABILITY FRACTIONS BY ZONE, A/C MOD AND WEAPON

	ZONE	MOD	WEAPON	1	2	3	4	5
D-FACTOR	1			.0024	.0012	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000
D-FACTOR	2			.0120	.0060	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000
D-FACTOR	3			.0120	.0060	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000
D-FACTOR	4			.0024	.0012	0.0000	0.0000	0.0000
VULN FRACTION		0		1.0000	1.0000	1.0000	1.0000	1.0000
VULN FRACTION		1		.9000	.9000	1.0000	1.0000	1.0000
VULN FRACTION		2		.8000	.8000	1.0000	1.0000	1.0000

NOTE: D-FACTOR = .002 TIMES WEAPON EFFECTIVE RANGE (METERS) TIMES WEAPON DENSITY (QTY/SQ. KM)

ATTRITION OPTION = T BASELINE A/C ATTRITION .0100

	1	2	3	4
ZONE WEIGHTING	.1000	.7000	.1500	.0500

SCENARIO PARAMETERS BY A/C MOD

A/C MOD	0	INBOUND DIST	180.	INBOUND TIME	0.
		INBOUND SPEED	200.	INBOUND ALT	1200.
		POPUP TERM ALT	4000.		
		SEARCH DIST	0.	SEARCH TIME	30.
		SEARCH SPEED	230.		
		DIVE ANGLE	30.		
		RET TGT DIST	0.	RET TGT TIME	45.
		RET TGT SPEED	200.		
		OUTBOUND DIST	180.	OUTBOUND TIME	0.
		OUTBOUND SPEED	200.	OUTBOUND ALT	1200.
		LOITER DIST	0.	LOITER TIME	120.
		LOITER SPEED	200.		
A/C MOD	1	INBOUND DIST	180.	INBOUND TIME	0.
		INBOUND SPEED	200.	INBOUND ALT	1200.
		POPUP TERM ALT	4000.		
		SEARCH DIST	0.	SEARCH TIME	30.
		SEARCH SPEED	230.		
		DIVE ANGLE	30.		
		RET TGT DIST	0.	RET TGT TIME	45.
		RET TGT SPEED	200.		
		OUTBOUND DIST	180.	OUTBOUND TIME	0.
		OUTBOUND SPEED	200.	OUTBOUND ALT	1200.
		LOITER DIST	0.	LOITER TIME	120.
		LOITER SPEED	200.		
A/C MOD	2	INBOUND DIST	180.	INBOUND TIME	0.
		INBOUND SPEED	200.	INBOUND ALT	1200.
		POPUP TERM ALT	4000.		
		SEARCH DIST	0.	SEARCH TIME	30.
		SEARCH SPEED	230.		
		DIVE ANGLE	30.		
		RET TGT DIST	0.	RET TGT TIME	45.
		RET TGT SPEED	200.		
		OUTBOUND DIST	180.	OUTBOUND TIME	0.
		OUTBOUND SPEED	200.	OUTBOUND ALT	1200.
		LOITER DIST	0.	LOITER TIME	120.
		LOITER SPEED	200.		

EVENT DEFENSE ZONES

	ZONE
INBOUND	1
POP-UP	2
SEARCH	2
DIVE	2
SWING-AROUND	2
CLIMB TO NEXT PASS	2
CLIMB FOR OUTBOUND	2
BETWEEN TARGET	3
OUTBOUND	4
LOITER DIVE	2
LOITER	2

(* - DENOTES CALCULATED VALUES)

NON-ABORTED FLIGHT SIZE 3.90

* A/C MOD	UNSCALED SURVIVAL PROBABILITY	NO. A/C SURVIVING PER FLIGHT
0	.86706	3.38154
1	.88021	3.43281
2	.89339	3.48420

PT=1. ATTRITION SCALING MAY NOT BE VALID
EVENT = SEARCH

PT=1. ATTRITION SCALING MAY NOT BE VALID
EVENT = SEARCH

PT=1. ATTRITION SCALING MAY NOT BE VALID
EVENT = SEARCH

MISSION TRADE-OFF MODEL

BASELINE AIRCRAFT (MOD 0)

STANDARD F-4 MOD .01 ATTRITION 5 WEAPONS

(* - DENOTES CALCULATED VALUES)

FLIGHT INFORMATION

INITIAL FLIGHT SIZE

4.

INITIAL NO. OF PASSES PER A/C

6

NO. OF ASSIGNED TARGETS

3

NO. OF PASSES PER TARGET

TARGET	PASSES
1	2
2	2
3	2

PROB. OF NO ABORT

.975

PROB. OF NO A/C GNE

.95

PROB. OF A/C FINDING ASSIGNED TARGETS

TARGET	PROB.
1	.95
2	.95
3	.95

PROB. OF A/C LOCK-ON

PASS

TARGET	1	2	3	4	5
1	1.00	1.00			
2	1.00	1.00			
3	1.00	1.00			

NO. OF A/C ABORTS

.100

* NO. OF PASSES DELIVERED (ALL A/C)

21.012

* NO. OF A/C KILLED

.039

* NO. OF PASSES LOST ON A/C KILLED

.120

* NO. OF A/C HOME SAFELY

3.961

* NO. OF PASSES BROUGHT HOME

2.868

MOD 0

* PROBABILITY OF SURVIVAL PER A/C

.99025

* PROBABILITY OF SURVIVAL PER A/C GIVEN NON-ABORT

.99000

* PROBABILITY OF DAMAGE PER A/C

.02925

MAINTENANCE SUMMARY

SORTIE INFORMATION

	UNSCHEDULED	SCHEDULED
MMH/FH	16.0	14.0
CONV.FACT.	.25	.25

	DAMAGE REPAIR	ABORT REPAIR
MMH/TASK	600.0	0.0
CONV.FACT.	.20	.33

TURNAROUND (CLOCK HOURS)

RE-ARM	RE-FUEL	PRE-FLIGHT INSP.	POST-FLIGHT INSP.
.50	.25	.25	.25

WAITING	TAXIING
10.00	.16

TOTAL DELAY TIME

11.41

PROB. OF ABORT	* PROB. OF KILL
.025	.010

LENGTH OF SORTIE	DAMAGE/KILL RATIO
1.10 HRS.	3.00

* SORTIE RATE PER A/C PER DAY

1.00

MOD 0

JOB SCALING FACTORS

NO. TARGETS TO BE ATTACKED=40000.0
LENGTH OF WAR= 30.0 DAYS
NO. PASSES REQUIRED TO ATTACK TARGET= 2.00
INITIAL FLIGHT SIZE= 4.
* SORTIE RATE= 1.00 SORTIES PER DAY
* PROBABILITY OF SURVIVING SORTIE= .99025

JOB SCALING OUTPUT

* MAXIMUM NO. SORTIES AVAILABLE PER A/C IN TW=30.0645
* EXP. NO. SORTIES AVAILABLE PER A/C IN TW=25.9137
* EXP. NO. SORTIES COMPLETED PER A/C IN TW=25.2659
* EXP. NO. TARGETS ATTACKED PER SORTIE=2.626
* EXP. NO. TARGETS ATTACKED PER A/C IN TW= 68.06
* EXP. NO. DAMAGES PER A/C IN TW= .8794
* PROBABILITY OF A/C SURVIVING WAR= .7449
* EXP. NO. A/C LOST IN TW= 149.95

* NUMBER OF A/C REQUIRED TO DO JOB= 587.70

(* - DENOTES CALCULATED VALUES)

MISSION TRADE-OFF METHODOLOGY
COST MODEL

MOD 0

ANNUAL DISCOUNT RATE= 0.00 PERCENT

RDTE COST INPUTS

YEARS/MONTHS TO START OF RDTE= 1/ 0

YEARS/MONTHS TO END OF RDTE= 3/ 0

COST OF RDTE=$ 0.00

ACQUISITION COST INPUTS

YEARS/MONTHS TO START OF ACQUISITION= 2/ 6

YEARS/MONTHS TO END OF ACQUISITION= 5/ 0

NUMBER OF AIRCRAFT IN TOTAL FORCE=1400.

NUMBER OF AIRCRAFT TO BE MODIFIED= 700.

NUMBER OF AIRCRAFT IN WAR FORCE= 587.70

COST OF MODIFICATION PER AIRCRAFT=$ 0.00000

COST OF AGE/COST OF MODIFICATION= .1000

COST OF SPARES/COST OF MODIFICATION= .1000

PEACETIME OPERATION AND SUPPORT COST INPUTS

YEARS/MONTHS TO START OF O+S= 3/ 9

YEARS/MONTHS TO END OF O+S=13/ 9

ANNUAL O+S COST PER SQUADRON=$ 17.49200

NUMBER OF AIRCRAFT PER SQUADRON= 24.

MOD 0

WARTIME OPERATION AND SUPPORT COST INPUTS

YEARS/MONTHS/DAYS TO START OF WAR=10/ 0/ 0

DURATION OF WAR IN DAYS= 30

CHANGE IN ANNUAL O+S COST/ANNUAL PEACETIME O+S COST= .5000

REPLACEMENT COST PER AIRCRAFT KILLED=$ 4.00

CREWS LOST PER AIRCRAFT KILLED= .5800

COST PER AIRCRAFT OF CREW REPLACEMENT=$ .41130

* PROBABILITY AN AIRCRAFT WILL SURVIVE THE WAR= .74485

* EXPECTED DAMAGED SORTIES FLOWN IN WAR PER AIRCRAFT= .88

REPAIR COST PER DAMAGED AIRCRAFT=$ .01840

* EXPECTED SORTIES FLOWN IN WAR PER AIRCRAFT= 25.91

* EXPECTED NUMBER OF WEAPONS USED PER SORTIE= 5.2529

COST PER WEAPON=$ .000195

* PRESENT VALUES--

RDTE COST=$	0.00
ACQUISITION COST=$	0.00
OPERATION AND SUPPORT COST=$	10203.67
CHANGE IN O+S COST FOR WAR=$	678.28
TOTAL LIFE CYCLE COST=$	10881.95

(* - DENOTES CALCULATED VALUES)

A/C MODIFICATION NUMBER 1

VULNERABILITY FACTOR = .9 OF BASELINE (MOD1 ATT = .9 X BASELINE ATT)

(* - DENOTES CALCULATED VALUES)

FLIGHT INFORMATION

INITIAL FLIGHT SIZE

4.

INITIAL NO. OF PASSES PER A/C

6

NO. OF ASSIGNED TARGETS

3

NO. OF PASSES PER TARGET

TARGET	PASSES
1	2
2	2
3	2

PROB. OF NO ABORT

.975

PROB. OF NO A/C GNE

.95

PROB. OF A/C FINDING ASSIGNED TARGETS

TARGET	PROB.
1	.95
2	.95
3	.95

PROB. OF A/C LOCK-ON

	PASS				
TARGET	1	2	3	4	5
1	1.00	1.00			
2	1.00	1.00			
3	1.00	1.00			

NO. OF A/C ABORTS

.100

* NO. OF PASSES DELIVERED (ALL A/C)

21.022

* NO. OF A/C KILLED

.035

* NO. OF PASSES LOST ON A/C KILLED

.108

* NO. OF A/C HOME SAFELY

3.965

* NO. OF PASSES BROUGHT HOME

2.870

MOD 1

* PROBABILITY OF SURVIVAL PER A/C

.99122

* PROBABILITY OF SURVIVAL PER A/C GIVEN NON-ABORT

.99100

* PROBABILITY OF DAMAGE PER A/C

.03022

MAINTENANCE SUMMARY

SORTIE INFORMATION

	UNSCHEDULED	SCHEDULED
MMH/FH	16.0	14.0
CONV.FACT.	.25	.25

	DAMAGE REPAIR	ABORT REPAIR
MMH/TASK	600.0	0.0
CONV.FACT.	.20	.33

TURNAROUND (CLOCK HOURS)

RE-ARM	RE-FUEL	PRE-FLIGHT INSP.	POST-FLIGHT INSP.
.50	.25	.25	.25

WAITING	TAXIING
10.00	.16

TOTAL DELAY TIME

11.41

PROB. OF ABORT	* PROB. OF KILL
.025	.009

LENGTH OF SORTIE	DAMAGE/KILL RATIO
1.10 HRS.	3.44

DELTA MMH

UNSCHEDULED	0.0
SCHEDULED	0.0
DAMAGE REPAIR	0.0
ABORT REPAIR	0.0

* SORTIE RATE PER A/C PER DAY

1.00

MOD 1

JOB SCALING FACTORS

NO. TARGETS TO BE ATTACKED=40000.0
LENGTH OF WAR= 30.0 DAYS
NO. PASSES REQUIRED TO ATTACK TARGET= 2.00
INITIAL FLIGHT SIZE= 4.
* SORTIE RATE= 1.00 SORTIES PER DAY
* PROBABILITY OF SURVIVING SORTIE= .99122

JOB SCALING OUTPUT

* MAXIMUM NO. SORTIES AVAILABLE PER A/C IN TW=29.9220
* EXP. NO. SORTIES AVAILABLE PER A/C IN TW=26.1957
* EXP. NO. SORTIES COMPLETED PER A/C IN TW=25.5310
* EXP. NO. TARGETS ATTACKED PER SORTIE=2.628
* EXP. NO. TARGETS ATTACKED PER A/C IN TW= 68.81
* EXP. NO. DAMAGES PER A/C IN TW= .9044
* PROBABILITY OF A/C SURVIVING WAR= .7682
* EXP. NO. A/C LOST IN TW= 134.76

* NUMBER OF A/C REQUIRED TO DO JOB= 581.30

(* - DENOTES CALCULATED VALUES)

MISSION TRADE-OFF METHODOLOGY
COST MODEL

MOD 1

ANNUAL DISCOUNT RATE= 0.00 PERCENT

RDTE COST INPUTS

YEARS/MONTHS TO START OF RDTE= 1/ 0

YEARS/MONTHS TO END OF RDTE= 3/ 0

COST OF RDTE=$ 10.00

ACQUISITION COST INPUTS

YEARS/MONTHS TO START OF ACQUISITION= 2/ 6

YEARS/MONTHS TO END OF ACQUISITION= 5/ 0

NUMBER OF AIRCRAFT IN TOTAL FORCE=1400.

NUMBER OF AIRCRAFT TO BE MODIFIED= 700.

NUMBER OF AIRCRAFT IN WAR FORCE= 581.30

COST OF MODIFICATION PER AIRCRAFT=$ .20000

COST OF AGE/COST OF MODIFICATION= .1000

COST OF SPARES/COST OF MODIFICATION= .1000

PEACETIME OPERATION AND SUPPORT COST INPUTS

YEARS/MONTHS TO START OF O+S= 3/ 9

YEARS/MONTHS TO END OF O+S=13/ 9

ANNUAL O+S COST PER SQUADRON=$ 17.49200

NUMBER OF AIRCRAFT PER SQUADRON= 24.

MOD 1

WARTIME OPERATION AND SUPPORT COST INPUTS

YEARS/MONTHS/DAYS TO START OF WAR=10/ 0/ 0

DURATION OF WAR IN DAYS= 30

CHANGE IN ANNUAL O+S COST/ANNUAL PEACETIME O+S COST= .500(

REPLACEMENT COST PER AIRCRAFT KILLED=$ 4.00

CREWS LOST PER AIRCRAFT KILLED= .5800

COST PER AIRCRAFT OF CREW REPLACEMENT=$ .41130

* PROBABILITY AN AIRCRAFT WILL SURVIVE THE WAR= .76817

* EXPECTED DAMAGED SORTIES FLOWN IN WAR PER AIRCRAFT= .90

REPAIR COST PER DAMAGED AIRCRAFT=$ .01840

* EXPECTED SORTIES FLOWN IN WAR PER AIRCRAFT= 26.19

* EXPECTED NUMBER OF WEAPONS USED PER SORTIE= 5.2556

COST PER WEAPON=$ .000195

* PRESENT VALUES--

RDTE COST=$	10.00
ACQUISITION COST=$	168.00
OPERATION AND SUPPORT COST=$	10203.67
CHANGE IN O+S COST FOR WAR=$	613.87
TOTAL LIFE CYCLE COST=$	10995.54

(* - DENOTES CALCULATED VALUES)

SUB-MOES

VA/CAK= 6.2500 (100-VA)/PL= .0250

	I1	I2	I3	I4
MOD 1	.945	1.050	0.000	0.000

DELTA PL=0.0, XI4=DELTA VA

A/C MODIFICATION NUMBER 2

VULNERABILITY FACTOR = .8 OF BASELINE (MOD2 ATT = .8 X BASELINE ATT)

(* - DENOTES CALCULATED VALUES)

FLIGHT INFORMATION

INITIAL FLIGHT SIZE	INITIAL NO. OF PASSES PER A/C
4.	6

NO. OF ASSIGNED TARGETS

3

NO. OF PASSES PER TARGET

TARGET	PASSES
1	2
2	2
3	2

PROB. OF NO ABORT

.975

PROB. OF NO A/C GNE

.95

PROB. OF A/C FINDING ASSIGNED TARGETS

TARGET	PROB.
1	.95
2	.95
3	.95

PROB. OF A/C LOCK-ON

	PASS				
TARGET	1	2	3	4	5
1	1.00	1.00			
2	1.00	1.00			
3	1.00	1.00			

NO. OF A/C ABORTS

.100

* NO. OF PASSES DELIVERED (ALL A/C)

21.033

* NO. OF A/C KILLED

.031

* NO. OF PASSES LOST ON A/C KILLED

.096

* NO. OF A/C HOME SAFELY

3.969

* NO. OF PASSES BROUGHT HOME

2.871

MOD 2

* PROBABILITY OF SURVIVAL PER A/C

.99220

* PROBABILITY OF SURVIVAL PER A/C GIVEN NON-ABORT

.99200

* PROBABILITY OF DAMAGE PER A/C

.03120

MAINTENANCE SUMMARY

SORTIE INFORMATION

	UNSCHEDULED	SCHEDULED
MMH/FH	16.0	14.0
CONV.FACT.	.25	.25

	DAMAGE REPAIR	ABORT REPAIR
MMH/TASK	600.0	0.0
CONV.FACT.	.20	.33

TURNAROUND (CLOCK HOURS)

RE-ARM	RE-FUEL	PRE-FLIGHT INSP.	POST-FLIGHT INSP.
.50	.25	.25	.25

WAITING	TAXIING
10.00	.16

TOTAL DELAY TIME

11.41

PROB. OF ABORT	* PROB. OF KILL
.025	.008

LENGTH OF SORTIE	DAMAGE/KILL RATIO
1.10 HRS.	4.00

DELTA MMH

UNSCHEDULED	0.0
SCHEDULED	0.0
DAMAGE REPAIR	0.0
ABORT REPAIR	0.0

* SORTIE RATE PER A/C PER DAY

.99

MOD 2

JOB SCALING FACTORS

NO. TARGETS TO BE ATTACKED=40000.0
LENGTH OF WAR= 30.0 DAYS
NO. PASSES REQUIRED TO ATTACK TARGET= 2.00
INITIAL FLIGHT SIZE= 4.
* SORTIE RATE= .99 SORTIES PER DAY
* PROBABILITY OF SURVIVING SORTIE= .99220

JOB SCALING OUTPUT

* MAXIMUM NO. SORTIES AVAILABLE PER A/C IN TW=29.7809
* EXP. NO. SORTIES AVAILABLE PER A/C IN TW=26.4592
* EXP. NO. SORTIES COMPLETED PER A/C IN TW=25.7977
* EXP. NO. TARGETS ATTACKED PER SORTIE=2.629
* EXP. NO. TARGETS ATTACKED PER A/C IN TW= 69.56
* EXP. NO. DAMAGES PER A/C IN TW= .9291
* PROBABILITY OF A/C SURVIVING WAR= .7920
* EXP. NO. A/C LOST IN TW= 119.61

* NUMBER OF A/C REQUIRED TO DO JOB= 575.00

(* - DENOTES CALCULATED VALUES)

MISSION TRADE-OFF METHODOLOGY
COST MODEL

MOD 2

ANNUAL DISCOUNT RATE= 0.00 PERCENT

RDTE COST INPUTS

YEARS/MONTHS TO START OF RDTE= 1/ 0

YEARS/MONTHS TO END OF RDTE= 3/ 0

COST OF RDTE=$ 10.00

ACQUISITION COST INPUTS

YEARS/MONTHS TO START OF ACQUISITION= 2/ 6

YEARS/MONTHS TO END OF ACQUISITION= 5/ 0

NUMBER OF AIRCRAFT IN TOTAL FORCE=1400.

NUMBER OF AIRCRAFT TO BE MODIFIED= 700.

NUMBER OF AIRCRAFT IN WAR FORCE= 575.00

COST OF MODIFICATION PER AIRCRAFT=$ .20000

COST OF AGE/COST OF MODIFICATION= .1000

COST OF SPARES/COST OF MODIFICATION= .1000

PEACETIME OPERATION AND SUPPORT COST INPUTS

YEARS/MONTHS TO START OF O+S= 3/ 9

YEARS/MONTHS TO END OF O+S=13/ 9

ANNUAL O+S COST PER SQUADRON=$ 17.49200

NUMBER OF AIRCRAFT PER SQUADRON= 24.

MOD 2

WARTIME OPERATION AND SUPPORT COST INPUTS

YEARS/MONTHS/DAYS TO START OF WAR=10/ 0/ 0

DURATION OF WAR IN DAYS= 30

CHANGE IN ANNUAL O+S COST/ANNUAL PEACETIME O+S COST= .5000

REPLACEMENT COST PER AIRCRAFT KILLED=$ 4.00

CREWS LOST PER AIRCRAFT KILLED= .5800

COST PER AIRCRAFT OF CREW REPLACEMENT=$ .41130

* PROBABILITY AN AIRCRAFT WILL SURVIVE THE WAR= .79198

* EXPECTED DAMAGED SORTIES FLOWN IN WAR PER AIRCRAFT= .93

REPAIR COST PER DAMAGED AIRCRAFT=$ .01840

* EXPECTED SORTIES FLOWN IN WAR PER AIRCRAFT= 26.46

* EXPECTED NUMBER OF WEAPONS USED PER SORTIE= 5.2583

COST PER WEAPON=$ .000195

*PRESENT VALUES--

RDTE COST=$	10.00
ACQUISITION COST=$	168.00
OPERATION AND SUPPORT COST=$	10203.67
CHANGE IN O+S COST FOR WAR=$	549.65
TOTAL LIFE CYCLE COST=$	10931.31

(* - DENOTES CALCULATED VALUES)

SUBMOES

VA/CAK= 6.2500 (100-VA)/PL= .0250

	I1	I2	I3	I4
MOD2	.840	1.050	0.000	0.000

DELTA PL=0.0, XI4=DELTA VA

Appendix C

FORTRAN PROGRAM LISTING FOR MTOM

```
      PROGRAM MTOM(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/PASS/ACH,ACK,MOD,PD,PH,PKBASE,PKMOD,PL,PS,PSNA
      DIMENSION A(8)
      CALL JOBIN
      CALL MTODIN
      CALL MTOW
      CALL MTOD
      DO 10 MOD=1,NAC
      IF(MOD.GT.1) GO TO 5
      WRITE(6,1000)
 1000 FORMAT(*1*,20X,*MISSION TRADE-OFF MODEL*///25X,*BASELINE AIRCRAFT*
     1,10X,7H(MOD 0)//)
      GO TO 7
    5 II=MOD-1
      WRITE(6,1001) II
 1001 FORMAT(*1*,20X,*A/C MODIFICATION NUMBER *,I1//)
    7 CALL MTOSIN(A)
      WRITE(6,1002) A
 1002 FORMAT (8A10//5X,31H(* - DENOTES CALCULATED VALUES),
     1 //25X,18HFLIGHT INFORMATION)
      CALL MTOP
      CALL MTOS
      CALL MTOF
      CALL MTOC(MOD)
      CALL SUBMOE
   10 CONTINUE
      STOP
      END


      SUBROUTINE JOBIN
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      READ(5,1000) NMOD
 1000 FORMAT(I10)
      READ(5,1001) XIFS,TW,XNT,RDK,WRKT
 1001 FORMAT(5(F10.2,5X))
      READ(5,1002) PNAV,PRABR,IMAX,JMAX
 1002 FORMAT(2(F10.3,5X),2(I10,5X))
      READ(5,1003) VABASE,PLBASE,IRDK
 1003 FORMAT(F10.2,5X,F10.2,5X,I1)
      NAC=NMOD+1
      DO 20 MOD=1,NAC
      READ(5,1004) WPNPAS(MOD),WPNTGT(MOD),WPNSOR(MOD)
 1004 FORMAT(2(F10.0,5X),F10.0)
      READ(5,1005)(PLOC(MOD,I),I=1,IMAX)
 1005 FORMAT(10(F7.3,1X))
      DO 10 I=1,IMAX
      READ(5,1005) (BETA(MOD,I,J),J=1,JMAX)
   10 CONTINUE
   20 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE MTODIN
      LOGICAL OPT
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      COMMON/STLEV/NSPSL(5),NALSL(5),SPSL(5,5),ALSL(5,5),RKSL(50,5,5)
      COMMON/POPUP/NAIPU(5),NATPU(5),AIPU(5,5),ATPU(5,5),RKPU(50,5,5)
      COMMON/DIVE/NAIDI(5),NANDI(5),AIDI(5,5),ANDI(5,5),RKDI(50,5,5)
      COMMON/SWING/NALSA(5),ALSA(5,5),RKSA(50,5)
      COMMON/SCENAR/ D3(10),T3(10),SP3(10),AL3(10),AT4(10),D45(10),
     1 T45(10),SP45(10),AN5(10),D7(10),T7(10),SP7(10),D8(10),T8(10),
     2 SP8(10),AL8(10),D95(10),T95(10),SP95(10)
      COMMON/DEFEN/ NWEPS,DEN(4,5),B(10,4,5),ND3,ND4,ND45,ND5,ND6,
     1 ND65,ND67,ND7,ND8,ND9,ND95,ND10
      COMMON/ATTR/OPT,ATT,GAMMA(4)
      DATA NSPSL,NALSL,NAIPU,NATPU,NAIDI,NANDI,NALSA / 35*0/
      DATA B/200*1./
      DATA RKSL,RKPU,RKDI,RKSA / 4000*0./
      NAC = NMOD +1
      READ 100, NWEPS
      READ 100, NSPSL, NALSL
      READ 100, NAIPU, NATPU
      READ 100, NAIDI, NANDI
      READ 100, NALSA
  200 READ 100, JWEP
      IF ( JWEP .EQ. 0) GO TO 201
      KMAX = NSPSL(JWEP)
      READ 102, (SPSL(JWEP, K),K=1,KMAX)
      LMAX= NALSL(JWEP)
      DO 1 L=1,LMAX
      READ 102, ALSL(JWEP,L),(RKSL(JWEP,L,K),K=1,KMAX)
    1 CONTINUE
      GO TO 200
  201 READ 100, JWEP
      IF( JWEP .EQ. 0) GO TO 202
      KMAX= NAIPU(JWEP)
      READ 102, (AIPU(JWEP, K),K=1,KMAX)
      LMAX= NATPU(JWEP)
      DO 2 L=1,LMAX
      READ 102, ATPU(JWEP,L),(RKPU(JWEP,L,K),K=1,KMAX)
    2 CONTINUE
      GO TO 201
  202 READ 100, JWEP
      IF( JWEP .EQ. 0) GO TO 203
      KMAX = NAIDI(JWEP)
      READ 102, (AIDI(JWEP,K),K=1,KMAX)
      LMAX = NANDI(JWEP)
      DO 3 L=1,LMAX
      READ 102, ANDI(JWEP,L),(RKDI(JWEP,L,K),K=1,KMAX)
    3 CONTINUE
      GO TO 202
  203 READ 100, JWEP
      IF( JWEP .EQ. 0) GO TO 204
      KMAX = NALSA(JWEP)
      DO 4 K=1,KMAX
      READ 102, ALSA(JWEP,K),RKSA(JWEP,K)
```

```
  4 CONTINUE
    GO TO 203
204 DO 5 J=1,NWEPS
    KMAX = NSPSL(J)
    IF ( KMAX .EQ. 0) GO TO 230
    LMAX = NALSL(J)
    DO 6 K=1,KMAX
    DO 6 L=1,LMAX
    DO 6 I=2,NAC
    IA = (I-1)*NWEPS+J
  6 RKSL(IA, L,K)=RKSL(J,L,K)
230 KMAX = NAIDI(J)
    IF ( KMAX .EQ. 0) GO TO 231
    LMAX = NATPU(J)
    DO 7 K=1,KMAX
    DO 7 L=1,LMAX
    DO 7 I=2,NAC
    IA = (I-1)*NWEPS+J
  7 RKPU(IA,L,K)=RKPU(J,L,K)
231 KMAX = NAIDI(J)
    IF ( KMAX .EQ. 0) GO TO 232
    LMAX = NANDI(J)
    DO 8 K=1,KMAX
    DO 8 L=1,LMAX
    DO 8 I=2,NAC
    IA = (I-1)*NWEPS+J
  8 RKDI(IA,L,K)=RKDI(J,L,K)
232 KMAX = NALSA(J)
    IF ( KMAX .EQ. 0) GO TO 5
    DO 9 K=1,KMAX
    DO 9 I=2,NAC
    IA = (I-1)*NWEPS+J
  9 RKSA(IA,K)=RKSA(J,K)
  5 CONTINUE
210 READ 100, IAC,  JWEP
    IF (IAC .EQ. 0) GO TO 211
    KMAX = NSPSL(JWEP)
    LMAX = NALSL(JWEP)
    READ 102, ( SPSL(JWEP,K),K=1,KMAX)
    IA = (IAC-1)*NWEPS+JWEP
    DO 10 L=1,LMAX
    READ 102, ALSL(JWEP,L),(RKSL(IA,L,K),K=1,KMAX)
 10 CONTINUE
    GO TO 210
211 READ 100, IAC,JWEP
    IF (IAC .EQ. 0) GO TO 212
    KMAX = NAIPU(JWEP)
    LMAX =  NATPU(JWEP)
    IA = (IAC-1)*NWEPS+JWEP
    READ 102, (AIPU(JWEP,K),K=1,KMAX)
    DO 11 L=1,LMAX
    READ 102, ATPU(JWEP,L),(RKPU(IA,L,K),K=1,KMAX)
 11 CONTINUE
    GO TO 211
212 READ 100, IAC,JWEP
    IF (IAC .EQ. 0) GO TO 213
    KMAX = NAIDI(JWEP)
```

```
      LMAX = NANDI(JWEP)
      IA = (IAC-1)*NWEPS +JWEP
      READ 102, (AIDI(JWEP,K),K=1,KMAX)
      DO 12 L=1,LMAX
      READ 102, ANDI(JWEP,L),(RKDI(IA,L,K),K=1,KMAX)
   12 CONTINUE
      GO TO 212
  213 READ 100, IAC,JWEP
      IF ( IAC .EQ. 0) GO TO 214
      KMAX = NALSA(JWEP)
      IA = (IA-1)*NWEPS+J
      DO 13 K=1,KMAX
      READ 102, ALSA(JWEP,K),RKSA(IA,K)
   13 CONTINUE
      GO TO 213
  214 READ 102, D3(1),T3(1),SP3(1),AL3(1),AT4(1),D45(1),T45(1),SP45(1),
     1 AN5(1), D7(1),T7(1),SP7(1),D8(1),T8(1),SP8(1),AL8(1),
     2 D95(1),T95(1),SP95(1)
      DO 21 I=2,NAC
      D3(I)=D3(1)
      T3(I)=T3(1)
      SP3(I)=SP3(1)
      AL3(I)=AL3(1)
      AT4(I)=AT4(1)
      D45(I)=D45(1)
      T45(I)=T45(1)
      SP45(I)=SP45(1)
      AN5(I)=AN5(1)
      D7(I)=D7(1)
      T7(I)=T7(1)
      SP7(I)=SP7(1)
      D8(I)=D8(1)
      T8(I)=T8(1)
      SP8(I)=SP8(1)
      AL8(I)=AL8(1)
      D95(I)=D95(1)
      T95(I)=T95(1)
      SP95(I)=SP95(1)
   21 CONTINUE
  220 READ 100,I
      IF(I.EQ.0) GO TO 221
      READ 102, D3(I),T3(I),SP3(I),AL3(I),AT4(I),D45(I),T45(I),SP45(I),
     1 AN5(I),D7(I),T7(I),SP7(I),D8(I),T8(I),SP8(I),AL8(I),D95(I),
     2T95(I),SP95(I)
      GO TO 220
  221 DO 20 I=1,4
      READ 102, (DEN(I,J),J=1,NWEPS)
   20 CONTINUE
      READ 100, ND3,ND4,ND45,ND5,ND6,ND65,ND67,ND7,ND8,ND9,ND95
      READ 113, OPT, ATT, GAMMA
  222 READ 106, IAC, JDEF, KWEP, BX
      IF( IAC .EQ. 0) GO TO 223
      B(IAC,JDEF,KWEP) = BX
      GO TO 222
  223 DO 31 I=1,NAC
      DO 32 J=1,NWEPS
      KMAX = NSPSL(J)
```

AD-A062 947 KEARNEY (A T) INC CHICAGO IL CAYWOOD-SCHILLER DIV F/G 9/2
THE MISSION TRADE-OFF METHODOLOGY (MTOM) MODEL: USER'S MANUAL.(U)
OCT 78 W J STRAUSS, N D BAILEY, M W KASPER F33615-74-C-5141
JTCG/AS-76-S-002 NL

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2 OF 2

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END
DATE
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3 -79
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DDC

```
      IF (KMAX .EQ. 0) GO TO 32
      M=I-1
      PRINT 120, M,J,(SPSL(J,K),K=1,KMAX)
      LMAX = NALSL(J)
      IA = (I-1)*NWEPS+J
      DO 33 L=1,LMAX
      PRINT 124, ALSL(J,L),(RKSL(IA,L,K),K=1,KMAX)
   33 CONTINUE
   32 CONTINUE
      DO 34 J=1,NWEPS
      KMAX = NAIPU(J)
      IF (KMAX .EQ. 0) GO TO 34
      LMAX = NATPU(J)
      IA = (I-1) *NWEPS+J
      M=I-1
      PRINT 121, M,J, (AIPU(J,K),K=1,KMAX)
      DO 35 L=1,LMAX
      PRINT 124, ATPU(J,L),(RKPU(IA,L,K),K=1,KMAX)
   35 CONTINUE
   34 CONTINUE
      DO 36 J=1,NWEPS
      KMAX = NAIDI(J)
      LMAX = NANDI(J)
      IF (KMAX .EQ. 0) GO TO 36
      IA = (I-1)*NWEPS+J
      M=I-1
      PRINT 122, M,J, (AIDI(J,K),K=1,KMAX)
      DO 37 L =1,LMAX
      PRINT 124, ANDI(J,L), ( RKDI(IA,L,K),K=1,KMAX)
   37 CONTINUE
   36 CONTINUE
      DO 38 J=1,NWEPS
      KMAX = NALSA(J)
      IF (KMAX .EQ. 0) GO TO 38
      IA = (I-1)*NWEPS+J
      M=I-1
      PRINT 123, M,J
      DO 39 K=1,KMAX
      PRINT 124, ALSA(J,K),RKSA(IA,K)
   39 CONTINUE
   38 CONTINUE
   31 CONTINUE
      PRINT 132
      DO 41 I=1,4
      PRINT 130, I, (DEN(I,J),J=1,NWEPS)
      DO 42 J=1,NAC
      M=J-1
      PRINT 131, M, (B(J,I,K),K=1,NWEPS)
   42 CONTINUE
   41 CONTINUE
      PRINT 185
  185 FORMAT (//1X,94HNOTE:  D-FACTOR = .002 TIMES WEAPON EFFECTIVE RANG
     1E (METERS) TIMES WEAPON DENSITY (QTY/SQ. KM) )
      PRINT 133, OPT,ATT, GAMMA
      PRINT 135
      DO 45 I=1,NAC
      M=I-1
```

```
      PRINT134,M,D3(I),T3(I),SP3(I),AL3(I),AT4(I),D45(I),T45(I),SP45(I),
     1 AN5(I),D7(I),T7(I),SP7(I),D8(I),T8(I),SP8(I),AL8(I),D95(I),
     2T95(I),SP95(I)
   45 CONTINUE
      PRINT 136, ND3,ND4,ND45,ND5,ND6,ND65,ND67,ND7,ND8,ND9,ND95
      RETURN
  100 FORMAT (2014)
  102 FORMAT (5X, 9F8.0)
  115 FORMAT (L1, 5F8.4)
  106 FORMAT (3I4, F8.4)
  134 FORMAT ( 5X,*A/C MOD*, I4,5X,*INBOUND DIST*,F12.0,5X,*INBOUND*,
     1 * TIME*,F12.0,/,21X,*INBOUND SPEED*,F11.0,5X,*INBOUND ALT*,F13.0,
     2/,21X,*POPUP TERM ALT*,F10.0,/,21X,*SEARCH DIST*,F13.0,5X,*SEARCH*
     3,* TIME*,F13.0,/,21X,*SEARCH SPEED*,F12.0,/,21X,*DIVE ANGLE*,
     4 F14.0,/,21X,*BET TGT DIST*,F12.0,5X,*BET TGT TIME*,F12.0,/,21X,
     5*BET TGT SPEED*,F11.0,/,21X,*OUTBOUND DIST*,F11.0,5X,*OUTBOUND*,
     6 * TIME*, F11.0,/,21X,*OUTBOUND SPEED*,F10.0,5X,*OUTBOUND ALT*,
     7 F12.0,/,21X, *LOITER DIST*, F13.0,5X,*LOITER TIME*, F13.0,/,21X,
     8 *LOITER SPEED*, F12.0,//)
  132 FORMAT (///5X,78HWEAPON DENSITY FACTORS AND VULNERABILITY FRACTION
     1S BY ZONE, A/C MOD AND WEAPON/
     2 13X,*ZONE*,6X,*MOD*,5X,*WEAPON*,8X,*1*,8X,*2*,8X,*3*,8X,*4*,
     3 8X,*5*)
  136 FORMAT ( ///, 5X,*EVENT DEFENSE ZONES*,//,25X,*ZONE*,/,
     1 5X,*INBOUND*,13X,I4,/,5X,*POP-UP*,14X,I4,/,5X,*SEARCH*,14X,I4,
     2 /,5X, *DIVE*,16X, I4,/,5X,*SWING-AROUND*,8X,I4,/,5X,
     3 *CLIMB TO NEXT PASS*, 2X,I4, /,5X,*CLIMB FOR OUTBOUND*,2X,I4,/,
     4 5X,*BETWEEN TARGET*,6X,I4,/,5X,*OUTBOUND*,12X,I4,/,5X,
     5 *LOITER DIVE*,9X,I4,/,5X,*LOITER*,14X,I4)
  135 FORMAT (///, 5X,*SCENARIO PARAMETERS BY A/C MOD*,///)
  130 FORMAT (1X,8HD-FACTOR,4X,I4,20X,5F9.4)
  131 FORMAT (7X,13HVULN FRACTION,2X,I4,11X,5F9.4)
  120 FORMAT (///5X,32HPK TABLE FOR STRAIGHT AND LEVEL ,
     1 *FLIGHT*,/,5X,*MOD*,I4,5X,*WEAPON*,I4,//,5X,*ALT*,26X,*SPEED*,/,
     2 19X, 5F9.0)
  124 FORMAT (5X,F9.0,5X,5F9.4)
  121 FORMAT (///5X,18HPK TABLE FOR POPUP/5X,3HMOD,I4,5X,
     1 *WEAPON*,I4,//, 5X, *TERM ALT*, 20X, *INIT ALT*,/,19X, 5F9.0)
  122 FORMAT (///5X,17HPK TABLE FOR DIVE/5X,3HMOD,I4,5X,
     1*WEAPON*,I4,//,5X,*ANGLE*,23X,*INIT ALT*,/,19X,5F9.0)
  123 FORMAT (///5X,25HPK TABLE FOR SWING AROUND/5X,
     1*MOD*,I4,5X,*WEAPON*,I4,//,5X,*ALT*)
  133 FORMAT (///,5X,*ATTRITION OPTION = *,L1,5X,*BASELINE A/C ATTRITION
     1*,F8.4,//,68X,*1*,7X,*2*,7X,*3*,7X,*4*,/5X,*ZONE WEIGHTING*,
     2 44X,4F8.4)
      END


      SUBROUTINE MTOW
      COMMON/JOB/BETA(10,10,5),EX8A,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/PASS/ACH,ACK,MOD,PD,PH,PKBASE,PKMOD,PL,PS,PSNA
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      QNST=(1.0-PRABR)*XIFS
      K=MOD
      DO 70 K=1,NAC
```

```
C  COMPUTE PASSES PER SORTIE
      PASSRT=WPNSOR(K)/WPNPAS(K)
      IPASS(K)=PASSRT
      TEST=PASSRT-IPASS(K)
      IF(TEST.EQ.0.0) GO TO 10
      WBH(K)=TEST*WPNPAS(K)
      WRITE(6,1000)
 1000 FORMAT(5X,*WARNING-CHECK INPUTS FOR FRACTIONAL PASS*)
      WRITE(6,1001) WBH(K)
 1001 FORMAT(20X,F4.1,1X,*WEAPONS WILL NOT BE USED*)
      PBH(K)=TEST
      GO TO 15
   10 PBH(K)=0.0
C  COMPUTE PASSES PER TARGET
   15 PASTGT=WPNTGT(K)/WPNPAS(K)
      IPAST(K)=PASTGT+0.999
      TESTT=IPAST(K)-PASTGT
      IF(TESTT.EQ.0.0) GO TO 20
      WRITE(6,1002)
 1002 FORMAT(5X,*WARNING-CHECK INPUTS-WPNS/PASS INCOMPATIBLE WITH WPNS/T
     *GT*)
C  COMPUTE TARGETS PER SORTIE
   20 XIPASS=IPASS(K)
      XIPAST=IPAST(K)
      TGTSOR=XIPASS/XIPAST
      IV(K)=TGTSOR+0.999
      IF(TGTSOR.GE.1.0) GO TO 30
C  ASSIGN PASSES PER TARGET
C  ONE PASS ONLY
      IW(K,1)=IPASS(K)
      GO TO 70
   30 TESTTT=IV(K)-TGTSOR
      IF(TESTTT.GT.0.0) GO TO 50
C  ALL TARGETS GET SAME NUMBER OF PASSES
      IIV=IV(K)
      DO 40 I=1,IIV
      IW(K,I)=IPAST(K)
   40 CONTINUE
      GO TO 70
C  LAST TARGET GETS LESS
   50 IIV=IV(K)-1
      DO 60 I=1,IIV
      IW(K,I)=IPAST(K)
   60 CONTINUE
      IIIV=IV(K)
      IW(K,IIIV)=TESTTT*IPAST(K)
   70 CONTINUE
      RETURN
      END


      SUBROUTINE MTOD
      LOGICAL OPT
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
```

```
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      COMMON/STLEV/NSPSL(5),NALSL(5),SPSL(5,5),ALSL(5,5),RKSL(50,5,5)
      COMMON/POPUP/NAIPU(5),NATPU(5),AIPU(5,5),ATPU(5,5),RKPU(50,5,5)
      COMMON/DIVE/NAIDI(5),NANDI(5),AIDI(5,5),ANDI(5,5),RKDI(50,5,5)
      COMMON/SWING/NALSA(5),ALSA(5,5),RKSA(50,5)
      COMMON/SCENAR/ D3(10),T3(10),SP3(10),AL3(10),AT4(10),D45(10),
     1 T45(10),SP45(10),AN5(10),D7(10),T7(10),SP7(10),D8(10),T8(10),
     2 SP8(10),AL8(10),D95(10),T95(10),SP95(10)
      COMMON/DEFEN/ NWEPS,DEN(4,5),B(10,4,5),ND3,ND4,ND45,ND5,ND6,
     1 ND65,ND67,ND7,ND8,ND9,ND95,ND10
      COMMON/ATTR/OPT,ATT,GAMMA(4)
      COMMON/ PTENT/ PT3(10),PT4(10,10),PT45(10),PT5(10),PT6(10),
     1 PT65(10),PT67(10),PT7(10),PT8(10),PT9(10),PT95(10),PT10(10)
      COMMON/SCALE/ SC3,SC4(10),SC45(10),SC5(10,5),SC6(10,5),
     1 SC65(10,5),SC67,SC7(10),SC8,SC9(10),SC95(10),SC10
      COMMON/PNORM/ PN3(10),PN4(10,10),PN45(10,10),PN5(10,10,5),
     1 PN6(10,10,5),PN65(10,10,5),PN67(10),PN7(10,10),PN8(10),
     2 PN9(10,10),PN95(10,10),PN10(10)
      DATA SC3,SC4,SC45,SC5,SC6,SC65,SC67,SC7,SC8,SC9,SC95,SC10/204*1./
      CALL COMPT
      CALL COMPS
      IF ( OPT) 200,201
  200 CALL COMSC
  201 CALL COMPN
      RETURN
      END



      SUBROUTINE COMPT
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      COMMON/STLEV/NSPSL(5),NALSL(5),SPSL(5,5),ALSL(5,5),RKSL(50,5,5)
      COMMON/POPUP/NAIPU(5),NATPU(5),AIPU(5,5),ATPU(5,5),RKPU(50,5,5)
      COMMON/DIVE/NAIDI(5),NANDI(5),AIDI(5,5),ANDI(5,5),RKDI(50,5,5)
      COMMON/SWING/NALSA(5),ALSA(5,5),RKSA(50,5)
      COMMON/SCENAR/ D3(10),T3(10),SP3(10),AL3(10),AT4(10),D45(10),
     1 T45(10),SP45(10),AN5(10),D7(10),T7(10),SP7(10),D8(10),T8(10),
     2 SP8(10),AL8(10),D95(10),T95(10),SP95(10)
      COMMON/DEFEN/ NWEPS,DEN(4,5),B(10,4,5),ND3,ND4,ND45,ND5,ND6,
     1 ND65,ND67,ND7,ND8,ND9,ND95,ND10
      COMMON/ PTENT/ PT3(10),PT4(10,10),PT45(10),PT5(10),PT6(10),
     1 PT65(10),PT67(10),PT7(10),PT8(10),PT9(10),PT95(10),PT10(10)
      NAC=NMOD+1
      DO 1 I=1,NAC
      IF ( D3(I) .EQ. 0. ) D3(I) = T3(I)*SP3(I)*0.001
      CALL SURV2( I,ND3, D3(I), SP3(I), AL3(I), NSPSL,NALSL,
     1 SPSL,ALSL,RKSL,PT3(I))
      D= (AT4(I)-AL3(I))*0.002
      CALL SURV2(I,ND4,D,AL3(I),AT4(I),NAIPU,NATPU,AIPU,ATPU,
     1 RKPU, PT4(I,1))
      D= AT4(I)*0.002 -0.3
      CALL SURV2(I,ND4,D,150.,AT4(I),NAIPU,NATPU,AIPU,ATPU,
```

```
     1 RKPU, PT65(I))
       NTG = IV(I)
       IF (NTG .EQ. 1) GO TO 200
       DO 2 J=2,NTG
     2 PT4(I,J)= PT65(I)
   200 IF (D45(I) .EQ. 0.) D45(I) =T45(I)*SP45(I)*0.001
       CALL SURV2(I,ND45,D45(I), SP45(I), AT4(I), NSPSL,NALSL,
     1 SPSL,ALSL,RKSL,PT45(I))
       ANG=0.017453 * AN5(I)
       D = ( AT4(I)*0.001-0.15)/SIN(ANG)
       CALL SURV2(I,ND5, D, AT4(I), AN5(I), NAIDI,NANDI,AIDI,ANDI,
     1 RKDI, PT5(I))
       PT9(I)= PT5(I)
       CALL SURV1(I,ND6,12.566,150.,NALSA,ALSA,RKSA,PT6(I))
       IF (D7(I) .EQ. 0.) D7(I)=T7(I)*SP7(I)*0.001
       CALL SURV2(I,ND7,D7(I),SP7(I),150.,NSPSL,NALSL,SPSL,ALSL,
     1 RKSL, PT7(I))
       IF ( D95(I) .EQ. 0.) D95(I) = T95(I)*SP95(I)*0.001
       CALL SURV2(I,ND95,D95(I),SP95(I),150.,NSPSL,NALSL,SPSL,ALSL,
     1 RKSL, PT95(I))
       D = 0.002*AL8(I)-0.3
       CALL SURV2(I,ND67,D,150.,AL8(I),NAIPU,NATPU,AIPU,ATPU,
     1 RKPU,PT67(I))
       IF ( D8(I) .EQ. 0.) D8(I)=T8(I)*SP8(I)*0.001
       CALL SURV2(I,ND8,D8(I),SP8(I),AL8(I),NSPSL,NALSL,SPSL,
     1 ALSL, RKSL,PT8(I))
       PT10(I)=PT3(I)
       ND10=ND3
     1 CONTINUE
       RETURN
       END



       SUBROUTINE SURV2(IAC,ND,D,X,Y,NX,NY,XX,YY,Z,P)
       COMMON/DEFEN/ NWEPS,DEN(4,5),B(10,4,5),ND3,ND4,ND45,ND5,ND6,
     1 ND65,ND67,ND7,ND8,ND9,ND95,ND10
       DIMENSION NX(5),NY(5),XX(5,5),YY(5,5),Z(50,5,5)
       ALPH=0.0
       DO 1 I=1,NWEPS
       IF (B(IAC,ND,I) *DEN(ND,I) .EQ. 0.) GO TO 1
       K = NWEPS*(IAC-1)+I
       CALL FIND2(I,K, NX(I),NY(I),XX,YY,X,Y,Z,R)
       ALPH = ALPH+R*DEN(ND,I)*B(IAC,ND,I)
     1 CONTINUE
       P= EXP(-       ALPH*D)
       RETURN
       END



       SUBROUTINE SURV1(IAC, ND, D, X, NX,XX,Z,P)
       DIMENSION NX(5), XX(5, 5), Z(50,5)
       COMMON/DEFEN/ NWEPS,DEN(4,5),B(10,4,5),ND3,ND4,ND45,ND5,ND6,
```

```
     1 ND65,ND67,ND7,ND8,ND9,ND95,ND10
       ALPH =0.
       DO 1 I=1,NWEPS
       IF (B(IAC,ND,I) *DEN(ND,I) .EQ. 0.) GO TO 1
       K= (IAC-1)*NWEPS +I
       CALL FIND1(I,K,NX(I), XX, X, Z, R)
       ALPH = ALPH + R*DEN(ND,I)*B(IAC,ND,I)
     1 CONTINUE
       P= EXP(-        ALPH*D)
       RETURN
       END



       SUBROUTINE FIND2 ( IWEP, IACW, IMAX, JMAX, XX,YY,X,Y,Z,VAL)
C***** SUBROUTINE TO PERFORM DOUBLE INTEROLOATION ON LETHAL RADII
C***** TABLES
C***** TABLE ENTRIES Z = F(X,Y)
C***** IWEP = INDEX OF WEAPON OF INTEREST
C***** IACW = WEAPON AND A/C MOD INDEX
C***** IMAX = NUMBER OF COLUMNS
C***** JMAX = NUMBER OF ROWS
C***** XX(I) = VALUE OF X FOR ITH COLUMN
C***** YY(J) = VALUE OF Y FOR JTH ROW
C*****Z(I,J) = TABLE ENTRY FOR ITH COLUMN JTH ROW
C***** X,Y VALUES FOR WHICH INTERPOLATION IS PERFORMED
C***** VAL = RESULT OF INTERPOLATION
       DIMENSION XX(5,5),YY(5,5),Z(50,5,5)
C***** LOOP OVER COLUMNS
       DO 1 I=2,IMAX
       IF (XX(IWEP,I) .GE. X) GO TO 200
     1 CONTINUE
       I=IMAX
C***** LOOP OVER ROWS
   200 DO 2 J=2,JMAX
       IF ( YY(IWEP,J) .GE. Y) GO TO 201
     2 CONTINUE
       J=JMAX
   201 A = (X-XX(IWEP,I-1))/(XX(IWEP,I)-XX(IWEP,I-1))
       B= (Y-YY(IWEP,J-1))/(YY(IWEP,J)-YY(IWEP,J-1))
       C = (1.-A)*Z(IACW,J-1,I-1)+A*Z(IACW,J-1,I)
       D= (1.-A)*Z(IACW,J,I-1)+A*Z(IACW,J,I)
       VAL = C+B*(D-C)
       IF( VAL .LT. 0.)  VAL=0.0
       RETURN
       END



       SUBROUTINE FIND1(IWEP,IACW,IMAX,XX,X,Z,VAL)
C**** SUBROUTINE TO PERFORM SINGLE INTERPOLATION ON TABLE WITH
C***** ENTRIES Z = F(X)
       DIMENSION XX(5,5),Z(50,5)
       DO 1 I=2,IMAX
       IF (XX(IWEP,I) .GE. X) GO TO 200
     1 CONTINUE
       I=IMAX
```

```
  200 A=(X-XX(IWEP,I-1))/(XX(IWEP,I)-XX(IWEP,I-1))
      VAL = Z(IACW,I-1)+A*(Z(IACW,I)-Z(IACW,I-1))
      IF( VAL .LT. 0.)  VAL=0.0
      RETURN
      END


      SUBROUTINE COMPS
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      COMMON/PTENT/ PT3(10),PT4(10,10),PT45(10),PT5(10),PT6(10),
     1 PT65(10),PT67(10),PT7(10),PT8(10),PT9(10),PT95(10),PT10(10)
C***** SUBROUTINE CALLED BY MTOD CALLING PSUR TO COMPUTE
C***** A/C MISSION SURVIVAL PROBABILI...S FOR ALL MODS AND
C***** INCLUDING THE EFFECTS OF DILUTION
C***** USES TENTATIVE A/C EVENT SURVVVIVAL PROBABILITIES FROM
C***** COMPT
      PRINT 101, QNST
      NAC = NMOD +1
      DO 1 I=1,NAC
      PS =1.
      QN= QNST
      CALL PSUR(PS,QN,PT3(I))
      QNNAV=QN
      PSNAV= PS*PNAV
      PSNNAV= PS*(1.-PNAV)
      NTG= IV(I)
      DO 2 J=1,NTG
      CALL PSUR( PSNAV, QN, PT4(I,J))
      CALL PSUR ( PSNAV , QN, PT45(I))
      PSLOC = PSNAV* PLOC (I,J)
      PSNLOC = PSNAV *(1.- PLOC(I,J))
      QNLOC = QN*PLOC(I,J)
      QNNLOC = QN* (1.-PLOC (I,J))
      NPS = IW (I,J)
      DO 3 K=1,NPS
      CALL PSUR( PSLOC,QNLOC,PT5(I))
      CALL PSUR ( PSLOC , QNLOC, PT6(I))
      IF ( K .EQ. NPS) GO TO 3
      CALL PSUR ( PSLOC , QNLOC , PT65(I))
    3 CONTINUE
      CALL PSUR(PSNLOC,QNNLOC,PT9(I))
      CALL PSUR ( PSNLOC, QNNLOC, PT95(I))
      QN = QNLOC+QNNLOC
      PSNAV = PSLOC+PSNLOC
      IF ( J .EQ. NTG) GO TO 210
      CALL PSUR ( PSNAV, QN, PT7(I))
    2 CONTINUE
  210 CALL PSUR (PSNAV, QN, PT67(I))
      CALL PSUR( PSNAV, QN, PT8(I))
      CALL PSUR ( PSNNAV,QNNAV, PT10(I))
      PS = PSNAV+PSNNAV
      QN = QN *PNAV + QNNAV *(1.-PNAV)
      IA=I-1
      PRINT 100,IA, PS, QN
```

```
    1 CONTINUE
      RETURN
  100 FORMAT (6X,I4,13X,F10.5,22X,F10.5)
  101 FORMAT (//5X,31H(* - DENOTES CALCULATED VALUES),
     1        //3X,25H  NON-ABORTED FLIGHT SIZE,F8.2/15H    * A/C MOD
     1 *UNSCALED SURVIVAL PROBABILITY* ,3X,
     2 *NO. A/C SURVIVING PER FLIGHT* )
      END



      SUBROUTINE PSUR (PS,QN,PT)
C***** SUBROUTINE CALLED BY COMPS TO COMPUTE A SURVIVAL PROBABILITY
C***** FOR A GIVEN EVENT, UPDATE MISSION SURVIVAL, AND UPDATE
C***** NUMBER OF A/C SURVIVING
C***** PS = MISSION SURVIVAL
C***** QN = NUMBER  OF A/C SURVIVING
C***** PT = SINGLE A/C EVENT SURVIVAL PROBABILITY
C***** COMPUTE DILUTION FACTOR
      QEX = AMAX1(1.,QN)
C***** COMPUTE EVENT SURVIVAL
      PSS = PT **(1./QEX)
C***** UPDATE QN
      QN = QN*PSS
C***** UPDATE PS
      PS = PS*PSS
      RETURN
      END



      SUBROUTINE COMSC
      LOGICAL OPT
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      COMMON/DEFEN/ NWEPS,DEN(4,5),B(10,4,5),ND3,ND4,ND45,ND5,ND6,
     1 ND65,ND67,ND7,ND8,ND9,ND95,ND10
      COMMON/ PTENT/ PT3(10),PT4(10,10),PT45(10),PT5(10),PT6(10),
     1 PT65(10),PT67(10),PT7(10),PT8(10),PT9(10),PT95(10),PT10(10)
      COMMON/SCALE/ SC3,SC4(10),SC45(10),SC5(10,5),SC6(10,5),
     1 SC65(10,5),SC67,SC7(10),SC8,SC9(10),SC95(10),SC10
      COMMON/ATTR/ OPT,ATT,GAMMA(4)
      COMMON/DVAL/ NDVAL
      DIMENSIONPK(4),GAM4(10),GAM45(10),GAM5(10,5),GAM6(10,5),
     1 GAM65(10,5),GAM7(10),GAM9(10),GAM95(10)
      DO 1 I=1,4
    1 PK(I) =0.0
      NTG= IV(1)
      GAM7(NTG)=0.0
      DO 20 I=1,NTG
      NPS = IW(1,I)
```

```
 20 GAM65(I,NPS) =0.0
    PS =1.
    CALL GM ( PK,PS,ND3,PT3(1),GAM3)
    PSNAV = PNAV *PS
    PSNNAV= PS*(1.-PNAV)
    DO 2 I=1,NTG
    CALL GM ( PK,PSNAV, ND4, PT4(1,I), GAM4(I))
    CALL GM( PK,PSNAV, ND45, PT45(1),GAM45(I))
    PSLOC = PSNAV *PLOC( 1,I)
    PSNLOC = PSNAV*(1.-PLOC (1,I))
    NPS = IW (1,I)
    DO 3 J=1,NPS
    CALL GM( PK,PSLOC, ND5, PT5(1), GAM5(I,J))
    CALL GM( PK,PSLOC, ND6, PT6(1), GAM6(I,J))
    IF ( J .EQ. NPS) GO TO 3
    CALL GM( PK,PSLOC, ND65, PT65(1), GAM65(I,J))
  3 CONTINUE
    CALL GM( PK, PSNLOC, ND9, PT9(1), GAM9(I))
    CALL GM( PK, PSNLOC, ND95, PT95(1), GAM95(I))
    PSNAV = PSLOC + PSNLOC
    IF ( I .EQ. NTG) GO TO 300
    CALL GM( PK, PSNAV, ND7, PT7(1), GAM7(I))
  2 CONTINUE
300 CALL GM( PK, PSNAV, ND67, PT67(1), GAM67)
    CALL GM( PK, PSNAV, ND8,PT8(1), GAM8)
    CALL GM( PK, PSNNAV, ND10, PT10(1), GAM10)
    QN = QNST
    PS = 1.
    SUM=0.0
    SUMPK =0.
    DO 10 I=1,4
    SUM=SUM+GAMMA(I)
 10 SUMPK= SUMPK+PK(I)
    IF (SUM .NE. 0.) GO TO 200
    DO 11 I=1,4

    GAMMA(I) = 1.
 11 PK(I)= SUMPK
    SUM=1.
200 IF ( PK(ND3) .NE. 0.) GAM3=GAM3*GAMMA(ND3)/(PK(ND3)*SUM)
    NDVAL = 1
    CALL SCAL( PS,ATT,GAM3,PT3(1), QN, SC3)
    PSNAV= PS*PNAV
    PSNNAV= PS*(1.-PNAV)
    QNNAV = QN
    DO 4 I=1,NTG
    IF( PK(ND4) .NE. 0.) GAM4(I)=GAM4(I)*GAMMA(ND4)/(PK(ND4)*SUM)
    NDVAL = 2
    CALL SCAL( PSNAV,ATT,GAM4(I),PT4(1,I),QN, SC4(I))
    IF (PK(ND45) .NE. 0.) GAM45(I)=GAM45(I)*GAMMA(ND45)/(PK(ND45)*
   1SUM)
    NDVAL = 3
    CALL SCAL( PSNAV, ATT, GAM45(I), PT45(I),QN, SC45(I))
    QNLOC = QN*PLOC(1,I)
    QNNLOC = QN*(1.-PLOC(1,I))
    PSLOC = PSNAV * PLOC(1,I)
    PSNLOC = PSNAV *(1.-PLOC(1,I))
```

```
      NPS = IW(1,I)
      DO 5 J=1,NPS
      IF( PK(ND5) .NE. 0.) GAM5(I,J)=GAM5(I,J)*GAMMA(ND5)/(PK(ND5)*SUM)
      NDVAL = 4
      CALL SCAL(PSLOC,ATT,GAM5(I,J),PT5(1),QNLOC, SC5(I,J))
      IF ( PK(ND6) .NE. 0.)GAM6(I,J)=GAM6(I,J)*GAMMA(ND6)/(PK(ND6)*SUM)
      NDVAL = 5
      CALL SCAL(PSLOC,ATT,GAM6(I,J),PT6(1),QNLOC,SC6(I,J))
      IF(PK(ND65).NE.0.)GAM65(I,J)=GAM65(I,J)*GAMMA(ND65)/(PK(ND65)*SUM)
      NDVAL = 6
      CALL SCAL(PSLOC, ATT, GAM65(I,J),PT65(1),QNLOC, SC65(I,J))
    5 CONTINUE
      IF(PK(ND9) .NE. 0.) GAM9(I)=GAM9(I)*GAMMA(ND9)/(PK(ND9)*SUM)
      NDVAL = 7
      CALL SCAL(PSNLOC,ATT, GAM9(I), PT9(1),QNNLOC,SC9(I))
      IF ( PK(ND95) .NE. 0.)GAM95(I)=GAM95(I)*GAMMA(ND95)/(PK(ND95)*SUM)
      NDVAL = 8
      CALL SCAL(PSNLOC, ATT, GAM95(I), PT95(1),QNNLOC, SC95(I))
      QN= QNLOC+QNNLOC
      PSNAV = PSLOC+PSNLOC
      IF ( PK(ND7) .NE. 0.) GAM7(I)=GAM7(I)*GAMMA(ND7)/(PK(ND7)*SUM)
      NDVAL = 9
      CALL SCAL( PSNAV, ATT, GAM7(I), PT7(1), QN, SC7(I))
    4 CONTINUE
      IF ( PK(ND67) .NE. 0.)GAM67=GAM67*GAMMA(ND67)/(PK(ND67)*SUM)
      NDVAL = 10
      CALL SCAL( PSNAV,ATT,GAM67,PT67(1),QN,SC67)
      IF ( PK(ND8) .NE. 0.)GAM8=GAM8*GAMMA(ND8)/(PK(ND8)*SUM)
      NDVAL = 11
      CALL SCAL( PSNAV, ATT, GAM8, PT8(1), QN, SC8)
      IF( PK(ND10) .NE. 0.) GAM10=GAM10*GAMMA(ND10)/(PK(ND10)*SUM)
      NDVAL = 12
      CALL SCAL( PSNNAV, ATT, GAM10, PT10(1), QNNAV, SC10)
      RETURN
      END



      SUBROUTINE GM(PK,PS,ND,PT,GAM)
C*****SUBROUTINE CALLED BY COMSC TO COMPUTE A KILL PROBABILITY
C*****FOR A GIVEN EVENT, TO UPDATE KILL PROBABILITIES FOR EACH
C*****DEFENSE ZONE, AND UPDATE A MISSION SURVIVAL PROBABABILITY
C*****PK(I) = KILL PROBABILITY ATTRIBUTABLE TO ITH DEFENSE ZONE
C*****  PS= MISSION SURVIVAL PROBABILITY
C*****  ND= DEFENSE ZONE INDEX FOR EVENT OF INTEREST
C*****  PT = SURVIVAL PROBABILTY FOR EVENT OF INTEREST
C*****  GAM = KILL PROBABILTY FOR EVENT OF INTEREST
      DIMENSION PK(4)
C*****  COMPUTE EVENT KILL PROBABILITY
      GAM = PS*(1.- PT)
C*****  UPDATE DEFENSE ZONE KILL PROBABILITY
      PK(ND) = PK(ND) +GAM
      RETURN
      END
```

```
      SUBROUTINE SCAL( PS,ATT,GAM, PT, QN, SC)
      COMMON/DVAL/ NDVAL
C***** SUBROUTINE CALLED BY COMSC TO COMPUTE A SCALING FACTOR
C***** FOR A GIVEN EVENT BASED ON AN INPUT ATTRITION, INPUT DEFENSE
C***** ZONE WEIGHTINGS, WEIGHTING BY KILL PROBABILITIES, AND
C***** DILUTION DUE TO MULTIPLE AIRCRAFT
C***** PS = MISSION SURVIVAL
C***** ATT = INPUT STANDARD AIRCRAFT ATTRITION
C***** GAM = COMPUTED EVENT WEIGHTING
C***** PT = TENTATIVE SURVIVAL PROBABILITY FOR EVENT OF INTEREST
C**** QN = NUMBER  AIRCRAFT SURVIVING
C***** SC = COMPUTED SCALING FACTOR FOR EVENT OF INTEREST
C***** ALSO UPDATES A MISSION SURVIVAL PROBABILITY AND SURVIVNG
C***** FLIGHT SIZE
C***** CHECK FOR NON-SURVIVABILITY
      IF(PT.EQ.1.0) GO TO 203
      IF ( PS .NE. 0.) GO TO 202
  200 SC=1.
      GO TO 201
C***** COMPUTE EVENT SURVIVAL PROBABILITY
  202 PSS=1.-GAM*ATT/PS
C**** COMPUTE DILUTION
      QEX= AMAX1(QN,1.)
C***** CHECK FOR NON-SURVIVABILITY
      IF ( PSS*PT .EQ. 0.) GO TO 200
C***** COMPUTE SCALING FACTOR
      SC= ALOG(PSS)*QEX/ALOG(PT)
C***** UPDATE NUMBER OF AIRCRAFT SURVIVING
      QN=QN*PSS
C***** UPDATE SURVIVAL PROBABILITY
      PS=PS*PSS
  201 RETURN
  203 PRINT 100
  100 FORMAT(5X,*PT=1. ATTRITION SCALING MAY NOT BE VALID*)
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12), NDVAL
    1 PRINT 101
      GO TO 201
    2 PRINT 102
      GO TO 201
    3 PRINT 103
      GO TO 201
    4 PRINT 104
      GO TO 201
    5 PRINT 105
      GO TO 201
    6 PRINT 106
      GO TO 201
    7 PRINT 107
      GO TO 201
    8 PRINT 108
      GO TO 201
    9 PRINT 109
      GO TO 201
   10 PRINT 110
      GO TO 201
   11 PRINT 111
      GO TO 201
```

```
   12 PRINT 112
  101 FORMAT (13X,15HEVENT = INBOUND /)
  102 FORMAT (13X,14HEVENT = POP-UP /)
  103 FORMAT (13X,14HEVENT = SEARCH /)
  104 FORMAT (13X,12HEVENT = DIVE /)
  105 FORMAT (13X,20HEVENT = SWING-AROUND /)
  106 FORMAT (13X,26HEVENT = CLIMB TO NEXT PASS /)
  107 FORMAT (13X,19HEVENT = LOITER DIVE /)
  108 FORMAT (13X,14HEVENT = LOITER /)
  109 FORMAT (13X,23HEVENT = BETWEEN TARGETS /)
  110 FORMAT (13X,26HEVENT = CLIMB FOR OUTBOUND /)
  111 FORMAT (13X,16HEVENT = OUTBOUND /)
  112 FORMAT (13X,11HEVENT = GNE /)
      GO TO 201
      END


      SUBROUTINE COMPN
C***** SUBROUTINE CALLED BY MTOD TO COMPUTE SCALED NON-DILUTED S
C***** SURVIVAL PROBABILITIES FOR ALL EVENTS IN MISSION, FOR ALL
C***** AIRCRAFT MODS
C***** PTX(I,J) = TENTATIVE SURVIVAL PROBABILITIES FOR EVENT X
C*****         FOR ITH MOD (JTH TARGET WHEN NECESSARY)
C*****           FROM COMPT
C***** SCX(I,J) = SCALING FACTOR FOR EVENT X (ITH TARGET,JTH
C*****             PASS WHEN NECESSARY) FROM COMSC
C***** PNX(I,J,K) = SCALED NON-DILUTED SURVIVAL PROBABILITY
C***** FOR EVENT X
C*****          FOR ITH MOD (JTH TARGET, KTH PASS WHEN NECESSARY)
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      COMMON/PTENT/PT3(10),PT4(10,10),PT45(10),PT5(10),PT6(10),PT65(10),
     1 PT67(10),PT7(10),PT8(10),PT9(10),PT95(10),PT10(10)
      COMMON/SCALE/ SC3,SC4(10),SC45(10),SC5(10,5),SC6(10,5),
     1 SC65(10,5),SC67,SC7(10),SC8,SC9(10),SC95(10),SC10
      COMMON/PNORM/ PN3(10),PN4(10,10),PN45(10,10),PN5(10,10,5),
     1 PN6(10,10,5),PN65(10,10,5),PN67(10),PN7(10,10),PN8(10),
     2 PN9(10,10),PN95(10,10),PN10(10)
      NAC = NMOD +1
C***** LOOP OVER AIRCRAFT MODS
      DO 1 I=1,NAC
C***** CYCLE THROUGH SEQUENCE OF EVENTS
      NTG= IV(I)
      PN7(I,NTG) =1.
      PN3(I)=PT3(I)**SC3
      PN8(I)=PT8(I)**SC8
      PN10(I)=PT10(I)**SC10
      PN67(I)=PT67(I)**SC67
C***** LOOP OVER TARGETS
      DO 1 J=1,NTG
      PN45(I,J)=PT45(I)**SC45(J)
      PN4(I,J)=PT4(I,J)**SC4(J)
      IF (J.EQ.NTG) GO TO 200
      PN7(I,J) = PT7(I)**SC7(J)
```

```
  200 PN9(I,J)= PT9(I)**SC9(J)
      PN95(I,J) = PT95(I) **SC95(J)
      NPS = IW(I,J)
      PN65(I,J,NPS) =1.
C***** LOOP OVER PASSES
      DO 1 K=1,NPS
      PN5(I,J,K) = PT5(I)**SC5(J,K)
      PN6(I,J,K) = PT6(I)**SC6(J,K)
      IF (K .EQ. NPS) GO TO 1
      PN65(I,J,K)= PT65(I)**SC65(J,K)
    1 CONTINUE
      RETURN
      END



      SUBROUTINE MTOSIN(A)
      COMMON/SORTIE/CTA,CTR,CTS,CTU,PLMOD,TA,TF,TPOF,TPRF,TQUE,TS,TTAX,
     *VAMOD,XMMHA,XMMHR,XMMHS,XMMHU
      DIMENSION A(8)
      READ(5,999) A
  999 FORMAT(8A10)
      READ(5,1000) CTA,CTR,CTS,CTU
 1000 FORMAT(4(F10.3,5X))
      READ(5,1001) TS,TA,TF,TPOF,TPRF,TQUE,TTAX
 1001 FORMAT(7(F7.2,3X))
      READ(5,1002) XMMHA,XMMHR,XMMHS,XMMHU
 1002 FORMAT(4(F10.2,5X))
      READ(5,1003) PLMOD,VAMOD
 1003 FORMAT(F10.1,5X,F10.1)
      RETURN
      END



      SUBROUTINE MTOP
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/PASS/ACH,ACK,MOD,PD,PH,PKBASE,PKMOD,PL,PS,PSNA
      COMMON/PNORM/PN3(10),PN4(10,10),PN45(10,10),PN5(10,10,5),PN6(10,10
     *,5),PN65(10,10,5),PN67(10),PN7(10,10),PN8(10),PN9(10,10),PN95(10,1
     *0),PN10(10)
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBW(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
C  1. A/C TAKE OFF
      II = MOD-1
      WRITE(6,2000)
 2000 FORMAT(/ 5X,*INITIAL FLIGHT SIZE*,10X,*INITIAL NO. OF PASSES PER A
     */C*/)
      WRITE(6,2001) XIFS,IPASS(MOD)
 2001 FORMAT(13X,F3.0,31X,I3/)
      WRITE(6,2002)
 2002 FORMAT(5X,*NO. OF ASSIGNED TARGETS*,10X,*NO. OF PASSES PER TARGET*
     */)
      WRITE(6,2003) IV(MOD)
```

```
 2003 FORMAT(13X,I3,24X,*TARGET*,5X,*PASSES*/)
      IIV=IV(MOD)
      DO 40 I=1,IIV
      WRITE(6,2004) I,IW(MOD,I)
 2004 FORMAT(42X,I2,9X,I2/)
   40 CONTINUE
      WRITE(6,2005)
 2005 FORMAT(10X,*PROB. OF NO ABORT*,14X,*PROB. OF NO A/C GNE*/)
      ABRTNO=1.0-PRABR
      WRITE(6,2006) ABRTNO,PNAV
 2006 FORMAT(14X,F5.3,30X,F4.2/)
      WRITE(6,2007)
 2007 FORMAT(10X,*PROB. OF A/C FINDING ASSIGNED TARGETS*/)
      WRITE(6,2008)
 2008 FORMAT(20X,*TARGET*,6X,*PROB.*/)
      DO 50 I=1,IIV
      WRITE(6,2009) I,PLOC(MOD,I)
 2009 FORMAT(22X,I2,8X,F4.2/)
   50 CONTINUE
      WRITE(6,2010)
 2010 FORMAT(10X,*PROB. OF A/C LOCK-ON*/)
      WRITE(6,2011)
 2011 FORMAT(30X,*PASS*/)
      WRITE(6,2012) (I,I=1,5)
 2012 FORMAT(19X,*TARGET*2X,8(I2,4X)/)
      DO 60 I=1,IIV
      IIW=IW(MOD,I)
      WRITE(6,2013) I,(BETA(MOD,I,J),J=1,IIW)
 2013 FORMAT(21X,I2,3X,8(F4.2,2X)/)
   60 CONTINUE
      ACK=0.0
      PL=0.0
      PD=0.0
      XINP=IPASS(MOD)*XIFS
C  2. A/C REACH FEBA
      ABORTS=XIFS*PRABR
      ACR=XIFS-ABORTS

      ACH=ABORTS
      PH=ABORTS*(XINP/XIFS)+PBH(MOD)*XIFS
      AVP=XINP-ABORTS*(XINP/XIFS)
C  3. A/C REACH TARGET AREA
C  3.1 A/C SURVIVE SEARCH FOR TARGET AREA
      XACR=AMAX1(1.0,ACR)
      EPSLN=PN3(MOD)**(1.0/XACR)
      CALL ACKILL(EPSLN,ACR,AVP,ACK,PL)
C  3.2 A/C LOCATE TARGET AREA
      IF(PNAV.EQ.1.0)  GO TO 65
      ACGH=ACR
      PGH=AVP
C  3.3 A/C GO HOME AND SURVIVE
      IF(ACGH.EQ.0.0) GO TO 65
      XACGH=AMAX1(1.0,ACGH)
      ZETA=PN10(MOD)**(1.0/XACGH)
      ACS33=ZETA*ACGH
      ACK33=ACGH-ACS33
      ACH33=ACS33
```

```
      ACK33=ACK33*(1.0-PNAV)
      ACH33=ACH33*(1.0-PNAV)
      PL33=ACK33*(PGH/ACGH)
      PH33=ACH33*(PGH/ACGH)
      ACK33=ACK33+ACK*(1.0-PNAV)
      PL33=PL33+PL*(1.0-PNAV)
      GO TO 70
   65 ACK33=0.0
      PL33=0.0
      ACH33=0.0
      PH33=0.0
   70 DO 200 I=1,IIV
C  4. A/C REACH ASSIGNED TARGET
C  4.1 A/C SURVIVE TARGET SEARCH POP-UP
      XACR=AMAX1(1.0,ACR)
      PHI=PN4(MOD,I)**(1.0/XACR)
      CALL ACKILL(PHI,ACR,AVP,ACK,PL)
C  4.15 A/C SURVIVE STRAIGHT AND LEVEL TARGET SEARCH
      XACR=AMAX1(1.0,ACR)
      GAMMA=PN45(MOD,I)**(1.0/XACR)
      CALL ACKILL(GAMMA,ACR,AVP,ACK,PL)
C  4.2 A/C LOCATE ASSIGNED TARGET
      ACLOCT=ACR*PLOC(MOD,I)
      ACL=ACR-ACLOCT
      AVPL=ACL*(AVP/ACR)
      AVP=AVP-AVPL
      ACR=ACR-ACL
C  4*. A/C LOITER
C  4.9 A/C DIVE TO LOITER ALTITUDE
      IF(ACL.EQ.0.0) GO TO 80
      XACL=AMAX1(1.0,ACL)
      XLAMB1=PN9(MOD,I)**(1.0/XACL)
      ACSL=XLAMB1*ACL
      ACKL=ACL-ACSL
      ACK=ACK+ACKL
      PSL=ACSL*(AVPL/ACL)
      PLL=AVPL-PSL
      ACL=ACL-ACKL
      AVPL=AVPL-PLL
      PL=PL+PLL
C  4.95 A/C LOITER STRAIGHT AND LEVEL
      XACL=AMAX1(1.0,ACL)
      XLAMB2=PN95(MOD,I)**(1.0/XACL)
      ACSL=XLAMB2*ACL
      ACKL=ACL-ACSL
      ACK=ACK+ACKL
      PSL=ACSL*(AVPL/ACL)
      PLL=AVPL-PSL
      ACL=ACL-ACKL
      AVPL=AVPL-PLL
      PL=PL+PLL
   80 IIW=IW(MOD,I)
      DO 100 J=1,IIW
C  5. A/C REACH LAUNCH POINT
C  5.1 A/C SURVIVE TO LAUNCH POINT
      XACR=AMAX1(1.0,ACR)
      SIGMA=PN5(MOD,I,J)**(1.0/XACR)
      CALL ACKILL(SIGMA,ACR,AVP,ACK,PL)
```

```
C  5.2 A/C LOCK-ON AND LAUNCH WEAPONS
      PDLV=ACR*BETA(MOD,I,J)
      AVP=AVP-PDLV
      PD=PD+PDLV
C  6. A/C SWINGAROUND
C  6.1 A/C SURVIVE SWINGAROUND
      XACR=AMAX1(1.0,ACR)
      THETA=PN6(MOD,I,J)**(1.0/XACR)
      CALL ACKILL(THETA,ACR,AVP,ACK,PL)
      IF(J.EQ.IIW) GO TO 100
C  6.5 A/C SURVIVE SWINGAROUND POP-UP
      XACR=AMAX1(1.0,ACR)
      ALPHA=PN65(MOD,I,J)**(1.0/XACR)
      CALL ACKILL(ALPHA,ACR,AVP,ACK,PL)
  100 CONTINUE
      IF(I.EQ.IIV) GO TO 300
C  7. A/C FLY TO NEXT TARGET
C  7.1 A/C SURVIVE BETQEEN TARGET DEFENSES
      ACR=ACR+ACL
      AVP=AVP+AVPL
      XACR=AMAX1(1.0,ACR)
      PSI=PN7(MOD,I)**(1.0/XACR)
      CALL ACKILL(PSI,ACR,AVP,ACK,PL)
  200 CONTINUE
C  8. A/C FLY HOME
  300 ACR=ACR+ACL
      AVP=AVP+AVPL
C  6.7 A/C SURVIVE POP-UP TO GO HOME
      XACR=AMAX1(1.0,ACR)
      ZETA67=PN67(MOD)**(1.0/XACR)
      CALL ACKILL(ZETA67,ACR,AVP,ACK,PL)
C  8.1 A/C SURVIVE HOMEBOUND DEFENSES
      XACR=AMAX1(1.0,ACR)
      ZETA=PN8(MOD)**(1.0/XACR)
      CALL ACKILL(ZETA,ACR,AVP,ACK,PL)
      ACK=ACK*PNAV+ACK33
      PL=PL*PNAV+PL33
      ACH=ACH+ACR*PNAV+ACH33
      PH=PH+AVP*PNAV+PH33
      PD=PD*PNAV
      PS=ACH/XIFS
      IF(PS.GT.0.999999)  PS=1.0000
      PK=1.0-PS
      RWA=(PD*WPNPAS(MOD))/XIFS
      WRITE(6,3000)
 3000 FORMAT (/8X,19H  NO. OF A/C ABORTS,8X,35H* NO. OF PASSES DELIVERED
     1 (ALL A/C),/)
      WRITE(6,3001) ABORTS,PD
 3001 FORMAT(16X,F5.3,26X,F6.3/)
      WRITE(6,3002)
 3002 FORMAT (8X,19H* NO. OF A/C KILLED,8X,34H* NO. OF PASSES LOST ON A/
     1C KILLED,/)
      WRITE(6,3003) ACK,PL
 3003 FORMAT(16X,F5.3,26X,F6.3/)
      WRITE(6,3004)
```

```
1999 FORMAT (15X,31H* PROBABILITY OF DAMAGE PER A/C,//28X,F7.5)
     TRNRND=TA+TF+TPRF+TPOF+TQUE+TTAX
     TCMU=XMMHU*CTU
     TCMS=XMMHS*CTS
     TCMR=XMMHR*CTR
     TCMA=XMMHA*CTA
     TERM1=TS*(1.0+TCMU+TCMS)*(1.0-PRABR)
     TERM2=TCMR*(1.0-PRABR)*PKUSE*RDKUSE
     TERM3=PRABR*TCMA
     DEN=TERM1+TERM2+TERM3+TRNRND
     SR=24.0/DEN
     WRITE(6,2000)
2000 FORMAT(///25X,*MAINTENANCE SUMMARY*//25X,*SORTIE INFORMATION*/)
     WRITE(6,2001)
2001 FORMAT(23X,*UNSCHEDULED*,3X,*SCHEDULED*/)
     WRITE(6,2002) XMMHU,XMMHS
2002 FORMAT(12X,*MMH/FH*,8X,F5.1,8X,F5.1/)
     WRITE(6,2003) CTU,CTS
2003 FORMAT(10X,*CONV.FACT.*,6X,F4.2,9X,F4.2/)
     WRITE(6,2004)
2004 FORMAT(23X,*DAMAGE REPAIR*,3X,*ABORT REPAIR*/)
     WRITE(6,2005) XMMHR,XMMHA
2005 FORMAT(11X,*MMH/TASK*,8X,F5.1,10X,F5.1/)
     WRITE(6,2006) CTR,CTA
2006 FORMAT(10X,*CONV.FACT.*,7X,F4.2,12X,F4.2/)
     WRITE(6,2007)
2007 FORMAT(23X,*TURNAROUND (CLOCK HOURS)*/)
     WRITE(6,2008)
2008 FORMAT(5X,*RE-ARM*,5X,*RE-FUEL*,5X,*PRE-FLIGHT INSP.*,5X,*POST-FLI
    *GHT INSP.*/)
     WRITE(6,2009) TA,TF,TPRF,TPOF
2009 FORMAT(5X,F5.2,6X,F5.2,11X,F5.2,17X,F5.2/)
     WRITE(6,2010)
2010 FORMAT(25X,*WAITING*,5X,*TAXIING*/)
     WRITE(6,2011) TQUE,TTAX
2011 FORMAT(26X,F5.2,6X,F5.2/)
     WRITE(6,4000) TRNRND
4000 FORMAT(26X,*TOTAL DELAY TIME* //32X,F6.2/)
     WRITE(6,2012)
2012 FORMAT (17X,16H  PROB. OF ABORT,3X,15H* PROB. OF KILL,/)
     WRITE(6,2013) PRABR,PKUSE
2013 FORMAT(23X,F5.3,13X,F5.3/)
     WRITE(6,2014)
2014 FORMAT(16X,*LENGTH OF SORTIE*,5X,*DAMAGE/KILL RATIO*/)
     WRITE(6,2015) TS,RDKUSE
2015 FORMAT(19X,F5.2,1X,*HRS.*,11X,F7.2/)
     IF(MOD.EQ.1) GO TO 30
     DMMHU=XMMHU-XMMHUB
     DMMHS=XMMHS-XMMHSB
     DMMHR=XMMHR-XMMHRB
     DMMHA=XMMHA-XMMHAB
     WRITE(6,3000)
3000 FORMAT(23X,*DELTA MMH*/)
     WRITE(6,3001) DMMHU,DMMHS,DMMHR,DMMHA
3001 FORMAT(5X,*UNSCHEDULED*,9X,F5.1/5X,*SCHEDULED*,11X,F5.1/5X,*DAMAGE
    * REPAIR*,7X,F5.1/5X,*ABORT REPAIR*,8X,F5.1/)
  30 WRITE(6,2016)
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```
3004 FORMAT (5X,24H* NO. OF A/C HOME SAFELY,6X,28H* NO. OF PASSES BROUG
    1HT HOME,/)
     WRITE(6,3005) ACH,PH
3005 FORMAT(16X,F5.3,26X,F6.3/)
     WRITE (6,3006) II
3006 FORMAT (1H1,55X,4HMOD ,I1/15X,33H* PROBABILITY OF SURVIVAL PER A/C
    1,/)
     WRITE(6,3007) PS
3007 FORMAT(28X,F7.5/)
     PSNA=(ACH-ABORTS)/(XIFS-ABORTS)
     WRITE(6,3008)
3008 FORMAT (8X,49H* PROBABILITY OF SURVIVAL PER A/C GIVEN NON-ABORT,/)
     WRITE(6,3007) PSNA
     IF(MOD.GT.1) GO TO 400
     PKBASE=PK
     GO TO 500
 400 PKMOD=PK
 500 RETURN
     END


     SUBROUTINE ACKILL(SURV,ACR,AVP,ACK,PL)
     ACSN=SURV*ACR
     ACKN=ACR-ACSN
     PSN=ACSN*(AVP/ACR)
     PLN=AVP-PSN
     ACK=ACK+ACKN
     PL=PL+PLN
     ACR=ACR-ACKN
     AVP=AVP-PLN
     RETURN
     END


     SUBROUTINE MTOS
     COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
    *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
     COMMON/PASS/ACH,ACK,MOD,PD,PH,PKBASE,PKMOD,PL,PS,PSNA
     COMMON/SORTIE/CTA,CTR,CTS,CTU,PLMOD,TA,TF,TPOF,TPRF,TQUE,TS,TTAX,
    *VAMOD,XMMHA,XMMHR,XMMHS,XMMHU
     IF(MOD.GT.1) GO TO 10
     PKUSE=PKBASE
     RDKUSE=RDK
     XMMHUB=XMMHU
     XMMHSB=XMMHS
     XMMHRB=XMMHR
     XMMHAB=XMMHA
     GO TO 20
  10 PKUSE=PKMOD
     IF(PKMOD.EQ.0.0) GO TO 15
     IF(IRDK.EQ.1) GO TO 15
     RDKUSE=((PKBASE*(RDK+1.0))/PKMOD)-1.0
     GO TO 20
  15 RDKUSE=RDK
  20 PRDAM=PKUSE*RDKUSE
     WRITE(6,1999) PRDAM
```

```
 2016 FORMAT (20X,29H* SORTIE RATE PER A/C PER DAY,/)
      WRITE(6,2017) SR
 2017 FORMAT(32X,F5.2/)
      RETURN
      END



      SUBROUTINE MTOF
      COMMON/JOB/BETA(10,10,5),EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,PRABR,
     *PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      COMMON/PASS/ACH,ACK,MOD,PD,PH,PKBASE,PKMOD,PL,PS,PSNA
      COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
     *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
      PRKT=WRKT/WPNPAS(MOD)
C  MAXIMUM NO. OF SORTIES AVAILABLE PER A/C IN TW
      SORTAV=SR*TW
C  EXP. NO. OF SORTIES PER A/C AVAILABLE IN TW
      IF(PS.EQ.1.0) GO TO 10
      TERM=PS**SORTAV
      SRTPAC=PS*((1.0-TERM)/(1.0-PS))
      GO TO 20
   10 SRTPAC=SORTAV
   20 CONTINUE
C  EXP. NO. WPN. DELIVERY PASSES COMPLETED PER SORTIE
      PDAC=PD/XIFS
C  EXP. NO. OF TARGETS KILLED PER SORTIE
      TKAC=PDAC/PRKT
C  EXP. NO. OF TARGETS KILLED PER A/C IN TW
      EXTK=SRTPAC*TKAC
C  FORCE SIZE REQUIRED TO DO JOB
      FSR=XNT/EXTK
C  PROBABILITY OF A/C SURVIVING WAR
      PSAB=(PS)**SORTAV
C  NUMBER OF DAMAGES PER A/C IN WAR
      EXBA=(1.0-PS)*RDKUSE*SORTAV
C  EXP. NO. SORTIES COMPLETED IN TW
      EXSORT=SRTPAC*(1.0-PRABR)
C  EXP. NO. A/C LOST IN TW
      ACLOST=FSR*(1.0-PSAB)
      II = MOD-1
      WRITE (6,2000) II
 2000 FORMAT (1H1,55X,4HMOD ,I1/10X,19HJOB SCALING FACTORS,//)
      WRITE(6,2001) XNT,TW,PRKT,XIFS,SR,PS
 2001 FORMAT(10X,*NO. TARGETS TO BE ATTACKED=*,F7.1/10X,*LENGTH OF WAR=*
     1,F5.1,* DAYS*/10X,*NO. PASSES REQUIRED TO ATTACK TARGET=*,F5.2/10X
     2,20HINITIAL FLIGHT SIZE=,F3.0/8X,14H* SORTIE RATE=,F5.2,16H SORTIE
     3S PER DAY/8X,34H* PROBABILITY OF SURVIVING SORTIE=,F7.5/)
      WRITE(6,2002)
 2002 FORMAT(/10X,*JOB SCALING OUTPUT*//)
      WRITE(6,2003) SORTAV,SRTPAC,EXSORT
 2003 FORMAT (8X,46H* MAXIMUM NO. SORTIES AVAILABLE PER A/C IN TW=,F7.4/
     1 8X,43H* EXP. NO. SORTIES AVAILABLE PER A/C IN TW=,F7.4/
     2 8X,43H* EXP. NO. SORTIES COMPLETED PER A/C IN TW=,F7.4)
      WRITE(6,3000) TKAC,EXTK,EXBA
```

```
 3000 FORMAT (8X,39H* EXP. NO. TARGETS ATTACKED PER SORTIE=,F5.3/
     1 8X,42H* EXP. NO. TARGETS ATTACKED PER A/C IN TW=,F6.2/
     2 8X,33H* EXP. NO. DAMAGES PER A/C IN TW=,F7.4)
      WRITE(6,3001) PSAB,ACLOST
 3001 FORMAT (8X,35H* PROBABILITY OF A/C SURVIVING WAR=,F7.4/
     1 8X,26H* EXP. NO. A/C LOST IN TW=,F7.2///)
      WRITE(6,2005) FSR
 2005 FORMAT (8X,35H* NUMBER OF A/C REQUIRED TO DO JOB=,F8.2///
     1 5X,31H(* - DENOTES CALCULATED VALUES))
      RETURN
      END



******
******MISSION TRADE-OFF METHODOLOGY COST MODEL
******
      SUBROUTINE MTOC(MOD)
      COMMON/COST/CAK,COMA
      COMMON /JOB/ BETA(10,10,5) ,EXBA,FSR,NAC,NMOD,PLOC(10,10),PNAV,
     1PRABR,PSAB,RDK,RDKUSE,RWA,SR,SRTPAC,TW,XIFS,XNT,IRDK
      EQUIVALENCE(ESBA,SRTPAC),(ANB,FSR)
******
******READ INPUT DATA
******
      READ 1000,Z
      READ 1001,NRS,MRS,NRE,MRE,CR
      READ 1001,NQS,MQS,NQE,MQE,ANG,ANGM,CQMA,RHA,RLA
      IF(RHA.EQ.0.0) RHA=0.1
      IF(RLA.EQ.0.0) RLA=0.1
      READ 1001,NGS,MGS,NGE,MGE,ANS,CGSY
      READ 1002,NBS,MBS,LBS,RCBG,CAK,CAX,CW,RDAK,CDK
      LWAR=TW+0.5
******
******PRINT OUT INPUT DATA
******
      II = MOD-1
      PRINT 2000,II,Z
      PRINT 2001,NRS,MRS,NRE,MRE,CR
      PRINT 2002,NQS,MQS,NQE,MQE,ANG,ANGM,ANB,CQMA,RHA,RLA
      PRINT 2003,NGS,MGS,NGE,MGE,CGSY,ANS
      PRINT 2004,II,NBS,MBS,LBS,LWAR,RCBG,CAK,RDAK,CDK
      PRINT 2005,PSAB,EXBA,CAX,ESBA,RWA,CW
******
******CONVERT DISCOUNT RATE FROM ANNUAL BASIS PERCENT FIGURE TO
******EQUIVALENT DAILY BASIS DECIMAL FIGURE
******
      Z=.01*Z
******
******COMPUTE DISCOUNT FACTORS
******
      VRZ=DF(365*NRS+30*MRS,365*(NRE-NRS)+30*(MRE-MRS),Z)
      VQZ=DF(365*NQS+30*MQS,365*(NQE-NQS)+30*(MQE-MQS),Z)
      VGZ=DF(365*NGS+30*MGS,365*(NGE-NGS)+30*(MGE-MGS),Z)
      VBZ=DF(365*NBS+30*MBS+LBS,LWAR,Z)
******
```

```
******COMPUTE PRESENT VALUE OF RDT+E COST
******
      C1=VRZ*CR
******
******COMPUTE PRESENT VALUE OF ACQUISITION COST
******
      ANGM=AMAX1(ANGM,ANB)
      C2=VQZ*CQMA*AMIN1(ANGM,ANG)*(1.0+RHA+RLA)
      IF(ANGM.LE.ANG) GO TO 1
      ABUY=ANGM-ANG
      ANG=ANGM
      C2=C2+ABUY*CAK
      PRINT 2008,ABUY
******
******COMPUTE PRESENT VALUE OF OPERATION AND SUPPORT COST
******
    1 CGAY=CGSY/ANS
      C3=VGZ*CGAY*ANG*(12*(NGE-NGS)+MGE-MGS)/12.0
******
******COMPUTE PRESENT VALUE OF WARTIME OPERATION AND SUPPORT COST
******
      C4=VBZ*ANB*(RCBG*CGAY*LWAR/365.0+(1.0-PSAB)*(CAK+RDAK*CDK)+
     1EXBA*CAX+ESBA*RWA*CW)
******
******COMPUTE PRESENT VALUE OF TOTAL LIFE CYCLE COST
******
      CLC=C1+C2+C3+C4
******
******PRINT OUT RESULTS
******
      PRINT 2007
      PRINT 2006,C1,C2,C3,C4,CLC
      PRINT 2050
 2050 FORMAT (5X,31H(* - DENOTES CALCULATED VALUES)////)
      RETURN
 1000 FORMAT(F10.0)
 1001 FORMAT(4I5,6F10.0)
 1002 FORMAT(3I5,5X,6F10.0)
 2000 FORMAT (1H1,20X,29HMISSION TRADE-OFF METHODOLOGY/30X,10HCOST MODEL
     1 //55X,4HMOD ,I1//22H ANNUAL DISCOUNT RATE=,F7.2,8H PERCENT////)
 2001 FORMAT(* RDTE COST INPUTS*//6X,*YEARS/MONTHS TO START OF RDTE=*,
     1I2,*/*,I2//6X,*YEARS/MONTHS TO END OF RDTE=*,I2,*/*,I2//6X,
     2*COST OF RDTE=$*,F15.2////)
 2002 FORMAT(* ACQUISITION COST INPUTS*//6X,*YEARS/MONTHS TO START OF *,
     1*ACQUISITION=*,I2,*/*,I2//6X,*YEARS/MONTHS TO END OF ACQUISITION=*
     2,I2,*/*,I2//6X,*NUMBER OF AIRCRAFT IN TOTAL FORCE=*,F5.0//6X,
     3*NUMBER OF AIRCRAFT TO BE MODIFIED=*,F5.0//6X,*NUMBER OF AIRCRAFT*
     4,* IN WAR FORCE=*,F7.2//6X,*COST OF MODIFICATION PER AIRCRAFT=$*,
     5F9.5//6X,*COST OF AGE/COST OF MODIFICATION=*,F7.4//6X,*COST OF *,
     6*SPARES/COST OF MODIFICATION=*,F7.4////)
 2003 FORMAT(* PEACETIME OPERATION AND SUPPORT COST INPUTS*//6X,*YEARS/*
     1,*MONTHS TO START OF O+S=*,I2,*/*,I2//6X,*YEARS/MONTHS TO END OF *
     2,*O+S=*,I2,*/*,I2//6X,*ANNUAL O+S COST PER SQUADRON=$*,F12.5//6X,
     3*NUMBER OF AIRCRAFT PER SQUADRON=*,F4.0////)
```

```
2004 FORMAT (1H1,
     1         55X,4HMOD ,I1//42H WARTIME OPERATION AND SUPPORT COST INPU
     1TS,//6X,6HYEARS/,
     1*MONTHS/DAYS TO START OF WAR=*,I2,*/*,I2,*/*,I2//6X,*DURATION OF*,
     2* WAR IN DAYS=*,I4//6X,*CHANGE IN ANNUAL O+S COST/ANNUAL PEACE*,
     3*TIME O+S COST=*,F7.4//6X,*REPLACEMENT COST PER AIRCRAFT KILLED=$
     4*,F11.2//6X,*CREWS LOST PER AIRCRAFT KILLED=*,F7.4//6X,*COST PER A
     5IRCRAFT OF CREW REPLACEMENT=$*,F9.5/)
2005 FORMAT (4X,47H* PROBABILITY AN AIRCRAFT WILL SURVIVE THE WAR=,
     1 F7.5//4X,53H* EXPECTED DAMAGED SORTIES FLOWN IN WAR PER AIRCRAFT=
     2,F5.2//6X,34HREPAIR COST PER DAMAGED AIRCRAFT=$,F9.5//4X,
     3 45H* EXPECTED SORTIES FLOWN IN WAR PER AIRCRAFT=,F7.2//4X,
     4 45H* EXPECTED NUMBER OF WEAPONS USED PER SORTIE=,F8.4//6X,
     5 17HCOST PER WEAPON=$,F9.6////)
2006 FORMAT(25X,*RDTE COST=$*,F15.2/18X,*ACQUISITION COST=$*,F15.2/8X,
     1*OPERATION AND SUPPORT COST=$*,F15.2/8X,*CHANGE IN O+S COST FOR *,
     2*WAR=$*,F15.2/35X,16(*=*)/13X,*TOTAL LIFE CYCLE COST=$*,F15.2////)
2007 FORMAT (3X,18H* PRESENT VALUES--,/)
2008 FORMAT(1X,F5.0,* ADDITIONAL AIRCRAFT PURCHASED*////)
     END



     FUNCTION DF(M,N,Z)
     C=1.0/(1.0+Z)
     IST=1+M/365
     IEND=1+(M+N)/365
     IF(IST.EQ.IEND) GO TO 2
     J=365-MOD(M,365)
     JEND=MOD(N-J,365)
     SUM=0.0
     DO 1 I=IST,IEND
     SUM=SUM+J*C**I
     J=365
     IF(I+1.GE.IEND) J=JEND
   1 CONTINUE
     DF=SUM/N
     RETURN
   2 DF=C**IST
     RETURN
     END



     SUBROUTINE SUBMOE
     COMMON/COST/CAK,COMA
     COMMON/PASS/ACH,ACK,MOD,PD,PH,PKBASE,PKMOD,PL,PS,PSNA
     COMMON/SORTIE/CTA,CTR,CTS,CTU,PLMOD,TA,TF,TPOF,TPRF,TQUE,TS,TTAX,
    *VAMOD,XMMHA,XMMHR,XMMHS,XMMHU
     COMMON/WEAPON/IPASS(10),IPAST(10),IV(10),IW(10,10),PBH(10),PLBASE,
    *QNST,VABASE,WBH(10),WPNPAS(10),WPNSOR(10),WPNTGT(10),WRKT
     IF(MOD.GT.1) GO TO 10
     TEST3=VABASE/CAK
     TEST4=(100.0-VABASE)/PLBASE
     GO TO 30
```

```
C   COMPUTE I1
    10 XNUM1=PKMOD*(CAK+CQMA)
       XI1=XNUM1/(PKBASE*CAK)
C   COMPUTE I2
       DELTVA=VABASE-VAMOD
       TERM1=1.0-(DELTVA/VABASE)
       TERM2=1.0+(CQMA/CAK)
       XI2=TERM1*TERM2
C   COMPUTE I3
       XI3=DELTVA/CQMA
       DELTPL=PLBASE-PLMOD
       IF(DELTPL.EQ.0.0)  DELTPL=1.0
       XI4=DELTVA/DELTPL
       WRITE(6,1000)
 1000 FORMAT(28X,*SUB-MODES*//)
       WRITE(6,1001) TEST3,TEST4
 1001 FORMAT(10X,*VA/CAK=*,1X,F6.4,10X,*(100-VA)/PL=*,1X,F6.4/)
       WRITE(6,1002)
 1002 FORMAT(15X,*I1*,10X,*I2*,10X,*I3*,10X,*I4*/)
       IMOD=MOD-1
       WRITE(6,1003) IMOD,XI1,XI2,XI3,XI4
 1003 FORMAT(3X,*MOD*,1X,I1,5X,F6.3,3(6X,F6.3)/)
       IF(DELTPL.NE.1.0) GO TO 30
       WRITE(6,1004)
 1004 FORMAT(3X,*DELTA PL=0.0, XI4=DELTA VA*)
   30 RETURN
       END
```

Appendix D

GLOSSARY OF PROGRAM TERMS

This glossary of program terms of MTOM is included as an aid to the analyst who wishes to investigate the MTOM programs in detail. The glossary gives the definitions of all the FORTRAN variables which appear as input, output or in common blocks in the MTOM subroutines. Also included in the definitions are the units of measure for all inputs and outputs.

For each of the alphabetized entries the following information is supplied, in addition to the definition, if the category is applicable to that variable:

Common: The name of the common block in which the variable can be found

Input: The name of the subroutine which reads the input variable

Output: The name of the subroutine which prints the output variable

Computed/utilized: The subroutines which the variable is either computed or used.

Glossary

Variable name	Common	Input	Output	Computed/ utilized	Definition
A		MTOSIN	MTOM		Alphameric header containing flight information data for a given aircraft type
ABORTS			MTOP	MTOP	Expected number of aircraft aborts for a given aircraft type
ABRTNO			MTOP	MTOP	P_I (aircraft non-abort)
ABUY			MTOC	MTOC	The number of new aircraft (incorporating the modification) that would have to be purchased in order to make up the difference between the force required to do the job and the number of aircraft in the total force. If this difference is negative, ABUY is set to zero
ACH	PASS		MTOP		Expected number of aircraft returning home for a given aircraft type
ACK	PASS		MTOP	MTOP, ACKILL	Expected number of aircraft killed on a mission for a given aircraft type: updated by ACKILL
ACLOST			MTOF	MTOF	Expected number of aircraft lost during war period for a given aircraft type
AIDI(I,J)	DIVE	MTODIN	MTODIN	COMPT	Initial altitude associated with jth column entries for dive maneuver PK tables for ith defensive weapon (meters)
AIPU(I,J)	POP-UP	MTODIN	MTODIN	COMPT	Initial altitude associated with jth column entries for pop-up maneuver PK tables for ith defensive weapon (meters)
ALSA(I,J)	SWING	MTODIN	MTODIN	COMPT	Altitude associated with jth row entries for swingaround maneuver PK tables for ith defensive weapon (meters)
ALSL(I,J)	STLEV	MTODIN	MTODIN	COMPT	Altitude associated with jth row entries for straight and level PK tables for ith defensive weapon (meters)
AL3(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft altitude during inbound flight for ith aircraft type (meters)
AL8(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft altitude during homebound flight for ith aircraft type (meters)
ANB			MTOC	MTOF, MTOC	The number of aircraft required to fight the war (EQUIVALENCE FSR)
ANDI(I,J)	DIVE	MTODIN	MTODIN	COMPT	Dive angle associated with jth row entries of dive maneuver PK tables for ith defensive weapon (degrees)

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
ANG		MTOC	MTOC		The number of aircraft in the total force
ANGM		MTOC	MTOC		The number of aircraft to be modified. The number is input, but is modified in the program based on the number of aircraft required to complete the defined job
ANS		MTOC	MTOC		Number of aircraft in a squadron
AN5(I)	SCENAR	MTODIN	MTODIN	COMPT	Dive angle for ith aircraft type (degrees)
ATPU(I,J)	POP-UP	MTODIN	MTODIN	COMPT	Terminal altitude associated with jth row of pop-up maneuver PK tables for ith defensive weapon (meters)
ATT	ATTR	MTODIN	MTODIN	COMSC, SCAL	Nominal attrition for baseline aircraft (optional)
AT4(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft altitude for target search for ith aircraft type (meters)
B(I,J,K)	DEFEN	MTODIN	MTODIN	SURV2, SURV1	Vulnerability factor for ith aircraft type, jth defense zone, kth defensive weapon
BETA(I,J,K)	JOB	JOBIN	MTOP	MTOP	Pr (aircraft lock-on target) for ith mod, jth target, kth pass
BX		MTODIN		MTODIN	Dummy variable name for vulnerability factors as they are read in
CAK	COST	MTOC	MTOC	MTOC, SUBMOE	Cost of an aircraft killed (millions of dollars)
CAX		MTOC	MTOC	MTOC	Cost to repair a damaged aircraft (millions of dollars)
CDK		MTOC	MTOC	MTOC	Cost per aircraft to replace a crew (millions of dollars)
CGSY		MTOC	MTOC	MTOC	Operation and support cost per squadron per year in peacetime (millions of dollars)
CQMA		MTOC	MTOC	MTOC, SUBMOE	Cost of modification per aircraft (millions of dollars)
CR		MTOC	MTOC	MTOC	Total cost of RDT&E (millions of dollars)
CTA	SORTIE	MTOSIN	MTOS	MTOS	Factor for converting manhours for abort repair to clock time
CTR	SORTIE	MTOSIN	MTOS	MTOS	Factor for converting manhours required for damage repair to clock time

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
CTS	SORTIE	MTOSIN	MTOS	MTOS	Factor for converting scheduled maintenance manhours to clock time
CTU	SORTIE	MTOSIN	MTOS	MTOS	Factor for converting unscheduled maintenance manhours to clock time
CW		MTOC	MTOC	MTOC	Cost of a weapon (millions of dollars)
C1			MTOC	MTOC	Present value of total RDT&E cost (millions of dollars)
C2			MTOC	MTOC	Present value of total acquisition cost (millions of dollars)
C3			MTOC	MTOC	Present value of total peacetime operation and support cost (millions of dollars)
C4			MTOC	MTOC	Present value of incremental operation and support cost due to war (millions of dollars)
DEN(I,J)	DEFEN	MTODIN	MTODIN	SURV2, SURV1	Density factor—DEN = 0.002 times weapon effective range (meters) times weapons per square kilometer
DMMHA			MTOS	MTOS	Δ manhours for abort repair (mod-baseline)
DMMHR			MTOS	MTOS	Δ manhours for damage repair (mod-baseline)
DMMHS			MTOS	MTOS	Δ scheduled maintenance manhours per flying hour (mod-baseline)
DMMHU			MTOS	MTOS	Δ unscheduled maintenance manhours per flying hour (mod-baseline)
D3(I)	SCENAR	MTODIN	MTODIN	COMPT	Distance traversed by aircraft during inbound flight for ith aircraft type (kilometers)
D45(I)	SCENAR	MTODIN	MTODIN	COMPT	Distance traversed by aircraft during target search for ith aircraft type (kilometers)
D7(I)	SCENAR	MTODIN	MTODIN	COMPT	Distance traversed by aircraft during between target flight for ith aircraft type (kilometers)
D8(I)	SCENAR	MTODIN	MTODIN	COMPT	Distance traversed by aircraft during homebound flight for ith aircraft type (kilometers)

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
D95(I)	SCENAR	MTODIN	MTODIN	COMPT	Distance traversed by aircraft during loiter for aircraft not locating target for ith aircraft type (kilometers)
ESBA	JOB			MTOF, MTOC	Expected number of sorties flown in war, per aircraft (EQUIVALENCE SRTPAC)
EXBA	JOB		MTOF	MTOF, MTOC	Expected number of aircraft damaged during war period for a given aircraft type
EXSORT			MTOF	MTOF	Expected number of sorties completed during war period for a given aircraft type
EXTK			MTOF	MTOF	Expected number of targets attacked during war period for a given aircraft type
FSR	JOB		MTOF	MTOF, MTOC	Expected number of aircraft required to complete job during war period for a given aircraft type (same as ANB)
GAMMA(I)	ATTR	MTODIN	MTODIN	COMSC	Nominal attrition allocation to ith defense zone (optional)
IAC		MTODIN		MTODIN	Indicator variable for inputting PK scenario characteristics, or vulnerability factor. IAC=0 → end of data, IAC≠0 → data for IACth aircraft type on following cards
II			MTOM	MTOM	Aircraft mod number, baseline=0
IMAX		JOBIN		JOBIN	Maximum number of targets to be attacked. IMAX $\leq$ 10
IMOD			SUBMOE	SUBMOE	Aircraft type index
IPASS(I)	WEAPON		MTOP	MTOW, MTOP	Number of passes to be attempted by ith aircraft
IPAST(I)	WEAPON			MTOW	Internal variable
IV(I)	WEAPON		MTOP	MTOW, COMPT, COMPS, COMSC, COMPN, MTOP, MTOS, SUBMOE	Number of targets attacked by ith aircraft type

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
IW(I,J)	WEAPON		MTOP	MTOW, COMPT, COMPS, COMSC, COMPN, MTOS, SUBMOE	Number of passes attempted by ith aircraft type on jth target
JDEF		MTODIN		MTODIN	Defense zone index for vulnerability factor input: B(IAC,JDEF,KWEP)
JMAX		JOBIN		JOBIN	Maximum number of passes per target. JMAX ≤ 5
JWEP		MTODIN		MTODIN	Indicator variable, indicates PK tables for JWEPth weapon follow
KWEP		MTODIN		MTODIN	Defensive weapon index for vulnerability factor inputs B(IAC,JDEF,KWEP)
LBS		MTOC	MTOC	MTOC	Number of days before the start of the war (after NBS years and MBS months)
LWAR			MTOC	MTOC	Duration of war to nearest integer number of days
MBS		MTOC	MTOC	MTOC	Number of months before start of war (after NBS years)
MGE		MTOC	MTOC	MTOC	Number of months before end of peacetime O&S period (after NGE years)
MGS		MTOC	MTOC	MTOC	Number of months before start of peacetime O&S period (after NGS years)
MOD	PASS			MTOM, MTOP, MTOS, MTOF, MTOC, SUBMOE	Aircraft type being evaluated by MTOP, MTOS, MTOF and MTOC, SUBMOE (baseline=1)
MQE		MTOC	MTOC	MTOC	Number of months before the end of the acquisition period (after NQE years)
MQS		MTOC	MTOC	MTOC	Number of months before start of acquisition period (after NQS years)
MRE		MTOC	MTOC	MTOC	Number of months before end of RDT&E period (after NRE years)
MRS		MTOC	MTOC	MTOC	Number of months before start of RDT&E period (after NRS years)

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
NAC	JOB			MTOM, JOBIN, MTOW, COMPT, COMPS, COMPN	Number of aircraft types being considered (NMOD+1)
NAIDI(I)	DIVE	MTODIN		MTODIN, COMPT	Number of dive angles (rows) for which dive maneuver PK are tabulated for ith defensive weapon ($\leq$5)
NAIPU(I)	POP-UP	MTODIN		MTODIN, COMPT	Number of initial altitudes (columns) for which pop-up maneuver PK are tabulated for ith defensive weapon ($\leq$5)
NALSA(I)	SWING	MTODIN		MTODIN, COMPT	Number of altitudes (rows) for which swingaround maneuver PK are tabulated for ith defensive weapon ($\leq$5)
NALSL(I)	STLEV	MTODIN		MTODIN, COMPT	Number of altitudes (rows) for which straight and level PK are tabulated for ith defensive weapon ($\leq$5)
NANDI(I)	DIVE	MTODIN		MTODIN, COMPT	Number of dive angles (rows) for which dive maneuver PK are tabulated for ith defensive weapon ($\leq$5)
NATPU(I)	POP-UP	MTODIN		MTODIN, COMPT	Number of terminal altitudes (rows) for which pop-up PK are tabulated for ith defensive weapon ($\leq$5)
NBS		MTOC	MTOC	MTOC	Number of years before start of war
ND10	DEFEN			COMPT, COMSC	Defense zone index associated with aircraft not locating target area and returning home (same as ND3)
ND3	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with inbound flight
ND4	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with pop-up to search
ND45	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with target search
ND5	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with attack dive
ND6	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with swingaround
ND65	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with climb to next pass

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
ND67	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with climb to outbound altitude
ND7	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with between target flight
ND8	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with homebound flight
ND9	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with dive to loiter altitude event for aircraft not locating the target
ND95	DEFEN	MTODIN	MTODIN	COMPT, COMSC	Defense zone index associated with loiter event for aircraft not locating target
NGE		MTOC	MTOC	MTOC	Number of years before end of peacetime O&S period
NGS		MTOC	MTOC	MTOC	Number of years before start of peacetime O&S period
NMOD	JOB	JOBIN		JOBIN, MTODIN, COMPT, COMPS, COMPN	Number of aircraft mods under construction
NQE		MTOC	MTOC	MTOC	Number of years before end of acquisition period
NQS		MTOC	MTOC	MTOC	Number of years before start of acquisition period
NRE		MTOC	MTOC	MTOC	Number of years before end of RDT&E period
NRS		MTOC	MTOC	MTOC	Number of years before start of RDT&E period
NSPSI(I)	STLEV	MTODIN		MTODIN, COMPT	Number of speeds for which straight and level lethal radii are tabulated for ith defensive weapon (≤ 5)
NWEPS	DEFEN	MTODIN		MTODIN, SURV2, SURV1	Number of defensive weapons
OPT	ATTR	MTODIN	MTODIN	MTOD	Nominal attrition scaling option indicator; T = attrition scaling; F = no attrition scaling
PBH(I)	WEAPON			MTOW, MTOP	Passes at home because of inconsistent weapon pass data for ith aircraft type

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
PD	PASS		MTOP	MTOP, MTOF	Expected number of passes delivered for a given aircraft type
PH	PASS		MTOP	MTOP	Expected number of passes not attempted for a given aircraft type
PKBASE	PASS			MTOP, MTOS, SUBMOE	Pr (baseline aircraft kill on sortie)
PKMOD	PASS			MTOP, MTOS, SUBMOE	Pr (modified aircraft kill during sortie)
PL	PASS		MTOP	MTOP, ACKILL	Expected number of passes lost due to aircraft kill for a given aircraft updated by ACKILL
PLBASE	WEAPON	JOBIN		SUBMOE	Payload for a baseline aircraft (kilograms)
PLMOD	SORTIE	MTOSIN		SUBMOE	Payload for a given aircraft mod (kilograms)
PLOC(I,J)	JOB	JOBIN	MTOP	COMPS, COMSC, MTOP	Pr (ith type aircraft locates jth target)
PNAV	JOB	JOBIN	MTOP	COMPS, COMSC, MTOP	Pr (aircraft locates target area (no gross navigational error))
PN10(I)	PNORM			COMPN, MTOP	Scaled non-diluted aircraft survival probability for return after not locating target area for ith aircraft type
PN3(I)	PNORM			COMPN, MTOP	Scaled non-diluted aircraft survival probability for inbound flight for ith aircraft type
PN4(I)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for pop-up to search for jth target for ith aircraft type
PN45(I)	PNORM			COMPN, MTOP	Scaled non-diluted aircraft survival probability for search event for ith aircraft type and jth target
PN5(I,J,K)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for attack dive event for ith aircraft, jth target and kth pass
PN6(I,J,K)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for swingaround event for ith aircraft type, jth target, kth pass

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
PN65(I,J)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for climb to next pass for ith aircraft type, jth target and kth pass
PN67(I)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for climb to homebound event for ith aircraft type
PN7(I,J)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for ith aircraft type and jth target
PN8(I)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for homebound flight for ith aircraft type
PN9(I,J)	PNORM			COMPN, MTOP	Scaled non-diluted aircraft survival probability for dive to loiter for aircraft not locating jth target for ith aircraft type
PN95(I,J)	PNORM			COMPN, MTOP	Scaled non-diluted survival probability for loiter for aircraft not locating jth target for ith aircraft type
PRABR	JOB	JOBIN	MTOS	MTOW, MTOP, MTOS, MTOF	Pr (aircraft abort)
PRDAM			MTOS	MTOS	Pr (aircraft damage) for a given aircraft type
PRKT			MTOS	MTOF	Number of passes required to attack targets for a given aircraft type
PS	PASS		MTOP	MTOP, MTOF	Pr (aircraft survives sortie) for a given aircraft type
PSAB	JOB		MTOF, MTOC	MTOF, MTOC	Pr (aircraft survives war period) for a given aircraft type
PSNA	PASS		MTOP	MTOP	Pr (aircraft survives sortie given non-abort) for a given aircraft type
PT10(I)	PTENT			COMPT, COMPS, COMSC, COMPN	Non-diluted tentative survival probability for return after non-location of target area (gross navigational error) for ith aircraft
PT3(I)	PTENT			COMPT, COMPS, COMSC, COMPN	Non-diluted tentative survival probability for inbound flight for ith aircraft type

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
PT4(I,J)	PTENT			COMPT, COMPS, COMSC, COMPN	Non-diluted tentative survival probability for pop-up to search for jth target for ith aircraft type
PT9(I)	PTENT			COMPT, COMPS, COMSC, COMPN	Non-diluted tentative survival probability for dive to loiter altitude for aircraft not locating target for ith aircraft type
PT95(I)	PTENT			COMPT, COMPS, COMSC, COMPN	Non-diluted tentative survival probability for loiter of aircraft not locating target for ith aircraft type
QN			COMPS	COMPS, PSUR	Expected number of aircraft surviving a mission for a given aircraft type (tentative) - updated by PSUR
QNST	WEAPON			MTOW, COMPS, COMSC	Number of aircraft attempting mission (after aborts are removed)
RCBG		MTOC	MTOC	MTOC	Ratio of change in annual O&S cost due to war divided by annual peacetime O&S cost
RDK	JOB	JOBIN		MTOS	Ratio of expected number of aircraft damage to expected number of aircraft kill for baseline aircraft
RDAK		MTOC	MTOC	MTOC	Ratio of crews lost to aircraft killed
RDKUSE	JOB		MTOS	MTOS, MTOF	Ratio of expected number of aircraft damaged to expected number of aircraft kills for a given aircraft type
RHA		MTOC	MTOC	MTOC	Ratio of cost of peculiar AGE to cost of aircraft modification
RKDI(I,J,K)	DIVE	MTODIN	MTODIN	COMPT	Dive PK for kth column (initial altitude) jth row (dive angle) where I=f (aircraft type and defensive weapon)
RKPU(I,J,K)	POP-UP	MTODIN	MTODIN	COMPT	Pop-up PK for kth column (initial altitude), jth row (terminal altitude) where I=f (aircraft type and defensive weapon)
RKSA(I,J)	SWING	MTODIN	MTODIN	COMPT	Swingaround PK for jth row (altitude) where I=f (aircraft type and defensive weapon)
RKSL(I,J,K)	STLEV	MTODIN	MTODIN	COMPT	Straight and level PK for jth row (altitude), kth column (speed) where I=f (aircraft type and defensive weapon)

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
RLA		MTOC	MTOC	MTOC	Ratio of cost of intitial spares to cost of aircraft modification
RWA	JOB			MTOP	Expected number of weapons delivered per sortie for a given aircraft type
SC10	SCALE			COMSC, COMPN	Scaling factor for returning home for aircraft not locating target area (gross navigational error)
SC3	SCALE			COMSC, COMPN	Scaling factor for inbound flight
SC4(I)	SCALE			COMSC, COMPN	Scaling factor for pop-up to search for ith target
SC45(I)	SCALE			COMSC, COMPN	Scaling factor for search for ith target
SC5(I,J)	SCALE			COMSC, COMPN	Scaling factor for attack dive for jth pass at ith target
SC6(I,J)	SCALE			COMSC, COMPN	Scaling factor for swingaround following dive for jth pass at ith target
SC65(I,J)	SCALE			COMSC, COMPN	Scaling factor for climb to next pass for jth pass at ith target
SC67	SCALE			COMSC, COMPN	Scaling factor for climb to homebound altitude after last target
SC7(I)	SCALE			COMSC, COMPN	Scaling factor for flight between ith and (I+1)th target
SC8	SCALE			COMSC, COMPN	Scaling factor for homebound flight
SC9(I)	SCALE			COMSC, COMPN	Scaling factor for dive to loiter altitude for aircraft not locating ith target
SC95(I)	SCALE			COMSC, COMPN	Scaling factor for loiter for aircraft not locating ith target
SORTAV			MTOF	MTOF	Maximum number of sorties available during war period for a given aircraft type
SPSL(I,J)	STLEV	MTODIN	MTODIN	COMPT	Aircraft speed for jth column entries of straight and level lethal radius tables for ith defensive weapon (m/sec)
SP3(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft speed during inbound flight for ith aircraft type (m/sec)
SP45(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft speed during target search for ith aircraft type (m/sec)

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
SP7(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft speed during between target flight for ith aircraft type (m/sec)
SP8(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft speed during homebound flight for ith aircraft type (m/sec)
SP95(I)	SCENAR	MTODIN	MTODIN	COMPT	Aircraft speed during loiter for aircraft not locating target for ith aircraft type (m/sec)
SR	JOB		MTOS, MTOF	MTOS, MTOF	Sortie rate for a given aircraft type
SRTPAC	JOB		MTOF	MTOF, MTOC	Expected number of sorties per aircraft during war period for a given aircraft type (same as ESBA)
TA	SORTIE	MTOSIN	MTOS	MTOS	Time required to re-arm aircraft for a given aircraft type (hours)
TEST3			SUBMOE	SUBMOE	Vulnerable area/dollar (for baseline aircraft) (VABASE/CAK)
TEST4			SUBMOE	SUBMOE	(100-VABASE)/PLBASE
TF	SORTIE	MTOSIN	MTOS	MTOS	Time required to refuel given aircraft type (hours)
TKAC			MTOF	MTOF	Expected number of targets attacked per sortie for a given aircraft type
TPOF	SORTIE	MTOSIN	MTOS	MTOS	Time required for post-flight inspection for given aircraft type (hours)
TPRF	SORTIE	MTOSIN	MTOS	MTOS	Time required for pre-flight inspection for a given aircraft type (hours)
TQUE	SORTIE	MTOSIN	MTOS	MTOS	Waiting time for given aircraft type (hours)
TRNRND			MTOS	MTOS	Sum of times (clock hours) required for re-arm, refuel, pre-flight inspection, post-flight inspection, waiting and taxiing per sortie
TS	SORTIE	MTOSIN	MTOS	MTOS	Sortie length for given aircraft type (hours)
TTAX	SORTIE	MTOSIN	MTOS	MTOS	Taxiing time for given aircraft type (hours)
TW	JOB	JOBIN	MTOF	MTOF	Length of war (days)
T3(I)	SCENAR	MTODIN	MTODIN	COMPT	Time required for inbound flight for ith aircraft type (seconds)

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
T45(I)	SCENAR	MTODIN	MTODIN	COMPT	Time required for target search for ith aircraft type (seconds)
T7(I)	SCENAR	MTODIN	MTODIN	COMPT	Time required for between target flight for ith aircraft type (seconds)
T8(I)	SCENAR	MTODIN	MTODIN	COMPT	Time required for homebound flight for ith aircraft type (seconds)
T95(I)	SCENAR	MTODIN	MTODIN	COMPT	Time of loiter for aircraft not locating a target for ith aircraft type (seconds)
VABASE	WEAPON	JOBIN		SUBMOE	Vulnerable area of baseline aircraft (m^2)
VAMOD	SORTIE	MTOSIN		SUBMOE	Vulnerable area for a given aircraft mod (m^2)
WBH(I)	WEAPON		MTOW	MTOW	Weapons not expended because of inconsistent weapons/pass and weapons/sortie data for ith aircraft type
WPNPAS(I)	WEAPON	JOBIN		MTOW, MTOP, MTOF	Number of weapons per pass for ith aircraft type
WPNSOR(I)	WEAPON	JOBIN		MTOW	Number of weapons available per sortie for ith aircraft type
WPNTGT(I)	WEAPON	JOBIN		MTOW	Number of weapons per target for ith aircraft type
WRKT	WEAPON	JOBIN		MTOF	Number of weapons required to attack a target
XIFS	JOB	JOBIN	MTOP, MTOF	MTOW, MTOP, MTOF	Initial flight size
XI1			SUBMOE	SUBMOE	A SUBMOE - ratio of expected cost per aircraft for mod aircraft killed to expected cost per aircraft for baseline aircraft killed
XI2			SUBMOE	SUBMOE	A SUBMOE - the product of two ratios: vulnerable area of a given mod to that of the baseline aircraft, and the cost of the given mod to the cost of the baseline
XI3			SUBMOE	SUBMOE	A SUBMOE - The vulnerable area reduction/dollar for a given aircraft modification
KI4			SUBMOE	SUBMOE	A SUBMOE - for a given aircraft mod the ratio of Δ vulnerable area to Δ payload

Glossary (Contd.)

Variable name	Common	Input	Output	Computed/ utilized	Definition
XMMHA	SORTIE	MTOSIN	MTOS	MTOS	Manhours per abort repair for a given aircraft type
XMMHR	SORTIE	MTOSIN	MTOS	MTOS	Manhours per damage repair for given aircraft type
XMMHS	SORTIE	MTOSIN	MTOS	MTOS	Scheduled maintenance manhours per flying hour for a given aircraft type
XMMHU	SORTIE	MTOSIN	MTOS	MTOS	Unscheduled maintenance manhours per flying hour for a given aircraft type
XNT	JOB	JOBIN	MTOF	MTOF	Number of targets to be attacked during war period
Z		MTOC	MTOC	MTOC	Annual discount rate as a percentage figure (converted to decimal internally)

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The Mission Trade-Off Methodology (MTOM) Model: User's Manual, by W. J. Strauss, N. D. Bailey, M. W. Kasper, A. T. Kearney, Inc., Chicago, IL. Wright-Patterson AFB, OH, ASD, for Joint Technical Coordinating Group/Aircraft Survivability. October 1978. 141 pp. (JTCG/AS-76-S-002, publication Unclassified.)

The MTOM programs provide a means for evaluating the relative cost-effectiveness of proposed aircraft modifications for the purpose of enhancing survivability. There are two programs: MTO/E (mission trade-off/effectiveness) model and MTO/C (mission trade-off/cost) model. This report is designed to enable

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