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Munitions Support for Tactical Air Operations: Tactical Resources and Combat Effectiveness (TRACE) Model

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PREFACE

For several years, Rand has been studying the uses of tactical air-power in a hypothetical, large-scale, high-intensity, conventional war in Central Europe. From these studies and others has come recognition of the need to look closely at the effects of materiel support availability on tactical air operations. At the 1971 review of the Project RAND research program, Rand and its Air Force Advisory Group jointly agreed that Rand should initiate, as part of its General Purpose Forces Studies Program, a study of support demand in tactical operations. Final results of this study are presented in a series of reports:

R-1174-PR, *Munitions Support for Tactical Air Operations: A Briefing* (U), March 1973 (Confidential).

R-1200-PR, *Munitions Support for Tactical Air Operations: Executive Summary* (U), June 1973 (Confidential).

R-1201-PR, *Munitions Support for Tactical Air Operations: Methodology, Applications, and Findings* (U), June 1973 (Secret).

R-1202-PR, *Munitions Support for Tactical Air Operations: The Tactical Resources and Combat Effectiveness (TRACE) Model*, August 1973.

R-1203-PR, *Munitions Support for Tactical Air Operations: Program Listing for the TRACE Model*, August 1973.

These reports describe (1) a new methodology relating materiel resource availability and operational capability, (2) a computer program implementing the methodology, and (3) some results obtained from applications of the methodology. The study will be of use to military budget analysts, munitions planners, logisticians, operational planners, and operational commanders. The methodology developed in this study can be used to evaluate the size and mix of theater stockpiles, analyze alternative munitions logistics systems, establish guidelines for base-level munitions stockpiles, and perform sensitivity analyses of planning factors such as sortie rates, deployment schedules, and weather.

The present report describes the assumptions and methodology of the TRACE simulation model and also serves as a user's manual.

SUMMARY

The study of munitions support for tactical air operations was initiated to examine and quantify the impact on combat capability of changes in the numbers and types of air-to-ground nonnuclear munitions available to the operational commander. The Tactical Resources and Combat Effectiveness (TRACE) model was developed to support this study. The model simulates the allocation of aircraft and munitions located at a set of operating bases against a wide variety of target types, which are identified by the following mission categories: Close Air Support, Counter Air, and Air Interdiction.

During a simulation, the capability of the individual bases may be either enhanced by munitions resupply and aircraft augmentation or degraded by losses suffered from attacks against the bases. The target system may also change during a simulation as targets are destroyed and repaired or replaced. The influence of weather and weather forecast errors on combat capability has also been incorporated in the TRACE model. The weather forecast influences the assignment of aircraft and munitions to targets and the actual weather influences the expected outcome of the assignments.

Allocation of sorties is computed as a function of target value and the number of targets of each type and also, if desired, as a function of the mission categories. The program attempts to meet the allocation goals as aircraft-munition combinations are assigned to targets as a function of available resources, delivery mode options given the weather forecast, expected targets destroyed, and expected aircraft attrition from ground defenses.

The primary measures of the outcome of a simulation include: the expected number of targets destroyed, the expected number of aircraft lost and remaining, and the expected amount of munitions consumed and remaining.

Current TRACE model specifications allow up to 20 airbases, 12 aircraft types, and 35 target types. In the present design, runs of up to 90 days of simulated air operations can be made. TRACE is programmed in FORTRAN IV and is currently running on an IBM 360/65 computer.

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GLOSSARY

a	Aircraft index
A	Number of aircraft types
AA	Airbase attack attrition rate (loss rate on ground)
AB	Abort rate
AE	Enroute attrition rate
AT	Expected attrition per pass
ATS	Attrition scaling factor
b	Base index
B	Number of airbases
c	Attack category
C	Weather constant
d	Day number
D	Day of simulation
E	Expected kills per sortie
eq	Target equivalence factor
f	Resupply fraction
F	Mission allocation fraction
G	Ground attack factor
IE	Ineffectiveness rate
j	Munition index
J	Number of munition types
JE	Jettison rate
k	Weather index
ℓ	Target load class
L	Aircraft load
m	Mission category
M	Resupply array number
n	Munition vulnerability category
N	Number of iterations in assignment algorithm
P	Weather probability
Q	Number of UE aircraft
R'	Target replacement rate
s'	Sortie rate

t Target index
T Number of target types
u Replacement target availability
U Number of munitions
val Target value
w Size of replacement target pool
W Number of targets

I. INTRODUCTION

For several years, Rand has been studying the uses of tactical air forces in a hypothetical, large-scale, conventional war in Central Europe and examining the effects on the land battle of variations in the allocation of tactical airpower among mission categories. From these studies has come recognition of the need to look closely at the effects of materiel support on tactical operations and to determine the relationship between the amount of materiel support provided and the resulting operational capabilities. A survey of existing analytical tools that might be used to relate materiel resource availability and operational capability revealed that methods then available were not adequate to meet these objectives. Therefore, a significant portion of the study effort was concerned with development of the model described in this report, which can perform the necessary analysis. The model was structured so that sortie allocation policies, availability of munitions (through stocks prepositioned at the bases or through resupply), and force activity rates are easily varied by the model user, allowing changes in support and operational policies to be compared directly.

The results of the study are presented in the following companion reports: R-1174-PR, *Munitions Support for Tactical Air Operations: A Briefing* (U) (Confidential); R-1200-PR, *Munitions Support for Tactical Air Operations: Executive Summary* (U) (Confidential); and R-1201-PR, *Munitions Support for Tactical Air Operations: Methodology, Applications, and Findings* (U) (Secret). These reports describe the use of the TRACE model to investigate the influence of budget constraints, in-theater resupply systems, and the composition of base-level stockpiles on munitions availability and thus on combat capability.

An overview of the TRACE model is presented in Sec. II of this report and serves as a framework for the detailed discussion of the model in Sec. III. Sections IV through VI are oriented toward the model users; Sec. IV describes input procedures; Sec. V discusses output options and includes a catalogue of error messages; and Sec. VI considers program organization. The appendix contains a complete test case. The

FORTTRAN code of the TRACE model is contained in the companion report R-1203-PR, *Munitions Support for Tactical Air Operations: Program Listing for the TRACE Model*.

II. OVERVIEW OF THE TRACE MODEL

TRACE is a one-sided expected-value model that simulates the allocation and consumption of resources from a set of airbases in a combat environment. It estimates the results of applying a given set of tactical aircraft and air-to-ground conventional munitions against a specified array of enemy targets. The output indicates the expected number of targets destroyed, number of aircraft lost, and amount of munitions consumed. Figure 1 is a simplified functional diagram of the TRACE model; its functions are separated into Allocation, Assignment, and Flying to and Attacking Targets.

The first function is allocation. At the beginning of each day, the available sorties are allocated among target types. The number of sorties available is determined by the number of aircraft available at the bases and the planned sortie rate for each type of aircraft. Sortie rates may be varied during a run (e.g., to reflect "initial" and "sustained" levels of effort). Mission allocations may specify that portions of the available sorties be assigned to the following mission categories: Immediate Close Air Support (ICAS), Counter Air (CA), Preplanned Close Air Support (PCAS), and Air Interdiction (AI). These mission allocation fractions may be changed during a run, if desired. Sortie allocation among target types is influenced by target value or importance and the number of targets of each type in the array for each day's operation. Target values are an input and may be changed once during a run. Sorties may be allocated without regard to mission categories; i.e., mission allocation fractions need not be defined and the allocation of sorties then becomes a function of only the target values and the number of targets of each type.

The next function of the TRACE model is assignment. After sorties have been allocated, aircraft-munition combinations are assigned based on available aircraft and munitions resources at the bases, delivery mode options, expected target kills per sortie, and expected aircraft attrition from ground defenses. Expected weather conditions in the target area limit the delivery mode options, and the forecast is a function

*may be changed during a run

Fig. 1 — Functional diagram of the TRACE model

of actual weather and a forecast error distribution that reflects the ability of forecasters to predict different types of weather in a given location during a particular season of the year (see Ref. 1, especially pp. 25-35). For ICAS sorties, the aircraft-munition combinations chosen are those that maximize expected target kills; for all other sorties (CA, PCAS, and AI), the choice is based on maximizing the ratio of expected target kills to expected aircraft losses from terminal attrition. If the first-choice munition is not available, the second choice is used, and so on. If effective aircraft-munition combinations are not available for all the sorties allocated to a particular target type, the unassigned sorties are reallocated to other target types within their mission category to achieve the desired mission allocation, if one exists. If effective aircraft-munition combinations are not available for all the sorties allocated to a particular mission category, the unassigned sorties are reallocated to the targets of the other mission categories. Only if *no* usable munitions are available given the weather forecast, will sorties *not* be flown.

After the aircraft and munitions at the bases have been assigned to targets, the next operation is flying to and attacking targets. Some sorties are lost because of enroute attrition, and others do not reach their targets because they either abort or jettison their munitions. Munitions from aborted sorties are returned to the airbase stockpile from which they were taken; jettisoned munitions and those on attrited aircraft are lost. When the sorties reach the target area, some may become ineffective because of inability to acquire the target. Munitions from these sorties are returned to the airbases.

The actual weather condition at the target determines the delivery mode options. These options, which may differ from those considered during assignment (depending on the forecast), may prevent the delivery of munitions by some of the sorties. In the TRACE model, weather is characterized as good, average, marginal, or bad. The actual weather and the weather forecast for each day can be determined in any of three ways: (1) by specifying distributions for daily random selections to determine the actual weather, the probability of error, and, given an error, the forecast; (2) by specifying a preplanned day-by-day sequence;

or (3) by specifying the probabilities associated with each possible combination of actual weather and weather forecast.

If actual weather and forecast weather are identical, munitions delivery takes place as planned; if actual weather and forecast weather are different, delivery mode options are examined and one is chosen using the same criteria as those used for munitions selection during the assignment process.* Munitions that cannot be delivered are returned to the appropriate airbase stockpile. Sorties that deliver munitions suffer terminal attrition based on the number of passes, the delivery mode employed, and the target defenses.

During the operations of flying and attacking targets, targets are destroyed, aircraft are lost, and munitions consumed. The TRACE model output for each day also includes the number of targets, aircraft, and munitions remaining, the number of sorties flown against each target type, the aircraft loss rate, and Military Worth Destroyed (MWD).† Cumulative values from the first day of operations are computed for targets destroyed, aircraft losses, the number of sorties flown, the aircraft loss rate, and MWD.

In addition to the changes in the number of targets, aircraft, and munitions that result from each day's operations, certain preplanned changes may occur. These preplanned changes occur at the beginning of each day before the number of available sorties is computed and allocated to targets. The targets destroyed earlier in a simulation may be either replaced or repaired (but not both). Replacements come either from replacement pools outside the target array or from some other target type (e.g., replacements for CAS tank targets might come from the AI tank targets). Repair times may be input defining when destroyed targets are to be returned to the target array. The TRACE user may also specify that when enemy shelters are hit, the aircraft inside are assumed to be destroyed but the shelters are assumed to be still usable.

* Maximize the expected target kills for ICAS sorties; maximize the ratio of expected target kills to expected aircraft losses for all other sorties.

† MWD is the weighted sum of all targets destroyed, where the weight of each target is the target value mentioned earlier.

When the aircraft replacement pool is depleted, all shelters are not filled, and the expected number of aircraft kills per attacking sortie is reduced accordingly.

Aircraft inventories at the bases may be increased through a pre-planned augmentation schedule and/or decreased because of attacks against the bases. On-base daily aircraft attrition rates are defined for each base and may be changed during a run, if desired. Munition stockpiles at the bases may be increased through a preplanned resupply schedule and/or decreased because of attacks against the bases. On-base daily munition attrition rates are defined for each base and may also be changed during a run.* Attacks against the bases are assumed to occur after any aircraft augmentation or munition resupply.

Current TRACE model specifications allow up to 20 bases, 12 aircraft types, and 35 target types. In the present design, runs of up to 90 days of simulated air operations can be made. TRACE is programmed in FORTRAN IV and is currently running on an IBM 360/65 computer.

The TRACE model is an analytic tool useful for measuring the relationships of resource availability to combat capability. TRACE was designed and programmed so that other resource constraints (e.g., POL and aircrews) could be incorporated. With the addition of other resource constraints, it would be possible to investigate the interactions among availability of various resources and the resulting net effects on combat capability.

* The munitions on the bases may be divided into two levels of vulnerability to attack.

III. METHODOLOGY OF TRACE

THE SIMULATION CYCLE

The TRACE model iterates on a cycle, which in practice has been considered to be equivalent to a 24-hour day. Thus, the cycle has been denoted a *day* in the printed output and in the definition of input units. However, except for the terminology, the cycle interval could be considered to be shorter or longer than a 24-hour day if the input variables are adjusted accordingly. The number of days per run is defined by the user in the input data card deck which in the current program has an upper limit of 90 days. A flow chart of the model appears in Fig. 2.

WEATHER IN THE TRACE MODEL

The four types of weather conditions that may be defined in the model are identified by the indices 1, HIGH; 2, MED; 3, LOW; and 4, NO. Increasing indices imply more stringent weather conditions. As will be described in detail below, the assignment of aircraft and munitions to targets is based on a forecast of one of four weather conditions, and the expected outcome of the assignment is based on the actual weather in the target area (also one of the four weather conditions). Letting k_1 denote an actual weather index, and letting k_2 denote a weather forecast index, we define $P_f(k_2)$ to be the probability that the weather forecast is k_2 and $P(k_1, k_2)$ to be the probability that the actual weather is k_1 and the weather forecast is k_2 . The TRACE model offers three ways to define these probabilities.

In weather method one, only one pair of indices on actual weather conditions and weather forecast occur together on any day. New pairs are selected each day using a Monte Carlo process. Input variables for this method are:

P_e = the probability that the weather forecast is in error.

$P_a(k_1)$ = the probability that the index of the actual weather is k_1 .

Fig. 2—Flow diagram--TRACE model

$P_c(k_2|k_1)$ = the conditional probability that the index of the weather forecast is k_2 , given that the actual weather is k_1 .

The program executes the following procedures to select an actual weather index $\bar{k}_1$ and a forecast index $\bar{k}_2$.

1. Generate a random number r_1^* .
2. $\bar{k}_1$ is the first index such that

$$\sum_{k_1=1}^{\bar{k}_1} P_a(k_1) \geq r_1.$$

3. Generate a random number r_2^* .
4. If $r_2 \geq P_e$, $\bar{k}_2 = \bar{k}_1$.
5. If $r_2 < P_e$,
 - a. Generate a random number r_3^* .
 - b. $\bar{k}_2$ is the first index such that

$$\sum_{k_2=1}^{\bar{k}_2} P_c(k_2|\bar{k}_1) \geq r_3.$$

Thus for each day,

$$P_f(k_2) = \begin{cases} 1 & \text{if } k_2 = \bar{k}_2 \\ 0 & \text{otherwise.} \end{cases}$$

*The routine used to generate the random numbers r_1, r_2, r_3 is initialized with three odd integers I_1, I_2, I_3 such that the same sequence of random numbers can be repeated.

$$P(k_1, k_2) = \begin{cases} 1 & \text{if } k_2 = \bar{k}_2 \text{ and } k_1 = \bar{k}_1 \\ 0 & \text{otherwise.} \end{cases}$$

In weather method two, as in method one, only one pair of actual weather conditions and weather forecast occur together on any day. Pairs of indices are input directly, based on a preplanned daily sequence. Letting $(\bar{k}_1, \bar{k}_2)$ be the input values, then

$$P_f(k_2) = \begin{cases} 1 & \text{if } k_2 = \bar{k}_2 \\ 0 & \text{otherwise.} \end{cases}$$

$$P(k_1, k_2) = \begin{cases} 1 & \text{if } k_2 = \bar{k}_2 \text{ and } k_1 = \bar{k}_1 \\ 0 & \text{otherwise.} \end{cases}$$

If weather method three is selected, the program computes the array $P(k_1, k_2)$. The methodology and input parameters are discussed in detail in Ref. 1. The array is computed from the following input parameters:

$P_a(k_1)$ = the probability that the actual weather is k_1 .

$P_p(k_1)$ = the probability that a "persistence forecast" (a forecast that the actual weather in the target area will be the same when the sorties arrive as it was at the time of the forecast) is correct.

$P_w(k_2 | k_1)$ = the probability that the weather forecast will equal k_2 given that the actual weather is k_1 and that the forecast is in error (also called weighting functions in Ref. 1).

C_1, C_2 = two constants employed to reflect the skill of weather forecasters, where skill is defined as the improvement over the persistence forecast.

Letting $p(k_1)$ be the probability that the weather forecast is correct, given that the actual weather is k_1 , then

$$p(k_1) = P_p(k_1) + (C_1 + C_2 \cdot P_a(k_1)) \cdot (1 - P_p(k_1)),$$

and the probability that the weather forecast is in error, when the actual weather is k_1 , is $1 - p(k_1)$. Thus,

$$P(k_1, k_2) = \begin{cases} P_a(k_1) \cdot p(k_1) & \text{if } k_2 = k_1 \\ P_a(k_1) \cdot (1 - p(k_1)) \cdot P_w(k_2|k_1) & \text{if } k_2 \neq k_1 \end{cases}$$

and

$$P_f(k_2) = \sum_{k_1} P(k_1, k_2).$$

ALLOCATION OF SORTIES TO MISSIONS AND TARGET TYPES

Allocation of sorties in the TRACE model requires definition of the fraction of the total number of sorties available for the day to be assigned to each of the target types. These allocation fractions must be regarded simply as goals, since it may be impossible to achieve them for several reasons. For instance, all munitions effective against a particular target type may have been consumed earlier in the simulation, the weather forecast for the day may preclude the assignment of aircraft to targets, or two or more target types may compete for munition types that are not available in sufficient quantities to satisfy the allocation requirements for the targets.

A *target* may belong to one of three mission categories: Close Air Support (CAS), Counter Air (CA), and Air Interdiction (AI). However, the *sorties* allocated to the CAS mission are divided into two distinct sets--Immediate (ICAS) and Preplanned (PCAS). (When aircraft and munitions are assigned to the ICAS sorties, different criteria are employed, as will be described below.) In the following discussion, mission categories will be used to designate the *sortie* mission categories

where 1 denotes ICAS, 2 denotes CA, 3 denotes PCAS, and 4 denotes AI. Thus, the CAS *targets* may belong to two *sortie* mission categories.

TRACE can compute target allocation fractions in two ways, and both employ the target values, defined for each target types. The target value, val_t , may assume one of two values. The user defines the day on which the second set of values becomes effective for all targets.

In allocation method 1, allocation fractions are input for each of the four sortie mission categories. (These mission allocation fractions may be changed during a run as is described below on p. 35.) The program computes the target allocation fractions. Letting $f_{m,t}$ denote the allocation fraction for type- t targets and mission m , then

$$f_{m,t} = \begin{cases} [W'_t \cdot val_t / \sum_{t \in T_m} W'_t \cdot val_t] F_m & \text{if } t \in T_m \\ 0 & \text{otherwise,} \end{cases}$$

where W'_t is the number of type- t targets after any repairs or replacements, T_m is the set of targets contained in mission m , val_t is the current target value, and F_m is the current mission allocation fraction.

In allocation method 2, only the fraction of the CAS sorties to be designated as Immediate, F_1 , is input. In this case,

$$f_{m,t} = [W'_t \cdot val_t / \sum_t W'_t \cdot val_t] F_m,$$

where

$$F_m = \begin{cases} 1 & \text{if } m = 2 \text{ or } 4 \text{ (CA or AI)} \\ F_1 & \text{if } m = 1 \text{ (ICAS)} \\ 1-F_1 & \text{if } m = 3 \text{ (PCAS).} \end{cases}$$

The number of sorties available for allocation to the targets is computed each day after any aircraft augmentation or airbase attacks. Letting SS denote the number of sorties available, then

$$SS = \sum_a s'_a \sum_b Q''_{b,a},$$

where s'_a is the sortie rate (sorties per aircraft per day) for type-a aircraft, and $Q''_{b,a}$ is the number of type-a aircraft at base b after any augmentation or on-base losses caused by enemy attacks.

ASSIGNMENT OF AIRCRAFT AND MUNITIONS TO SORTIES

For each of the sortie mission categories (in the order ICAS, CA, PCAS, AI) and for each target type within the mission category (in the order of target value), the program selects the best aircraft-munition combination to assign to the target. For sorties allocated to the ICAS mission, the selection is based upon maximizing the expected targets destroyed. For all other sorties, the selection is based on maximizing the ratio of expected targets destroyed to expected aircraft lost to terminal attrition.

Expected target kills per sortie are input to the TRACE model not only as a function of the target, aircraft, and munition but also as a function of the delivery mode employed. The aircraft-munition combinations considered for selection are restricted to those with delivery mode options that are feasible considering the weather forecast for the target area. We define $E_{t,a,j,k}$ to be the expected kills per sortie for target type t, aircraft type a, munition type j, and delivery mode k. Up to four delivery modes may be defined and each is assumed to require weather conditions equal to or better than some specified minimum, where the minimum is the weather condition with the corresponding index. Since increasing weather condition indices implies more restrictive conditions, a delivery mode k is feasible if and only if the weather condition index is less than or equal to k. Conversely, if the weather forecast index is k_2 , then only the delivery modes greater than or equal to k_2 are considered for selection (i.e., delivery modes that are feasible in conditions equal to or more stringent than those associated with k_2).

Expected terminal attrition is input to the model based on expected attrition per pass. We define $AT_{t,j,k}$ to be the expected attrition per

pass for target type t , munition type j , and delivery mode k . The number of passes per sortie depends on the attack category of the munition and the load class of the target. If the munition attack category is 1, the number of passes per sortie is assumed to equal the number of munitions carried. If the attack category is 2, the entire load is assumed to be delivered in a single pass. The aircraft load is input to the model as a function of aircraft type, munition type, and the load class of the target, where the load class reflects requirements for extra fuel and electronic countermeasures (ECM) pods. Thus, letting N be the number of passes per sortie, then

$$N_{t,a,j} = \begin{cases} L_{a,j,\ell_t} & \text{if } c_j = 1 \\ 1 & \text{if } c_j = 2, \end{cases}$$

where ℓ_t is the load class of target type t , c_j is the attack category of munition type j , and L_{a,j,ℓ_t} is the aircraft load (number of munitions).

Since for sorties allocated to the ICAS mission the selection is based on maximizing the expected target kills, for these sorties the aircraft-munition-delivery-mode combination (a,j,k) selected is that which yields

$$\max_{a,j,k \geq k_2} (E_{t,a,j,k}).$$

For the sorties allocated to missions other than ICAS (that is, CA, PCAS, and AI), in which the selection is based on maximizing the ratio of expected target kills to expected aircraft lost to terminal attrition, the aircraft-munition-delivery-mode combination (a,j,k) selected is that which yields

$$\max_{a,j,k \geq k_2} (E_{t,a,j,k} / [1 - (1 - AT_{t,j,k})^{N_{t,a,j}}]),$$

where $AT_{t,j,k}$ is the expected attrition per pass and $N_{t,a,j}$ is the expected number of passes.

After selecting the best aircraft-munition combination, (a,j) , the number of these sorties available at the bases is determined. Letting $S''_{b,a}$ denote the number of type-a aircraft sorties available from base b, then

$$S''_{b,a} = s'_a \cdot Q''_{b,a},$$

where s'_a is the sortie rate and $Q''_{b,a}$ is the current number of type-a aircraft at base b after any augmentation or airbase attacks. Letting x_b denote the number of best sorties available at the base, then

$$x_b = \min (S''_{b,a}, U''_{b,j} / L_{a,j, \ell_t}),$$

where $U''_{b,j}$ is the number of type-j munitions on the base after any re-supply or airbase attacks, and L_{a,j, ℓ_t} is the aircraft load given the load class of the target, ℓ_t . For the total number of "best" sorties located at all bases, we have

$$X = \sum_b x_b.$$

Should no "best" sorties be available at the bases ($X=0$), the program selects the next best choice. However, if sorties are available ($X>0$), they will be assigned to the target as a function of the allocation goals. Letting Y denote the number assigned, then

$$Y = \min(X, \bar{f}_{m,t} \cdot SS),$$

where $\bar{f}_{m,t}$ is the allocation goal for target type t and mission category m , and SS is the total number of sorties available for assignment. The sorties are assumed to be drawn from the bases in the same relative proportions as their availability. Letting Y_b denote the number of sorties assigned from base b , then

$$Y_b = [x_b/X]Y$$

Following the assignment, the number of type- a sorties available at base b , $S''_{b,a}$, is reduced by the quantity Y_b , and the number of type- j munitions available at base b , $U''_{b,a}$, is reduced by the quantity $Y_b \cdot L_{a,j,\ell_t}$. If the number of best sorties at the bases is less than the allocation goal ($X < \bar{f}_{m,t} \cdot SS$), the program advances to the next best choice to attempt to satisfy the goal.

If the allocation method is 1 (and mission allocation goals are defined), and if aircraft and munitions are not available for all the sorties allocated to one or more of the target types of a mission category, the unassigned sorties are reallocated to other target types within the mission category and the attempt to assign these sorties is repeated (to meet the mission allocation goal) before proceeding to the next mission category. Letting $\bar{\bar{f}}_{m,t}$ be the revised allocation goals for target t , mission category m , then

$$\bar{\bar{f}}_{m,t} = \begin{cases} [f_{m,t} / \sum_{t \in \hat{T}_m} f_{m,t}] \bar{F}_m & \text{if } t \in \hat{T}_m \\ 0 & \text{otherwise,} \end{cases}$$

where $f_{m,t}$ is the original target allocation goal, $\hat{T}_m$ is the set of target types in mission category m for which sorties are still available, and $\bar{F}_m$ is the unsatisfied portion of the mission allocation fraction. If the second attempt to satisfy the mission allocation goal is not successful, further attempts continue to be made with revised target

allocation goals until the goal is reached or until aircraft-munition combinations are not available for any of the targets of the mission category.

If the allocation method is 1 (and mission allocation goals are defined), and if, after aircraft and munitions have been selected for the targets of all the mission categories, aircraft and munitions are not available for all the sorties allocated to one or more of the mission categories, the unassigned sorties are reallocated to the other mission categories and the attempt to assign these sorties is repeated. Letting $\bar{F}_m$ be the revised mission allocation goal, then

$$\bar{F}_m = \begin{cases} [F_m / \sum_{m \in \hat{M}} F_m] \overline{FF} & \text{if } m \in \hat{M} \\ 0 & \text{otherwise,} \end{cases}$$

where F_m is the original mission allocation goal, $\hat{M}$ is the set of mission categories containing targets for which sorties are still available, and $\overline{FF}$ is the unsatisfied portion of the overall allocation goal (which may initially be less than one as will be described below). The allocation goals of the target types within the mission categories are also revised using the formula described above for $\bar{f}_{m,t}$. If the second attempt to satisfy the overall allocation goal is not successful, attempts continue to be made until the goal is reached or until aircraft-munition combinations are not available for any of the targets of any mission category.

If the allocation method for the run is method 2 (no mission allocation goals are defined other than the relative proportions of the CAS sorties that are to be designated Immediate or Preplanned), only after the program attempts to select aircraft and munitions for sorties allocated to all the target types of all the missions are the target allocation goals revised. The sorties not yet assigned are reallocated to all the target types for which aircraft and munitions are still available. Letting $\bar{f}_{m,t}$ be the revised target allocation goal, then

$$f_{m,t} = \begin{cases} [f_{m,t}/\sum_{t \in \hat{T}_m} f_{m,t}] \overline{FF} & \text{if } t \in \hat{T}_m \\ 0 & \text{otherwise,} \end{cases}$$

where $f_{m,t}$ is the original target allocation goal, $\hat{T}_m$ is the set of target types of mission m for which sorties are still available, and $\overline{FF}$ is the unsatisfied portion of the overall allocation goal.

Finally, since the assignment algorithm gives preference to missions and to targets within a mission, it is possible that all the aircraft or all the munitions that can be assigned against a particular target (considering the weather forecast) will be assigned to other targets before the algorithm considers the target. However, this may not represent what might occur in actual operations. In order to lessen the effect and allow the lower-priority targets within lower-priority missions an opportunity to be assigned some sorties, the assignment process may be divided into N sections, where N is defined by the user. In each of the N sections, the assignment algorithm is entered with an overall allocation fraction of $1/N$. The initial mission and target allocation fractions are set equal to $1/N$ of their original values. For example, if the mission allocation fractions for the 4 missions were each equal to $1/4$, and N were set equal to 2, then the program would attempt to assign only $1/8$ of the total available sorties to the targets of a mission category before proceeding to the next category.

EXPECTED OUTCOME OF THE ASSIGNMENTS

The expected outcome of an assignment of sorties to targets depends on the actual weather in the target area. For each combination of actual weather, k_1 , and forecast weather, k_2 , there exists a probability $P(k_1, k_2)$ that the pair occur together. The expected outcome for the assignments given the forecast k_2 is computed for each possible index of actual weather for which $P(k_1, k_2) > 0$ and weighted by $P(k_1, k_2)$. (The summation over the possible values of actual weather is described

in the next section.) Here we describe the expected outcome of an assignment assuming that the actual weather is k_1 . An assignment defines:

Y = the number of sorties
a = the aircraft type
j = the munition type
t = the target type
m = the mission category
k = a delivery mode.

If the actual weather in the target area is identical to the forecast ($k_1 = k_2$), the delivery mode employed will be that selected when the sorties were assigned as being the "best" for the given aircraft, munition, and weather. If the actual weather is not identical to the forecast ($k_1 \neq k_2$), a new delivery mode is selected based on the target, aircraft, munition, and the actual weather. This process is similar to that described on p. 15, but the possible choices are limited to aircraft type a, munition type j, and delivery modes $\geq k_1$. If the actual weather causes the number of possible choices to be reduced to zero, the aircraft will not deliver their munitions and we denote this condition here by letting $k = 0$.

The sortie characteristics input to the model, which influence the expected outcome of an assignment include:

AB_a = an abort rate for type-a aircraft sorties.
 $JE_{a,m}$ = a munitions jettison rate for type-a aircraft sorties assigned against targets of mission category m.
 $AE_{a,m}$ = an enroute attrition rate for type-a aircraft sorties assigned to targets of mission category m.
 IE_{a,m,c_j} = an ineffective rate for type-a aircraft sorties assigned to targets of mission category m, carrying munition type j (with attack category c_j^*). Ineffective sorties are those which are unable to locate targets after reaching the target area.

* See p. 15.

$AT_{t,j,k}$ = expected terminal attrition rate per pass for sorties assigned against target type t , carrying munition type j , and employing delivery mode k .

$E_{t,a,j,k}$ = expected kills per sortie given target type t , aircraft type a , munition type j , and delivery mode k .

For each of the assignments, the TRACE model computes the expected number of munitions returned to the bases, the expected aircraft losses, and the expected number of targets destroyed.

Munitions Returned to Bases

All aborted sorties are assumed to return their munitions to the bases. If the actual weather precludes the delivery of munitions after the sorties have arrived in the target area, then the unaborted sorties that neither jettison their munitions nor lose them to enroute attrition are assumed to return their munitions to the bases. If the actual weather allows the delivery of munitions, the unaborted sorties that neither jettison their munitions nor lose them to enroute attrition but are unable to locate targets are assumed to return their munitions to the bases. Letting g denote the expected number of munitions returned and letting k be the delivery mode selected, then if $k = 0$ (no delivery),

$$g = [AB_a + (1 - AB_a)(1 - JE_{a,m})(1 - AE_{a,m})]Y \cdot L_{a,j,\ell_t}$$

and if $k \neq 0$,

$$g = [AB_a + (1 - AB_a)(1 - JE_{a,m})(1 - AE_{a,m})IE_{a,m,c_j}]Y \cdot L_{a,j,\ell_t},$$

where AB_a is the abort rate, $JE_{a,m}$ is the jettison rate, $AE_{a,m}$ is the enroute attrition rate, IE_{a,m,c_j} is the ineffective rate given the

attack category of the munition, c_j , Y is the number of sorties assigned, and L_{a,j,ℓ_t} is the aircraft load given the load class of the target, ℓ_t .

Aircraft Losses

If the actual weather precludes the delivery of munitions, the un-aborted sorties that have not jettisoned their munitions are subject only to enroute attrition. If the actual weather allows the delivery of munitions, the unaborted sorties that have not jettisoned their munitions and are able to locate targets are subject to both enroute and terminal attrition. Terminal attrition is input to the model as the expected attrition per pass. The number of passes depends on the aircraft, munition, and target type, as has been defined on p. 15. Letting $N'_{t,a,j}$ be the number of passes[†] and letting $AT'_{t,j,k}$ denote the expected attrition per sortie, then

$$AT'_{t,j,k} = 1 - (1 - AT_{t,j,k})^{N'_{t,a,j}},$$

where $AT_{t,j,k}$ is the expected attrition per pass.

The attrition factors used to estimate losses to ground defenses are based on the severity of the defenses and the length of time an attacking aircraft will be exposed to them. Should it be necessary to alter the defense severity, the TRACE user may define an attrition scaling factor for the run. All input values of expected attrition per pass are multiplied by the scaling factor at the beginning of the run.

Letting h denote the expected aircraft losses and letting k denote the delivery mode selected, then if $k = 0$ (no delivery),

$$h = (1 - AB_a)(1 - JE_{a,m})(AE_{a,m})Y,$$

and if $k \neq 0$,

* See p. 15.

† See p. 23.

$$h = (1 - AB_a)(1 - JE_{a,m})[1 - (1 - AE_{a,m})\{1 - (IE_{a,m,c_j})AT'_{t,j,k}\}]Y,$$

where AB_a is the abort rate, $JE_{a,m}$ is the jettison rate, $AE_{a,m}$ is the enroute attrition rate, IE_{a,m,c_j} is the ineffectiveness rate given the attack category of the munition, c_j , and Y is the number of sorties assigned.

Targets Destroyed

If the actual weather precludes the delivery of munitions, then of course no targets are destroyed. If the weather allows the delivery of munitions, the unaborted sorties that neither jettison their munitions nor lose them enroute to the target area nor are unable to find targets once in the target area attempt to deliver their munitions. Letting $N'_{t,a,j}$ denote the expected number of *successful* passes and assuming that an aircraft is as likely to be lost before the delivery of munitions during a pass as after, then

$$N'_{t,a,j} = \sum_{n=1}^{N_{t,a,j}} (1 - AT_{t,j,k})^{(n-1/2)},$$

where $N_{t,a,j}$ is the potential number of passes (discussed on p. 15), and $AT_{t,j,k}$ is the expected attrition per pass. This expression simply sums the probabilities that a sortie successfully completes each of its potential passes.

Enroute attrition is input to the TRACE model as a rate per sortie. Letting $AE'_{a,m}$ denote the attrition en route to the target and assuming that an aircraft is as likely to be lost before arriving in the target area as after, then

$$AE'_{a,m} = 1 - (1 - AE_{a,m})^{1/2},$$

where $AE'_{a,m}$ is the enroute attrition rate per *sortie*.

Letting e denote the expected number of targets destroyed and letting k be the delivery mode selected, then if $k = 0$ (no delivery),

$$e = 0,$$

and if $k \neq 0$,

$$e = (1 - AB_a)(1 - JE_{a,m})(1 - AE'_{a,m})(1 - IE_{a,m,c_j}) \left[\frac{N'_{t,a,j}}{N_{t,a,j}} \right] E_{t,a,j,k} \cdot Y,$$

where AB_a is the abort rate, $JE_{a,m}$ is the jettison rate, IE_{a,m,c_j} is the ineffectiveness rate given the attack category of the munition, c_j , $E_{t,a,j,k}$ is the expected number of kills per sortie, and Y is the number of sorties assigned.

SUMMARIES FOR THE DAY AND FOR THE COMPUTER RUN

All, some, or none of several daily summaries may be printed each day. (A description of the output options appears in Sec. V--Output, and the printed output of a test case appears in the Appendix.) In the following definitions of the contents of the daily summaries, we employ the expression $P_f(k_2)$ to denote the probability that the weather forecast is k_2 and $P(k_1, k_2)$ to denote the probability that the actual weather is k_1 and the weather forecast is k_2 . If weather methods 1 or 2 have been selected for a run, both of which daily identify one value for actual weather, $\bar{k}_1$, and one value for the weather forecast, $\bar{k}_2$, then

$$P(k_1, k_2) = \begin{cases} 1 & \text{if } k_1 = \bar{k}_1 \text{ and } k_2 = \bar{k}_2 \\ 0 & \text{otherwise.} \end{cases}$$

$$P_f(k_2) = \begin{cases} 1 & \text{if } k_2 = \bar{k}_2 \\ 0 & \text{otherwise.} \end{cases}$$

Target Status--Long Form^{*}

For each target type and each aircraft-munition combination assigned against the target, the program displays:

$ss_{D,t,a,j}$ = the number of type-a aircraft sorties carrying the type-j munitions assigned against type-t targets on day D.

$\hat{e}_{D,t,a,j}$ = the expected number of targets destroyed by type-a aircraft sorties carrying type-j munitions against type-t targets on day D.

These expressions are defined as follows:

$$ss_{D,t,a,j} = \sum_{(I_{t,a,j})} Y_i P_f(k_2(i))$$

and

$$\hat{e}_{D,t,a,j} = \sum_{(I_{t,a,j})} \sum_{k_1} e_{i,k_1} P(k_1, k_2(i)),$$

where $I_{t,a,j}$ is the set of assignments of type-a aircraft carrying type-j munitions to type-t targets, $e_{i,k}$ is the expected number of targets destroyed given assignment i and actual weather k_1 , Y_i is the number of sorties assigned, and $k_2(i)$ is the weather forecast assumed when assignment i was made.

Target Status--Short Form[†]

For each target type the program displays:

$\bar{e}_{D,t}$ = the expected number of type-t targets destroyed on day D.

$\bar{E}_{D,t}$ = the expected number of type-t targets destroyed through day D.

^{*}Included in output options 1 and 2.

[†]Included in output options 1, 2, 3, and 4.

$\bar{v}_{D,t}$ = the expected target value destroyed among type-t targets on day D.

$\bar{V}_{D,t}$ = the expected target value destroyed among type-t targets through day D.

$\bar{s}_{D,t}$ = the expected number of sorties assigned against type-t targets on day D.

$\bar{S}_{D,t}$ = the expected number of sorties assigned against type-t targets through day D.

$\bar{s}'_{D,t}$ = the expected fraction of all the sorties assigned on day D that were assigned to type-t targets.

$\bar{S}'_{D,t}$ = the expected fraction of all the sorties assigned through day D that were assigned to type-t targets.

$W_{D,t}''''$ = the expected number of type-t targets at the end of day D.

These expressions are defined as follows:

$$\bar{e}_{D,t} = \sum_a \sum_j \hat{e}_{D,t,a,j}$$

$$\bar{E}_{D,t} = \sum_{d=1}^D \bar{e}_{d,t}$$

$$\bar{v}_{D,t} = \text{val}_t \bar{e}_{D,t}$$

$$\bar{V}_{D,t} = \sum_{d=1}^D \bar{v}_{d,t}$$

$$\bar{s}_{D,t} = \sum_{(I_t)} Y_i P_f(k_2(i))$$

$$\bar{S}_{D,t} = \sum_{d=1}^D \bar{s}_{d,t}$$

$$\bar{s}'_{D,t} = \bar{s}_{D,t} / \bar{S}_{D,t}$$

$$\bar{s}'_{D,t} = \bar{s}_{D,t} / s_D$$

$$w'_{D,t} = w'_{D,t} - \bar{e}_{D,t},$$

where val_t is the current target value of type-t targets, I_t is the set of assignments to type-t targets, Y_i is the number of sorties assigned, $k_2(i)$ is the weather forecast assumed when assignment i was made, s_D and S_D are the daily and cumulative total number of sorties assigned (both defined on p. 32 below), $w'_{D,t}$ is the number of type-t targets on day D after any replacements or repairs, and $\hat{e}_{D,t,a,j}$ has been defined above.

Aircraft Status--At Bases*

The number of aircraft lost on an assignment is assumed to be distributed over the bases that contributed sorties to the assignment in the same proportions as the contributions. Thus, for the losses of type-a aircraft at a base b we have

$$\bar{h}_{D,b,a} = \sum_{(I_a)} (Y_{i,b}/Y_i) \sum_{k_1} h_{i,k_1} P(k_1, k_2(i)),$$

where I_a is the set of assignments of type-a aircraft, $Y_{i,b}$ is the number of sorties assigned from base b by the i^{th} assignment, Y_i is the number of sorties assigned, h_{i,k_1} is the expected number of aircraft lost given assignment i and actual weather k_1 , and $k_2(i)$ is the weather forecast predicted when assignment i was made.

For each aircraft type and each base, the program displays:

$Q'_{D,b,a}$ = the expected number of type-a aircraft at base b at the end of day D.

* Included in output options 1, 2, and 3.

$\hat{Q}_{D,a}$ = the expected number of type-a aircraft at all bases at the end of day D.

These expressions are defined as follows:

$$Q'''_{D,b,a} = Q''_{D,b,a} - \bar{h}_{D,b,a}$$

$$\hat{Q}_{D,a} = \sum_b Q'''_{D,b,a}$$

where $Q''_{D,b,a}$ is the number of type-a aircraft at base b on day D after all augmentation and all airbase attacks.

Munition Status*

For each munition type and each base, the program displays

$\bar{g}_{D,b,j}$ = the expected number of type-j munitions at base b consumed[†] during day D.

$\hat{g}_{D,j}$ = the expected number of type-j munitions consumed[†] by all bases during day D.

$U'''_{D,b,j}$ = the expected number of type-j munitions on base b at the end of day D.

$\hat{U}_{D,j}$ = the expected number of type-j munitions on all bases at the end of day D.

These expressions are defined as follows:

$$\bar{g}_{D,b,j} = \sum_{(I_j)} Y_{i,b} L_i P_f(k_2(i)) - (Y_{i,b}/Y_i) \sum_{k_1} g_{i,k_1} P(k_1, k_2(i))$$

$$\hat{g}_{D,j} = \sum_b \bar{g}_{D,b,j}$$

* Included in output options 1, 2, and 3.

† Consumed munitions are the munitions assigned to sorties less those returned to the bases and do not include the munitions lost on base because of airbase attacks.

$$U'_{D,b,j} = U''_{D,b,j} - \bar{g}_{D,b,j}$$

$$\hat{U}_{D,j} = \sum_b U'_{D,b,j},$$

where I_j is the set of assignments of type-j munitions, $Y_{i,b}$ is the number of sorties assigned from base b by the i^{th} assignment, Y_i is the number of sorties assigned, L_i is the aircraft load for the i^{th} assignment, $^*g_{i,k_1}$ is the expected number of munitions returned to bases given assignment i and actual weather k_1 , $k_2(i)$ is the weather forecast predicted when assignment i was made, and $U''_{D,b,j}$ is the number of type-j munitions at base b after any resupply or airbase attacks.

Aircraft Status--Summary[†]

For each aircraft type, the program displays:

$sa_{D,a}$ = the number of type-a aircraft sorties available on day D.

$SA_{D,a}$ = the number of type-a aircraft sorties available through day D.

$\hat{s}_{D,a}$ = the number of type-a aircraft sorties assigned to targets on day D.

$\hat{S}_{D,a}$ = the number of type-a aircraft sorties assigned to targets through day D.

$\hat{h}_{D,a}$ = the number of type-a aircraft lost to either enroute or terminal attrition on day D.

$\hat{H}_{D,a}$ = the number of type-a aircraft lost to either enroute or terminal attrition through day D.

$\hat{h}'_{D,a}$ = the number of type-a aircraft lost per sortie assigned on day D.

$\hat{H}'_{D,a}$ = the number of type-a aircraft lost per sortie assigned through day D.

* See p. 15.

† Included in output options 1, 2, and 3.

These expressions are defined as follows:

$$sa_{D,a} = s'_a \sum_b Q''_{D,b,a}$$

$$SA_{D,a} = \sum_{d=1}^D sa_{d,a}$$

$$\hat{s}_{D,a} = \sum_{(I_a)} Y_i P(k_2(i))$$

$$\hat{S}_{D,a} = \sum_{d=1}^D \hat{s}_{d,a}$$

$$\hat{h}_{D,a} = \sum_b \bar{h}_{D,b,a}$$

$$\hat{H}_{D,a} = \sum_{d=1}^D \hat{h}_{d,a}$$

$$\hat{h}'_{D,a} = \hat{h}_{D,a} / \hat{s}_{D,a}$$

$$\hat{H}'_{D,a} = \hat{H}_{D,a} / \hat{S}_{D,a}$$

where s'_a is the current sortie rate, I_a is the set of assignments of type-a aircraft, Y_i is the number of sorties assigned, $k_2(i)$ is the weather predicted when the i^{th} assignment was made, and $Q''_{D,b,a}$ and $\bar{h}_{D,b,a}$ have been defined above.

Allocation Data*

The allocation data section of the daily summary presents a measure of how well the assignment algorithm approaches the allocation goals for the day. For each weather forecast and each sortie mission category, the program displays:

* Included in output option 1.

$F_{D,m}$ = the allocation fraction goal for mission m for day D,
 F'_{D,m,k_2} = the achieved allocation fraction for mission m on day D given that the weather forecast is k_2 ,

and for each target type within the mission category:

$f_{D,m,t}$ = the allocation fraction goal for target type t of mission category m on day D.
 f'_{D,m,t,k_2} = the achieved allocation fraction for target type t of mission category m on day D given that the weather forecast is k_2 .

The program also displays:

$F''_{D,m}$ = the achieved allocation fraction for mission m over all values of weather forecast on day D.
 $f''_{D,m,t}$ = the achieved allocation fraction for target type t of mission category m over all values of weather forecast on day D.

The expressions for $F_{D,m}$ and $f_{D,m,t}$ have been discussed on p. 13.
The remainder of the expressions are defined as follows:

$$f'_{D,m,t,k_2} = \left[\begin{matrix} \Sigma \\ (I_{m,t,k_2}) \end{matrix} Y_i \right] / sa_{D,a}$$

$$F'_{D,m,t,k_2} = \Sigma_{(T_m)} f'_{D,m,t,k_2}$$

$$f''_{D,m,t} = \Sigma_{k_2} f'_{D,m,t,k_2} P_f(k_2)$$

$$F''_{D,m,t} = \Sigma_{(T_m)} f''_{D,m,t}$$

where I_{m,t,k_2} is the set of assignments to type-t targets and mission m if the weather forecast is k_2 , Y_1 is the number of sorties assigned, T_m is the set of target types belonging to mission category m, and $sa_{D,a}$ has been defined above.

Run Summary*

At the conclusion of a run, a summary of the expected outcome is displayed. For each day of the run, the program displays:

- s_D = the number of sorties assigned on day D
- S_D = the number of sorties assigned through day D
- $v_{D,m}$ = the expected MWD among targets of mission m on day D
- $V_{D,m}$ = the expected MWD among targets of mission m through day D
- $\hat{v}_D$ = the expected MWD on day D
- $\hat{V}_D$ = the expected MWD through day D.

These expressions are defined as follows:

$$s_D = \sum_a \hat{s}_{D,a}$$

$$S_D = \sum_{d=1}^D s_d$$

$$v_{D,m} = \sum_{(T_m)} \text{val}_t \bar{e}_{D,t}$$

$$V_{D,m} = \sum_{d=1}^D v_{D,m}$$

$$\hat{v}_D = \sum_m v_{D,m}$$

$$\hat{V}_D = \sum_{d=1}^D \hat{v}_d$$

* Included in all output options.

where T_m is the set of targets belonging to mission m , and $\hat{s}_{D,a}$, val_t , and $\bar{e}_{D,t}$ have been defined above.

SYSTEM CHANGES

At the beginning of each day, changes in the number of aircraft and amount of munitions at the bases, the number of targets, and the values of selected input parameters may occur. While some of these changes are effected by a preplanned schedule, others occur automatically each day. Scheduled changes may include munitions resupply, aircraft augmentation, and target replacement. Scheduled changes may also include parameter changes for mission allocation fractions, airbase attack attrition rates, sortie rates, and indices of actual and forecast weather conditions (weather method 2 only). Changes that occur automatically each day include target replacement, target repair, and aircraft and munition losses on the bases from airbase attacks. Also included are parameter changes for target identification probability update for true/false targets^{*} and indices of actual and forecast weather conditions (weather method 1 only).

Scheduled Changes

Schedule cards (showing a number between 60 and 68 in card columns 1 to 2) may be contained in the TRACE input data card deck. Each schedule card identifies in card columns 15 to 16 the day when the event is to occur. During the input and initialization phase of a run, the schedule cards, which may appear in any order in the data card deck, are read and ordered on increasing values of day. With the exception of the wholesale munitions resupply events, which always occur first, the remainder of the events for a particular day are executed in the order in which they appear in the input data card deck.

Type-60 Event--Aircraft Augmentation

A type-60 event card defines a base, b , up to four pairs of values for an aircraft type, a , and the number of unit equipment (UE)

*For discussion of true/false targets see p. 40.

aircraft, ^{*} $\Delta Q_{b,a}$, to arrive at base b on the day specified. If a base is to receive more than four types of aircraft on a particular day, more than one type-60 card may be defined for the base.

Letting $Q_{b,a}$ be the number of type-a ground attack aircraft at base b at the beginning of the day and $Q'_{b,a}$ be the number after augmentation, then

$$Q'_{b,a} = Q_{b,a} + \Delta Q_{b,a} \cdot G_a,$$

where G_a is a user-defined ground attack factor which expresses the fraction of the UE aircraft of type a to be used in the ground attack role.

Type-61 Event--Selective Munition Resupply

A type-61 event card defines a base, b, up to four pairs of values for a munition type, j, and the number of munitions, $\Delta U_{b,j}$, to arrive at base b on the day specified. If a base is to receive more than four types of munitions on a particular day, more than one type-61 card may be defined for the base. However, the type-61 card was designed to allow the user a simple method for defining munition resupply when resupply events are few and far between. The type-68 card (described below) should be used for an extensive resupply schedule.

Letting $U_{b,j}$ be the number of type-j munitions at base b at the beginning of the day and letting $U'_{b,j}$ be the number after resupply, then

$$U'_{b,j} = U_{b,j} + \Delta U_{b,j}.$$

Type-62 Event--N-Day Target Replacement

A type-62 event card simply defines a day and a target type. On the specified day, the program will attempt to replace a user-defined

^{*}The authorized number of operational aircraft assigned to a theater or base.

fraction of all the targets of the specified type destroyed since the beginning of the simulation. This replacement algorithm is subject to the rules associated with the daily target replacement process and for convenience is defined on p. 37 with that process.

Type-64 Event--Mission Allocation Fractions Replacement

A type-64 event card defines a new set of mission allocation fractions which become effective on the day indicated and remain in effect until another type-64 event is defined. The use of the mission allocation fractions is discussed on p. 13.

Type-65 Event--Airbase Attack Attrition Rates Replacement

A type-65 event card defines a base, a daily on-base attrition rate for the aircraft at the base, and attrition rates for the two munition vulnerability categories. The attrition rates become effective on the day indicated and remain in effect until another type-65 card for base b is defined. The use of the airbase attack attrition rates is discussed on p. 39.

Type-66 Event--Sortie Rates Replacement

A type-66 event card defines an aircraft type and a sortie rate which becomes effective on the day indicated and remains in effect until another type-66 card for the aircraft is defined.

Type-67 Event--Forecast and Actual Weather Replacement

A type-67 event card defines a weather forecast index and actual weather index (where 1 denotes HIGH; 2, MED; 3, LOW; and 4, NO) which become effective on the day indicated and remain in effect until another type-67 card is defined. This event was included in the TRACE model to allow the user to input a specific weather sequence on either a daily or irregular interval.

Type-68 Event--Wholesale Munitions Resupply

A type-68 event card identifies the number of a two-dimensional resupply array* which contains a munitions resupply potential for each base and each munition type (e.g., the stocks at a depot). The type-68 card also defines the day on which the munitions defined in the array are to begin arriving at the bases as d_1 ; the interval between resupply days as Δd ; the last day on which the munitions will be delivered as d_2 ; and the fraction of the munitions at the resupply potential which will arrive on each of the resupply days as f .

Let m be the index of the resupply potential array; $U_{b,j}$, the number of munitions of type j at base b at the beginning of the day, and $U'_{b,j}$ the number after resupply; $\Delta U_{b,j,m}$ the entry in the m^{th} array for munition j , base b ; then, on days $d_1, d_1 + \Delta d, \dots, d_2^{\dagger}$ for all bases b and all munition types j

$$U'_{b,j} = U_{b,j} + f \cdot \Delta U_{b,j,m}$$

Automatic Daily Changes

Daily Target Replacement. During a TRACE run, replacements for targets destroyed may come from one of two sources: (1) a replacement pool which is in sanctuary and not subject to losses, or (2) the survivors of another target type. As an example of the use of the latter target source, the tank targets of the AI mission might replace the tank targets of the CAS mission. At the initiation of a run, the user identifies the type of replacement source (if any) available to each target type. If the source is a replacement pool, the number of targets in the pool is also defined. If the source is identified as some other target type, the user defines the number of source targets that are equivalent to one of the replaced targets (e.g., an AI tank target may contain more tanks per target than a CAS tank target).

* Resupply arrays are defined on p. 66.

[†] Should $d_1 + n \cdot \Delta d < d_2 < d_1 + (n + 1) \cdot \Delta d$, then $d_1 + n \cdot \Delta d$ is the last day the bases will be resupplied.

The model has been structured to allow the user to specify that only a subset of the targets of a source target type be made available as replacements. Thus at the beginning of the run, the user defines the fraction of the source targets that are available. However, since the source target type itself may receive replacements (e.g., from a replacement pool), the available fraction is continually updated under the following assumptions: (1) Any replacements received by a source target type are available as replacements for the target type drawing on them but not on the same day they were received by the source target type; (2) losses suffered by a source target type are assumed to occur uniformly over both the available and unavailable targets.

The user also defines two types of replacement fractions for a replaceable target which, in combination with the history of target losses, determine the replacement rate. The first such fraction is the daily replacement fraction, $R'_{t,1}$. The program attempts every day to replace this fraction of the previous day's losses. The second fraction is the N-day replacement fraction, $R'_{t,2}$. The program attempts to replace this fraction of the difference between the original number of targets and the current number of targets on the days specified by the user on type-62 event cards (e.g., if $R'_{t,2} = 1$, the program will attempt to return the number of targets of type t to the initial number available on day 1).

The attempt to replace targets and the associated depletion of a source target is the same for both the daily and the N-day replacements. However, on the days that an N-day replacement occurs, the daily replacement is ignored.

Letting y be the desired replacement, K_t the type- t targets destroyed in the previous day, $\hat{W}_t$ the original number of type- t targets, and W_t the number of type- t targets at the beginning of the day, then

$$y = \begin{cases} (\hat{W}_t - W_t) \cdot R'_{t,2} & \text{if an N-day replacement is attempted} \\ K_t \cdot R'_{t,1} & \text{if a daily replacement is attempted.} \end{cases}$$

Letting x be the replacement achieved, if the replacement source for target t is some other target $\hat{t}$,

$$x = \min (y, W_{\hat{t}} \cdot u_t),$$

where u_t is the current fraction of the replacement source available. If the replacement source for target t is a pool containing w_t targets, then

$$x = \min (y, w_t).$$

The program effects the replacement by executing the following steps, in the order presented, where x and y are defined above, W'_t is the number of type- t targets after replacement, and eq_t is the equivalence factor--the number of source targets that are equivalent to one type- t target:

1. If target t is a source for some target $\bar{t}$, then

$$u_{\bar{t}} = \frac{u_t \cdot W_t + x}{W_t + x}.$$

2. $W'_t = W_t + x.$

3. If the replacement source for target t is some target $\bar{t}$, then

- a.
$$u_t = \frac{u_{\bar{t}} \cdot W_{\bar{t}} - x \cdot eq_t}{W_{\bar{t}} - x \cdot eq_t}.$$

(If the denominator of the above expression should equal 0, then u_t is set equal to 1.)

$$b. \quad W'_t = W'_t - x \cdot eq_t.$$

4. If the replacement source for target t is a pool, then

$$w_t = w_t - x.$$

Daily Target Repair. A target type may be identified as repairable by defining a repair time for it and expressing repair time in whole days. However, a target may not be both repairable and replaceable. If a repair time of ΔD_t has been defined for target type t , then letting D be the current day, all type- t targets destroyed on $D - \Delta D_t + 1$ are assumed to be repaired on day D . Thus, letting W_t be the number of targets at the beginning of the day, W'_t the number after repair, and $K_{t,d}$ the number of targets of type t destroyed on day d , then

$$W'_t = W_t + K_{t,D-\Delta D_t+1}.$$

Daily On-Base Losses. The aircraft and/or the munitions located at each base may be subject to a daily airbase attack. Three loss rates are defined for each base: (1) for the aircraft; (2) for vulnerability category 1 munitions; and (3) for vulnerability category 2 munitions. These attrition rates may be changed either daily or at irregular intervals by means of the type-65 event card described above. Letting $AA_{b,1}$ be the current aircraft attrition rate for base b , letting $Q'_{b,a}$ be the number of type- a aircraft at base b after augmentation, and letting $Q''_{b,j}$ be the number after the airbase attacks, then for all b and a ,

$$Q''_{b,a} = Q'_{b,a} (1 - AA_{b,1}).$$

Letting $AA_{b,2}$ and $AA_{b,3}$ be the current attrition rates for vulnerability categories 1 and 2 munitions at base b , letting $U'_{b,j}$ be the number of

type-j munitions at base b after resupply, and letting $U''_{b,j}$ be the number after the airbase attacks, then for all b and j

$$U''_{b,j} = U'_{b,j}(1 - AA_{b,n_j+1}),$$

where n_j is the vulnerability category of the type-j munitions.

Update of Target Identification Probability for True/False Targets.

Two target types, $\hat{t}_1$ and $\hat{t}_2$, may be identified as having the special characteristic of containing both true and false targets. During the input phase of a run, the user defines the total number of targets (both true and false), $\hat{W}_t$, which is assumed to remain constant throughout the run. As the value of W_t , the current number of true targets, changes during a run, the expected kills per sortie will also change. Assuming that an aircraft is as likely to attack a false target as a true target, and letting E_t denote one of the values of expected kills per sortie against true targets of type t, then we define an effective-kills-per-sortie rate, $\hat{E}_t$, where

$$\hat{E}_t = E_t \left(\frac{W_t}{\hat{W}_t} \right), \quad t = \hat{t}_1, \hat{t}_2.$$

In the allocation procedure described above, the number of sorties allocated to these special targets is based on the current number of true targets.

TRACE INPUT DATA CARD DECK

[illegible]

(See p. 41.) NOTE: Columns 73 through 80 are not shown on card format figures.

* Columns 73 through 80 are not used.

columns 3 through 10 appear on each page of the printed output. The contents of columns 3 through 72 appear on the first page of the printed output and on the summary page at the end of the run. One type-01 card must appear in the data card deck and must be the first card. The card format is shown in Fig. 4.

00	0000000	11111111	22222222	22222222	33333333	33333333	44444444	44444444	55555555	55555555	66666666	66666666	77777777
01	ID ₁	234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890
					ID ₂								

Notes: Card 01

ID₁--These 8 columns are printed on *each* page of the printed output.

ID₂--These columns are printed on the first and last page of the printed output.

(See p. 41.)

Fig. 4—Card type 01

Card 02, Methods. The TRACE model was organized to allow the inclusion of alternate methods for several of the model procedures. Procedures with only one method incorporated in the current model, but for which alternate methods may be readily added, continue to be carried on the methods card. The card identifies methods for:

- o Input
 - 1. Only one method exists.
- o Allocation of sorties to targets
 - 1. Sorties are to be allocated first to missions and then to the targets within the missions (discussed on p. 12).
 - 2. Sorties are allocated to targets without concern for mission categories. However, sorties allocated to CAS targets are identified as either Immediate or Preplanned (discussed on p. 13).
- o Assignment of loaded aircraft to targets
 - 1. Only one method exists.
- o Computation of expected outcome of the assignments
 - 1. Only one method exists.

- o Output Method

- 1-5. The five output methods are discussed in Sec. V.

- o Weather Method

- 1. The Monte Carlo method (see p. 8).
 - 2. Direct input method (see p. 11).
 - 3. Expected weather method (see p. 11).

One type-02 card must appear in the data card deck and it must immediately follow the type-01 identification card. The card format is shown in Fig. 5.

Card 03, Control Variables. The type-03 card defines the first and last days of the simulation, the day on which the target values change from the first to the second of the two input values, the attrition scaling factor (discussed on p. 22), and the number of iterations desired in the assignment algorithm (discussed on p. 19). The number of airbases is also defined as a check that the data required for all bases are defined in the data card deck. (The number of aircraft, target, and munition types will have been previously defined in the pre-processor program, PREPROC.) One type-03 card must be contained in the data card deck. The card format is shown in Fig. 5.

Card 04, Mission Allocation Fractions. If allocation method 1 has been selected on the type-02 card, the type-04 card contains the allocation fractions for each of the four sortie mission categories on the first day of the simulation. If allocation method 2 has been selected, the type-04 card defines the desired fraction of CAS sorties to be designated as Immediate on the first day of the simulation. The fractions remain in effect for all succeeding days until replaced by the data on a type-64 schedule card. A type-04 card must appear in the data card deck. The card format is shown in Fig. 6.

Card 05, True/False Targets. Target types that contain both true and false targets are discussed on p. 40. The type-05 card identifies which target types have this characteristic and the total number of true and false targets. The format for this card, which is not a required card, is shown in Fig. 6.

[illegible]

Notes: Card 02

I_n -- Computation method.

n = 1--Input.

2--Allocation.

3--Assignment.

4--Expected outcome.

5--Output.

6--Weather.

Card 03

B--Number of airbases.

D_{min} -- First day of the simulation.

$D_{\max}$ --Last day of the simulation.

D_T--Day on which target values change.

ATS--Attrition scaling factor.

N--Number of iterations in assignment algorithm.

(See p. 42.)

Fig. 5—Card types 02 and 03

00	00000000	11111111	11122222	22222223	33333333	33444444	44444455	55555555	55666666	66666677	77
12	34567890	123456	7890123	4567890	1234567	8901234	5678901	2345678	9012345	6789012	3456789012
04			F_1	F_2	F_3	F_4					
05			t_1	w_1	t_2	w_2					

Notes: Card 04

F_m -- Mission allocation fraction.

m = 1--Immediate Close Air Support.

2--Counter Air.

3--Preplanned Close Air Support.

4--Air Interdiction.

Card 05

t_n -- Index of a true/false target type.

W_n -- Number of true and false targets of type t_n .

(See p. 43.)

Fig. 6—Card types 04 and 05

Cards 10, 11, and 12, Weather Method 1 Data. If weather method 1 has been selected on the type-02 card, the program expects one type-10 card, one type-11 card for each of the four possible weather conditions, and one type-12 card. The card formats are shown in Fig. 7, and the computation method is discussed on p. 8.

00	000000001111	111111112222	222222233333	333333334444	444444555555	555555566666	666666677777
12	345678901234	567890123456	789012345678	901234567890	123456789012	345678901234	567890123456789012
10			P_e	$P_a(1)$	$P_a(2)$	$P_a(3)$	$P_a(4)$
11		k_1	$P_c(1 k_1)$	$P_c(2 k_1)$	$P_c(3 k_1)$	$P_c(4 k_1)$	
12			I_1	I_2	I_3		

Notes: Card 10

P_e --Probability that the weather forecast is in error.
 $P_a(k_1)$ --Probability that the index of the actual weather is k_1 .
 Weather index = 1--HIGH.
 2--MED.
 3--LOW.
 4--NO.

Card 11

k_1 --An actual weather index.
 $P_c(k_2|k_1)$ --Probability that the weather forecast is k_2 , given that the actual weather is k_1 .

Card 12

I_n --An odd integer used to initialize the selection of random numbers to determine
 $n = 1$ --The actual weather.
 2--If there is a forecast error.
 3--The weather forecast, given that the weather forecast is in error.

(See p. 45.)

Fig. 7—Card types 10, 11, and 12

Card 13, Weather Method 2 Data. If weather method 2 has been selected on the type-02 card, the program expects one type-13 card which defines the actual weather and the weather forecast for the first day of the simulation and for all succeeding days until replaced by the data on a type-67 schedule card. The card format is shown in Fig. 8.

Cards 14 and 15, Weather Method 3 Data. If weather method 3 has been selected on the type-02 card, the program expects one type-14 card and one type-15 card for each of the four possible weather conditions. The card formats are shown in Fig. 8, and the computation method is discussed on p. 11.

00	00000000	11111111	11112222	22222223	33333333	33444444	44444455	55555555	56666666	66666677	77
12	34567890	1234567890	1234567890	1234567890	1234567890	89012345678901	2345678901	2345678901	9012345678901	2345678901	2
13			k_1	k_2							
14			C_1	C_2							
15		k_1	$P_a(k_1)$	$P_p(k_1)$	$P_w(1 k_1)$	$P_w(2 k_1)$	$P_w(3 k_1)$	$P_w(4 k_1)$			

Notes: Card 13

k_1 --The actual weather on the first day of the simulation.

k_2 --The weather forecast on the first day of the simulation.

Card 14

C_1 --First constant for weather method 3.

C_2 --Second constant for weather method 3.

Card 15

k_1 --An actual weather index.

$P_a(k_1)$ --Probability that the actual weather is k_1 .

$P_p(k_1)$ --The persistence forecast probability given that the actual weather is k_1 .

$P_w(k_2|k_1)$ --Weighting factor for forecast k_2 given that the actual weather is k_1 .

(See p. 45.)

Fig. 8—Card types 13, 14, and 15

Card 21, Munitions Data. The program expects one card for each munition defined during execution of the preprocessor program, PREPROC. The card defines the damage category of the munition type (discussed on p. 39), and its format is shown in Fig. 9.

Cards 30, 31, and 32, Base Data. The type-30 card defines a base, up to 4 pairs of values for an aircraft type, and the number of UE aircraft of that type located on the base on the first day of the simulation. The type-31 card defines a base, up to 4 pairs of values for a munition type, and the number of munitions of that type located on the base on the first day of the simulation. If more than 4 types of aircraft or munitions are to be located on a base, more than one type-30 or type-31 card may be defined for that base. The type-32 card defines the expected daily on-base attrition rates from airbase attacks for aircraft and munitions at the bases on the first day of the simulation and for all succeeding days until changed by a type-65 schedule card. On-base attrition is discussed on p. 39. At least one card of each

00	0000	000	001	1111111	1112222	2222223	3333333	3344444	4444455	5555555	5666666	6666777
12	34567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890
21		j			n_j							
30			b		a_1	Q_{b,a_1}	a_2	Q_{b,a_2}	a_3	Q_{b,a_3}	a_4	Q_{b,a_4}
31			b		j_1	U_{b,j_1}	j_2	U_{b,j_2}	j_3	U_{b,j_3}	j_4	U_{b,j_4}
32			b		$AA_{b,1}$	$AA_{b,2}$	$AA_{b,3}$					

Notes: Card 21

j --A munition index.

n_j --Vulnerability category for munition j (1 or 2).

Card 30

b --A base index.

a_n --An aircraft index.

Q_{b,a_n} --The number of type- a UE aircraft on base b on the first day of the simulation.

Card 31

b --A base index.

j_n --A munition index.

U_{b,j_n} --The number of type- j munitions on base b on the first day of the simulation.

Card 32

b --A base index.

$AA_{b,1}$ --Airbase attack attrition rate for aircraft located on base b .

$AA_{b,2}$ --Airbase attack attrition rate for vulnerability category 1 munitions on base b .

$AA_{b,3}$ --Airbase attack attrition rate for vulnerability category 2 munitions on base b .

(See p. 46.)

Fig. 9—Card types 21, 30, 31, and 32

type is required for each base to ensure that a base has not inadvertently been ignored. (If the user wishes to define a base containing either no aircraft or no munitions, the respective cards for that base may simply identify a single aircraft or munition type and indicate the number located on the base as zero.) The card formats are shown in Fig. 9.

Cards 41, 42, 43, and 44, Aircraft Data. The program expects one card of each of these four types for each aircraft type defined during execution of the preprocessor programs. The cards contain sortie, abort, jettison, enroute attrition, and ineffectiveness rates. Sortie rates may be changed during a run by the type-66 schedule card. The cards also contain the ground attack factor which is discussed on p. 34. The card format is shown in Fig. 10.

00	00	000001111111	11122222	2222223	3333333	3344444	4444455	5555555	5666666	6666777
12	34	567890123456	78901234567890	1234567890	1234567	8901234	5678901	2345678	9012345	6789012
41	a		s' _a	AB _a	G _a					
42	a		JE _{a,1}	JE _{a,2}	JE _{a,3}	JE _{a,4}				
43	a		AE _{a,1}	AE _{a,2}	AE _{a,3}	AE _{a,4}				
44	a		IE _{a,1,1}	IE _{a,1,2}	IE _{a,2,1}	IE _{a,2,2}	IE _{a,3,1}	IE _{a,3,2}	IE _{a,4,1}	IE _{a,4,2}

Notes: Card 41

a--An aircraft index.

s'_a--Sortie rate for type-a aircraft.

AB_a--Abort rate for type-a aircraft.

G_a--Ground attack factor for type-a aircraft.

Card 42

a--An aircraft index.

JE_{a,m}--Jettison rate for type-a aircraft on mission m.

Card 43

a--An aircraft index.

AE_{a,m}--Enroute attrition rate for type-a aircraft on mission m.

Card 44

a--An aircraft index.

IE_{a,m,c}--Ineffectiveness rate for type-a aircraft on mission m carrying munitions of attack category c.

(See p. 47.)

Fig. 10—Card types 41, 42, 43, and 44

Cards 50, 51, and 52, Target Data. The program expects one type-50 card which determines the number of targets and the target values for each target type defined during execution of the preprocessor programs. The type-51 card specifies the replacement characteristics of the target (discussed on p. 36), but this need not be done for each. The existence of a type-52 card tells that a target is repairable, and it also contains the repair time (discussed on p. 39). A type-52 card is not required for a target and it may not be defined for a target that has been specified as replaceable on a type-51 card. Up to ten target types may be defined as repairable. The card formats are shown in Fig. 11.

Cards 60 through 68, Schedule Cards. The schedule cards have been discussed in detail on p. 33. Their formats are shown in Figs. 12 to 14, although these cards are not required.

[illegible]

Notes: Card 50

t--A target index.

W_t -- Number of type- t targets on the first day of the simulation.

val_{t,1}--Target value of type-t targets before day D_T (defined on card 03).

$$\text{val}_{t,2} \text{--Target value of type-}t \text{ targets on and after day } D_T.$$

Card 51

t--A target index.

$\hat{t}$ --Index of the target type that is a replacement source for target type t .

$R'_{t,1}$ --The daily replacement rate for type-t targets.

$R'_{t,2}$ -- The N-day replacement rate for type-t targets.

w_t -- If $t = 0$, the size of the replacement pool for type- t targets.

eq_t--If $\hat{t} = 0$, the number of type- $\hat{t}$ targets that equal one type- t target.

u_t -- If $t = 0$, the fraction of the type- t targets available as replacements.

Card 52

t--A target index.

 ΔD_t -- Repair time for type-t targets.

(See p. 48.)

Fig. 11—Card types 50, 51, and 52

[illegible]

Notes: Card 60

b--A base index.

d--Day of the event, augmentation.

a_n --An aircraft index.

Q_{b,a_n} -- The number of type- a_n aircraft arriving on base b on day d .

Card 61

b--A base index.

d--Day of the event, resupply.

j_n--A munition index.

U_{b,j_n} -- The number of type- j_n munitions arriving on base b on day d .

Card 62

t--A target index.

d--The day of the event, N-day target replacement.

Card 64

d--The day of the event, replace mission allocation fractions.

F_m --Mission allocation fraction.

m = 1--Immediate Close Air Support.

2--Counter Air

3--Preplanned Close Air Support.

4--Air Interdiction.

(See p. 48.)

Fig. 12—Card types 60, 61, 62, and 64

[illegible]

Notes: Card 65

b--A base index.

d--The day of the event, replace airbase attack attrition rates.

AA_{b,1}--Airbase attack attrition rate for the aircraft on base b.

AA_{b,2}--Airbase attack attrition rate for vulnerability category 1 munitions.

AA_{b.3}--Airbase attack attrition rate for vulnerability category 2 munitions.

Card 66

a--An aircraft index.

d--Day of the event, replace sortie rates.

s'_a --Sortie rate for type-a aircraft.

Card 6 /

d--Day of the event, replace actual weather and weather forecast.

k_1 -- Actual weather index.

k_2 --Weather forecast index.

(See p. 48.)

Fig. 13—Card types 65, 66, and 67

00	0000000	1111111	1112222	2222223	3333333	3344444	4444555	5555555	5666666	6666666	777
12	34567890	123456	7890123	4567890	1234567	89012345	678901	2345678	9012345	6789012	
68			d_1	d_2	Δd	f	M				

Notes: Card 68

d₁--First day of a resupply schedule.

d₂--Last day of a resupply schedule.

 Δd --Interval between resupply days.

f--Fraction of resupply potential array arriving at the bases on resupply days.

M--Resupply potential array number.

(See p. 48.)

Fig. 14—Card type 68

TRACE DATA SETS

The three TRACE input data sets contain arrays which rarely change from one run to the next. The data set names and unit assignments are as follows:

FORTTRAN Unit	Data Set
15	Definitions
16	Weapon Effects Table
17	Resupply Arrays

Three auxiliary programs have been written to create and/or modify these data sets. The relationship between these auxiliary programs and the data sets is shown in Fig. 15.

TRACE PROGRAM DIMENSIONS

The current version of the TRACE simulation model allows:

35	target types
12	aircraft types
25	munition types
20	airbases
4	weather conditions
4	mission categories
90	days per run
20	target types within one mission category
10	repairable target types
20	resupply arrays in the resupply array data set
10	resupply arrays used per run
30	type-68 wholesale resupply cards
200	type-60, 61, 62, 64, 65, 66, 67 scheduled events
2500	nonzero values of expected kills per sortie
1500	combinations of target, aircraft, and munition for which there exists at least one nonzero value for expected kills per sortie
2	true/false target types
100	nonzero values of expected kills per sorties for each of the two true/false target types

The upper bounds of arrays generated by the program allow:

400	assignments of sorties to targets for one value of weather forecast
800	assignments of sorties to targets from individual bases for one value of weather forecast.

Auxiliary Programs

Fig. 15 —TRACE data sets

AUXILIARY PROGRAM--PRELOAD

This program reads, from data cards, values defining expected kills per sortie, expected terminal attrition per pass, and aircraft loads and writes the values on two disk data sets. At the same time, the program maps the data from the indexing system it carried, as it originally arrived at Rand, into the TRACE indexing system. The major difference between the two indexing systems is that each combination of munition type and delivery mode is identified by a single index in the original system, but in the TRACE system each combination is identified by two indices. Also, the original data defined expected kills per sortie and attrition per pass for only three delivery modes, but the TRACE indexing system allows a fourth delivery mode.

The PRELOAD program allows the user to delete aircraft, munition, or target types contained in the original indexing system. PRELOAD creates two data sets: The first contains data on the expected kills per sortie and is an input data set for the program PREPROC; the second is the definitions data set, defined in detail below, which is an input data set for both the PREPROC program and for TRACE.

A listing of the program appears in Ref. 2. The input data card deck for a test case is in the appendix.

Input to PRELOAD

Although the input format for PRELOAD is similar to that of all the other TRACE input cards, it is not identical. The first 12 card columns are reserved for index information and columns 13 through 72 contain ten fields of data. (In the remainder of the TRACE cards, the first 16 card columns are reserved for indexing information and columns 17 through 72 contain eight fields of data.)

Card Type 70, Array Sizes. The first card in the input data card deck specifies the number of aircraft, munition, and target types contained in the original data and the numbers to be contained in the TRACE data. The card format is shown in Fig. 16.

Card Type 71, Aircraft References. An aircraft reference card defines the index in the TRACE indexing system for one of the original aircraft indices. The program expects one card for each index. If the

[illegible]

Notes: Card 70

A_T --Number of aircraft types in input indexing system.

T_I --Number of target types in input indexing system.

J_T --Number of munition types in input indexing system.

A_T --Number of aircraft types in TRACE indexing system.

T_T --Number of target types in TRACE indexing system.

J_T --Number of munition types in TRACE indexing system.

Card 71

a_T--An aircraft index in the input indexing system.

a_T--An aircraft index in the TRACE indexing system.

Card 72

t_T --A target index in the input indexing system.

t_T--A target index in the TRACE indexing system.

Card 73

j_r--A munition index in the input indexing system.

j_T--A munition index in the TRACE indexing system.

k_{tr}--A delivery mode in the TRACE indexing system.

(See p. 53.)

Fig. 16—Card types 70, 71, 72, and 73

aircraft type is to be deleted, the user defines a zero for the TRACE index. The card format is shown in Fig. 16.

Card Type 72, Target Reference. A target reference card determines the index in the TRACE indexing system for one of the original target indices. The program expects one card for each index. If the target type is to be deleted, the user defines a zero for the TRACE index. The card format is shown in Fig. 16.

Card Type 73, Munition Reference. A munition reference card defines both the munition index and the delivery mode index in the TRACE indexing system for one of the original munition-delivery mode indices. The program expects one card for each index. If the munition type is to be deleted, the user simply specifies a zero for the TRACE munition index. The card format is shown in Fig. 16.

Card Type 74, Expected Kills per Sortie. The cards fixing expected kills per sortie identify an aircraft index, a target index, a card

number, and ten values for expected kills per sortie. The aircraft and target indices are both expressed in the original indexing system, and the card number relates the ten values on the card to the original munition indexing system. Card 1 contains values for munitions 1 through 10; card 2 contains values for munitions 11 through 20; etc. The program expects values to be input for all munitions contained in the original indexing system as defined on the first data card and for the aircraft and target types identified with a TRACE index.

Card Type 75, Expected Attrition per Pass. Each card identifies a target index (expressed in the original indexing system), a card number, and ten values for expected attrition per pass. The card number relates the ten values on the card to the original munition indexing system. Card 1 contains values for munitions 1 through 10; card 2 contains values for munitions 11 through 20; etc. The program expects values to be input for all the munitions contained in the original indexing system as defined on the first data card and for the targets identified with a TRACE index. The card format is shown in Fig. 17.

[illegible]

Notes: Card 74

a_T--An aircraft index in the input indexing system.

t_i --A target index in the input indexing system.

c--A card number.

E_n -- Expected kills per sortie for aircraft type a_i , target type t_i , and munition type $[(c - 1) \cdot 10 + n]$.

Card 75

t_i --A target index in the input indexing system.

c--A card number.

AT_n--Expected attrition per pass for target type t_i and munition type [(c - 1) · 10 + n].

Card 76

a_T--An aircraft index in the input indexing system.

j_I --A munition index in the input indexing system.

$L_{a_I, j_I, n}$ -- Aircraft load for aircraft type a_I , munition type j_I , and load class n .

(See p. 54.)

Fig. 17—Card types 74, 75, and 76

Card Type 76, Aircraft Loads. An aircraft load card identifies an aircraft and a munition index (both expressed in the original indexing system) and the 2 aircraft load values associated with the 2 load classes.* The program expects one card for each aircraft-munition combination for which a TRACE index has been identified. The card format is shown in Fig. 17.

Data Card Deck Structure

Within the data card deck, the array sizes card must appear first, and all the type-71, 72, and 73 cards *must* appear before any type-74, 75, or 76 cards.

PRELOAD Program Dimensions

The program allows up to 12 aircraft types and 35 target types in both the original and the TRACE indexing systems. Up to 35 munition delivery mode types are allowed in the original indexing system (thus up to 4 card numbers for the type-74 and 75 cards), and up to 25 munition types are allowed in the TRACE indexing system. The program allows that attrition per pass and expected kills per sortie data be defined for three delivery modes for each of the munitions in the TRACE indexing systems. Data for the fourth delivery mode are added by the program PRELOAD when writing the two output data sets. These additional data are all set equal to zero. Nonzero values for the fourth delivery mode may be input using the program PREPROC.

Output of PRELOAD

Printed Output. The printed output identifies the indices (in the original indexing system) of all targets, munitions, and aircraft types deleted. The program also identifies any aircraft-munition-target-delivery-mode combinations for which the expected kills per sortie are greater than zero while the expected attrition per pass is less than or equal to zero.

Data Set Output. Two data sets are created by the program. The first is a direct access data set containing the values for expected

* Load classes have been discussed on p. 15.

kills per sortie to be input to the program PREPROC. This data set contains up to 35 records (one record per target type in the TRACE indexing system), and each record contains 1200 4-byte* words. Values of zero are inserted for the fourth delivery mode required by TRACE. The data set is assigned to FORTRAN Unit 10 and defined in the main routine by:

```
DEFINE FILE 10(35,1200,U,ITVAR).
```

The second data set is a sequential access data set assigned to FORTRAN Unit 11 containing one record of up to 16,596 bytes. This data set is the definitions data set which is input to both PREPROC and TRACE. The record contains:

- o Three 2-byte words defining the number of aircraft, target, and munition types in the TRACE indexing system.
- o Up to 35 (one for each target type) 2-byte words defining the load class[†] and the mission category.[†]
- o Up to 25 (one for each munition type) sets of: one 2-byte word defining the attack category;[†] and up to 24 2-byte words defining the aircraft loads.
- o Up to 3500 4-byte words defining the expected attrition per pass (values of zero are inserted for the fourth delivery mode required by TRACE).

PRELOAD Error Conditions

In order to test that the data are complete, all reference data and all required values for the three arrays must be defined in a single run of the program PRELOAD. Otherwise, an error is assumed (i.e., data have been inadvertently omitted). Whenever one of the following error conditions occurs, an appropriate message is printed and the run terminated.

* A byte in a hexadecimal computer is equivalent to 8 binary bits.

† This variable, which is required by the program PREPROC, is set equal to a negative value in PRELOAD which if not replaced by a positive value in the input phase of PREPROC signals an error condition.

- o The type-70 (array sizes) card is not the first card in the data card deck.
- o A type-74, 75, or 76 card precedes the type-71, 72, and 73 cards.
- o A card type less than 70 or greater than 76 appears in the data card deck.
- o An index is out of the range of the indexing system defined by the type-70, array sizes, card.
- o An index is out of the range of the program dimensions (dimensions are described above).
- o An aircraft, munition, or target index in the TRACE indexing system has not been referenced by some index in the original indexing system or has been referenced more than once.
- o Two cards of the same type containing identical indexing information in card columns 3 to 12 appear in the data card deck.
- o Load data are inconsistent--more than one of the original munition delivery mode indices will map to a single TRACE munition index. If the load data are not identical, an error is assumed.

AUXILIARY PROGRAM--PREPROC

This program creates the ordered weapon effects table described on p. 84 and writes it on a disk data set for input to TRACE. The data for the table may be contained in the input data card deck or in two input data sets written by the program PRELOAD or written during prior runs of PREPROC. The program allows the user to modify previously created data sets before the weapon effects table is created. Possible modifications include:

- o Definition of data for new aircraft, target, or munition types.
- o Replacement of previously defined data.
- o Multiplication of the expected kills per sortie array by

a constant: for all values of a specified target, for all values of a specified target and aircraft, or for all values of a specified target *except* those of a specified aircraft type

- o Copying the data associated with an aircraft, target, or munition index (or combinations of indices) into the arrays associated with another index (or indices). This modification may *not* be performed during a run that includes the three preceding modifications. Copying must occur in a separate run of the program.

A listing of the program appears in Ref. 2, and the input data card deck for a test case appears in the appendix.

Data Set Assignments

The program PREPROC employs three data sets *each* for both the definitions data and the expected kills per sortie data; one for input (if any), one for output, and a third for temporary or scratch use. Since the output data sets are not written until the program has successfully executed all procedures, they can be set equal to the input data sets in the data definitions cards of the job control language. However, this assignment should be made cautiously, for if an input-output error should occur during the final writing, the original data will be lost. The FORTRAN unit assignments follow:

FORTTRAN Unit	Data Set Contents
11	Definitions Data--Input
13	Definitions Data--Scratch
15	Definitions Data--Output
10	Expected Kills per Sortie--Input
12	Expected Kills per Sortie--Scratch
14	Expected Kills per Sortie--Output

PREPROC Program Dimensions

The program allows up to 12 aircraft types, 35 target types, and

25 munition types. (If these are to be increased, the programmer must also redefine the array sizes in the array KLIM(K,4), where K = 1 denotes aircraft, K = 2 denotes targets, and K = 3 denotes munitions.) The program does require that if less than the maximum number of types are defined, that indexing be continuous, e.g., definitions of munitions types 1 through 9 and 11 through 25 would be assumed to be an error--that munition type 10 had been inadvertently undefined.

Data Card Input for PREPROC

The format of the input data cards is identical to that of the TRACE model. Card columns 1 to 2 contain a card type, card columns 3 to 16 contain indexing information, and card columns 17 to 72 contain eight fields of data.

Card Type 90, Control Card. The first card in the input data card deck defines a program control variable and a print control variable. The following are control variable options:

1. The purpose of the run is simply to produce the printed output as indicated by the print control variable.
2. The purpose of the run is simply to copy the two input data sets onto the two output data sets and to produce the desired printed output; a new weapon effects table is not created.
3. The purpose of the run is to modify previously defined data with the modifications contained on the type-91 through 97 cards, create a new weapon effects table, and produce the desired printed output.
4. The purpose of the run is to define the weapon effects entirely from the input data card deck (i.e., there exist no previously defined data), create the weapon effects table, and produce the desired printed output.
5. The purpose of the run is to reindex previously defined data by copying selected arrays into the space occupied by others as specified on the type-98 cards, create the weapon effects table, and produce the desired printed output.

The printed output of the program PREPROC contains two types of arrays--the "X-0" array and the value array. The program prints one "X-0" array for each aircraft type. For each combination of target type, munition type, and delivery mode the program prints an "X" if the associated value for expected kills per sortie is greater than zero and an "0" if it is not. The program also displays the number of values greater than zero contained in the array for each target-delivery-mode combination, each target, each munition-delivery-mode combination, and each munition. The program also displays for each target type the number of munition types for which there is at least one nonzero value, and for each munition type the number of target types for which there is at least one nonzero value. The program prints one value array for each aircraft type. The array contains the values of expected kills per sortie for each combination of target type, munition type, and delivery mode.

The print control options are:

1. Do not print the weapon effects data.
2. Print the "X-0" arrays only.
3. Print both the "X-0" arrays and the value arrays.

Card Type 91, Expected Kills per Sortie. A type-91 card defines an aircraft type, a target type, a munitions type, and the four values for expected kills per sortie associated with the four delivery modes. The card format is shown in Fig. 18.

Card Type 92, Expected Attrition per Pass. A type-92 card specifies a target type, a munition type, and the four values for expected attrition per pass associated with the four delivery modes. The card format is shown in Fig. 18.

Card Type 93, Aircraft Loads. A type-93 card defines an aircraft, a munition type, and the two values for aircraft loads associated with the two load classes. The card format is shown in Fig. 19.

Card Type 94, Attack Categories. A type-94 card determines the munition type and the attack category associated with the munition. If this is the first run of PREPROC using data sets created by the program PRELOAD, this card is required for each munition type. The card format is shown in Fig. 19.

[illegible]

Notes: Card 90

Control--Program control variable.

Print--Print control variable.

Card 91

a--An aircraft index.

t--A target index.

j--A munition index.

E_n -- Expected kills per sortie given aircraft type a, target type t, munition type j, and delivery mode n.

Card 92

t--A target index.

j--A munition index.

AT_n--Expected attrition per pass given target type t, munition type j, and delivery mode n.

(See p. 60.)

Fig. 18—Card types 90, 91, and 92

[illegible]

Notes: Card 93

a--An aircraft index.

j--A munition index.

$L_{a,j,n}$ -- Aircraft load given aircraft type a, munition type j, and load class n.

Card 94

j--A munition index.

c_j--Attack category for munition j (1 or 2).

Card 95

t--A target index.

ℓ_t --Load class of type-t target (1 or 2).

m_t--Mission category of type-t targets (CAS-1, CA-2, AI-3).

(See p. 61.)

Fig. 19—Card types 93, 94, and 95

Card Type 95, Target Data. A type-95 card defines a target type and both the load class and the mission category associated with the target. If this is the first run of PREPROC using data sets created by the program PRELOAD, this card is required for each target type. The card format is shown in Fig. 19.

Card Type 96, Expected Kills per Sortie Multiplier. A type-96 card specifies a target type, an aircraft type, and a multiplier. All values for expected kills per sortie associated with the target type and the aircraft type will be multiplied. The card format is shown in Fig. 20.

[illegible]

Notes: Cards 96 and 97

a--An aircraft index.

t--A target index.

Mult.--A multiplier.

Card 98

a--An aircraft index.

t--A target index.

j--A munition index.

Copy--The index of the array into which the data of either a or t or j is to be copied.

(See p. 63.)

Fig. 20—Card types 96, 97, and 98

Card Type 97, Expected Kills per Sortie Multiplier. A type-97 card, like a type-96 card, defines a target type, an aircraft type, and a multiplier. However, unlike the 96 card, all values for expected kills per sortie associated with the target type and *not* associated with the aircraft type are multiplied by the multiplier. If the aircraft index is set equal to zero, this causes all values of expected kills per sortie for the target to be multiplied. The card format is shown in Fig. 20.

Card Type 98, Copy Card. A type-98 card identifies either an aircraft type, a target type, or a munition type and a copy index. The

copy index is the index *into* which data will be copied. To ensure that the copying process does not cause the inadvertent loss of data, each index identified as a copy index must be identified on some other card as an index *to be* copied. If the user does not wish that the data for an index be saved, a copy index of zero is defined for it. The format of the type-98 card is shown in Fig. 20.

Data Card Deck Structure

The control card, card type 90, must be the first card in the data card deck. The remainder of the cards may appear in any order but, when ordering cards of like type, care must be taken that they appear in the order in which the processing is desired. The program executes its procedures in the following order where items 1 and 2 are mutually exclusive:

- 1a. Load the data defined on the type-91 through 95 cards in the order in which they appear in the data card deck.
- b. Perform the multiplications defined by type-96 and 97 cards in the order in which they appear in the data card deck.
2. Copy the data as defined by the type-98 cards. If the copy option is selected in order to release space for new data, the program should be run twice--first to copy the data, leaving the copied data in place, and then to introduce the new data which will replace the copied data.
3. Create the weapon effects table for input to TRACE.
4. Produce the printed output (if any).
5. Write the revised and/or new data onto the output data sets.

Output of PREPROC

Printed Output. The printed output has been described above with the discussion of the output options on the type-90 card.

Data Set Output. The program creates three data sets. The first two are the definitions data set and the expected kills per sortie. The contents of these data sets have been described above with the program PRELOAD. The third data set written by PREPROC contains the

weapon effects table. This data set is a sequential access data set assigned to FORTRAN Unit 16 containing one record of up to 50,214 bytes.

PREPROC Error Conditions

Whenever one of the following error conditions occurs, an appropriate message is printed and the run terminated.

- o The control card is not the first card in the input data card deck.
- o The program control variable or the print control variable is out of the range of possible options.
- o A card type less than 91 or greater than 98 follows the control card.
- o All required values for attack category, load class, mission category, expected attrition per pass, aircraft loads, or expected kills per sortie have not been defined.
- o A multiplier on a type-96 or 97 card is negative.
- o The dimensions of the weapon effects table have been exceeded. (The table is dimensioned to allow 2500 nonzero entries.)
- o The dimensions of a temporary array used to order the weapon effects array have been exceeded for some target type. (The temporary array allows up to 925 nonzero entries for each target type.)
- o An aircraft, target, or munition index on a data card exceeds the program dimensions.
- o Input values for attack category, mission category, or load class are out of allowed ranges.
- o A type-98 card is ambiguous in that it contains either no entries or more than one entry in card columns 3 to 8.
- o A type-98 card will cause data to be copied into a location for which an associated type-98 card has not been defined.
- o More than one type-98 card contains the same copy index.

Card Type 81, Array Entries. The control card may be followed by any number of array entry cards. Each card defines an array number, m , and a munitions type, j . These are followed by up to 4 pairs of values for a base, b , and an entry for the array, an integer I .^{*} Letting $\Delta U_{b,j,m}$ denote the entry for base b and munition j in the m^{th} resupply array, then the program sets

$$\Delta U_{b,j,m} = I.$$

If the array entry card refers to an array previously created, the entries in the array are simply replaced with the new values on the card. If the array entry card refers to an array *not* previously created, an array is first created containing zeros and then the new values are entered. When several cards are required to define the entries in an array for a particular value of munition type, the cards may appear in any order. Within the card, the base numbers may appear in any order. The format for the array entry card is shown in Fig. 21.

Output of RESUPPLY

Printed Output. If the user so indicates on the control card, all the resupply arrays will be printed. An example appears in the appendix.

Data Set Output. The resupply array data set contains 21 records, 1000 bytes per record. The first record contains a 20-word, single-dimensioned array identifying which of the 20 possible arrays have or have not been created. The remaining 20 records contain the arrays, 1 array per record. Each record contains 500 2-byte integers.^{*} The program expects the resupply matrix data set to be assigned to FORTRAN Unit 17. The data set is a direct access data set, defined in the main routine by:

DEFINE FILE 17(21,250,U,IRVAR).

RESUPPLY Error Conditions

Whenever one of the following error conditions occurs, an appropriate message is printed and the run terminated.

^{*} See the note on Fig. 21.

- o The type-80 control card is not the first card in the data card deck.
- o An array entry card does not contain an 81 in card columns 1 to 2.
- o A base index, munition index, or matrix number exceeds the dimensions of the program. Up to 20 matrices are allowed, and each matrix may contain entries for 20 bases and 25 munition types.

V. OUTPUT

The printed output of the TRACE model contains a listing of the input data card deck, a summary of the expected outcome for each day, and a summary for the entire run. The daily summary contains several parts and the user indicates at the beginning of the run which parts (if any) are to be printed.

TYPES OF PRINTED OUTPUT

The parts of the printed output include:

- a. Input Deck--a simple listing of the input data card deck.
- b. Weather Table--if the method for determining the daily actual weather and weather forecast is method 3, the program displays the computed array-- $P(k_1, k_2)$.^{*}
- c. Resupply Table--if a munitions resupply schedule has been defined by type-61 data cards, by type-68 data cards, or by both, the program displays an array containing the number of munitions of each type that will be delivered to each base during days 1 through 90; the total number of munitions of each type that will be delivered to all bases is also displayed.
- d. Daily Allocation Data--for each of the four possible weather forecasts, the program displays all assignments of sorties to targets and the desired allocation fraction and achieved allocation fraction for each target type and each mission type; the achieved allocation fractions for the day (the sum of the achieved fractions for each forecast weighted by the probability of the forecast) are also displayed. The contents of this part are defined in detail on p. 30.
- e. Daily Target Status--Long Form--a listing of the number of sorties assigned and expected number of targets destroyed for each aircraft-munition-target combination for which sorties were as-

^{*} See p. 11.

signed. The contents of this part are defined in detail on p. 25.

- f. Daily Target Status--Short Form--for each target type, a daily and cumulative list of targets and the associated target value destroyed, number of sorties assigned, and fraction of the total number of assigned sorties assigned to the target: The number of targets remaining at the end of the day is also displayed for each target type. The contents of this part are defined in detail on p. 25.
- g. Daily Aircraft Status--At Bases--an array containing the number of aircraft of each type located at each base at the end of the day; the number of aircraft of each type located at all the bases is also displayed. The contents of this part are defined in detail on p. 27.
- h. Daily Munition Status--Remaining Stocks--an array containing the number of munitions of each type located at each base at the end of the day; the number of munitions of each type located at all the bases is also displayed. The contents of this part are defined in detail on p. 28.
- i. Daily Munition Status--Today's Consumption--an array containing the amount of munitions of each type consumed at each base during the day; the number of munitions of each type consumed at all bases is also displayed. The contents of this part are defined in detail on p. 28.
- j. Daily Aircraft Status--Summary--for each aircraft type, a daily and cumulative list of sorties available for the day, number of sorties assigned to targets, number of aircraft lost on missions, and number of aircraft lost per sortie assigned. The contents of this part are defined in detail on p. 29.
- k. Run Summary--a list for each day of the run of the daily and cumulative number of sorties assigned to targets, MWD for each mission category, and MWD over all mission categories. The contents of this part are defined in detail on p. 32.

BASIC OUTPUT

The program always prints parts a(Input Deck), b(Weather Table), c(Resupply Table), and k(Run Summary). Parts g(Aircraft at Bases) and h(Munitions at Bases) are also printed for the beginning of the run.

OPTIONAL OUTPUT

The user selects the contents of the daily output by specifying an output method in the input data card deck--a value between one and five. Output method one causes all parts of the daily summary to be printed each day. As the value of the output method increases, the amount of daily output decreases.

Output Method	Optional Daily Parts Printed	
	Daily	Last Day Only
1	d,e,f,g,h,i,j	--
2	e,f,g,h,i,j	--
3	f,g,h,i,j	e
4	f	e,f,g,h,i,j
5	--	e,f,g,h,i,j

In the test case in the appendix, output method one has been selected and thus examples of all the parts of the printed output are displayed.

TRACE ERROR MESSAGES

Many of the error messages are self-explanatory. In the following list, the messages are presented in alphabetical order, and the name of the subroutine that printed the message is enclosed in parentheses.

ALLOCATION METHOD OUT OF ALLOWED RANGE (ALLOCD)

ASSIGNMENT METHOD OUT OF ALLOWED RANGE (FRAGD)

AN INDEX ON PRECEDING CARD OUT OF ALLOWED RANGE (INCARD)

This message immediately follows a card containing a required index in card columns 3 to 16 that is less than one or greater than the program dimensions or, in the case of aircraft, target, or munition indices, is greater than the number defined on the input definitions data set. This message also follows the type-30, 31, 60, 61, and 67 cards if indexing information in the data fields in card columns 17 to 72 exceeds the program dimensions or, in the case of aircraft, target, or munition indices, is greater than the number defined on the input definitions data set.

A TYPE-62 CARD APPEARS FOR TARGET ____ BUT A TYPE-51 CARD DOES NOT (SCHED)

A type-62 card specifies the day of an N-day target replacement event, while the type-51 card defines the N-day replacement rate.

A TYPE ____ CARD IS MISSING (INERR)

This message will be printed identifying the cards missing if the input data card deck does not contain all required cards. Card requirements are discussed with the definition of the cards. If there are no other errors, all missing cards will be identified in one run.

BASE INDEX ON A TYPE-30, 31, OR 32 CARD GREATER THAN NUMBER ON THE TYPE-03 CARD (INPUT)

BOTH A TYPE-51 AND TYPE-52 CARD APPEAR FOR TGT ____ (INPUT)

A target may not be both replaceable and repairable.

CARD TYPE 01 IS NOT THE FIRST CARD IN THE DECK (INPUT)

CARD TYPE 02 IS NOT THE SECOND CARD IN THE DECK (INPUT)

CARD TYPE ON PRECEDING CARD DOES NOT EXIST (INCARD)

DAY 1 IS GREATER THAN DAY 2 ON THE PRECEDING TYPE-68 CARD (INCARD)

EXPECTED OUTCOME METHOD OUT OF ALLOWED RANGE (FLYD)

MORE THAN ONE TGT TYPE REFERS TO TGT ____ AS A REPLACEMENT SOURCE (INCARD)

MORE THAN ONE TYPE-62 CARD APPEARS FOR TGT ____ ON DAY ____ (SCHED)

NO. OF KPS VALUES FOR A TRUE/FALSE TGT EXCEEDS DIMENSIONS (INITR)

NO. OF REPAIRABLE TARGETS EXCEEDS DIMENSIONS (INCARD)

NO. OF RESUPPLY ARRAYS REQUIRED EXCEEDS DIMENSIONS (RSPLY)

NO. OF TGTS FOR TRUE/FALSE TGT TYPE EXCEEDS NO. ON THE TYPE-05 CARD (INITR)

PROGRAM DIMENSIONS EXCEEDED FOR NO. OF ASSIGNMENTS (CHOOSE)

PROGRAM DIMENSIONS EXCEEDED FOR NO. OF ASSIGNMENTS FROM BASES (TAKE)

PROGRAM DIMENSIONS EXCEEDED FOR NO. OF TGT TYPES PER MISSION CATEGORY (INITR)

PROGRAM DIMENSIONS EXCEEDED FOR NO. OF TYPE-68 CARDS (INCARD)

PROGRAM DIMENSIONS EXCEEDED FOR NO. OF TYPE-60, 61, 62, 64, 65, 66, AND 67 EVENTS (INCARD)

Each pair of values on the type-60 and 61 cards counts as a single event.

PROGRAM ERROR-DSCHED (DSCHED)

An internally generated index is out of the range of a computed GO TO statement. Not a user error.

PROGRAM ERROR-RPLACE (RPLACE)

An internally generated index is out of the range of a computed GO TO statement. Not a user error.

RANDOM NO. IN ERROR (WXD1)

A generated random number is greater than 1. Not a user error.

REPAIR TIME ON PRECEDING CARD IS LESS THAN OR EQUAL TO ZERO (INCARD)

RESUPPLY ARRAY REQUESTED EXCEEDS NO. ON DISK (INCARD)

RESUPPLY ARRAY REQUESTED HAS NOT BEEN DEFINED (RSPLY)

SUM OF ACTUAL WX PROBABILITIES ON TYPE-10 CARD LESS THAN 1 (INCARD)

SUM OF ENTRIES ON PRECEDING TYPE-11 CARD LESS THAN 1 (INCARD)

TGT EQUIV. FACTOR IS ZERO ON PRECEDING CARD (INCARD)

THE MAX. NO. OF DAYS FOR THE RUN IS EITHER LESS THAN MIN. NO. OR EXCEEDS PROGRAM DIMENSIONS (INCARD)

THE NO. OF BASES ON THE TYPE-03 CARD EITHER LESS THAN 1 OR EXCEEDS DIMENSIONS (INCARD)

TWO TYPE-52 CARDS APPEAR FOR TGT ____ (INCARD)

VULNERABILITY CATEGORY ON PRECEDING CARD OUT OF ALLOWED RANGE (INCARD)

WEATHER METHOD OUT OF ALLOWED RANGE (WXD)

WX METHOD 3 - PERS. FORECAST FOR TYPE ____ WX NOT IN INTERVAL (0,1) (WXR3)

WX METHOD 3 - SUM OF ACTUAL WX PROB. NOT EQUAL TO 1 (WXR3)

WX METHOD 3 - SUM OF SKILL CONSTANTS NOT IN INTERVAL (0,1)
(WXR3)

WX METHOD 3 - SUM OF WEIGHTING FACTORS FOR TYPE ___ WX NOT
EQUAL TO 1

VI. PROGRAM ORGANIZATION

The relationships of the routines of the TRACE model and its three auxiliary programs are depicted in Figs. 22 to 24.

SPACE AND TIME REQUIREMENTS

The TRACE program requires 220K bytes of core storage on Rand's IBM 360/65 computer. The requirement for PRELOAD is 200K bytes; for PREPROC, 170K bytes; and for RESUPPLY, 64K bytes. TRACE runs operating at 70 percent of the program's storage capacity require approximately 10 central processing unit (CPU) seconds per day.

SUBROUTINES

With one exception, the subroutines of TRACE and its auxiliary programs are written in FORTRAN IV. The exception is the random number generator (RANDOM), which is written in OS/360 assembly language. In the following brief descriptions of the routines, those for the auxiliary programs follow the TRACE routines.

TRACE Routines

MAIN: contains all DEFINE FILE statements and controls the daily cycle iteration.

ALLOCD: selects the appropriate allocation method.

ALLOC1: allocates sorties to target types based on the number of targets, the target values, and the input allocation fractions.

ALLOC2: allocates sorties to target types as a function of the number of targets and the target values.

ALTER1: used if the allocation method is type 1; revises the mission allocation fractions and executes a call to subroutine ALTER2.

ALTER2: used if the allocation method is type 1; revises the target allocation fractions.

ALTER3: revises the target allocation fractions if the allocation method is type 2.

Fig. 22 — Relationship of TRACE routines

PRELOAD

RESUPPLY

Fig. 23—Relationship of PRELOAD and RESUPPLY routines

Fig. 24 — Relationship of PREPROC routines

BAVAIL: computes the number of sorties of a given aircraft type carrying a given munition type available at a given base.

BLOSS: computes the expected number of aircraft and amount of munitions remaining at each base as a function of the airbase attack attrition rates.

CHOOSE: given a target type, selects the best aircraft-munition combination to assign to the target.

CUMAL: creates the arrays containing the achieved allocation fractions.

DELMOD: selects an alternate delivery mode when the actual weather is not identical to the forecast weather.

DLVR1: computes the expected number of aircraft lost, the expected number of targets destroyed, and the expected number of munitions retained to bases for an assignment of aircraft to targets when the actual weather permits the delivery of weapons.

DPRTA1: prints the Daily Aircraft Status--At Bases.

DPRTA2: prints the Daily Aircraft Status--Summary.

DPRTM: prints the Daily Munitions Status.

DPRTT: prints the Daily Target Status.

DSCHED: effects the scheduled aircraft augmentation, selective munitions resupply, N-day target replacement, mission allocation changes, airbase attack attrition rate changes, sortie rate changes, and the actual weather and weather forecast changes.

EXPASS: computes the expected number of successful passes per sortie.

FLYD: selects the appropriate method for computing the expected outcome of the assignments of sorties to targets (only one method is currently contained in the model).

FLY1: controls the computation of the expected outcome of the assignments of sorties to targets.

FRAGD: selects the appropriate method for assigning sorties to targets (only one method is currently contained in the model).

FRAG1: controls the order in which mission categories and target types are selected to be assigned sorties.

FRGFLY: controls the execution of the assignments and computation of the expected outcome of the assignments.

IFRAG1: initializes the arrays required by subroutine FRAG1.

INCARD: reads all the input data cards following the type-01 and 02 cards.

INERR: prints the message "A type __ card is missing."

INITD: initializes the variables at the beginning of each day.

INITR: initializes the variables at the beginning of the run.

INPUT: reads the input definitions data set and the input weapon effects table data set, reads the identification and control cards, executes a call to subroutine INCARD which reads the remainder of the data card deck, executes all tests for completeness of input data, and executes a call to subroutine RSPLY which reads the input resupply arrays data set.

NDLVR1: computes the expected outcome of an assignment of sorties to a target type when the actual weather does not permit the delivery of weapons.

NPASS: computes the number of passes attempted per sortie as a function of the attack category of the munition.

ORDER: ranks the elements of a one-dimensional array.

PRINTA: is called by subroutine RSPLY to print the Resupply Table.

PRNTAL: prints the Daily Allocation Data.

RANDOM: generates a real single-precision random number in the open interval (0,1) and is written in OS/360 assembly language. The TRACE model calls to this routine include:

CALL RSTART (N)

which initializes RANDOM to produce the same sequence of random numbers, where N is an odd integer, and

CALL NEXTR (R,N)

which obtains a random number, R, and returns the integer, N, that determines the next random number to be generated.

RPLACE: effects both the daily and N-day target replacement.

RSPLY: reads the input resupply arrays data set, prints the cumulative Resupply Table, and effects the daily wholesale munitions resupply.

SCHED: orders the scheduled events defined by the type-60, 61, 62, 64, 65, 66, and 67 cards.

SMFLY1: summarizes the expected outcome of the assignment of sorties to targets for a day.

SPRT: prints the run summary.

SUMRY: updates the cumulative expected outcome of the assignment of sorties to targets and computes the number of aircraft, munitions, and targets remaining at the end of each day.

SUMRYD: controls the daily output as a function of the input-print control variable.

SUMRYR: controls the output for the final day of the run.

TAKE: given a specified aircraft-munition combination, scans the bases to identify available sorties.

WXD: selects the appropriate method for computing the daily actual weather and weather forecast.

WXD1: computes the daily actual weather and weather forecast given the weather method is type one.

WXD2: sets the daily actual weather and weather forecast equal to the input values given that the weather method is type 2.

WXR3: computes and prints the probabilities that the 16 possible pairs of actual weather and weather forecast occur together when the weather method is type 3.

PRELOAD Routines

MAIN: contains the DEFINE FILE statement for the kills per sortie data set (FORTRAN Unit 10), and executes calls to subroutines INITR, INCNTRL, INCARD, TESTD, and OUTDSK.

INCARD: reads the input data cards that follow the control card, compares the data with the program dimensions using the functions KTEST and ITEST, and records the appearance of the cards in the data card deck; executes a call to the routine TESTR when the first card type greater than 73 is detected.

INCNTRL: reads the control card and compares the data with the program dimensions using the function KTEST.

INITR: sets the contents of all arrays not defined in the BLOCK DATA routine equal to zero.

ITEST: tests if a variable is greater than or equal to zero and

also less than or equal to an upper bound specified in the calling sequence.

KTEST: tests if a variable is greater than zero and also less than or equal to an upper bound specified in the calling sequence.

OUTDSK: identifies any aircraft-target-munition-delivery-mode combination for which the expected kills per sortie are greater than zero when the expected attrition per pass is less than or equal to zero; writes the expected kills per sortie data set; and writes the definitions data set.

TESTD: tests that all required values for expected kills per sortie, attrition per pass, and aircraft loads have been defined in the input data card deck.

TESTR: tests that all indices in the TRACE indexing system have been referenced on the type-71 through 73 reference cards. This routine also prints the indices (in the original indexing system) that have been deleted (i.e., not included in the TRACE indexing system).

PREPROC Routines

MAIN: contains all DEFINE FILE statements and controls the flow of the program as a function of the input program control variable.

COPY: executes the reindexing as defined on the type-98 cards.

ENTERT: loads values of expected kills per sortie into the weapon effects table.

INCTRL: reads the control card and tests that the control options are within the program bounds.

INDATA: reads all data following the control card and compares the data with the program dimensions.

INITR: sets the contents of the arrays to their initial values and rewinds the three sequential access data sets.

IODEF: contains the input and output instructions for the definitions data set.

LDKPS: replaces values on the expected kills per sortie data set, with the values contained in the data card deck.

MULT: executes the multiplication of values for expected kills per sortie as defined on the type-96 and 97 input data cards.

ORDER: ranks the elements of a one-dimensional array.

ORDERT: orders the entries in the weapon effects table.

OUTDSK: writes the output definitions data set and the output expected kills per sortie data set.

PRINT: executes calls to the subroutines PRINTV and PRINTX as a function of the input print control variable.

PRINTV: prints the value array.

PRINTX: prints the "X-0" array.

SET: performs the comparison of the input indexing information with the program dimensions.

SETLIM: initializes the number of output aircraft, target, and munition types either to the number on the input definitions data set or to zero.

SETNEG: initializes several arrays to negative values to be used as a test for completeness of the input data.

TABLE: controls the creation and ordering of the weapon effects table and writes the weapon effects table data set.

TESTA: tests that all required values for load classes, mission categories, and attack categories have been defined.

TESTB: tests that all required values for attrition per pass and aircraft loads have been defined.

TESTC: tests that the rules associated with the type-98 cards have been satisfied.

RESUPPLY Routines

MAIN: contains the DEFINE FILE statement for the resupply array data set (FORTRAN Unit 17), and calls subroutines INPUT and PRINT.

INPUT: reads all previously defined resupply arrays (if any), reads and prints the input data cards, enters the new values into the appropriate resupply arrays, and writes the revised arrays on the resupply array data set.

PRINT: executes a call to routine PRINTI for each resupply array that has been created during the current or previous runs of the program.

PRINTI: prints a resupply array.

SETZ: sets all the entries in a single resupply array equal to zero.

ORDERED WEAPON EFFECTS TABLE

The weapon effects table contains entries only for the nonzero values of expected kills per sortie and is loaded first by target type, then within each target type by aircraft type, by munition type, and by delivery mode in that order. Assuming I nonzero entries, the i^{th} entry in the table contains the following elements:

a_i = an aircraft type
 j_i = a munitions type
 k_i = a delivery profile
 E_i = expected kills per sortie
 AT_i = expected attrition per pass

The following arrays serve to locate the entries for target type t :

$L1STCH_{t,1}$ = the location in the weapon effects table of the largest value of expected kills per sortie for target t (criterion for assigning ICAS sorties).

$L1STCH_{t,2}$ = the location in the weapon effects table of the largest value of the ratio of expected kills per sortie to expected losses per sortie for target t (criterion for assignment of CA, PCAS, and AI sorties).

$NCHOIC_t$ = the number of entries in the weapon effects table for target type t .

The number of entries per target type may vary and thus to save space the order of the table is carried within the table itself using the following variables:

$NEXT_{i,1}$ = the location in the weapon effects table of the next largest value of E_i (if none, a zero) for target t .

$NEXT_{i,2}$ = the location in the weapon effects table of the next largest value of the ratio of expected kills per sortie to expected losses per sortie (if none, a zero) for target t .

Appendix

TEST CASE

The input deck for the TRACE test case is listed on p. 87. In this test case, four aircraft types and four munition types are distributed over four bases. The target array contains eight target types with target types three, six, and eight replaceable and target type one repairable. Target type six is designated as a true/false target type. Aircraft augmentation occurs on day 1 at base one, selective munitions resupply occurs on day 1 at bases three and four, and whole-sale munitions resupply occurs on days 1 through 3. N-day target replacements are scheduled for target types three and eight on day 2. Parameter changes include the mission allocation fractions on day 3, sortie rates on day 3, and airbase attack attrition rates on day 2. The weather method is type 3 with the type-14 and 15 cards defining the required parameters. The allocation method is type 1, and the output method is type one causing all of the daily output to be printed.

The simulation begins on day 1 and terminates at the end of day 3. The printed output of the test case appears on p. 89.

The input decks and excerpts from the printed output of the runs of the auxiliary programs required to create the input data sets for the test case follow the TRACE printed output. Although the PRELOAD program has been executed in order to present a sample input deck, the input data card deck for the PREPROC program is complete and the run of PRELOAD was not required.

TEST CASE INPUT DECK--PROGRAM TRACE

```
//M5897#TR JOB (3171,250,141,0010,000),'TRACE',CLASS=F
//GO EXEC PGM=TRACE,REGION=220K
//STEPLIB DD DISP=SHR,DSN=M.M5897.A3171.TRACE
//GO.FT05F001 DD DDNAME=SYSIN
//GO.FT06F001 DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1330)
//GO.FT07F001 DD SYSOUT=B
//GO.FT15F001 DD DISP=OLD,DSN=M.M5897.A3171.DEFTST
//GO.FT16F001 DD DISP=OLD,DSN=M.M5897.A3171.TABLTST
//GO.FT17F001 DD DISP=OLD,DSN=M.M5897.A3171.RSPYTST
//GO.SYSIN DD *
01TEST TRACE TEST CASE
02 1 1 1 1 1 3
03 4 1 3 11 1.0 2
04 0.25 0.25 0.25 0.25
05 6 100
14 0.0 0.61
15 1 0.248 0.480 0.00 0.75 0.20 0.05
15 2 0.270 0.423 0.75 0.00 0.20 0.05
15 3 0.222 0.197 0.40 0.50 0.00 0.10
15 4 0.260 0.497 0.25 0.25 0.50 0.00
21 1 1
21 2 2
21 3 1
21 4 2
30 1 1 10 3 10
30 2 2 10 4 10
30 3 1 10 2 10 3 10 4 10
30 4 1 10 2 10 3 10 4 10
31 1 1 20 2 20 3 20 4 20
31 2 2 20 4 20
31 3 1 20 3 20
31 4 1 20
32 1
32 2
32 3
32 4
41 1 1 1
41 2 1 1
41 3 1 1
41 4 1 1
42 1
42 2
42 3
42 4
43 1
43 2
43 3
43 4
44 1
44 2
44 3
44 4
50 1 100 1 1
50 2 100 2 2
50 3 100 3 3
50 4 0 4 4
50 5 100 5 5
50 6 100 6 6
50 7 100 7 7
50 8 0 8 8
51 3 0 .5 .5 100
51 6 8 .5 .5 1.0 1.0
51 8 0 .5 .5 0
52 1 1
60 1 2 2 10
61 3 1 3 50 4 50
61 4 1 3 50 .4 50
62 3 2
62 8 2
64 3 .75 .10 .10 .05
65 3 1.0 1.0 1.0
66 1 3 1
68 1 2 1 1 1
68 1 10 1 0.5 3
/*
//
```

TEST CASE OUTPUT--PROGRAM TRACE

CASE TEST TRACE TEST CASE

DAY = 0., CASE = TEST

WEATHER TABLE

ACTUAL WX	FORECAST WX				
	HI	MED	LO	NO	
HI	0.139	0.082	0.022	0.005	0.248
MED	0.098	0.140	0.026	0.007	0.270
LO	0.062	0.077	0.068	0.015	0.222
NO	0.028	0.028	0.055	0.150	0.260
	0.325	0.327	0.171	0.177	

CUMULATIVE MUNITION RESUPPLY SCHED ON DAY 90
SCHED INCLUDES TYPE 61 CARD RESUPPLY

DAY = 0., CASE = TEST

	BASE																				TOTAL
MUN TYPE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	14.	14.	10.	10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	48.
2	14.	14.	10.	10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	48.
3	10.	10.	60.	60.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	140.
4	10.	10.	60.	60.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	140.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

DAY = 0., CASE = TEST

A/C STATUS - AT BASES

	1	BASE 2	3	4		TOTAL
A/C TYPE						
1	10.	0.	10.	10.		30.
2	0.	10.	10.	10.		30.
3	10.	0.	10.	10.		30.
4	0.	10.	10.	10.		30.
SUM	20.	20.	40.	40.		120.

MUNITION STATUS - REMAINING STOCKS

	1	BASE 2	3	4		TOTAL
MUN TYPE						
1	20.	0.	20.	20.		60.
2	20.	20.	0.	0.		40.
3	20.	0.	20.	0.		40.
4	20.	20.	0.	0.		40.

DAY = 1., CASE = TEST

ALLOCATION FOR DAY 1. FORECAST MISSION HI	TGT	A/C	MUN	DLVRY	SORTIES
1	6	1	1	HI	6.43
1	5	1	1	HI	5.36
1	2	1	1	HI	2.14
1	1	1	1	HI	1.07
2	3	1	1	HI	2.50
2	3	1	3	HI	12.50
3	6	2	1	HI	0.75
3	6	2	3	HI	5.68
3	5	2	3	HI	5.36
3	2	2	3	HI	2.14
3	1	2	3	HI	1.07
4	7	2	3	HI	6.07
4	7	3	3	HI	8.93
1	6	2	2	HI	5.75
1	6	2	4	HI	0.68
1	5	2	4	HI	2.50
1	5	3	2	HI	2.86
1	2	3	2	HI	2.14
1	1	3	2	HI	1.07
2	3	3	3	HI	9.36
2	3	4	3	HI	4.36
2	3	3	2	HI	0.01
2	3	3	4	HI	1.27
3	6	3	4	HI	4.36
3	6	4	2	HI	0.01
3	6	4	4	HI	2.06
3	5	4	4	HI	5.36
3	2	4	4	HI	2.14
3	1	4	4	HI	1.07
4	7	4	4	HI	7.72

DAY = 1., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = HI

MISSION = 1

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 2

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.25
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 4

GOAL 0.25
ACTUAL 0.19

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.19
8	0.0	0.0

ALLOCATION FOR DAY 1.
FORECAST MISSION
MED

	TGT	A/C	MUN	DLVRY	SORTIES
1	6	1	1	MED	6.43
1	5	1	1	MED	5.36
1	2	1	1	MED	2.14
1	1	1	1	MED	1.07
2	3	1	1	MED	2.50
2	3	1	3	MED	12.50
3	6	2	1	MED	0.75
3	6	2	3	MED	5.68
3	5	2	3	MED	5.36
3	2	2	3	MED	2.14
3	1	2	3	MED	1.07
4	7	2	3	MED	6.07
4	7	3	3	MED	8.93
1	6	2	2	MED	5.75
1	6	2	4	MED	0.68
1	5	2	4	MED	2.50
1	5	3	2	MED	2.86
1	2	3	2	MED	2.14
1	1	3	2	MED	1.07
2	3	3	3	MED	9.36
2	3	4	3	MED	4.36
2	3	3	2	MED	0.01
2	3	3	4	MED	1.27
3	6	3	4	MED	4.36
3	6	4	2	MED	0.01
3	6	4	4	MED	2.06
3	5	4	4	MED	5.36
3	2	4	4	MED	2.14
3	1	4	4	MED	1.07
4	7	4	4	MED	7.72

DAY = 1., CASE = TEST

DAY = 1., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = MED

MISSION = 1

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 2

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.25
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 4

GOAL 0.25
ACTUAL 0.19

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.19
8	0.0	0.0

ALLOCATION FOR DAY 1.
FORECAST MISSION
LO

	TGT	A/C	MUN	DLVRY	SORTIES
1	6	1	1	LO	6.43
1	5	1	1	LO	5.36
1	2	1	1	LO	2.14
1	1	1	1	LO	1.07
2	3	1	1	LO	2.50
2	3	1	3	LO	12.50
3	6	2	1	LO	0.75
3	6	2	3	LO	5.68
3	5	2	3	LO	5.36
3	2	2	3	LO	2.14
3	1	2	3	LO	1.07
4	7	2	3	LO	6.07
4	7	3	3	LO	8.93
1	6	2	2	LO	5.75
1	6	2	4	LO	0.68
1	5	2	4	LO	2.50
1	5	3	2	LO	2.86
1	2	3	2	LO	2.14
1	1	3	2	LO	1.07
2	3	3	3	LO	9.36
2	3	4	3	LO	4.36
2	3	3	2	LO	0.01
2	3	3	4	LO	1.27
3	6	3	4	LO	4.36
3	6	4	2	LO	0.01
3	6	4	4	LO	2.06
3	5	4	4	LO	5.36
3	2	4	4	LO	2.14
3	1	4	4	LO	1.07
4	7	4	4	LO	7.72

DAY = 1., CASE = TEST

DAY = 1., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = LC

MISSION = 1

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 2

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.25
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 4

GOAL 0.25
ACTUAL 0.19

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.19
8	0.0	0.0

DAY = 1., CASE = TEST

ALLOCATION FOR DAY 1. FORECAST MISSION NO	TGT	A/C	MUN	DLVRY	SORTIES
1	6	1	1	NO	6.43
1	5	1	1	NO	5.36
1	2	1	1	NO	2.14
1	1	1	1	NO	1.07
2	3	1	1	NO	2.50
2	3	1	3	NO	12.50
3	6	2	1	NO	0.75
3	6	2	3	NO	5.68
3	5	2	3	NO	5.36
3	2	2	3	NO	2.14
3	1	2	3	NO	1.07
4	7	2	3	NO	6.07
4	7	3	3	NO	8.93
1	6	2	2	NO	5.75
1	6	2	4	NO	0.68
1	5	2	4	NO	2.50
1	5	3	2	NO	2.86
1	2	3	2	NO	2.14
1	1	3	2	NO	1.07
2	3	3	3	NO	9.36
2	3	4	3	NO	4.36
2	3	3	2	NO	0.01
2	3	3	4	NO	1.27
3	6	3	4	NO	4.36
3	6	4	2	NO	0.01
3	6	4	4	NO	2.06
3	5	4	4	NO	5.36
3	2	4	4	NO	2.14
3	1	4	4	NO	1.07
4	7	4	4	NO	7.72

ALLOCATION FRACTIONS

DAY = 1., CASE = TEST

FORECAST = NC

MISSION = 1

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 2

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.25
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 4

GOAL 0.25
ACTUAL 0.19

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.19
8	0.0	0.0

DAY = 1., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = ALL

MISSION = 1

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 2

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.25
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.25

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.02
2	0.04	0.04
5	0.09	0.09
6	0.11	0.11

MISSION = 4

GOAL 0.25
ACTUAL 0.19

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.19
8	0.0	0.0

SUMMARY FOR DAY 1.

DAY = 1., CASE = TEST

TOTAL SORTIES AVAILABLE = 120.00
FRACTION OF TOTAL SORTIES ASSIGNED = 0.939

TARGET STATUS - LONG FORM
RESULTS TODAY

TGT	A/C	MUN	TGT KILLS	SORTIES
1	1	1	0.27	1.07
	2	3	0.27	1.07
	3	2	0.26	1.07
	4	4	0.26	1.07
2	1	1	0.53	2.14
	2	3	0.53	2.14
	3	2	0.52	2.14
	4	4	0.52	2.14
3	1	1	0.62	2.50
		3	3.10	12.50
	3	2	0.00	0.01
		3	2.32	9.36
		4	0.31	1.27
	4	3	1.08	4.36
5	1	1	1.33	5.36
	2	3	1.33	5.36
		4	0.60	2.50
	3	2	0.69	2.86
	4	4	1.29	5.36
6	1	1	1.59	6.43
	2	1	0.19	0.75
		2	1.38	5.75
		3	1.41	5.68
		4	0.16	0.68
	3	4	1.05	4.36
	4	2	0.00	0.01
		4	0.50	2.06
7	2	3	1.51	6.07
	3	3	2.21	8.93
	4	4	1.90	7.72

DAY = 1., CASE = TEST

TARGET STATUS - SHORT FORM

RESULTS TODAY

RESULTS - CUMULATIVE

MISS	TGT	KILLS	MWD	SORTIES	FRAC. OF SORT. FLOWN	KILLS	MWD	SORTIES	FRAC. OF SORT. FLOWN	TGTS REMAINING
CAS	1	1.05	1.05	4.29	0.0380	1.05	1.05	4.29	0.0380	98.95
	2	2.10	4.19	8.57	0.0760	2.10	4.19	8.57	0.0760	97.90
	5	5.24	26.19	21.43	0.1901	5.24	26.19	21.43	0.1901	94.76
	6	6.29	37.72	25.71	0.2281	6.29	37.72	25.71	0.2281	93.71
	SUM		69.15	60.00	0.5323		69.15	60.00	0.5323	
CA	3	7.44	22.32	30.00	0.2661	7.44	22.32	30.00	0.2661	92.56
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SJM		22.32	30.00	0.2661		22.32	30.00	0.2661	
AI	7	5.62	39.33	22.72	0.2016	5.62	39.33	22.72	0.2016	94.38
	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SUM		39.33	22.72	0.2016		39.33	22.72	0.2016	
ALL			130.79	112.72	1.0000		130.79	112.72	1.0000	

A/C STATUS - AT BASES

	BASE			
A/C TYPE	1	2	3	4
1	10.	0.	10.	10.
2	0.	9.	10.	10.
3	9.	0.	10.	9.
4	0.	10.	9.	9.
SUM	19.	19.	39.	38.

DAY = 1., CASE = TEST

TOTAL

29.
29.
28.
28.
115.

MUNITION STATUS - REMAINING STOCKS

	BASE			
MUN TYPE	1	2	3	4
1	0.	0.	0.	0.
2	0.	0.	0.	0.
3	5.	0.	0.	0.
4	21.	0.	32.	0.

TOTAL

0.
0.
5.
53.

DAY = 1., CASE = TEST

MUNITION STATUS - TODAY'S CONSUMPTION

MUN TYPE	BASE				TOTAL
	1	2	3	4	
1	23.	3.	21.	21.	68.
2	22.	23.	1.	1.	47.
3	16.	1.	71.	51.	139.
4	0.	21.	19.	51.	91.

A/C STATUS - SUMMARY

A/C TYPE	SORTIES AVAIL.		SORTIES FLOWN		LOSSES		LOSSES PER SORTIE FLOWN	
	TODAY	CUM	TODAY	CUM	TODAY	CUM	TODAY	CUM
1	30.	30.	30.	30.	0.75	0.75	0.025	0.025
2	30.	30.	30.	30.	1.38	1.38	0.046	0.046
3	30.	30.	30.	30.	1.51	1.51	0.050	0.050
4	30.	30.	23.	23.	1.50	1.50	0.066	0.066
SUM	120.	120.	113.	113.	5.14	5.14	0.046	0.046

ALLOCATION FOR DAY 2.
FORECAST MISSION
HI

	TGT	A/C	MUN	DLVRY	SGRTIES
1	6	1	1	HI	1.00
1	6	1	2	HI	1.00
1	6	1	3	HI	1.64
1	6	1	4	HI	0.91
1	5	1	4	HI	3.83
1	2	1	4	HI	1.01
1	2	2	1	HI	0.57
1	1	2	1	HI	0.18
1	1	2	2	HI	0.63
2	3	2	3	HI	0.50
2	3	2	2	HI	0.23
2	3	2	4	HI	0.50

DAY = 2., CASE = TEST

ALLOCATION FRACTIONS

DAY = 2., CASE = TEST

FORECAST = H1

MISSION = 1

GOAL 0.25
ACTUAL 0.12

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.01
2	0.04	0.02
5	0.09	0.04
6	0.11	0.05

MISSION = 2

GOAL 0.25
ACTUAL 0.01

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.01
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.0
2	0.04	0.0
5	0.09	0.0
6	0.11	0.0

MISSION = 4

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.0
8	0.0	0.0

DAY = 2., CASE = TEST

ALLOCATION FOR DAY 2. FORECAST MED	MISSION	TGT	A/C	MUN	DLVRY	SORTIES
1	6	1	1	MED	1.00	
1	6	1	2	MED	1.00	
1	6	1	3	MED	1.64	
1	6	1	4	MED	0.91	
1	5	1	4	MED	3.83	
1	2	1	4	MED	1.01	
1	2	2	1	MED	0.57	
1	1	2	1	MED	0.18	
1	1	2	2	MED	0.63	
2	3	2	3	MED	0.50	
2	3	2	2	MED	0.23	
2	3	2	4	MED	0.50	

DAY = 2., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = MED

MISSION = 1

GOAL 0.25
ACTUAL 0.12

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.01
2	0.04	0.02
5	0.09	0.04
6	0.11	0.05

MISSION = 2

GOAL 0.25
ACTUAL 0.01

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.01
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.0
2	0.04	0.0
5	0.09	0.0
6	0.11	0.0

MISSION = 4

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.0
8	0.0	0.0

DAY = 2., CASE = TEST

ALLOCATION FOR DAY 2. FORECAST LO	MISSION	TGT	A/C	MUN	DLVRY	SORTIES
	1	6	1	1	LO	1.00
	1	6	1	2	LO	1.00
	1	6	1	3	LO	1.64
	1	6	1	4	LO	0.91
	1	5	1	4	LO	3.83
	1	2	1	4	LO	1.01
	1	2	2	1	LO	0.57
	1	1	2	1	LO	0.18
	1	1	2	2	LO	0.63
	2	3	2	3	LO	0.50
	2	3	2	2	LO	0.23
	2	3	2	4	LO	0.50

ALLOCATION FRACTIONS

DAY = 12., CASE = TEST

FORECAST = LD

MISSION = 1

GOAL 0.25
ACTUAL 0.12

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.01
2	0.04	0.02
5	0.09	0.04
6	0.11	0.05

MISSION = 2

GOAL 0.25
ACTUAL 0.01

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.01
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.0
2	0.04	0.0
5	0.09	0.0
6	0.11	0.0

MISSION = 4

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.0
8	0.0	0.0

DAY = 2., CASE = TEST

ALLOCATION FOR DAY 2. FORECAST NO	MISSION	IGT	A/C	MUN	DLVRY	SORTIES
	1	6	1	1	NU	1.00
	1	6	1	2	NU	1.00
	1	6	1	3	NU	1.64
	1	6	1	4	NU	0.91
	1	5	1	4	NU	3.83
	1	2	1	4	NU	1.01
	1	2	2	1	NU	0.57
	1	1	2	1	NU	0.18
	1	1	2	2	NU	0.63
	2	3	2	3	NU	0.50
	2	3	2	2	NU	0.23
	2	3	2	4	NU	0.50

ALLOCATION FRACTIONS

DAY = 2., CASE = TEST

FORECAST = NC

MISSION = 1

GOAL 0.25
ACTUAL 0.12

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.01
2	0.04	0.02
5	0.09	0.04
6	0.11	0.05

MISSION = 2

GOAL 0.25
ACTUAL 0.01

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.01
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.0
2	0.04	0.0
5	0.09	0.0
6	0.11	0.0

MISSION = 4

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.0
8	0.0	0.0

DAY = 2., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = ALL

MISSION = 1

GOAL 0.25
ACTUAL 0.12

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.01
2	0.04	0.02
5	0.09	0.04
6	0.11	0.05

MISSION = 2

GOAL 0.25
ACTUAL 0.01

TARGETS		
NO.	GOAL	ACTUAL
3	0.25	0.01
4	0.0	0.0

MISSION = 3

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.02	0.0
2	0.04	0.0
5	0.09	0.0
6	0.11	0.0

MISSION = 4

GOAL 0.25
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.25	0.0
8	0.0	0.0

SUMMARY FOR DAY 2.

DAY = 2., CASE = TEST

TOTAL SORTIES AVAILABLE = 86.19
 FRACTION OF TOTAL SORTIES ASSIGNED = 0.139

TARGET STATUS - LONG FORM
 RESULTS TODAY

TGT	A/C	MUN	TGT KILLS	SORTIES
1	2	1	0.04	0.18
		2	0.15	0.63
2	1	4	0.24	1.01
	2	1	0.14	0.57
3	2	2	0.06	0.23
		3	0.12	0.50
		4	0.12	0.50
5	1	4	0.92	3.83
6	1	1	0.23	1.00
		2	0.23	1.00
		3	0.38	1.54
		4	0.20	0.91

TARGET STATUS - SHORT FORM

DAY = 2., CASE = TEST

RESULTS TODAY					RESULTS - CUMULATIVE					
MISS	TGT	KILLS	MWD	SORTIES	FRAC. OF SORT. FLOWN	KILLS	MWD	SORTIES	FRAC. OF SORT. FLOWN	TGTS REMAINING
CAS	1	0.20	0.20	0.81	0.0674	1.24	1.24	5.09	0.0408	99.80
	2	0.39	0.77	1.58	0.1319	2.48	4.96	10.16	0.0814	97.52
	5	0.92	4.61	3.83	0.3192	6.16	30.81	25.26	0.2025	93.84
	6	1.04	6.27	4.55	0.3788	7.33	43.98	30.26	0.2426	92.67
	SUM		11.85	10.77	0.8973		81.00	70.77	0.5674	
CA	3	0.30	0.91	1.23	0.1027	7.74	23.23	31.23	0.2504	95.98
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SUM		0.91	1.23	0.1027		23.23	31.23	0.2504	
AI	7	0.0	0.0	0.0	0.0	5.62	39.33	22.72	0.1822	94.38
	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SUM		0.0	0.0	0.0		39.33	22.72	0.1822	
ALL			12.76	12.01	1.0000		143.55	124.73	1.0000	

DAY = 2., CASE = TEST

A/C STATUS - AT BASES

	BASE				TOTAL
A/C TYPE	1	2	3	4	
1	9.	0.	0.	10.	19.
2	10.	9.	0.	10.	29.
3	9.	0.	0.	9.	19.
4	0.	10.	0.	9.	19.
SUM	28.	19.	0.	38.	85.

MUNITION STATUS - REMAINING STOCKS

	BASE				TOTAL
MUN TYPE	1	2	3	4	
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.

MUNITION STATUS - TODAY'S CONSUMPTION

DAY = 2., CASE = TEST

MUN TYPE	BASE				TOTAL
	1	2	3	4	
1	3.	3.	0.	1.	7.
2	3.	3.	0.	1.	7.
3	6.	1.	0.	1.	8.
4	22.	1.	0.	1.	24.

A/C STATUS - SUMMARY

A/C TYPE	SORTIES AVAIL.		SORTIES FLOWN		LOSSES		LOSSES PER SORTIE FLOWN	
	TODAY	CUM	TODAY	CUM	TODAY	CUM	TODAY	CUM
1	20.	50.	9.	39.	0.71	1.46	0.076	0.037
2	29.	59.	3.	33.	0.13	1.50	0.049	0.046
3	19.	49.	0.	30.	0.0	1.51	0.0	0.050
4	19.	49.	0.	23.	0.0	1.50	0.0	0.066
SUM	86.	206.	12.	125.	0.84	5.98	0.070	0.048

DAY = 3., CASE = TEST

ALLOCATION FOR DAY 3.						
FORECAST	MISSION	TGT	A/C	MUN	DLVRY	SORTIES
HI						
	1	6	1	1	HI	0.50
	1	6	1	2	HI	0.50
	1	6	1	3	HI	0.50
	1	6	1	4	HI	0.50
	1	6	2	1	HI	0.25
	1	6	2	2	HI	0.25
	1	6	2	3	HI	0.25
	1	6	2	4	HI	0.25

DAY = 3., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = H1

MISSION = 1

GOAL 0.75
ACTUAL 0.02

TARGETS		
NO.	GOAL	ACTUAL
1	0.06	0.0
2	0.11	0.0
5	0.27	0.0
6	0.32	0.02

MISSION = 2

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
3	0.10	0.0
4	0.0	0.0

MISSION = 3

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.01	0.0
2	0.01	0.0
5	0.04	0.0
6	0.04	0.0

MISSION = 4

GOAL 0.05
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.05	0.0
8	0.0	0.0

DAY = 3., CASE = TEST

ALLOCATION FOR DAY 3.						
FORECAST	MISSION	TGT	A/C	MUN	DLVRY	SORTIES
MED	1	6	1	1	MED	0.50
	1	6	1	2	MED	0.50
	1	6	1	3	MED	0.50
	1	6	1	4	MED	0.50
	1	6	2	1	MED	0.25
	1	6	2	2	MED	0.25
	1	6	2	3	MED	0.25
	1	6	2	4	MED	0.25

DAY = 3., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = MED

MISSION = 1

GOAL 0.75
ACTUAL 0.02

TARGETS		
NO.	GOAL	ACTUAL
1	0.06	0.0
2	0.11	0.0
5	0.27	0.0
6	0.32	0.02

MISSION = 2

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
3	0.10	0.0
4	0.0	0.0

MISSION = 3

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.01	0.0
2	0.01	0.0
5	0.04	0.0
6	0.04	0.0

MISSION = 4

GOAL 0.05
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.05	0.0
8	0.0	0.0

ALLOCATION FOR DAY 3. FORECAST MISSION	TGT	A/C	MUN	DLVRY	SORTIES
LO					
1	6	1	1	LO	0.50
1	6	1	2	LO	0.50
1	6	1	3	LO	0.50
1	6	1	4	LO	0.50
1	6	2	1	LO	0.25
1	6	2	2	LO	0.25
1	6	2	3	LO	0.25
1	6	2	4	LO	0.25

DAY = 3., CASE = TEST

ALLOCATION FRACTIONS

DAY = 3., CASE = TEST

FORECAST = LC

MISSION = 1

GOAL 0.75
ACTUAL 0.02

TARGETS		
NO.	GOAL	ACTUAL
1	0.06	0.0
2	0.11	0.0
5	0.27	0.0
6	0.32	0.02

MISSION = 2

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
3	0.10	0.0
4	0.0	0.0

MISSION = 3

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.01	0.0
2	0.01	0.0
5	0.04	0.0
6	0.04	0.0

MISSION = 4

GOAL 0.05
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.05	0.0
8	0.0	0.0

DAY = 3., CASE = TEST

ALLOCATION FOR DAY 3.
FORECAST MISSION
NO

	TGT	A/C	MUN	DLVRY	SORTIES
1	6	1	1	NO	0.50
1	6	1	2	NO	0.50
1	6	1	3	NO	0.50
1	6	1	4	NO	0.50
1	6	2	1	NO	0.25
1	6	2	2	NO	0.25
1	6	2	3	NO	0.25
1	6	2	4	NO	0.25

DAY = 3., CASE = TEST

ALLOCATION FRACTIONS

FORECAST = NO

MISSION = 1

GOAL 0.75
ACTUAL 0.02

TARGETS		
NO.	GOAL	ACTUAL
1	0.06	0.0
2	0.11	0.0
5	0.27	0.0
6	0.32	0.02

MISSION = 2

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
3	0.10	0.0
4	0.0	0.0

MISSION = 3

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.01	0.0
2	0.01	0.0
5	0.04	0.0
6	0.04	0.0

MISSION = 4

GOAL 0.05
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.05	0.0
8	0.0	0.0

ALLOCATION FRACTIONS

FORECAST = ALL

MISSION = 1

GOAL 0.75
ACTUAL 0.02

TARGETS		
NO.	GOAL	ACTUAL
1	0.06	0.0
2	0.11	0.0
5	0.27	0.0
6	0.32	0.02

MISSION = 2

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
3	0.10	0.0
4	0.0	0.0

MISSION = 3

GOAL 0.10
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
1	0.01	0.0
2	0.01	0.0
5	0.04	0.0
6	0.04	0.0

MISSION = 4

GOAL 0.05
ACTUAL 0.0

TARGETS		
NO.	GOAL	ACTUAL
7	0.05	0.0
8	0.0	0.0

DAY = 3., CASE = TEST

SUMMARY FOR DAY 3.

DAY = 3., CASE = TEST

TOTAL SORTIES AVAILABLE = 122.93
FRACTION OF TOTAL SORTIES ASSIGNED = 0.024

TARGET STATUS - LONG FORM
RESULTS TODAY

TGT	A/C	MUN	TGT KILLS	SORTIES
6	1	1	0.11	0.50
		2	0.11	0.50
		3	0.11	0.50
		4	0.11	0.50
	2	1	0.06	0.25
		2	0.06	0.25
		3	0.06	0.25
		4	0.06	0.25

DAY = 3., CASE = TEST

TARGET STATUS - SHORT FORM

RESULTS TODAY					RESULTS - CUMULATIVE					
MISS	TGT	KILLS	MWD	SORTIES	FRAC. OF SORT. FLOWN	KILLS	MWD	SORTIES	FRAC. OF SORT. FLOWN	IGTS REMAINING
CAS	1	0.0	0.0	0.0	0.0	1.24	1.24	5.09	0.0399	100.00
	2	0.0	0.0	0.0	0.0	2.48	4.96	10.16	0.0795	97.52
	5	0.0	0.0	0.0	0.0	6.16	30.81	25.26	0.1978	93.84
	6	0.68	4.08	3.00	1.0000	8.01	48.06	33.26	0.2604	91.99
	SJM		4.08	3.00	1.0000		85.07	73.77	0.5776	
CA	3	0.0	0.0	0.0	0.0	7.74	23.23	31.23	0.2445	96.13
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SUM		0.0	0.0	0.0		23.23	31.23	0.2445	
AI	7	0.0	0.0	0.0	0.0	5.62	39.33	22.72	0.1779	94.38
	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SUM		0.0	0.0	0.0		39.33	22.72	0.1779	
ALL			4.08	3.00	1.0000		147.63	127.73	1.0000	

DAY = 3., CASE = TEST

A/C STATUS - AT BASES

	1	BASE 2	3	4	TOTAL
A/C TYPE					
1	9.	0.	0.	10.	19.
2	10.	9.	0.	10.	29.
3	9.	0.	0.	9.	19.
4	0.	10.	0.	9.	19.
SUM	28.	19.	0.	38.	85.

MUNITION STATUS - REMAINING STOCKS

	1	BASE 2	3	4	TOTAL
MUN TYPE					
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.

DAY = 3., CASE = TEST

MUNITION STATUS - TODAY'S CONSUMPTION

TOTAL

	1	BASE 2	3	4
MUN TYPE				
1	1.	1.	0.	1.
2	1.	1.	0.	1.
3	1.	1.	0.	1.
4	1.	1.	0.	1.

3.
3.
3.
3.

A/C STATUS - SUMMARY

A/C TYPE	SORTIES AVAIL.		SORTIES FLOWN		LOSSES		LOSSES PER SORTIE FLOWN	
	TODAY	CUM	TODAY	CUM	TODAY	CUM	TODAY	CUM
1	56.	106.	2.	41.	0.12	1.58	0.060	0.038
2	29.	88.	1.	34.	0.06	1.56	0.060	0.047
3	19.	68.	0.	30.	0.0	1.51	0.0	0.050
4	19.	68.	0.	23.	0.0	1.50	0.0	0.066
SUM	123.	329.	3.	128.	0.18	6.16	0.060	0.048

SUMMARY FOR RUN
TEST TRACE TEST CASE

DAY = 3., CASE = TEST

DAY	SORTIES FLOWN		CAS		MILITARY WORTH DESTROYED				ALL	
	DAILY	CUM	DAILY	CUM	CA		AI		DAILY	CUM
1	113.	113.	69.	69.	22.	22.	39.	39.	131.	131.
2	12.	125.	12.	81.	1.	23.	0.	39.	13.	144.
3	3.	128.	4.	85.	0.	23.	0.	39.	4.	148.

TEST CASE INPUT DECK--PROGRAM PRELOAD

```
//M5897#PL JOB (3171,010,141,0005,000),'PRELOAD',CLASS=F
// EXEC PGM=PRELOAD,REGION=200K
//STEPLIB DD DISP=SHR,DSN=M.M5897.A3171.TRACE
//GO.FT05F001 DD DDNAME=SYSIN
//GO.FT06F001 DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1330)
//GO.FT07F001 DD SYSOUT=B
//GO.FT10F001 DD UNIT=USER,DSN=M.M5897.A3171.KPSTST,
// SPACE=(4800,35),DISP=(NEW,CATLG),VOL=SER=USER05
//GO.FT11F001 DD UNIT=USER,DSN=M.M5897.A3171.DEFTST,
// SPACE=(800,(21,1)),DISP=(NEW,CATLG),VOL=SER=USER05
//GO.SYSIN DD *
70      5      8      5      4      8      2
71 1      1
71 2      2
71 3      4
71 4      3
71 5      0
72 1      1
72 2      2
72 3      3
72 4      4
72 5      5
72 6      6
72 7      7
72 8      8
73 1      1      1
73 2      1      2
73 3      1      3
73 4      2      1
73 5      2      2
74 1 1      10.40000.30000.20000.40000.3000
74 1 2      10.40000.30000.20000.40000.3000
74 1 3      10.40000.30000.20000.40000.3000
74 1 4      10.40000.30000.20000.40000.3000
74 1 5      10.40000.30000.20000.40000.3000
74 1 6      10.40000.30000.20000.40000.3000
74 1 7      10.40000.30000.20000.40000.3000
74 1 8      10.40000.30000.20000.40000.3000
74 2 1      10.40000.30000.20000.40000.3000
74 2 2      10.40000.30000.20000.40000.3000
74 2 3      10.40000.30000.20000.40000.3000
74 2 4      10.40000.30000.20000.40000.3000
74 2 5      10.40000.30000.20000.40000.3000
74 2 6      10.40000.30000.20000.40000.3000
74 2 7      10.40000.30000.20000.40000.3000
74 2 8      10.40000.30000.20000.40000.3000
74 3 1      10.40000.30000.20000.40000.3000
74 3 2      10.40000.30000.20000.40000.3000
74 3 3      10.40000.30000.20000.40000.3000
74 3 4      10.40000.30000.20000.40000.3000
74 3 5      10.40000.30000.20000.40000.3000
74 3 6      10.40000.30000.20000.40000.3000
74 3 7      10.40000.30000.20000.40000.3000
74 3 8      10.40000.30000.20000.40000.3000
74 4 1      10.40000.30000.20000.40000.3000
74 4 2      10.40000.30000.20000.40000.3000
74 4 3      10.40000.30000.20000.40000.3000
```

74	4	4	10.40000.30000.20000.40000.3000	
74	4	5	10.40000.30000.20000.40000.3000	
74	4	6	10.40000.30000.20000.40000.3000	
74	4	7	10.40000.30000.20000.40000.3000	
74	4	8	10.40000.30000.20000.40000.3000	
75	1	10.01000.02000.03000.01000.0200		
75	2	10.01000.02000.03000.01000.0200		
75	3	10.01000.02000.03000.01000.0200		
75	4	10.01000.02000.03000.01000.0200		
75	5	10.01000.02000.03000.01000.0200		
75	6	10.01000.02000.03000.01000.0200		
75	7	10.01000.02000.03000.01000.0200		
75	8	10.01000.02000.03000.01000.0200		
76	1	1	2	4
76	1	2	2	4
76	1	3	2	4
76	1	4	2	4
76	1	5	2	4
76	2	1	2	4
76	2	2	2	4
76	2	3	2	4
76	2	4	2	4
76	2	5	2	4
76	3	1	2	4
76	3	2	2	4
76	3	3	2	4
76	3	4	2	4
76	3	5	2	4
76	4	1	2	4
76	4	2	2	4
76	4	3	2	4
76	4	4	2	4
76	4	5	2	4
/*				
//				

TEST CASE OUTPUT--PROGRAM PRELOAD

INDICES OF INPUT TARGETS DELETED

INDICES OF INPUT A/C DELETED

5

INDICES OF INPUT MUNITIONS DELETED

INDICES OF -TGT- -A/C- -MUN- -WX- WHEN THERE EXISTS A KPSI GT ZERO AND A TERM. ATTR. LE ZERO

TEST CASE INPUT DECK--PROGRAM PREPROC

```
//M5897#PP JOB (3171,010,141,0005,000),'PREPROC',CLASS=F
// EXEC PGM=PREPROC,REGION=170K
//STEPLIB DD DISP=SHR,DSN=M.M5897.A3171.TRACE
//GO.FT05F001 DD DDNAME=SYSIN
//GO.FT06F001 DD SYSOUT=A,DCB=(RECFM=FRA,LRECL=133,BLKSIZE=1330)
//GO.FT07F001 DD SYSOUT=B
//GO.FT10F001 DD DSN=M.M5897.A3171.KPSTST,DISP=OLD
//GO.FT11F001 DD DSN=M.M5897.A3171.DEFTST,DISP=OLD
//GO.FT12F001 DD UNIT=SYSDA,SPACE=(4800,35)
//GO.FT13F001 DD UNIT=SYSDA,SPACE=(800,(21,1))
//GO.FT14F001 DD DSN=M.M5897.A3171.KPSTST,DISP=OLD
//GO.FT15F001 DD DSN=M.M5897.A3171.DEFTST,DISP=OLD
//GO.FT16F001 DD DSN=M.M5897.A3171.TABLTST,SPACE=(800,(21,1)),
// DISP=(NEW,CATLG),VOL=SER=USER05,UNIT=USER
//GO.SYSIN DD *
90
91 1 1 1 0.4 0.3 0.2 0.1
91 1 1 2 0.4 0.3 0.2 0.1
91 1 1 3 0.4 0.3 0.2 0.1
91 1 1 4 0.4 0.3 0.2 0.1
91 2 1 1 0.4 0.3 0.2 0.1
91 2 1 2 0.4 0.3 0.2 0.1
91 2 1 3 0.4 0.3 0.2 0.1
91 2 1 4 0.4 0.3 0.2 0.1
91 3 1 1 0.4 0.3 0.2 0.1
91 3 1 2 0.4 0.3 0.2 0.1
91 3 1 3 0.4 0.3 0.2 0.1
91 3 1 4 0.4 0.3 0.2 0.1
91 4 1 1 0.4 0.3 0.2 0.1
91 4 1 2 0.4 0.3 0.2 0.1
91 4 1 3 0.4 0.3 0.2 0.1
91 4 1 4 0.4 0.3 0.2 0.1
91 1 2 1 0.4 0.3 0.2 0.1
91 1 2 2 0.4 0.3 0.2 0.1
91 1 2 3 0.4 0.3 0.2 0.1
91 1 2 4 0.4 0.3 0.2 0.1
91 2 2 1 0.4 0.3 0.2 0.1
91 2 2 2 0.4 0.3 0.2 0.1
91 2 2 3 0.4 0.3 0.2 0.1
91 2 2 4 0.4 0.3 0.2 0.1
91 3 2 1 0.4 0.3 0.2 0.1
91 3 2 2 0.4 0.3 0.2 0.1
91 3 2 3 0.4 0.3 0.2 0.1
91 3 2 4 0.4 0.3 0.2 0.1
91 4 2 1 0.4 0.3 0.2 0.1
91 4 2 2 0.4 0.3 0.2 0.1
91 4 2 3 0.4 0.3 0.2 0.1
91 4 2 4 0.4 0.3 0.2 0.1
91 1 3 1 0.4 0.3 0.2 0.1
91 1 3 2 0.4 0.3 0.2 0.1
91 1 3 3 0.4 0.3 0.2 0.1
91 1 3 4 0.4 0.3 0.2 0.1
91 2 3 1 0.4 0.3 0.2 0.1
91 2 3 2 0.4 0.3 0.2 0.1
91 2 3 3 0.4 0.3 0.2 0.1
91 2 3 4 0.4 0.3 0.2 0.1
91 3 3 1 0.4 0.3 0.2 0.1
```


91 3 3 2	0.4	0.3	0.2	0.1
91 3 3 3	0.4	0.3	0.2	0.1
91 3 3 4	0.4	0.3	0.2	0.1
91 4 3 1	0.4	0.3	0.2	0.1
91 4 3 2	0.4	0.3	0.2	0.1
91 4 3 3	0.4	0.3	0.2	0.1
91 4 3 4	0.4	0.3	0.2	0.1
91 1 4 1	0.4	0.3	0.2	0.1
91 1 4 2	0.4	0.3	0.2	0.1
91 1 4 3	0.4	0.3	0.2	0.1
91 1 4 4	0.4	0.3	0.2	0.1
91 2 4 1	0.4	0.3	0.2	0.1
91 2 4 2	0.4	0.3	0.2	0.1
91 2 4 3	0.4	0.3	0.2	0.1
91 2 4 4	0.4	0.3	0.2	0.1
91 3 4 1	0.4	0.3	0.2	0.1
91 3 4 2	0.4	0.3	0.2	0.1
91 3 4 3	0.4	0.3	0.2	0.1
91 3 4 4	0.4	0.3	0.2	0.1
91 4 4 1	0.4	0.3	0.2	0.1
91 4 4 2	0.4	0.3	0.2	0.1
91 4 4 3	0.4	0.3	0.2	0.1
91 4 4 4	0.4	0.3	0.2	0.1
91 1 5 1	0.4	0.3	0.2	0.1
91 1 5 2	0.4	0.3	0.2	0.1
91 1 5 3	0.4	0.3	0.2	0.1
91 1 5 4	0.4	0.3	0.2	0.1
91 2 5 1	0.4	0.3	0.2	0.1
91 2 5 2	0.4	0.3	0.2	0.1
91 2 5 3	0.4	0.3	0.2	0.1
91 2 5 4	0.4	0.3	0.2	0.1
91 3 5 1	0.4	0.3	0.2	0.1
91 3 5 2	0.4	0.3	0.2	0.1
91 3 5 3	0.4	0.3	0.2	0.1
91 3 5 4	0.4	0.3	0.2	0.1
91 4 5 1	0.4	0.3	0.2	0.1
91 4 5 2	0.4	0.3	0.2	0.1
91 4 5 3	0.4	0.3	0.2	0.1
91 4 5 4	0.4	0.3	0.2	0.1
91 1 6 1	0.4	0.3	0.2	0.1
91 1 6 2	0.4	0.3	0.2	0.1
91 1 6 3	0.4	0.3	0.2	0.1
91 1 6 4	0.4	0.3	0.2	0.1
91 2 6 1	0.4	0.3	0.2	0.1
91 2 6 2	0.4	0.3	0.2	0.1
91 2 6 3	0.4	0.3	0.2	0.1
91 2 6 4	0.4	0.3	0.2	0.1
91 3 6 1	0.4	0.3	0.2	0.1
91 3 6 2	0.4	0.3	0.2	0.1
91 3 6 3	0.4	0.3	0.2	0.1
91 3 6 4	0.4	0.3	0.2	0.1
91 4 6 1	0.4	0.3	0.2	0.1
91 4 6 2	0.4	0.3	0.2	0.1
91 4 6 3	0.4	0.3	0.2	0.1
91 4 6 4	0.4	0.3	0.2	0.1
91 1 7 1	0.4	0.3	0.2	0.1
91 1 7 2	0.4	0.3	0.2	0.1

91	1	7	3	0.4	0.3	0.2	0.1
91	1	7	4	0.4	0.3	0.2	0.1
91	2	7	1	0.4	0.3	0.2	0.1
91	2	7	2	0.4	0.3	0.2	0.1
91	2	7	3	0.4	0.3	0.2	0.1
91	2	7	4	0.4	0.3	0.2	0.1
91	3	7	1	0.4	0.3	0.2	0.1
91	3	7	2	0.4	0.3	0.2	0.1
91	3	7	3	0.4	0.3	0.2	0.1
91	3	7	4	0.4	0.3	0.2	0.1
91	4	7	1	0.4	0.3	0.2	0.1
91	4	7	2	0.4	0.3	0.2	0.1
91	4	7	3	0.4	0.3	0.2	0.1
91	4	7	4	0.4	0.3	0.2	0.1
91	1	8	1	0.4	0.3	0.2	0.1
91	1	8	2	0.4	0.3	0.2	0.1
91	1	8	3	0.4	0.3	0.2	0.1
91	1	8	4	0.4	0.3	0.2	0.1
91	2	8	1	0.4	0.3	0.2	0.1
91	2	8	2	0.4	0.3	0.2	0.1
91	2	8	3	0.4	0.3	0.2	0.1
91	2	8	4	0.4	0.3	0.2	0.1
91	3	8	1	0.4	0.3	0.2	0.1
91	3	8	2	0.4	0.3	0.2	0.1
91	3	8	3	0.4	0.3	0.2	0.1
91	3	8	4	0.4	0.3	0.2	0.1
91	4	8	1	0.4	0.3	0.2	0.1
91	4	8	2	0.4	0.3	0.2	0.1
91	4	8	3	0.4	0.3	0.2	0.1
91	4	8	4	0.4	0.3	0.2	0.1
92	1	1		.01	.02	.03	.04
92	1	2		.01	.02	.03	.04
92	1	3		.01	.02	.03	.04
92	1	4		.01	.02	.03	.04
92	2	1		.01	.02	.03	.04
92	2	2		.01	.02	.03	.04
92	2	3		.01	.02	.03	.04
92	2	4		.01	.02	.03	.04
92	3	1		.01	.02	.03	.04
92	3	2		.01	.02	.03	.04
92	3	3		.01	.02	.03	.04
92	3	4		.01	.02	.03	.04
92	4	1		.01	.02	.03	.04
92	4	2		.01	.02	.03	.04
92	4	3		.01	.02	.03	.04
92	4	4		.01	.02	.03	.04
92	5	1		.01	.02	.03	.04
92	5	2		.01	.02	.03	.04
92	5	3		.01	.02	.03	.04
92	5	4		.01	.02	.03	.04
92	6	1		.01	.02	.03	.04
92	6	2		.01	.02	.03	.04
92	6	3		.01	.02	.03	.04
92	6	4		.01	.02	.03	.04
92	7	1		.01	.02	.03	.04
92	7	2		.01	.02	.03	.04
92	7	3		.01	.02	.03	.04

92	7	4	.01	.02	.03	.04
92	8	1	.01	.02	.03	.04
92	8	2	.01	.02	.03	.04
92	8	3	.01	.02	.03	.04
92	8	4	.01	.02	.03	.04
93	1	1	2	4		
93	2	1	2	4		
93	3	1	2	4		
93	4	1	2	4		
93	1	2	2	4		
93	2	2	2	4		
93	3	2	2	4		
93	4	2	2	4		
93	1	3	2	4		
93	2	3	2	4		
93	3	3	2	4		
93	4	3	2	4		
93	1	4	2	4		
93	2	4	2	4		
93	3	4	2	4		
93	4	4	2	4		
94		1	2			
94		2	1			
94		3	2			
94		4	1			
95	1		2	1		
95	2		2	1		
95	3		1	2		
95	4		1	2		
95	5		2	1		
95	6		2	1		
95	7		1	3		
95	8		1	3		
/*						
//						

TEST CASE OUTPUT--PROGRAM PREPROC

[illegible]

[illegible]

[illegible]

A/C TYPE 4, PAGE 1 OF 1

MUN	1				2				3				4																													
TGT	H	M	L	N	H	M	L	N	H	M	L	N	H	M	L	N	H	M	L	N	H	M	L	N	H	M	L	N	H	M	L	N	H	M	L	N	ALL	MUN				
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																					4	4
2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	4	4	4	4	16	4
3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	4	4	4	4	16	4
4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	4	4	4	4	16	4
5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	4	4	4	4	16	4
6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	4	4	4	4	16	4
7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	4	4	4	4	16	4
8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	4	4	4	4	16	4
SUM	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8																	32	32	32	32		
ALL		32				32				32				32				32																								
TGT		8				8				8				8				8																								

A/C TYPE 1, PAGE 1 OF 2

MUN	1				2				3			
TGT	H	M	L	N	H	M	L	N	H	M	L	N
1	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
2	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
3	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
4	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
5	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
6	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
7	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
8	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000

A/C TYPE 1, PAGE 2 OF 2

MUN													
TGT	H	M	L	N	H	M	L	N	H	M	L	N	
1	0.4000	0.3000	0.2000	0.1000									
2	0.4000	0.3000	0.2000	0.1000									
3	0.4000	0.3000	0.2000	0.1000									
4	0.4000	0.3000	0.2000	0.1000									
5	0.4000	0.3000	0.2000	0.1000									
6	0.4000	0.3000	0.2000	0.1000									
7	0.4000	0.3000	0.2000	0.1000									
8	0.4000	0.3000	0.2000	0.1000									

A/C TYPE 2, PAGE 1 OF 2

MUN	1				2				3			
TGT	H	M	L	N	H	M	L	N	H	M	L	N
1	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
2	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
3	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
4	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
5	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
6	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
7	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
8	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000

A/C TYPE 2, PAGE 2 OF 2

MUN			4										
TGT	H	M	L	N	H	M	L	N	H	M	L	N	
1	0.4000	0.3000	0.2000	0.1000									
2	0.4000	0.3000	0.2000	0.1000									
3	0.4000	0.3000	0.2000	0.1000									
4	0.4000	0.3000	0.2000	0.1000									
5	0.4000	0.3000	0.2000	0.1000									
6	0.4000	0.3000	0.2000	0.1000									
7	0.4000	0.3000	0.2000	0.1000									
8	0.4000	0.3000	0.2000	0.1000									

A/C TYPE 3, PAGE 1 OF 2

MUN	1				2				3			
TGT	H	M	L	N	H	M	L	N	H	M	L	N
1	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
2	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
3	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
4	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
5	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
6	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
7	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
8	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000

A/C TYPE 3, PAGE 2 OF 2

MUN													
TGT	H	M	L	N	H	M	L	N	H	M	L	N	
1	0.4000	0.3000	0.2000	0.1000									
2	0.4000	0.3000	0.2000	0.1000									
3	0.4000	0.3000	0.2000	0.1000									
4	0.4000	0.3000	0.2000	0.1000									
5	0.4000	0.3000	0.2000	0.1000									
6	0.4000	0.3000	0.2000	0.1000									
7	0.4000	0.3000	0.2000	0.1000									
8	0.4000	0.3000	0.2000	0.1000									

A/C TYPE 4, PAGE 1 OF 2

MUN	1				2				3			
TGT	H	M	L	N	H	M	L	N	H	M	L	N
1	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
2	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
3	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
4	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
5	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
6	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
7	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000
8	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000	0.4000	0.3000	0.2000	0.1000

A/C TYPE 4, PAGE 2 OF 2

MUN			4										
TGT	H	M	L	N	H	M	L	N	H	M	L	N	
1	0.4000	0.3000	0.2000	0.1000									
2	0.4000	0.3000	0.2000	0.1000									
3	0.4000	0.3000	0.2000	0.1000									
4	0.4000	0.3000	0.2000	0.1000									
5	0.4000	0.3000	0.2000	0.1000									
6	0.4000	0.3000	0.2000	0.1000									
7	0.4000	0.3000	0.2000	0.1000									
8	0.4000	0.3000	0.2000	0.1000									

TEST CASE INPUT DECK--PROGRAM RESUPPLY

```
//M5897#RS JOB (3171,010,141,0005,000),'RESUPPLY',CLASS=D
//GD EXFC PGM=RESUPPLY,REGION=64K
//STEPLIB DD DISP=SHR,DSN=M.M5897.A3171.TRACE
//GD.FT05F001 DD DDNAME=SYSIN
//GD.FT06F001 DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1330)
//GD.FT07F001 DD SYSOUT=B
//GD.FT17F001 DD UNIT=USER,SPACE=(1000,21),DSN=M.M5897.A3171.RSPYTST,
// DISP=(NEW,CATLG),VOL=SER=USER05
//GD.SYSIN DD *
80
81 1 1 1 1
81 2 1 1 2 2 2
81 3 2 3 50 4 50
81 4 2 3 50 4 50
81 1 3 1 2 2 2 3 2 4 2
81 2 3 1 2 2 2 3 2 4 2
81 3 3 1 2 2 2 3 2 4 2
81 4 3 1 2 2 2 3 2 4 2
/*
//
```

TEST CASE OUTPUT--PROGRAM RESUPPLY

MUNITION RESUPPLY ARRAY 1

	1	BASE 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
MUN TYPE																					
1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MUNITION RESUPPLY ARRAY 2

	1	BASE 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
MUN TYPE																					
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
4	0	0	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MUNITION RESUPPLY ARRAY 3

	BASE																				TOTAL
MUN TYPE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
3	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
4	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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