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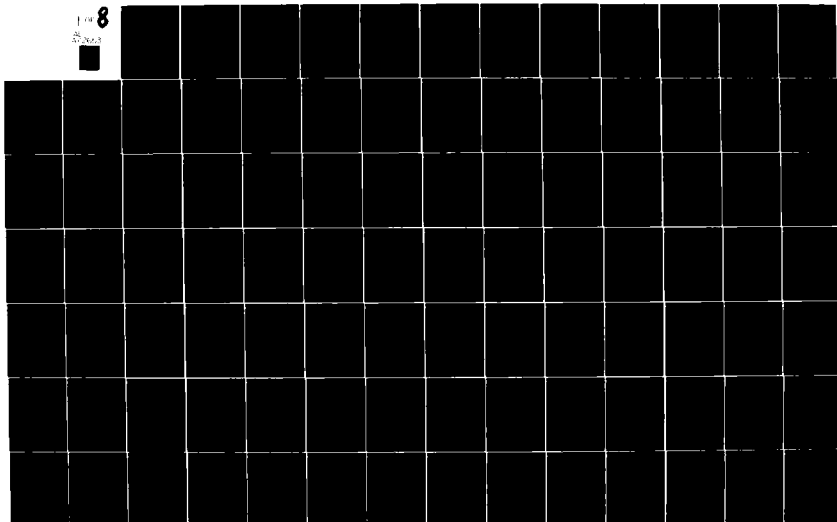
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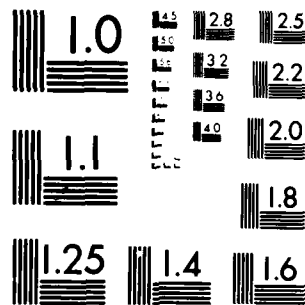
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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

(2)

Technical Report TR 8-76  
July 1976

Directorate of Combat Operations Analysis  
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Fort Leavenworth, Kansas 66027

DIVWAG MODEL DOCUMENTATION  
VOLUME II  
PROGRAMMER/ANALYST MANUAL

ACN 21704

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## CHAPTER 13

### MOVEMENT MODEL

1. **MILITARY UNIT MOVEMENT.** The DIVWAG Movement Model is designed to represent the movement of military units about the battlefield. The model accomplishes the repositioning of units by considering characteristic administrative or tactical movement rates for the type unit to be moved; the effects of barriers and facilities that may tend to impede or improve the unit's movement capability; the effects of variations in terrain, weather, and light conditions on the unit's movement capability; and the availability of fuel.

a. **DSL-Ordered Movement.** Tactical and administrative movement of units by ground or air in the Movement Model is usually in response to gamer-planned DSL orders. The gamer must plan, coordinate, and schedule all movement performed by this model, except that controlled by the Engineer Model.

b. **Model-Ordered Movement.** The Engineer Model sets up the necessary parameters and calls the Movement Model, allowing it to perform the actual relocation of an engineer unit. The Engineer Model is described in Chapter 14 to this section.

c. **Automatic Movement.** For the most part, movements of units not in direct response to gamer input orders are accomplished within other models of the DIVWAG System. The Ground Combat Model (Chapter 7) moves maneuver units while they are actually engaged in combat, the Combat Service Support Model (Chapter 16) controls logistic movements, and the Air Ground Engagement Model (Chapter 10) accomplishes the movement of air units when this movement is in response to automatically generated missions. The reconnaissance portion of the Intelligence and Control Model regulates movement of reconnaissance units and subunits. Treatment of these movement categories is documented with the appropriate models.

## 2. **MODEL DESIGN:**

a. **General.** The Movement Model is designed to represent aerial and ground movement capabilities using a four-phase process to integrate gamer-planned and scheduled unit movement into dynamic unit locations within the DIVWAG System during the game period. This process is illustrated in Figure IV-13-1, Movement Model Macroflow, with the phases identified as I, II, III, and IV. Briefly, these four phases consist of the development of DSL movement orders: phase I; the integration of these orders into model path segments, phase II; the determination of the appropriate unit rate along these model paths, phase III; and, finally, the performance of the unit's movement along the model segment and the update of unit location and consumption data, phase IV. The last three phases are internally performed during the dynamic game period by the movement submodels, while the initial phase is performed external to the Movement Model as a gamer function or internal function of another model.

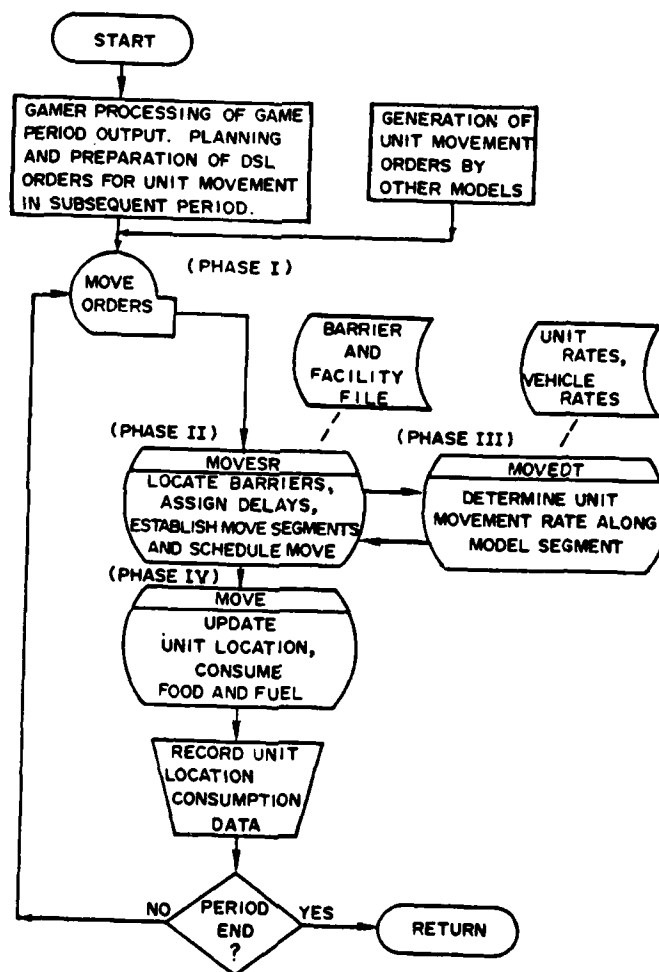


Figure IV-13-1. Movement Model Macroflow

(1) Unit Movement Planning, Phase I. Briefly, the first phase consists of the planning, coordination, and scheduling of unit movement and, in the case of gamer-ordered movements, is accomplished prior to each game period. (planning accomplished internal to other models is documented with those models). Phase I provides the Movement Model with movement parameters from which to generate the required unit movement. Although this first phase is external to the movement submodels representing the other three phases in the figure, it nonetheless provides the vital information necessary to generate unit movement within the model. The DSL orders pertinent to phase I are discussed in subparagraph b(1) below.

(2) Model Move Segments and Coordination. Phase II is the move segment determination and coordination (routine MOVESR) and functions to integrate the movement orders into scheduled model move segments within the DIVWAG system. This routine divides the total move path (order segment) into model move segments, the endpoints of which specify the positions where the units are actually located within the model. This submodel also integrates effects of barriers and facilities on movement into the unit's movement schedule when required to do so.

(3) Unit Movement Timing. The movement rate determination routine (MOVEDT) establishes the appropriate unit movement rates along the model's move segments. This rate, when combined with the length of the move segment, provides the time sequencing information needed to schedule the completion time of the model's movement event activity.

(4) Move Segment Completion. The performance of the move along the model segment is accomplished in the fourth phase by the move performance routine (MOVE). In this routine the unit's location in the model is updated, and the unit's consumption of food and fuel along the move segment is recorded.

b. Specific Model Design. This paragraph discusses the specific design aspects of the Movement Model applying to the overall model. It provides a summary overview of the various submodel functions. The model design is discussed with respect to four topics: DSL movement orders, model move segments, unit movement rates, and the Movement Model interfaces with other DIVWAG models.

(1) DSL Movement Orders. The gamer DSL orders that schedule the simulated ground movement in the model are move, advance, and withdraw. The corresponding order for air movement is the fly order. A typical ground movement order given to a unit might be of the following form:

STAY UNTIL 0800.  
MOVE TO X<sub>1</sub>-Y<sub>1</sub>, X<sub>2</sub>-Y<sub>2</sub>, X<sub>D</sub>-Y<sub>D</sub> BY TRGM.

The movement path schematic for the unit given such an order is illustrated in Figure IV-13-2. The DSL ground movement order contains the Movement Model parameters in the form of the travel mode mnemonic, TRGM; the specific type of move order, MOVE; the series of DSL path segment endpoints specifying the



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travel route to be followed, I1, I2, and D; and the scheduled time of departure, 0800, as determined by the stay order immediately preceding the move order. (Nonmovement, or remaining in position, is accomplished by the stay and prepare orders for ground units and by the loiter order for air units).

(a) Travel Mode Mnemonic. The travel mode mnemonic contains the gamer specification of the type of unit movement desired, the route type, and the unit's formation type. The type of unit movement requested may be administrative or tactical:

A - Administrative. This category implies movement of units by road nets and uses the most efficient transportation systems available with tactical considerations of secondary importance.

T - Tactical. Movement of this type includes cross country; movement in partially deployed, reconnaissance, or column march formations; and tactical road marches as part of an attack, withdrawal, or other tactical plan external to maneuver movement within ground combat engagements.

The route type defined in the DSL travel mode mnemonic is one of the following types:

CC - Cross Country. Route of the unit is subject to natural terrain conditions existing in its path.

RA - Paved Roads. This route type is such that road beds are asphalt or concrete with at least two lanes with good shoulders, and the route is not significantly dependent upon short range or local terrain features.

RG - Gravel Roads. Route is gravel or similar surfaced road with periodic maintenance.

RD - Dirt Roads. Route is dirt, road is narrow and/or marginally maintained and is subject to terrain undulations and other local terrain features.

The unit formation is specified as column march formation, reconnaissance, or deployed, and is identified as:



- M - Column March. The unit is in a column formation on a road or cross country route.
- R - Reconnaissance. Deployment pattern on cross country by a unit on a ground reconnaissance type mission.
- D - Deployed. Unit is partially deployed in a formation in anticipation of imminent contact with the enemy.

The letters composing the travel mode mnemonic are used in the model to identify the movement parameters applicable to the current unit movement. The first character specifies the move type, the second and third are used to indicate the route type, and the fourth is used to designate the formation type. The various combinations allowed in any particular game are defined in the pregame data preparation process. A typical group used for a game might be as follows:

- ARAM - Administrative move on all-weather roads in march column formation.
- ARGM - Administrative move on gravel roads in march column formation.
- TRAM - Tactical move on asphalt, concrete, or similar paved road in a march column formation.
- TRGM - Tactical move on improved, gravel, or similar surfaced roads in a march column formation.
- TRDM - Tactical move on unpaved or dirt roads in a march column formation.
- TRGR - Tactical move on improved, gravel roads in a reconnaissance type formation.
- TCCM - Tactical cross country move in a march column formation.
- TCCR - Tactical cross country move in a reconnaissance formation.
- TCCD - Tactical cross country move in a deployed formation.

The travel mode mnemonic is discussed extensively in Appendix A to this chapter.

(b) Travel Route. In addition to the type of route specified for the unit's movement, the actual route to be traversed is designated in the movement order by a set of intermediate coordinates and the final objective coordinates for the move; thus, the gamer specifies the actual route to be taken by the unit as a series of line segments. These segments are referred to as order segments and are to be distinguished from the model move segments discussed in subparagraph (2) below. Both types of segments are illustrated on the movement schematic of Figure IV-13-2. If the route type specified in the travel mode mnemonic is by road, the gamer-generated order segments are to be chosen such that the straight line segments approximate road routes actually available to the unit. In the model's computation of road movements a factor of 10 percent is automatically added to the straight-line distance to allow for a representation of the actual minor deviations from a straight line experienced on most roads. (This subject is discussed in the move rate determination routine, MOVEDT). In road movement, as well as in other unit movement, the DSL movement parameters in the DSL order must be carefully chosen to realistically represent the terrain environment of the unit as derived from a detailed map study of the travel routes designated.

(c) Unit Time of Departure. The scheduled time at which the model commences to move the unit is implied in the DSL order string. In the example, the preceding stay order for the unit established the departure time as 0800 or, equivalently in the model, the completion time of the unit's stay activity.

(2) Model Move Segments. Within the Movement Model, dynamic relocation of a unit is accomplished in discrete model move segments. The model move segments are determined by the location of the unit with respect to endpoints of the order segment, the boundaries of terrain cells, and the locations of barriers in the path of the moving unit. Although units will always complete a model move segment, it is possible for a unit not to complete an order segment and to stop en route to the desired objective. The termination of model move segments at terrain cell boundaries allows the unit's movement rate to be adjusted to represent unit mobility response to changing terrain features. In the case of a barrier, if the unit's route will cause the unit to encounter the barrier, the endpoint of a model move segment is determined by the location of the barrier. The effect of the barrier on the unit's movement is assessed as discussed in the specifications for routine MOVESR.

(3) Unit Movement Rates. To represent unit movement rates along the DSL ordered routes, the model requires two sets of rate tables: the unit type designator (UTD) normal rate tables for road and cross country movement and the mobility class rate tables for road and cross country movement. Both sets of tables are developed in the pregame data preparation phase in accordance with the procedure described in Appendix A to this Chapter. The rates in these tables are representative rates for the various terrain, weather, and light conditions. Briefly, the mobility class rates are intended to represent short-term characteristic vehicle rates under the specified conditions, while the UTD normal rates reflect unit movement for given situations, formations, and

environmental conditions. The UTD normal rates are representative of long-term or sustained rates to be expected under the existing circumstances, representing standard or planning rates. These rates are discussed in greater detail in the specifications of the move rate determination routine, MOVEDT. Once the rate of the unit is established for the segment, it is combined with the length of the segment to compute the required time for the unit to complete the movement along the model segment. This time is then used in the event sequencing structure of the DIVWAG system to effect the timing of the dynamic performance of the move and subsequent updating of the unit location on the terrain cell grid.

(4) Movement Model Interfaces with Other Models. The Movement Model provides the Combat Service Support Model and the Ground Combat Model with rates for generating automatic movement internal to these models. It interfaces the system Environment Model, using weather, terrain, and light conditions to establish the appropriate move rates. An interface is also effected with the Area Fire and Air Ground Engagement Models when casualties due to indirect or aerial fires are assessed and the unit's movement is interrupted. The detection of moving units by the Intelligence and Control Model is triggered by initiation of each move segment. The Engineer Model provides all barrier information for the Movement Model.

(a) Ground Combat Model Interface. Movement within the Ground Combat Model represents cross country ground maneuver movement in a deployed formation while in contact with the enemy. To accomplish this movement, the Ground Combat Model requires the vehicular mobility class rates used within the Movement Model. The specific use of these rates is described in Chapter 7 of this section. The Movement Model initiates a ground combat engagement when an advancing attacker comes within range of an opposing unit, which has been predesignated within a DSL battle scenario.

(b) Combat Service Support Model Interface. To develop resupply schedules and to represent the movement of logistical vehicles, the Combat Service Support Model accesses the vehicular movement rate tables provided in the Movement Model. Details are specified in Chapter 16 of this section.

(c) Environment Model Interface. To determine rates representative of environmental conditions the Movement Model uses weather, terrain, and light conditions supplied by the Environment Models to locate the correct rates in the movement rate tables. The rate tables are prepared pregame and include consideration of all possible environmental conditions that might be encountered during the game period. The specific parameters and their use are described in detail in the specifications of routine MOVEDT.

(d) Engineer Model Interface. A routine of the Engineer Model is interrogated to determine if a move segment intersects a barrier line. If it does, the Engineer Model also provides other information about the barrier, which may allow the unit to be routed around the barrier or to an existing facility. If such rerouting is not feasible, the information is used to decide

whether to force the barrier or to request the Engineer Model to construct a facility (breach or bridge) at that point.

(e) Nuclear Assessment Model Interface. Craters and radiation resulting from nuclear detonations serve as barriers to unit mobility. If the Movement Model is informed that a unit's move segment will intersect a nuclear barrier, additional information is obtained from the Nuclear Assessment Model. This information allows the Movement Model to determine if the unit should bypass the barrier or cross the barrier and accept the radiation.

(f) Area Fire Model and Air Ground Engagement Model Interfaces. Target coverage calculations within the Area Fire Model are synchronized with Movement Model move segment determination so that the location of a moving unit at the time of impact is correctly projected for use in assessing the effects of each area fire volley. Details of the target coverage calculation are contained in Chapter 8.

(g) Suppression Model Interface. Both the Area Fire and Air Ground Engagement Models set up an activity suppression event that causes a unit's movement to be interrupted when it receives fire. A detailed explanation of the modeling of suppression is contained in Chapter 11.

(h) Intelligence and Control Model Interface. The movement event scheduling routine calls the conditional collection of moving targets routine to determine if any stationary sensor is in a position to detect the moving unit during the current model move segment.

### 3. SUBMODEL SPECIFICATIONS:

a. General. Each of the three movement submodels is discussed in the following subparagraphs. Together, they represent the Movement Model's response to gamer orders. The model Move Segment Determination and Coordination Submodel (routine MOVESR) interfaces unit movement activity into the DIVWAG system consistent with other unit military activities represented by other models. The Movement Rate Determination Submodel (routine MOVEDT) establishes typical unit rates and provides the MOVESR Submodel with time sequencing information for the proper coordination of unit movement events. Each arrival at the endpoint of a model move segment is scheduled as a movement event. Actions performed by the MOVE Submodel consist of updating the unit's location and consumables, particularly fuel, when the arrival at a model move segment is scheduled. The submodels are described in the sequence in which they operate in the system.

b. Model Move Segment Determination and Coordination. The macroflow of MOVESR is shown in Figure IV-13-3. Based on the pending movement order, the endpoint of the next model move segment is determined and, in conjunction with the Move Rate Determination Submodel (MOVEDT), the projected time of unit arrival at that endpoint is calculated. The actual move event, which is arrival at this endpoint, is then entered into the DIVWAG event sequencing logic, as discussed in Chapter 2 of this section.

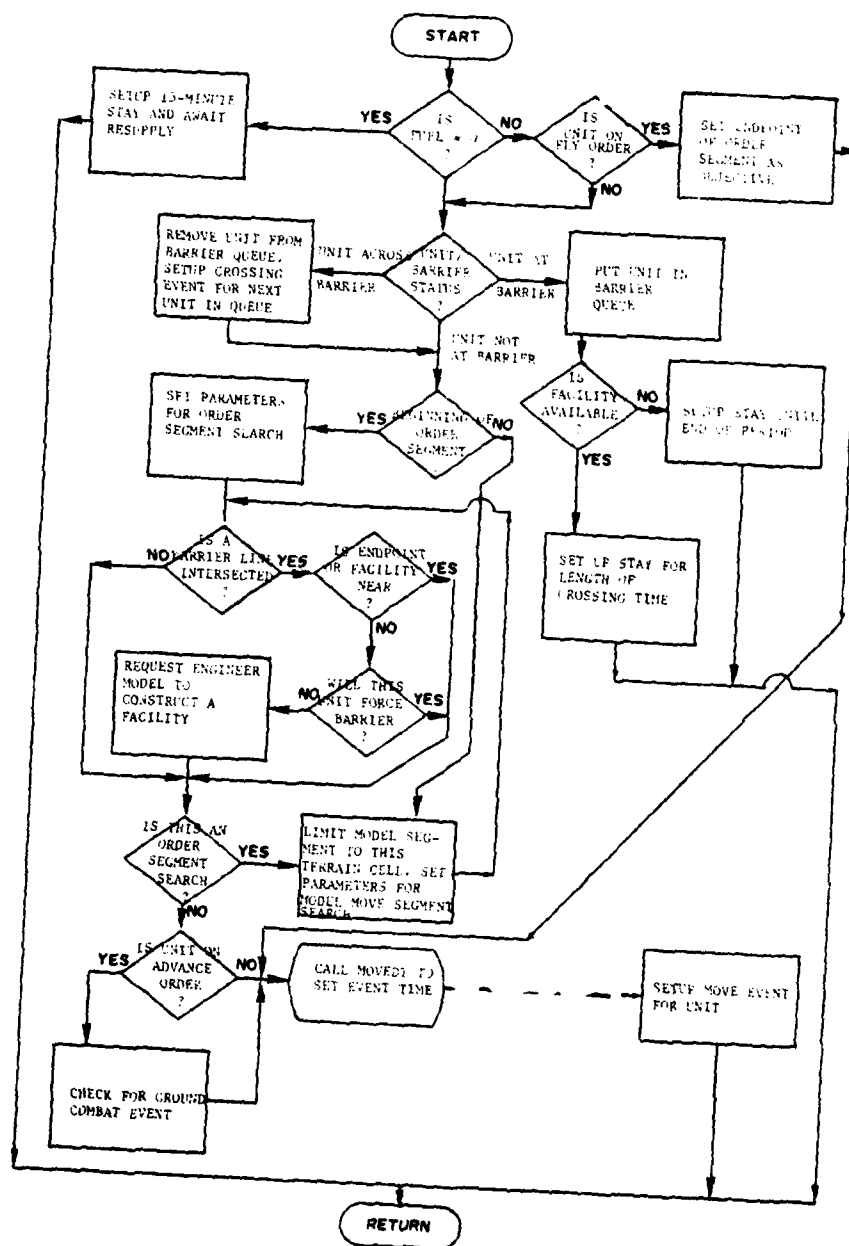


Figure IV-13-3. MOVESR Macroflow

(1) Ground Movement. The model move segments of a ground movement will have their endpoints at the endpoints of order segments, at terrain cell boundaries, or at barriers. The concept is illustrated in Figure IV-13-2 where 13 model move segment endpoints are generated; three for the order segments, one for the barrier, and nine for terrain cell boundaries. One cycle through each routine is generally required for each model move segment. As each move event (arrival at an endpoint) is completed, MOVESR is called to find the next model move segment's endpoint, and MOVEDT is called to schedule arrival time at that point.

(2) Air Movement. Since terrain characteristics or ground obstacles do not affect air movement, the model move segment endpoints are those of the DSL move segments for air movement. The DSL fly order specifies a flight speed, which is used to schedule arrival of the unit at move segment endpoints.

(3) Movement Delays:

(a) MOVESR automatically schedules a movement delay if a unit is out of fuel by generation of a stay event of 15-minutes duration for the unit. Additional 15-minute stays are assessed until the unit is resupplied with fuel. This procedure will cause a unit to cease movement when fuel is exhausted and to remain immobile (stay) until its fuel is replenished by the Combat Service Support Model. When the unit once more has fuel, its movement is continued along the ordered route.

(b) A unit may be delayed by barriers as described in subparagraph (4) below.

(4) Effects of Barriers and Facilities:

(a) As a unit begins its movement along an ordered move segment, a search, using force intelligence information, is made to determine if that segment intersects a barrier line (e.g., river, minefield, forest). If it does, the unit will be routed around the end of the barrier line or to an existing facility, if either is sufficiently close. The current criterion for nearness is one-half the sum of the unit's width and depth. If neither an end of the barrier or a facility is near, the unit will continue its movement to the point of intersection.

(b) If the barrier may be forced (e.g., minefield), a decision table is interrogated to determine if the unit should force or should request engineering action and wait for a facility to be constructed. The force/no force decision is a function of the time required to breach the barrier, the casualties that would be assessed if it is forced, and the priority of the move. This decision table is part of the pregame constant data.

(c) If the barrier cannot be forced (e.g., a river), or the decision is not to force, the Engineer Model is requested to provide a facility at the point of intersection. This request is made at the time the barrier is discovered to be in the unit's path. When the unit arrives at the site of construction, it is given a stay order and will remain in the stay mode until the facility is complete or the period ends.

(d) As the Movement Model prepares to move the unit along each model move segment, a second search for barriers is made along that portion of the movement path with actual barrier information being used. This allows the effects of barriers and facilities unknown to the unit's force intelligence to be modeled. If an intersection with an active barrier (e.g., minefield or nuclear radiation) is found, casualties will be assessed the unit discovering the barrier. Then the logic described in subparagraphs (a), (b), and (c) above is employed again to determine the unit's course of action.

(e) Unless the facility provided is a bridge constructed as part of a roadway and the unit is marching on that road, passing through the facility will temporarily disrupt the formation of the unit and will cause lost time. The Engineer Model provides a crossing rate in terms of vehicles per minute. This rate and a count of the vehicles in the unit allow the time lost to be calculated.

(f) It is possible that a unit will request the use of a facility while it is already in use or while it is under construction and other units are waiting for its completion. If this situation occurs, the unit will be placed in a wait queue. If the unit has decided to force the barrier and no engineer activity has begun, it will be placed first in the queue and be allowed to force immediately. Otherwise, the unit will be positioned in queue by priority and, within priority, on a first-in-first-out basis.

(5) Advance to Ground Combat Engagement. If a move is ordered by a DSL advance order, MOVESR coordinates the initiation of the designated battle. A sample advance order string is:

ADVANCE TO 1162000 - 0910000.  
ENGAGE IN BATTLE FOXTROT.

MOVESR continues to move the unit toward the objective point in 300-meter move segments. Each segment is checked to determine if the unit will come within 3000 meters of an opposing unit listed in the scenario of Battle FOXTROT. Upon reaching that point, the unit is automatically released from the Movement Model and is turned over to the Ground Combat Model by converting the order from advance to engage. If a unit listed in a battle scenario is given a DSL withdraw order, it is also moved in 300-meter segments and automatically released to the Ground Combat Model when the battle is initiated.

c. Movement Rate Determination Submodel (MOVEDT). Unit movement rates are established in the MOVEDT. A macroflow is illustrated in Figure IV-13-4, and a schematic of the rate selection process is shown in Figure IV-13-5. The rates available to the model are established in the pregame data preparation phase as illustrated in the lower left and right corners of Figure IV-13-5. The unit's movement rate is established by identifying the nature of the move from the travel mode mnemonic and by the prevailing environmental conditions. Using these parameters the appropriate unit movement rate tables and the mobility class short-term rate tables are obtained. The unit is checked to ascertain its present composition in terms of vehicular mobility classes and is not allowed to exceed the maximum rate at which its component vehicles can move. If a delay is encountered on a tactical move, the unit is allowed to exceed its standard movement rate in an attempt to make up for lost time. The rate used is that of the unit's slowest vehicle not in an excluded mobility class. Exclusion of mobility classes is discussed in subparagraph (2)(c), below. Thus, a unit executing a tactical move is able to draw from a reserve mobility capability, if it exists, along each order segment when required to do so by dynamic events causing delays for the unit.

(1) Environmental Parameters. The Movement Model uses selected environmental parameters as listed below. (A detailed discussion of the Environment Model used within DIWAG is contained in Chapter 4 of this section.

(a) Road Terrain Factors. The roughness and vegetation index of the Environment Model is used to specify two road terrain factors for each terrain cell: terrain I, flat, gently rolling to undulating (roughness and vegetation index equals 1 to 5); and terrain II, undulating, broken to rough (roughness and vegetation index equals 6 to 9).

(b) Day and Night. Times from Beginning of Morning Nautical Twilight (BMNT) to End of Evening Nautical Twilight (EENT) are considered daylight, and times from EENT to BMNT are considered night.

(c) Weather. The weather factors considered in the model are precipitation; none, light, or heavy; and fog. The model is designed to require data for only typical summer or typical winter conditions during a single game. It is expected that input data for summer and winter would differ significantly. The model assumes fog has the same effect as heavy precipitation upon unit movement.

(d) Cross Country Terrain Factors. Cross country movement rates may be specified for up to 20 terrain trafficability indexes as described in Chapter 4 of this section.

(2) Movement Rate Data. Three basic groups of data are used by the Movement Rate Determination Submodel: unit mobility category movement rates, equipment mobility class movement rates, and equipment mobility class exclusion tables.

(a) Unit Mobility Category Movement Rates. In the pregame data preparation process, type units are grouped together into unit mobility



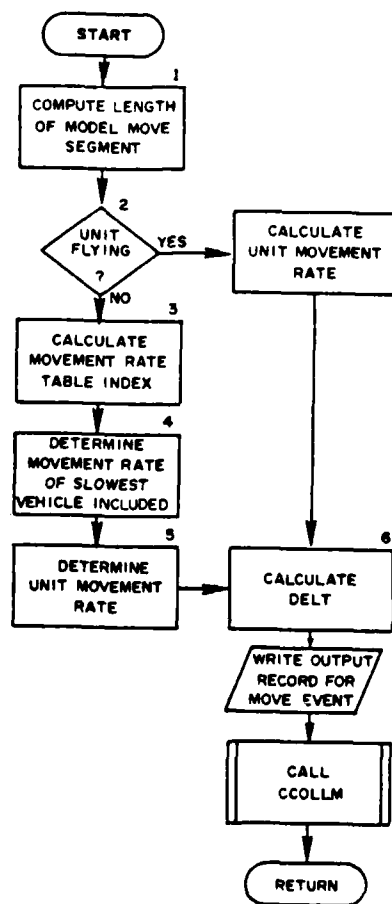


Figure IV-13-4. MOVEDT Macroflow



categories. A unit mobility category is a group of type units, all of which will move at similar unit movement rates under similar conditions. For each unit mobility category, a set of unit movement rates must be contained in the data base. These are the rates at which units in the specified mobility category will normally move in each type of movement to be defined by a movement mode mnemonic [see paragraph 2b(1)(a)] under the set of environmental conditions treated by the model. Infantry and tank mobility categories must always be defined, as the movement rates for these categories are defaulted to under the conditions discussed in subparagraph (3)(d) below.

(b) Equipment Mobility Class Movement Rates. In pregame data preparation, all ground mobility items to be played in a game are assigned to mobility classes, which group together items assumed to have similar mobility characteristics and, thus, similar movement rates. A maximum of 20 mobility classes may be defined for each force, with the first class reserved for foot movement. For each mobility class, a set of movement rates is required, which is representative of maximum rates achievable for short-term movement (short-term catch-up rates). These rates are required for road and cross country movement under the set of environmental conditions dealt with in the model.

(c) Mobility Class Exclusion Tables. To allow for situations in which certain of the unit's mobility items should not be allowed to limit the unit's rate of movement (e.g., reconnaissance movement in which organic logistic vehicles would not normally be used), the mobility class exclusion tables identify for given unit mobility categories and travel modes the equipment mobility classes not allowed to limit unit movement. The foot class is used only as a default rate and need not be excluded.

(3) Movement Rate Determination. The rate at which a unit moves is determined by the travel mode mnemonic of the DSL order, environmental conditions at the time of the move, and the movement rate data. Generally, the travel mode mnemonic, the unit's mobility category, and environmental conditions are used to determine the unit mobility category movement rate that applies. Items organic to the unit at the time of the move are checked, via the equipment mobility class movement rate data, to ensure that the unit rate does not exceed equipment capability. The mobility class exclusion table may, however, override this check.

(a) Administrative Ground Movement. All DSL orders that specify administrative movement use the standard unit mobility category rates with the mobility class constraints applied as described above. The unit's actual rate of movement,  $R_A$ , is always the minimum of the unit mobility category rate,  $R_N$ , and the limiting equipment mobility class rate,  $R_{MC}$ ; i.e.,

$$R_A = \text{MINIMUM } (R_N, R_{MC}) \quad (\text{IV-13-1})$$

(b) Tactical Ground Movement. When the DSL order identifies the unit's movement type as tactical, the determination of the unit's actual movement rates requires an additional check on the status of the unit's movement along the entire DSL segment. The status is parameterized by the time delays resulting in unit movement delays that have occurred during this DSL segment. If the unit is not operating under a time delay, the movement rate,  $R_A$ , is established by Equation IV-13-1. If, however, the unit has been delayed, it is allowed to move at the limiting mobility class rate (assuming that rate exceeds the unit mobility category rate). The time behind schedule or model delay parameter,  $\delta T_L$ , is determined from three sources: i.e., the obstacle delays in MOVESR, the mobility class limits of MOVEDT, and movement interruption caused by enemy fire.

1. If a unit encounters an enemy obstacle, MOVESR updates the delay parameter by adding a representative delay time,  $\delta T_{\text{delay}}$ , to the time behind schedule as:

$$\delta T_L(\text{new}) = \delta T_L(\text{old}) + \delta T_{\text{delay}} \quad (\text{IV-13-2})$$

When the unit reaches the endpoint of a DSL segment,  $\delta T_L$  is reset to zero, thus providing a representation of the nonsustainability of the short-term catch-up rates.

2. The delay parameter is also adjusted whenever a unit in a tactical move effectively falls behind schedule because of limiting mobility class characteristics. The actual time delay is adjusted as:

$$\delta T_L(\text{new}) = \delta T_L(\text{old}) + d_{ss} \left( \frac{1}{R_A} - \frac{1}{R_N} \right) \quad (\text{IV-13-3})$$

where:

$d_{ss}$  = subsegment length of the current tactical movement by a cross country route

$d_{ss} = (1.1) \times (\text{subsegment length})$  if the route is a road type.

3. The delay caused by enemy fire is set by the Suppression Model.

(c) Road Planning Factor. In road movement for both tactical and administrative moves the actual model movement rate along the model move subsegment is adjusted to represent the actual road route involved. The rate tables specify the actual road rates, but since the DSL segments are straight

line segments, the model rates along these segments need to be adjusted to represent actual road movement. For road movement a 10 percent road planning allowance factor is used to give an adjusted model rate,  $R_M$ ,

$$R_M = \frac{R_A}{1.1} \quad (\text{IV-13-4})$$

and the delay parameter,  $\delta T_L$ , in Equation IV-13-3 as indicated. The road movement logic requires the DSL gamer-ordered road movement to be planned with the 10 percent road allowance factor in mind to represent realistic road movement rates.

(d) Default Rates. If the move combination specified in the order has not been defined in the pregame requirements table of travel mode mnemonics versus mobility categories, a default to the dismounted personnel rate is used. If the DSL-ordered travel mode mnemonic is invalid, TCCD is used. If the movement rate table required by a particular combination is undefined, the movement rate of heavy tracked vehicles (tanks) is used.

(e) Move Event Time. The time,  $\Delta T$ , to complete the move subsegment is computed in MOVEDT as:

$$\Delta T = \frac{d_{ss}}{R_M} \quad \text{or} \quad \frac{d_{ss}}{R_A} \quad (\text{IV-13-5})$$

as appropriate and is used to set the move event time in MOVESR. This time is the only parameter returned by the MOVEDT routine.

d. Movement Execution Submodel (MOVE). The movement event scheduled in MOVESR is actually performed in MOVE. This routine updates the unit's actual coordinate location to the endpoint of the model move segment and accounts for consumption of class III or class IIIA and food. A macroflow of the MOVE routine is illustrated in Figure IV-13-6.

(1) For moving units, the total fuel consumption is determined by:

$$C_s = \sum_{i=1}^M r_{cs_i} \cdot D \cdot N_{E_i} \quad (\text{IV-13-6})$$

for equipment types having distance-dependent consumption rates, and by:

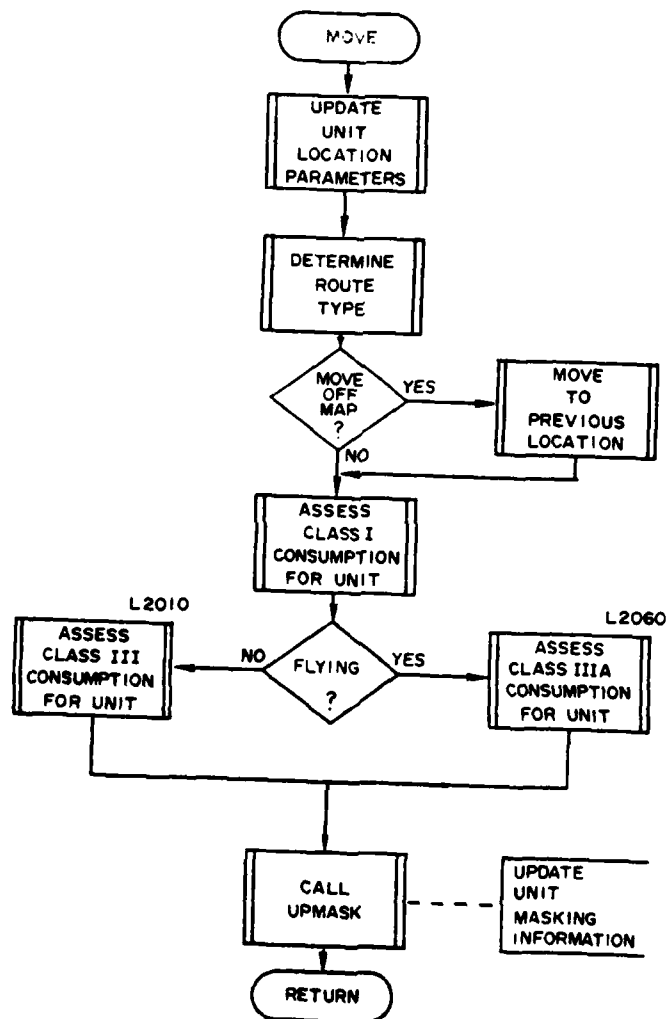


Figure IV-13-6. MOVE Macroflow

$$C_t = \sum_{j=1}^N r_{ctj} \cdot \Delta t \cdot N_{Ej} \quad (\text{IV-13-7})$$

for equipment types having time-dependent consumption rates, where:

- $C_s$  = amount of fuel (gallons) consumed by distance-dependent vehicles
- $C_t$  = amount of fuel (gallons) consumed by time-dependent vehicles
- $M$  = number of distance-dependent vehicle types in unit
- $N$  = number of time-dependent vehicle types in unit
- $r_{cs_i}$  = fuel consumption rate (gallons/meter/vehicle) for distance-dependent vehicle  $i$
- $r_{ct_j}$  = fuel consumption rate (gallons/meter/vehicle) for time-dependent vehicle  $j$
- $D$  = length (meters) of subsegment
- $\Delta t$  = time (minutes) increment
- $N_E$  = number of distinct items of equipment for a given item code.

(2) Fuel consumption for stationary units (e.g., idling engines, generators) is determined in much the same manner except that all vehicles have time-dependent fuel consumption rates. The calculation is as follows:

$$C_t = \sum_{j=1}^{MN} r_{ctj} \cdot \Delta t \cdot N_{Ej} \quad (\text{IV-13-8})$$

where:

- $C_t$ ,  $r_{ct}$ ,  $\Delta t$  and  $N_E$  are as previously defined, and
- $MN$  = total number of vehicle types in the unit.

(3) Consumption of food is recorded continuously for all simulated activities within the DIWAG system. The food available to a unit must be carried within the unit's own supplies. The rate of consumption is specified for a force in terms of pounds per man per day, but this value is converted

to pounds per man per minute at the time of execution. This consumption value is determined by:

$$C_f = (G + B) \cdot r_{cf} \cdot \Delta t \quad (IV-13-9)$$

where:

$C_f$  = amount (pounds) of food consumed

$G$  = suppressed (combat ineffective) personnel in the unit

$B$  = present effective personnel in the unit

$r_{cf}$  = food consumption rate (pounds/man/minute)

$\Delta t$  = time (minutes) increment of event.

4. HISTORY TAPE OUTPUT. The Movement Model writes the following event records onto the period history tape.

<u>Record Type</u>	<u>Title</u>	<u>Frequency</u>
611	Movement Event	One record for each model movement segment scheduled.

The detailed description of the record formats is presented in paragraph 2c of Appendix A to Chapter 1 of Section VI.



## APPENDIX A

### MOVEMENT MODEL INPUT REQUIREMENTS

1. INTRODUCTION. This appendix describes the movement of units in the DIVWAG system. These units may be in various combat formations and may encounter various types of environmental factors, such as facilities, which may speed the movement of the unit, or barriers, which may delay the unit or prevent it from reaching its objective. The purpose of this appendix is to provide the necessary instructions for data preparation to develop the constant data input needed by the Movement Model. The first data files to be loaded in DIVWAG are those for TOE load, as explained in Chapter 3 of this section. Following the loading of those files, the constant data for any model may be loaded in any order desired.

a. Data Requirements. The data required for this model define the mobility characteristics of the forces being simulated in the game. This is accomplished in a two-phase data base developmental process. First, groupings based on similar unit organizational and functional usages and on vehicular characteristics are established. These groupings are merely a convenience used to reduce the total data requirements of the model and to avoid redundancy in the data preparation process. Secondly, appropriate movement rates applicable to each of the above groups, and subject to environmental conditions and considerations of unit tactical mission function, are developed. Thus, the data preparation is a detailed procedure for establishing appropriate unit categories and vehicular classes that possess similar mobility characteristics and then assigning realistic movement rates to each category and class. The dynamic function of the Movement Model is to identify the extenuating circumstances existing during the game period and use the appropriate rates that were developed in the pregame data preparation. The movement rates are used by the Movement Model in response to movement orders, and the Ground Combat Model and the Combat Service Support Model use the same rates to generate automatic movement within the DIVWAG system.

b. Contents. This appendix provides detailed instructions in the data entry for constant data inputs to the Movement Model. The first paragraph relates the preceding instructions to those pertaining to the Movement Model. The second and succeeding paragraphs relate to the transcribing of constant data to the formats for the various cards needed to enter such data in the files of the Movement Model. In each of these paragraphs a brief statement is made and, where feasible, a data array is constructed to provide an overview of the information required.

c. Data Base Files. The Movement Model uses four files to store the constant data inputs. These files are illustrated in Figure IV-13-A-1. Data file 14 contains the class IIIA fuel consumption rates, data file 15 contains the class III consumption rates, data file 19 contains the mobility category movement rates, and data file 9 contains the mobility categorization and classification tables. The mobility load program, MOVELD, creates these files from the card input.

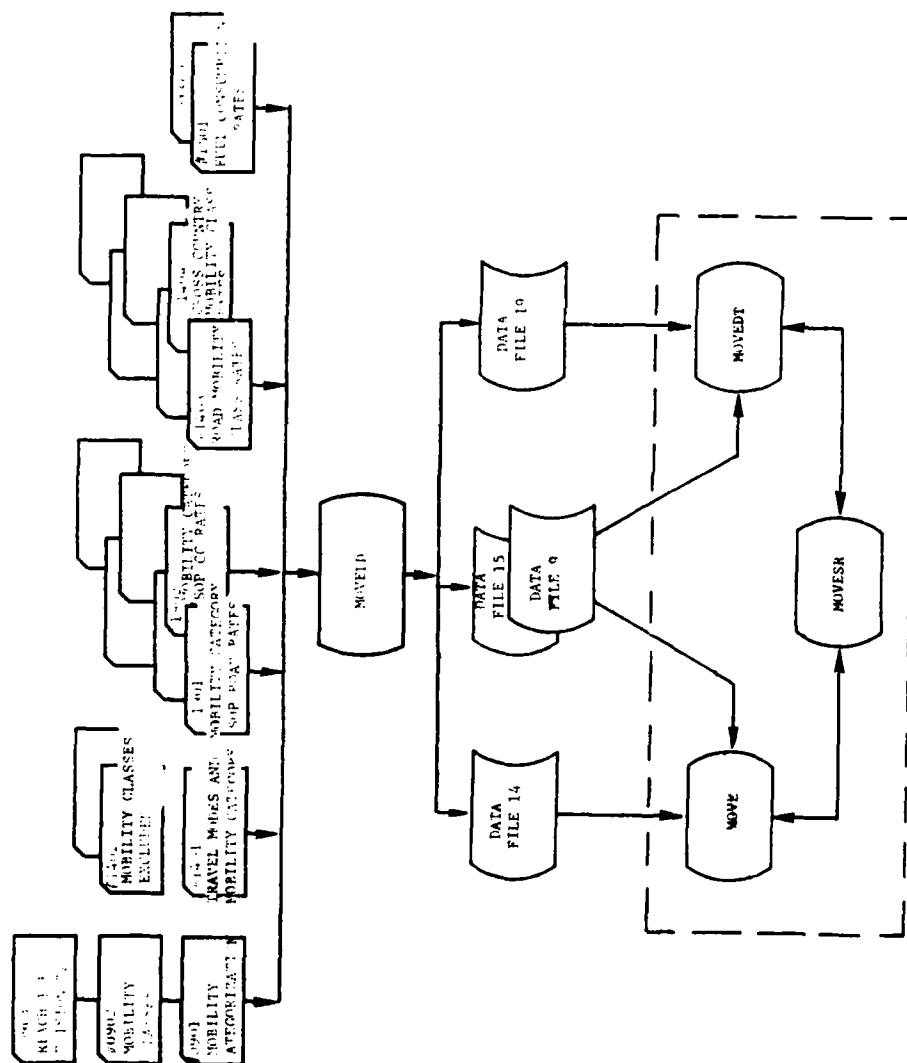


Figure IV-13-A-1. Movement Model Data Base

d. **Data Needed.** The data needed for the constant input of the DIVWAG system consists of six major items with subdivisions or subclassifications.

(1) **Mode of Travel.** The mode of travel mnemonic is used in the orders specifying ground movement. It is a four-character mnemonic specifying unit movement type, route type, and military unit formation. The various combinations to be used in any game period must be defined and loaded into the data base.

(2) **Mobility by Unit Type Designator.** All units that will be given ground movement orders must be assigned to a mobility category. The mobility category represents a group of units that will always have common rates of movement for the same travel mode mnemonic and environmental conditions. Units assigned to the same mobility category will be treated as having identical mobility characteristics, and no unit may be assigned to more than one mobility category.

(3) **Equipment Item Mobility Classes.** In addition to the mobility categories based on unit organizational mobility characteristics, the model requires a vehicular mobility classification scheme to represent the mobility characteristics of mobility items in the forces, regardless of the organizational units of which they may be part. Thus, each equipment item representing a means of transport must be assigned to a mobility class, and all items in the same mobility class will be treated by the model as possessing identical mobility characteristics. Also, no equipment item may be assigned to more than one mobility class. A maximum of 20 mobility classes per force is recognized by the model.

(4) **Movement Rates.** Each mobility class and mobility category defined in subparagraphs (2) and (3) above must be accompanied by a set of movement rate tables. For mobility classes, the rates in these tables represent the short term or limiting rates at which vehicles in the class can move subject to specified route type, weather, and terrain conditions. As such, they form the constraints that limit a unit's movement. For mobility categories, however, the set of rates for each category represents the normal planning sustained rates expected for the unit under existing conditions of route type, weather, and terrain, as well as move type and unit formation. Thus, rates for mobility categories are based on organizational and functional unit movement characteristics as well as environmental parameters. A particular unit moving during the game period under specified orders and environmental conditions will have a single typical mobility category rate and several limiting mobility class rates dependent upon the dynamic composition of the unit as expressed in terms of the mobility classes contained in the unit.

(5) **Consumption of Expendables.** Unit consumption rates of fuel are supplied in the MOVELD data base.

(6) **Breach or Force Decision Tables.** If a unit executing an ordered move event encounters an active barrier (e.g., minefield) which it cannot bypass

or cross by means of an existing facility, a decision to force the barrier or request engineering assistance and wait for a breach to be constructed must be made. The factors influencing this decision are the unit's movement priority, the casualties to be assessed the unit if it chooses to force, and the amount of time the unit will be delayed if it waits for a breach to be constructed. Tables containing yes/no decisions as a function of these factors must be prepared and loaded into the data base.

2. ASSEMBLING THE DATA BASE. The following subparagraphs are intended to provide the user with a detailed description of the contents of the data base. There are implicit relationships among the data entries prepared for the card formats; and, thus, proper preparation of the data base requires an understanding of these relationships as they exist between the data base, the orders, and the internal functioning of the Movement Model. The most important, as well as the most difficult, phase of the data base preparation consists of identifying mobility categories for unit structures and mobility classes for vehicular equipment contained within units. Subparagraph a below discusses this phase in detail. In addition to the categorization and classification process, appropriate rates of movements must be developed. The parameters to be included in determining these rates and how they are used within the model are discussed in subparagraph b. Subparagraph c summarizes the data base preparation process with a procedure for developing a consistent and representative set of data for the Movement Model.

a. Mobility Classes and Categories. To represent unit movement in a realistic manner within the confines of a manageable data base it is imperative to reduce to a limited number of parameters the enormous quantity of details that can affect movement of troops and supplies. The mobility classes and categories represent the approach used in the DIVWAG Movement Model to accomplish this and still retain the primary mobility characteristic of the force involved.

(1) Mobility Category. A mobility category, as discussed previously, represents a group of unit organizational structures that are expected to have similar mobility characteristics. For example, the first mobility category in the model is always reserved for unit organizational structures that can be expected to move as a typical dismounted infantry unit. Another category might be typified by a heavy armor battalion. The implication is always that a unit belongs to the mobility category that best represents that unit's mobility characteristics (i.e., rate of movement under the specified conditions). The model allows up to 20 distinct mobility categories per force. The categories are developed from the unit type designators (UTDs), which were discussed in Chapter 3 of this section. Since the allowable number of distinct unit type designators is large, and since the unit type designator is not meant to be representative of unit mobility characteristics, the mobility categories are required to eliminate redundancy and compact the data base requirements.

A unit type can only be assigned to a single mobility category, but several unit types can belong to a single category.

(a) Mobility Category Codes. Each mobility category is assigned a code letter which appears as the last character of a four-character mnemonic. The code letters "I" and "T" are reserved. Other code letters are arbitrarily selected by the user and assigned to a particular means of conveyance. The infantry category must have the letter "I" as its category code; thereafter, for this constant data input, the letter "I" would be associated with infantry units that move on foot. The armor unit's category must have the letter "T" assigned as its code. "C" might be assigned for a cavalry unit category. In this manner a mobility category code is constructed. The table below is an example of the various mobility categories mentioned in the preceding subparagraphs and summarized for clarity.

<u>Code</u>	<u>Mobility Category</u>	<u>Unit Type Designator</u>
<u>I</u> NFY	Dismounted infantry unit	IMMI
<u>T</u> ANK	Tank armored unit	EAMT, ITCT, ITMT, BTCT
<u>C</u> AVY	Cavalry unit	ICCC, ITMC

(b) Mobility Category Movement Rates. Every mobility category developed for a game must be accompanied by a set of movement rates characteristic of all units assigned to this category. These rates are subject to the following considerations:

- . Type movement being performed
- . Type route being traversed
- . Formation of unit
- . Weather conditions
- . Day or night conditions
- . Terrain conditions.

These items constitute the set of model parameters that affect unit movement; they are described in detail in subparagraph b below. The rates are expressed in kilometers per hour and must be developed for all combinations of the model parameters that may occur during the game. The number of rate tables required for a particular mobility category is dependent upon the number of travel modes in which this category is allowed to move as illustrated in Figure IV-13-A-2. For example, if the units assigned to a tank mobility category are given a move order containing the travel mode TCCD (tactical cross country move in a deployed formation) a rate table that specifies the planning rates typical for such a unit must be developed. The rate table for this mnemonic will contain 120 ( $3 \cdot 2 \cdot 20$ ) entries to represent all possible combinations of weather (3 types), light conditions (2 types), and cross country trafficability conditions (20 types). If the travel mode TRDM (tactical movement in a march column on a dirt road) is also to be used, a set of rates representing all combinations of road/terrain types (2), weather types (3), and light conditions (2 types), or 12 rate entries, is required for the same tank mobility category. The rates to be entered into the data base are to be representative of typical rates to be

**Figure IV-13-A-2. Matrix of Travel Modes Required for Mobility Categories**

expected under the set of conditions specified. They can be developed in a manner analogous to actual planning operation rates used in real situations. Units in the model will move at these rates subject to constraints imposed by the mobility class limiting rates discussed in subparagraph (2) below.

(2) Mobility Class. Mobility class always refers to the type of conveyance used to move units about the battlefield. These types refer to items of equipment, which in the DIVWAG system are identified with an equipment item code. An example of a mobility class is track-laying vehicles, in which tanks and armored personnel carriers might be classed. Some self-propelled artillery and air defense vehicles might also come under the same class. Also, a combat engineer vehicle with M60 chassis, a 165mm gun, and 50 caliber machine-gun may be in the track-laying vehicles mobility class. On the other hand, an engineer bulldozer, although a track-laying vehicle, may not be assigned to this mobility class since its rate of sustained or maximum movement, either cross country or on roads, is slower than the other combat items. Another candidate mobility class is the 81mm mortar, full-tracked, M125A1 carrier or the light-tracked, M577, command post carrier. Since these types of conveyances have relatively the same rates of movement, as well as trafficability and movement capability both on roads and cross country, these lighter tracked vehicles might be placed in the same class. The same is true with wheeled vehicles in which the heavy wheeled vehicles, such as 10-ton dump trucks and similar vehicles would be placed in a class different from that of a 10-ton tractor-trailer truck. The model reserves mobility class index 1 for the mobility class typical of the dismounted foot soldier and allows for a maximum of 19 additional classes. It is to be remembered that all vehicles assigned to the same mobility class will have identical mobility characteristics. Thus, if two competing vehicle types are to be distinguished by their mobility performance parameters, they must belong to separate mobility classes. Mobility categories are representative of entire organizational units acting in concert, and mobility classes are representative of the vehicular components of that unit.

(a) Mobility Class Codes. Each of the mobility classes is assigned a code number, with the number 1 being reserved for dismounted infantry. Thus, the light-tracked vehicles may have a mobility class code 4 assigned. Code 5 might be assigned to light wheeled vehicles, such as jeeps. Code 2 may be assigned to medium wheeled vehicles, such as 2-1/2-ton cargo trucks, as well as tankers and similar wheeled vehicle types. The code 3 may have been assigned to the heavy wheeled vehicles, and this may include towed 8-inch howitzers, towed 155mm howitzers or guns, and heavy dump trucks or similar wheeled vehicles. These indexes are used internally in the model to identify the mobility classes present in a unit.

(b) Mobility Class Movement Rates. Whereas the mobility category rates are representative of organizational units as a whole, the mobility class rates do not represent any specific organizational structure and, as such, are not dependent upon the type of move or unit formation parameters discussed below. The parameters applicable to developing mobility class rates are the following:

- . Type of route being traversed
- . Weather conditions
- . Day or night conditions
- . Terrain conditions

As such, mobility class rates are more representative of the performance characteristics of individual vehicles. Unit movement is restricted to the speed of its slowest vehicle if unit integrity is to be maintained during the movement. This restriction is used in the model with reference to the mobility classes contained in the unit. The model will always impose this restriction to unit movement (subject to modification by the mobility class exclusion table) and will check compositions of units to ensure that the rate of movement of the slowest mobility class present is not exceeded. The Mobility Model uses the mobility class rates in a manner analogous to a short-term catch-up rate (i.e., a mobility class can achieve this rate for a short period of time but cannot sustain this rate on a long move). Each mobility class defined requires 36 road rates ( $3 \cdot 2 \cdot 3 \cdot 2$ ) and 120 cross country rates ( $1 \cdot 20 \cdot 3 \cdot 2$ ) to represent vehicular characteristics subject to route (1 cross country type or 3 road types), terrain conditions (2 road types or 20 cross country types), weather conditions (3 types), and light conditions (2 types).

(c) Mobility Class Exclusion Table. To identify vehicles that are not considered as moving with the parent unit and thus not immediately restricting a unit's movement, a mobility class exclusion table is required. For example, an armor battalion, prior to taking a combat position may have sent its trains back to join the brigade. Thus, when the armor battalion moves in a cross country deployed formation, the supply train vehicles are not contained in the formation and will not impede the movement rate of the battalion. The exclusion table allows the mobility class representing the supply train vehicles to be excluded from consideration in restricting the armor battalion.

b. Model Parameters Influencing Unit Movement. The model parameters that influence the movement rate of units have already been identified in the subparagraphs discussing mobility category rates and mobility class rates. They are repeated for emphasis:

- . Movement type
- . Route type
- . Unit formation
- . Weather conditions
- . Day or night conditions
- . Terrain conditions
- . Movement priorities



The first three move parameters--movement type, route type, and formation of unit--are always contained in the order and, as such, convey gamer planning and coordination information. They are specified in the travel mode mnemonic. The next three parameters--weather conditions, light conditions, and terrain conditions--are established by the DIVWAG Environmental Model and establish the environmental conditions existing during dynamic game play. The last parameter--movement priorities--also contained in the order, indicates the importance of the unit's movement and establishes its priority.

(1) Travel Mode Mnemonic. The travel mode mnemonic is a four-character code containing movement type, route type, and unit formation type information. The model recognizes only those combinations defined in the data preparation, and these combinations must be developed from the movement types, route types, and unit formation types discussed in following subparagraphs. The travel mode mnemonic is specified in DSL-directed moves. One exception is that units that are to travel cross country in a deployed formation (TCCD) do not require the mnemonic. This particular method and formation is also used as the default travel mode; that is, any unit ordered to move, but not given a specific travel mode mnemonic, will travel cross country in a deployed formation. Through the travel mode the gamer may directly influence the rate at which the various units will move. Thus, the preparation of realistic movement orders consistent with the travel modes and rates developed in the data preparation phase is essential for a realistic performance of the move. In addition, the definitions of the move type, route type, and unit formations should be increased in detail and clarity if necessary to ensure that the travel mode mnemonic and implied movement rates are consistent with the military intent of those using the model.

(a) Movement Type. The type of unit movement planned is restricted by the model to include two categories, administrative and tactical:

- . A - Administrative: This category implies movement of units by road nets and uses the most efficient transportation systems available, with tactical considerations of secondary importance.
- . T - Tactical: Movement of this type includes cross country movement in partially deployed, reconnaissance, or column march formations, and tactical road marches as part of an attack, withdrawal, or other tactical plan external to maneuver movement within the ground combat engagements.

(b) Route Type. The route type must also be defined prior to developing travel mode combinations and actual movement rates. Available types are listed below. These types are fixed by the model but should be defined in greater detail in relation to the actual routes planned for the game to ensure gamer consistency in their usage. These route type descriptors

specify the type of ground surface that the unit will be moving on in an order. These descriptors are:

- . CC - Cross Country: Route of the unit is subject to natural terrain conditions existing in its path.
- . RA - Paved Roads: This route type is such that road beds are asphalt or concrete with at least two lanes with good shoulders, and the route is not significantly dependent upon short range or local terrain features.
- . RG - Gravel Roads: Route is gravel or similar surfaced road with periodic maintenance.
- . RD - Dirt Roads: Route is dirt, road is narrow and/or marginally maintained and is subject to terrain undulations and other local terrain features.

(c) Unit Formation. The last character of the travel mode specifies the unit's move formation for the current move. Three types are available in the model; and, as with the route and move types, the definitions given below can be enriched better to define the existing conditions intended in using this parameter. For example, a unit may be much more cautious in approaching the vicinity of hostile forces than it would in marching through friendly terrain. The fact that the enemy force is near has an influence in reducing speed of movement. In the case of the unit passing through friendly territory and on its way to an assembly area for a battle several days hence, the formation may be a march column; however, that unit about to make contact with the enemy is probably in a deployed formation or reconnaissance formation. Available formations are the following:

- . M - Column March: The unit is in a column formation on a road or cross country route.
- . R - Reconnaissance: Deployment pattern on cross country by a unit on a ground reconnaissance type mission.
- . D - Deployed: Unit is partially deployed in a formation in anticipation of imminent contact with the enemy.

(2) Allowable Modes of Travel. The allowable combinations of move type, route type, and formation type are defined in the pregame data load. A maximum of 20 combinations is allowed. A typical group required for a game might be as follows:

<u>Code</u>	<u>Move, Route and Formation Defined</u>
ARAM	Administrative move on all weather roads in march column
ARGM	Administrative move on gravel roads in march column
IRAM	Tactical move on improved paved roads in march column
IRGM	Tactical move on improved, gravel, or other similar surfaced roads in march column
TRDM	Tactical move on unpaved or dirt roads in march column
TRGR	Tactical move on improved, gravel roads in reconnaissance formation
TCCM	Tactical cross country move in march column
TCCR	Tactical cross country move in reconnaissance formation
TCCD	Tactical cross country move in deployed formation

(3) Environmental Consideration. The weather and terrain always influence the rate of military movements over any type of surface. For the Movement Model these parameters are defined in the DIVWAG Environmental Model, but for purposes of preparing the move rate tables it is necessary to obtain descriptions of these parameters before considering the actual rates involved. Thus, the following factors should be used in determining the appropriate rates for the rate tables.

(a) Road Terrain Factors. Road terrain factors are derived from the roughness and vegetation index specified for each terrain cell in the data load. The categorizations used in the Movement Model are as follows:

- . T<sub>1</sub> - Terrain 1: Flat, gently rolling to undulating. Roughness and vegetation indexes 1 through 5.
- . T<sub>2</sub> - Terrain 2: Undulating, broken to rough. Roughness and vegetation indexes 6 through 9.

(b) Day and Night Conditions. Day and night conditions are derived from the Environment Model and are such that the rate tables reflect the following typical conditions:

- . D - Day: Daylight hours, beginning of morning nautical twilight (BMNT) to end of evening nautical twilight (EENT).

- . N - Night: EENT to BMNT with light levels typical of quarter moon.

(c) Weather Conditions. Weather factors considered in filling out the rate tables are defined in the following manner:

- . W1 - Weather 1: Temperature greater than 32°F, no rain; or temperature less than 32°F, no rain or snow.
- . W2 - Weather 2: Temperature greater than 32°F, light rain; or temperature less than 32°F, light rain or snow.
- . W3 - Weather 3: Temperature greater than 32°F, heavy rain or fog; or temperature less than 32°F, heavy rain or snow.

The model is designed to include only typical winter or typical summer conditions during a single game. Either the first set or the second set is chosen, and appropriate rate tables are filled out accordingly.

(d) Cross Country Terrain Factors. The cross country travel mode uses up to 20 combinations of terrain, soil, and forest types. A typical categorization of these soil slope, and trafficability indices, T<sub>1</sub> through T<sub>20</sub>, is as follows:

- T<sub>1</sub> - Flat to gently rolling, coarse-grained, poorly graded sand and silt with clay layer, forested.
- T<sub>2</sub> - Flat to gently rolling, coarse-grained, poorly graded sand and silt with clay layer, not forested.
- T<sub>3</sub> - Flat to gently rolling, silt over clay type sand and sandy clay, forested.
- T<sub>4</sub> - Flat to gently rolling, silt over clay type sand and sandy clay, not forested.
- T<sub>5</sub> - Gently rolling to undulating, coarse-grained, poorly graded sand and silt with clay layer, forested.
- T<sub>6</sub> - Gently rolling to undulating, coarse-grained, poorly graded sand and silt with clay layer, not forested.
- T<sub>7</sub> - Gently rolling to undulating, silt over clay type sand and sandy clay, forested.
- T<sub>8</sub> - Gently rolling to undulating, silt over clay type sand and sandy clay, not forested.

- T9 - Undulating to broken, coarse-grained, poorly graded sand and silt with clay layer, forested.
- T10 - Undulating to broken, coarse-grained, poorly graded sand and silt with clay layer, not forested.
- T11 - Undulating to broken, silt over clay type sand and sandy clay, forested.
- T12 - Undulating to broken, silt over clay type sand and sandy clay, not forested.
- T13 - Broken to rough, coarse-grained, poorly graded sand and silt with clay layer, forested.
- T14 - Broken to rough, coarse-grained, poorly graded sand and silt with clay layer, not forested.
- T15 - Broken to rough, silt over clay type sand and sandy clay, forested.
- T16 - Broken to rough, silt over clay type sand and sandy clay, not forested.
- T17 - Rough terrain, coarse-grained, poorly graded sand and silt with clay layer, forested.
- T18 - Rough terrain, coarse-grained, poorly graded sand and silt with clay layer, not forested.
- T19 - Rough terrain, silt over clay type sand and sandy clay, forested.
- T20 - Rough terrain, silt over clay type sand and sandy clay, not forested.

(4) Movement Priorities. A unit's movement priority affects its decision to breach or force an active barrier, if one is encountered, and is also used to determine the priority of any engineering task this unit might find necessary to request. Four priorities are defined below. The limitation of four priorities is arbitrary as are the definitions. A maximum of six priorities may be defined in compiling the data.

- Priority 1: This priority is the highest. It would be given units if their completion of a move on time is essential to the success of the division's maneuver.
- Priority 2: Successful completion of moves given this priority would greatly facilitate the operation, but it would not collapse without it.

- . Priority 3: Successful completion of moves in this priority is desirable, but would effect the operation to a lesser degree.
- . Priority 4: This priority is the lowest and would be defaulted to if a priority is not specified by the priority modifier. Routine maneuvers fall into this class.

c. Recommended Data Base Preparation Procedures. The following procedure is described as an example of a systematic approach that might be used to develop the Movement Model data base. The procedure is not a fixed set of independent steps that may be separately performed but is a logical process whereby a comprehensive overview of the model's structure can be obtained as well as an understanding of the detailed data requirements. Figure IV-13-A-3 illustrates the data base preparation process.

(1) Step 1. Standardize the definitions of the weather types and terrain conditions to ensure that the definitions used for the Movement Model parameters are consistent with the environmental parameters (e.g., terrain, cell, soil, slope and trafficability) prepared for the environmental load programs. For example, the soil, slope and trafficability conditions defined in the terrain cell load data should be identical to the definition used in the Movement Model data preparation.

(2) Step 2. Establish game definitions of what conditions will be implied by the gamer usage of the travel mode mnemonic specifying move types, route types, and formation types. It is essential that the gamer in writing movement orders have a clear understanding of the conditions and corresponding movement rates implied by the travel mode mnemonic.

(3) Step 3. Classify all mobility vehicles to be used by a force into mobility classes and determine mobility class rates in the following manner:

(a) Step 3a. Choose a particular vehicle that is expected to be typical of a mobility class and assign this vehicle to a mobility class and define the mobility class.

(b) Step 3b. Develop a movement rate table to describe the short term sustained rates of this type vehicle subject to road or cross country terrain conditions, weather conditions, and light conditions that have been defined in steps 1 and 2.

(c) Step 3c. Scan the list of mobility vehicles that have not yet been classified and select one that may also belong to this same mobility class. Consider the rate table that was filled out for the mobility class being developed and decide if the vehicle being considered will have the same rates previously entered into the rate table. If this is the case, assign this vehicle to the same mobility class. If this is not the case, scan the list for

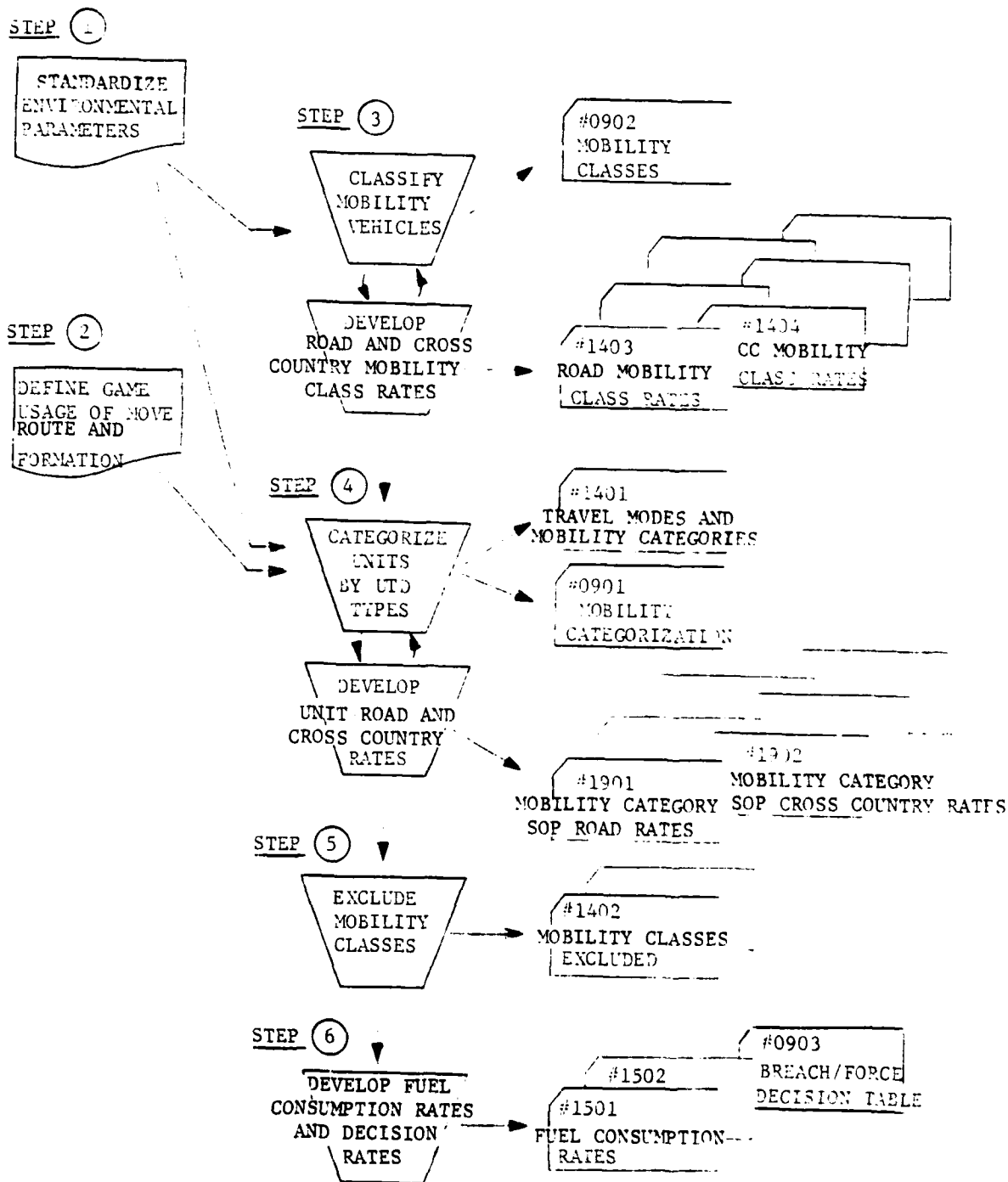


Figure IV-13-A-3. Data Base Preparation Schematic

a different vehicle and repeat the process until all vehicles belonging to this mobility class have been identified.

(d) Step 3d. When all vehicles belonging to a mobility class have been defined select a typical vehicle characteristic of another mobility class and repeat the process. Continue in this manner until all vehicular mobility items have been classified.

(4) Step 4. Categorize all unit type designators (UTDs) into mobility categories and establish mobility category rates in the following manner:

(a) Step 4a. Select a unit type designator that is considered a typical example of a particular mobility category.

(b) Step 4b. List all travel mode mnemonic combinations needed in the game to represent movement of this typical unit.

(c) Step 4c. For each travel mode selected, complete the appropriate mobility category rate table.

(d) Step 4d. Select another UTD type and repeat step 4b. For travel modes already allowed for this category, check the UTD type being considered to ensure that the rates are consistent. For travel modes not already included, develop a set of rate tables as in step 4c.

(e) Step 4e. Continue the selection of UTD types until all UTDs belonging to this category have been considered.

(f) Step 4f. When one category is completed, repeat steps 4a through 4e for the next category. Continue in this fashion until all UTDs to be used in the game have been categorized and the corresponding rate tables are developed. The performance of step 4 culminates with the completion of the matrix of movement modes and mobility categories (Figure IV-13-A-2) and is a summary of the categories, travel modes, and allowed combinations developed in the data base.

(5) Step 5. The fifth step in defining the data base is to consider each unit type designator with every allowed travel mode and to specify those mobility classes normally contained in the type unit TOE that will not be permitted to limit the unit's rate of movement under the conditions specified in the travel mode. This required step allows the model to realistically identify unit supply trains, bridging equipment, etc., that are not limiting mobility factors in the unit's current mission objective.

(6) Step 6. Develop appropriate fuel consumption rates for vehicles and aircraft equipment items.

(7) Step 7. Develop barrier decision table. If a unit under control of the Movement Model must cross an active barrier, a decision table is interrogated to decide if the unit should accept casualties and force



the barrier or accept the time delay and wait for a breach to be constructed. One table is required for each movement priority used during the game. A maximum of six tables may be used, but at least one table must be used. The decision tables are independent of the unit's mobility category and other data necessary for the Movement Model. A sample decision table for a priority is shown in Figure IV-13-A-4. The times shown are fixed and cannot be changed, but the number of casualties applying to each column is arbitrary and is put on the data form.

Breach or Force Decision* for Priority: <u>(1)</u>				
Time Unit Is Delayed If Barrier Is Breached (Hours)	Number of Casualties Assessed If Unit Forces Barrier (Vehicles)			
	0 - 1	2 - 4	5 - 8	Greater Than 8
0.0 - 0.5	1	1	1	1
0.5 - 1.0	1	1	1	1
1.0 - 2.0	1	1	1	1
2.0 - 3.0	2	2	1	1
3.0 - 5.0	2	2	2	1
Greater Than 5.0	2	2	2	1

\* 1 = Request barrier be breached

2 = Force barrier

Figure IV-13-A-4. Example of Breach or Force Decision Table

(a) Step 7a. Determine the number of priorities that will be used during the game and agree upon a written description of each priority. One decision table will be required for each priority used.

(b) Step 7b. Construct a work form similar to Figure IV-13-A-4 for each table.

(c) Step 7c. Complete the form for each table using the number 1 to indicate the unit should wait for a breach to be constructed or 2 to indicate the unit should force the barrier.

3. TRAVEL MODE AND MOBILITY CATEGORY. The travel mode and mobility category are specified on card type 1 with ID of 1401. The information desired is the various modes of travel correlated to the mobility category. This is the first card to be entered in the data base as a rigidly structured data deck.

a. Travel Mode and Mobility Categories. The model recognizes two categories of movement, administrative and tactical. Each of these movement types is associated with the rate of movement and the environmental conditions found in combat. The explanation of the two movements recognized by the sub-model follows.

(1) Administrative (A). Employing movement of units by road nets or by air using the most efficient transportation system available. This movement is to be conducted over all weather paved roads or improved roads but not all weather gravel or similar type surfaced roads.

(2) Tactical (T). In this category are included cross country ground formations of partially deployed, reconnaissance, or column march. Also included are tactical road marches as part of an attack, withdrawal, or other tactical plan external to the Movement Model.

b. Route Type. The route type as previously discussed is an indication for the model, of the movement with respect to the specific ground path that a unit will take to its destination from its present position. These route descriptors merely specify the type of surface that the unit will use in moving to its objective. These descriptors are:

(1) Cross Country (CC). Route of unit is subject to natural terrain and environmental conditions including soil of different or varying trafficability. Speed is somewhat dependent on weather for day or night movement including clear and inclement weather.

(2) Paved Roads (RA). The path used by the unit will be over a roadbed of asphalt, concrete, or other hard surfaced material used for roadways. These roads have at least two lanes with good shoulders, and movement does not depend significantly upon short range terrain or weather factors.

(3) Gravel Roads (RG). Gravel or small crushed stone, coarse sand, or similar road surface substance is used in building a firm surface but requires frequent or periodic maintenance.

(4) Dirt Roads (RD). This route does not have a hard surface but is of dirt. The road is narrow, following undulations of the terrain, and is marginally maintained.

c. Unit Formation:

(1) Column March (M). The unit is in a column march formation on a road or cross country.

(2) Reconnaissance (R). The unit has been deployed usually on a cross country movement on a ground reconnaissance mission.

(3) Deployed (D). Unit is partially deployed in a formation in anticipation of imminent contact with the enemy.

d. Allowable Combinations for Mode of Travel. Selected combinations of move type, route type, and formations are allowable in the submodel. A typical group required for a game is listed in subparagraph 2b.

e. Card Type and Designator (Columns 1-2). The card format for this type data is illustrated in Figure IV-13-A-5. In column 1 is preprinted the number 1. Make no changes. In column 2 only one of two designators is to be entered, "R" for Red force or "B" for Blue force. Any other entry will be unacceptable.

f. Travel Mnemonic (Columns 4-7). In these columns are to be entered one of the codes suggested in subparagraph b above. Each individual entering data for a particular force may use such mnemonics as desired but must adhere to the rules for developing abbreviations.

g. Index to Travel Mnemonic (Columns 8-9). In these columns are entered the number of the mnemonic, which is an arbitrarily assigned number ranging from 1 to 20. It is not essential that all 20 mnemonics be identified at the start of the game or during the period of the game.

h. Unit Type Designator Mobility Code (Column 14). A code is established in which various types of units may be grouped for similar movements. Thus, as shown in Figure IV-13-A-2, the codes I and T are used to indicate infantry category of movement and armor vehicle movement respectively. Other possible listings are artillery, engineer, signal, cavalry, air defense units, and others. The entries I and T are essential and should be among the first two entries each time that the data base is initiated.

i. Category Description (Columns 15-30). These data are not entered into the data base but are of assistance in checking card image type data to identify data entered into the files. Write an abbreviation for the description of the unit mobility category code inscribed in column 14. This may be infantry for foot and armor for tank.

j. Index to Mobility Category Code (Columns 31-50). Refer to Figure IV-13-A-5. Entries for columns 31-50 were explained in subparagraphs a through d above.

4. UTD BY MOBILITY CATEGORY. Data for this card format are prepared concurrent with that for the ID 1401 card. Both deal with the mobility categories and the units that are to be grouped together on the basis of having similar movement characteristics. The format of the UTDs listed by mobility category is shown in Figure IV-13-A-6.





a. Card Type and Force Designator (Columns 1-2). The card type is preprinted with the number 1 as shown in Figure IV-13-A-6, and is not changed. In card column 2 is to be entered only an "R" for Red forces or "B" for Blue forces.

b. Mobility Category Code (Column 4). This is an alphabetic entry of which any of the 26 letters of the alphabet may be used. The letter "O" may be ruled out in that it resembles zero, as is also the case with the letter "Z" and the number 2. Enter the letter to be applied to one of the mobility categories. The letter "I" must be reserved for foot or infantry and the letter "T" must be reserved for tanks or armor.

c. UTD of Units in this Category (Columns 9-12). A series of units having similar movement characteristics is listed in these card columns. Four letters are required for the UTD, and the movement characteristics are dependent upon the primary mission assignments anticipated for that unit plus the types of vehicular equipment that are given this unit. A careful examination should be made to assist in grouping all like units together; however, if some of the units are overlooked, or their grouping cannot be readily determined, they may be entered separately. The more individual entries of this type that are made, the larger the data burden that is placed on the user. The data base for constant data input will accept each unit separately or in combination with others.

d. Other UTDs (Columns 14-67). There are 12 UTDs that may be entered on this card format. If additional space is required to enter more UTDs, additional cards may be used for this purpose.

e. Additional Cards. Additional cards may be necessary to enter all data needed for this category of information. These cards are completed as explained above.

5. MOBILITY CLASSIFICATION. The mobility classification is the grouping of equipment item code which have similar movement characteristics. Each class is assigned a code number to identify the classifications. The card format used in transcribing these data is illustrated in Figure IV-13-A-7.

a. Card Type and Force Indicator (Columns 1-2). The preprinted number 1 is in card column 1 and is not to be changed. In card column 2 is entered only an "R" for Red force or "B" for Blue force.

b. Mobility Class Code (Columns 5-6). This is an arbitrarily selected number assigned to a grouping of like vehicular equipment identified by their equipment item codes. This classification number may range from 1 through 20, but only 12 to 15 such classifications may be needed.

c. Item Code (Columns 7-9). The equipment item code is entered in these card columns. The equipment items are vehicular equipment having the same



movement characteristics over both roads and cross country so that rates will be very closely allied, and overall performance will be very similar.

d. Additional Vehicles (Columns 10-69). As additional vehicular equipment items are grouped with this class, they are entered in the additional columns provided for this purpose. Up to 11 different item codes can be entered on this card. Additional cards are prepared for groupings beyond 11 in any one class.

e. Additional Cards. All additional cards must be prepared as explained previously.

6. UTD CLASS EXCLUSION LIST. This list identifies mobility classifications that are nonrestrictive in the movement of the unit: i.e., vehicles that are not considered as moving with the parent unit and will not hold down the overall rate of movement. Thus, the list excludes certain mobility classes from the move. For example, it might be desirable to allow the supply vehicles organic to a tank unit to fall behind the main part of the unit and not restrict its movement rate when certain travel mode mnemonics are being used. The exclusion list allows this to be accomplished. The format of this with card ID 1402 is illustrated in Figure IV-13-A-8, Mobility Exclusion List.

a. Card Type and Force Designator (Columns 1-2). In card column 1 has been preprinted the number 1; make no change. In card column 2 only one of two entries is permitted, "R" for Red force or "B" for Blue force.

b. Unit Type Designator (Columns 4-7). For each UTD listed in Card ID 0901 there may be a card prepared with the UTD listed in these columns.

c. Travel Mode Mnemonic (Columns 9-12). The travel mode mnemonic is taken from the list prepared in card ID 1401.

d. Nonrestrictive Mobility Classification (Columns 13-15). Enter one of the mobility classifications that were developed in card ID 0902 which will not restrict the movement of this unit.

e. Additional Mobility Classifications (Columns 16-69). If there are additional mobility classifications that will not restrict the movement of this unit they are entered in these card columns. Additional cards may be prepared with more mobility classifications if needed.

f. Additional Cards (Columns 73-76). Additional cards are prepared as described above.

7. UNIT ROAD MOVEMENT RATE. The rate in kilometers per hour at which a unit moves over the roadways is entered in this card format. The controlling factors are the mobility category code, the formation code, and the weather and light conditions. For each such combination there is one card entry. Referring to Figure IV-13-A-2, Matrix of Movement Mode and Mobility Category, each





number 1 entered in the illustration must be accounted for by a set of rates related to each travel mode. For example, referring to Figure IV-13-A-2, if there were six number ones (1) entered for cavalry, there would be six road movement cards prepared for each of the formations. The formation is specifically the last letter of the travel mode. Thus, the letter M is a march column formation for ARAM. The letter R is reconnaissance formation in the mode labeled TRCR. A proportionate number of cards must be prepared for artillery. In this matter a check list can be developed to ensure that the complete constant data for this portion of the Movement Model is ready for operations. The format of this card is illustrated in Figure IV-13-A-9, Unit Road Movement Rates.

a. Card Type and Force Designator (Columns 1-2). In card column 1 has been preprinted the number 1; make no change. In column 2 enter either an "R" for Red force or "B" for Blue force.

b. Mobility Category Code (Column 4). From Figure IV-13-A-2, select the mobility category code that is applicable and enter it in column 4.

c. Formation Code (Column 5). The unit formation code is entered in this column. Referring to Figure IV-13-A-2 at the top of the figure are the listings of the travel modes. The last letter on the travel modes is an indication of the formation. The three formations were M for march column, R for reconnaissance, and D for deployed. See subparagraphs 3a(7) through 3a(9) for more information.

d. Weather and Climatic Conditions (Columns 8-10). In subparagraphs 2b and 2c are listed the weather and day or night conditions and their abbreviations. These conditions are entered in columns 8-10. In column 8 enter D for day condition or N for night condition. In column 9 always enter the letter W. In column 10 the index of the weather conditions is entered as 1, 2, or 3 depending upon the weather type being considered. There are six possible combinations of light and weather conditions. They are:

- . DW1 - Day, weather conditions type 1
- . DW2 - Day, weather conditions type 2
- . DW3 - Day, weather conditions type 3
- . NW1 - Night, weather conditions type 1
- . NW2 - Night, weather conditions type 2
- . NW3 - Night, weather conditions type 3.

e. Administrative Move on Paved Roads Over Good Terrain (Columns 16-20). Enter the rate in kilometers per hour at which the unit will move over this type of road.



f. Other Road Conditions Rates, Kilometers per Hour (Columns 16-65). Rates entered in these card columns are for the conditions for road movement in both administrative and tactical conditions. This information is entered after being acquired from authorized sources. Each of these rates is different and should be stated in numerical figures. All fractions and decimals are reduced to whole numbers, and only whole number entries are acceptable.

g. Additional Cards. There will be six cards for each mobility category and unit formation. Each will have administrative and tactical movement rates on paved, gravel, and dirt roads for a specific weather and day or night condition and must be filled out completely as described above.

h. Combinations of Tactical and Administrative Moves. Certain combinations of travel modes may exclude the completion of selected card columns on this form. For example, if this category and formation combination only applies to tactical movement, then no information on rates will need to be entered in the administrative move columns. Conversely, if the move is administrative only, then the tactical columns will not be completed. There are no administrative moves over dirt roads since there is no column provided for RD indicating dirt roads.

8. VEHICULAR ROAD MOVEMENT RATES. The vehicular road movement rates provide the speed at which individual vehicles such as tanks or trucks can travel over roadways or cross country. The mobility class on the vehicular road movement rate card ID 1403 is taken from the mobility classification card 0902; that is, the classification code was initiated on card format 0902. The equipment item code was also listed on this card format and this body of information must be related to that of movements on roads. This card format is illustrated in Figure IV-13-A-10, Vehicular Road Movement Rate, card ID 1403. Comparing this format with that in Figure IV-13-A-9 shows that the card format segment labeled unit road movement tactical move is identical with that of the Figure IV-13-A-10 format.

a. Card Format. In the format illustrated in Figure IV-13-A-10, the mobility class is the major variable, and weather and light conditions with types of road and terrain conditions are secondary. The same weather conditions exist in this card format as were stated in road movement for units. The road types are limited to paved, gravel, and dirt roads as were for tactical conditions in the unit move. Thus, the weather, light, and road conditions considered in data for vehicular road movement are identical in nature to those required for unit road movement.

b. Card Type and Force Designator (Columns 1-2). Card type 1 has been preprinted in column 1 of this format and is not to be changed. In column 2 only one of two authorized characters is entered, "R" for Red force or "B" for Blue force.

c. Mobility Class (Columns 4-5). The mobility class must agree with that assigned in card ID 0902. Care must be exercised to ensure that each mobility classification listed on that card has been recorded on this card format and that appropriate road movement rates have been entered.



d. Weather Climatic Conditions (Columns 8-10). In subparagraphs 2b and 2c were listed the weather and day or night conditions and their abbreviations. These weather and day or night conditions abbreviations are entered exactly as was described in subparagraph 7d. The road movement rates in kilometers per hour will be developed accordingly with the stated climatic conditions.

e. Rate with Paved Roads, Good Terrain (Columns 16-20). Enter the rate in kilometers per hour at which the vehicle will move over these roads at these weather conditions.

f. Rate with Paved Roads, Poor Terrain (Columns 21-25). Enter the rate in kilometers per hour at which vehicles will move over these roads at the weather conditions specified.

g. Rate with Other Road and Terrain Types (Columns 26-45). Enter in these card columns the rate in kilometers per hour at which the vehicles listed in this mobility class will travel over the roads as stated in the terrain and under the weather conditions stipulated. This should be done for gravel as well as dirt roads.

h. Additional Mobility Classes. The card format as shown in Figure IV-13-A-10 will handle one mobility class under one type of weather conditions. Additional cards are prepared for other mobility classes and different weather and light conditions.

(1) Additional Weather Conditions. The first card may be designated to handle daylight with no rain (DW1) weather conditions, while the second set of weather conditions on the second card format may be daylight with light rain (DW2). Each succeeding card format with a different combination will require data entries.

(2) Mobility Class Rate Tables Required. One mobility class requires six cards. If there are as many as 10 mobility classes, taken from card ID 0902, then 60 cards will be prepared.

9. UNIT CROSS COUNTRY MOVEMENT RATE. Preparation of data for entries in cross country movement should not be undertaken until the travel mode and mobility categories are completed and UTDs have been grouped by mobility categories. Referring to Figure IV-13-A-3, card ID 1401 and card ID 0901 should be completed prior to undertaking the unit cross country movement rates.

a. Card Format. The format for this card type is illustrated in Figure IV-13-A-11, Unit Cross Country Movement Rate with card ID 1902. The variables required on this card are mobility category code, type of military formation, weather conditions, and 20 movement rates corresponding to variations in terrain, soil, slope, and trafficability. As part of the check on this card format, for each number 1 entered in columns 31-50 of card format ID 1401, a cross country unit movement rate for the combination must be prepared. It is well to review the number of different cards to prepare for unit cross country movement and to ensure that the data entered in this card format are in response to that entered in card ID 1401.

[illegible]

Figure IV-13-A-11. Unit Cross Country Movement Rate

b. Card Type and Force Designator (Columns 1-2). Preprinted in column 1, as shown in Figure IV-13-A-11, is the number 1. Make no change. In column 2 enter either "R" for Red force or "B" for Blue force; no other entry is acceptable.

c. Mobility Category (Column 4). Enter the mobility category code as assigned in card ID 1401.

d. Military Unit Formation Code (Column 5). The unit formation code is entered here. Referring to Figure IV-13-A-2, at the top of the figure are listings of the travel modes. The last letter on the travel modes is an indication of the formation. The three formations are M for march column, R for reconnaissance, and D for deployed. See subparagraph 3c for further details.

e. Weather and Climatic Conditions (Columns 7-9). In subparagraphs 2b and 2c were listed the weather and light conditions and their abbreviations. These weather conditions abbreviations are entered exactly as described in subparagraphs 7d and 8d.

f. Rate with Terrain Flat to Gently Rolling, Forested, Coarse-Grained (Columns 10-12). Entered here is the rate in kilometers per hour for movement over this type of terrain and in accordance with the weather conditions stated in columns 7-9. Only whole numbers are entered in these card columns. Decimals or fractions are rounded to the nearest whole number, and the figure entered in this field is right justified.

g. Rate with Terrain Flat to Gently Rolling, Open, Coarse-Grained (Columns 13-15). Enter the kilometers per hour speed that this mobility category will have for this type of terrain, weather conditions, and other factors concerned with the units grouped together to form the category.

h. Rate with Other Varying Terrain and Soil Conditions (Columns 16-69). Entries in these card columns are in kilometers per hour, adjusted to meet the cross country factors that the units will encounter and considering the type of vehicles that are issued that unit under the climatic conditions stated in card columns 7-9. An entry should be made for each terrain type until data have been completed for all 20 types of terrain.

i. Additional Categories. One card format can record the data for one weather condition of one mobility category. Since there are six weather or climatic conditions expressed, for each mobility category there will be six cards. If there is more than one mobility category, 12 or more cards will be used.



j. Additional Cards. Additional cards will be required as more categories are defined. Each of these card formats will have the number 1 in card column 1 and the ID 1403 in card columns 73-76.

10. VEHICULAR CROSS COUNTRY MOVEMENT RATES. Vehicular cross country movement will have similar factors to those which relate to unit cross country movement. Desired for data entry into this card format are values for mobility classification, weather or climatic conditions, and movement rates corresponding to 20 degrees of terrain, slope, and soil trafficability.

a. Card Contents. The data elements in this card format are very similar to those for the unit cross country movement rate. Figure IV-13-A-12, Vehicular Cross Country Movement Rate, illustrates the card format with card ID 1404. Instructions for entry of data are almost identical and will be explained only briefly.

b. Card Type and Designator (Columns 1-2). The card column 1 has been preprinted with the number 1, and no change is to be made. Card column 2 will have only one of two entries, "R" for Red force and "B" for Blue force.

c. Mobility Classification (Column 4). Reference is made to the format for card ID 0902 in which the various mobility classifications were listed. For each of the classes listed in card ID 0901 a set of cards will be prepared of the type in ID 1404. This may be used as a check list to ensure that all the required cross country movement rates for vehicles are entered in the data base.

d. Weather Climatic Conditions (Columns 7-9). In subparagraphs 2b and 2c were listed the weather and light conditions and their abbreviations. These conditions are entered exactly as described before in subparagraphs 7d, 8d, and 9d.

e. Rate for Terrain Flat to Gently Rolling, Forested, Coarse-Grained (Columns 10-12). Enter here the kilometers per hour rate for this type of terrain and, in accordance with the weather conditions expressed in card columns 7-9, the speed which this class of mobility is anticipated to have. This will be a weighted figure which represents the collective speeds of the various types of vehicles grouped in this classification.

f. Rate for Terrain Flat to Gently Rolling, Open, Coarse-Grained (Columns 13-15). Enter here the kilometers per hour speed that this mobility category will have for this type of terrain, weather conditions, and other factors associated in the combination of vehicles into this classification.

g. Rate for Other Terrain, Forestation, and Soil (Columns 16-69). The cross country movement rates in kilometers per hour for the remaining types of terrain are entered.

VEHICULAR CROSS COUNTRY MOVEMENT RATE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
CARD TYPE	MOBILITY CLASS	WEATHER <sup>1</sup>	TERRAIN <sup>2</sup> (KILOMETERS PER HOUR) - ROUGHNESS, VEGETATION, FORESTATION, SOIL-SLOPE-TRAFFICABILITY																				CARD ID	CARD SEQ. NR.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
			T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>	T <sub>7</sub>	T <sub>8</sub>	T <sub>9</sub>	T <sub>10</sub>	T <sub>11</sub>	T <sub>12</sub>	T <sub>13</sub>	T <sub>14</sub>	T <sub>15</sub>	T <sub>16</sub>	T <sub>17</sub>	T <sub>18</sub>	T <sub>19</sub>	T <sub>20</sub>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Figure IV-13-A-12. Vehicular Cross Country Movement Rate

h. Additional Classes. In one card format can be recorded the movement rates for one mobility class and one weather condition. Since there are a maximum of six weather and light conditions there may be as many as six different cards prepared for one mobility classification. If there are two or more mobility classifications then there will be 12 or more cards prepared.

i. Additional Cards. The additional cards must all bear the same card type number 1 as printed in column 1 and must have the ID 1404 in card columns 73-76.

11. GROUND MOVEMENT FUEL CONSUMPTION RATE. Each of the vehicles listed in card ID 0902, Mobility Class, must have its fuel consumption listed in this card format. Some of the vehicles or equipment items are stationary, such as air compressors for pneumatic hammers, and for these type of vehicles or equipment items the unit of measure for fuel is gallons per hour.

a. Format. The card format with identifier 1501 includes data for both moving and stationary equipment items. Since each item of equipment is specifically identified with its equipment item code all items that consume fuel must be included in this card format, illustrated in Figure IV-13-A-13. The equipment item list used in TOE load (see Chapter 3 of this section) may be consulted to ensure that a complete check list of fuel-consuming items have been included in this segment of the data base.

b. Card Type and Designator (Columns 1-2). In column 1 has been entered the number 1. In column 2 "B" for Blue force or "R" for Red force is entered.

c. Equipment Item Code (Columns 3-6). The number assigned the equipment item as its code is to be entered in these columns. This code positively identifies this item and sets it apart from all others.

d. Gallons of Fuel per Kilometer, Cross Country (Columns 11-16). Enter the gallons of fuel per kilometer that this type equipment will achieve in cross country operations. The types of cross country to be considered are all conditions of terrain as listed in both cards ID 1403 and 1404. The consumption rate will be a composite figure for both day and night travel and that conducted during the spectrum of weather conditions. Consumption rates may be expressed in decimal fractions.

e. Gallons of Fuel per Kilometer, Paved Roads (Columns 17-22). The consumption rate of fuel in gallons per kilometer is to be entered for this vehicle when on paved roads.

f. Gallons of Fuel per Kilometer, Gravel Roads (Columns 23-28). The consumption rate of fuel in gallons per kilometer is entered for this vehicle when on gravel roads.

g. Gallons of Fuel per Kilometer, Dirt Roads (Columns 29-34). The consumption of fuel at the gallons per kilometer rate is to be entered here

VEHICULAR FUEL CONSUMPTION RATES												
CARD TYPE	ITEM CODE	FUEL CONSUMPTION KM/GAL				GALS/HR FOR EACH ITEM CODE				CARD ID	CARD SEQ. NR.	
		MODE ACTIVITY				ENGINEER ACTIVITY						
		CROSS COUNTRY (CC)	PAVED ROADS (RA)	GRAVEL ROADS (RG)	DIRT ROADS (RD)	TEMP	90/32TEMP	90/32 TEMP	90/32TEMP			
1	1	1	1	1	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1	1	1	1	1
1	3	1	1	1	1	1	1	1	1	1	1	1
1	4	1	1	1	1	1	1	1	1	1	1	1
1	5	1	1	1	1	1	1	1	1	1	1	1
1	6	1	1	1	1	1	1	1	1	1	1	1
1	7	1	1	1	1	1	1	1	1	1	1	1
1	8	1	1	1	1	1	1	1	1	1	1	1
1	9	1	1	1	1	1	1	1	1	1	1	1
1	10	1	1	1	1	1	1	1	1	1	1	1
1	11	1	1	1	1	1	1	1	1	1	1	1
1	12	1	1	1	1	1	1	1	1	1	1	1
1	13	1	1	1	1	1	1	1	1	1	1	1
1	14	1	1	1	1	1	1	1	1	1	1	1
1	15	1	1	1	1	1	1	1	1	1	1	1
1	16	1	1	1	1	1	1	1	1	1	1	1
1	17	1	1	1	1	1	1	1	1	1	1	1
1	18	1	1	1	1	1	1	1	1	1	1	1
1	19	1	1	1	1	1	1	1	1	1	1	1
1	20	1	1	1	1	1	1	1	1	1	1	1
1	21	1	1	1	1	1	1	1	1	1	1	1
1	22	1	1	1	1	1	1	1	1	1	1	1
1	23	1	1	1	1	1	1	1	1	1	1	1
1	24	1	1	1	1	1	1	1	1	1	1	1
1	25	1	1	1	1	1	1	1	1	1	1	1
1	26	1	1	1	1	1	1	1	1	1	1	1
1	27	1	1	1	1	1	1	1	1	1	1	1
1	28	1	1	1	1	1	1	1	1	1	1	1
1	29	1	1	1	1	1	1	1	1	1	1	1
1	30	1	1	1	1	1	1	1	1	1	1	1
1	31	1	1	1	1	1	1	1	1	1	1	1
1	32	1	1	1	1	1	1	1	1	1	1	1
1	33	1	1	1	1	1	1	1	1	1	1	1
1	34	1	1	1	1	1	1	1	1	1	1	1
1	35	1	1	1	1	1	1	1	1	1	1	1
1	36	1	1	1	1	1	1	1	1	1	1	1
1	37	1	1	1	1	1	1	1	1	1	1	1
1	38	1	1	1	1	1	1	1	1	1	1	1
1	39	1	1	1	1	1	1	1	1	1	1	1
1	40	1	1	1	1	1	1	1	1	1	1	1
1	41	1	1	1	1	1	1	1	1	1	1	1
1	42	1	1	1	1	1	1	1	1	1	1	1
1	43	1	1	1	1	1	1	1	1	1	1	1
1	44	1	1	1	1	1	1	1	1	1	1	1
1	45	1	1	1	1	1	1	1	1	1	1	1
1	46	1	1	1	1	1	1	1	1	1	1	1
1	47	1	1	1	1	1	1	1	1	1	1	1
1	48	1	1	1	1	1	1	1	1	1	1	1
1	49	1	1	1	1	1	1	1	1	1	1	1
1	50	1	1	1	1	1	1	1	1	1	1	1
1	51	1	1	1	1	1	1	1	1	1	1	1
1	52	1	1	1	1	1	1	1	1	1	1	1
1	53	1	1	1	1	1	1	1	1	1	1	1
1	54	1	1	1	1	1	1	1	1	1	1	1
1	55	1	1	1	1	1	1	1	1	1	1	1
1	56	1	1	1	1	1	1	1	1	1	1	1
1	57	1	1	1	1	1	1	1	1	1	1	1
1	58	1	1	1	1	1	1	1	1	1	1	1
1	59	1	1	1	1	1	1	1	1	1	1	1
1	60	1	1	1	1	1	1	1	1	1	1	1
1	61	1	1	1	1	1	1	1	1	1	1	1
1	62	1	1	1	1	1	1	1	1	1	1	1
1	63	1	1	1	1	1	1	1	1	1	1	1
1	64	1	1	1	1	1	1	1	1	1	1	1
1	65	1	1	1	1	1	1	1	1	1	1	1
1	66	1	1	1	1	1	1	1	1	1	1	1
1	67	1	1	1	1	1	1	1	1	1	1	1
1	68	1	1	1	1	1	1	1	1	1	1	1
1	69	1	1	1	1	1	1	1	1	1	1	1
1	70	1	1	1	1	1	1	1	1	1	1	1
1	71	1	1	1	1	1	1	1	1	1	1	1
1	72	1	1	1	1	1	1	1	1	1	1	1
1	73	1	1	1	1	1	1	1	1	1	1	1
1	74	1	1	1	1	1	1	1	1	1	1	1
1	75	1	1	1	1	1	1	1	1	1	1	1
1	76	1	1	1	1	1	1	1	1	1	1	1
1	77	1	1	1	1	1	1	1	1	1	1	1
1	78	1	1	1	1	1	1	1	1	1	1	1
1	79	1	1	1	1	1	1	1	1	1	1	1
1	80	1	1	1	1	1	1	1	1	1	1	1
1	81	1	1	1	1	1	1	1	1	1	1	1
1	82	1	1	1	1	1	1	1	1	1	1	1
1	83	1	1	1	1	1	1	1	1	1	1	1
1	84	1	1	1	1	1	1	1	1	1	1	1
1	85	1	1	1	1	1	1	1	1	1	1	1
1	86	1	1	1	1	1	1	1	1	1	1	1
1	87	1	1	1	1	1	1	1	1	1	1	1
1	88	1	1	1	1	1	1	1	1	1	1	1
1	89	1	1	1	1	1	1	1	1	1	1	1
1	90	1	1	1	1	1	1	1	1	1	1	1
1	91	1	1	1	1	1	1	1	1	1	1	1
1	92	1	1	1	1	1	1	1	1	1	1	1
1	93	1	1	1	1	1	1	1	1	1	1	1
1	94	1	1	1	1	1	1	1	1	1	1	1
1	95	1	1	1	1	1	1	1	1	1	1	1
1	96	1	1	1	1	1	1	1	1	1	1	1
1	97	1	1	1	1	1	1	1	1	1	1	1
1	98	1	1	1	1	1	1	1	1	1	1	1
1	99	1	1	1	1	1	1	1	1	1	1	1
1	100	1	1	1	1	1	1	1	1	1	1	1

Figure IV-13-A-13. Vehicular Fuel Consumption Rates

for dirt roads under all types of weather conditions and considering night or day driving. If the vehicle or equipment item operates while stationary, such as an electric generator, then these card columns are left blank.

h. Engineer and Stay Type Activities (Columns 35-58). Several selected equipment types, such as tanks of an armored unit, armored personnel carriers, or self-propelled artillery, are not entered in these columns because they are not used in engineering type activities during the course of the game.

i. Engineer Activity, Temperature Between 32° and 90° (Columns 35-40). Enter the gallons per hour of fuel consumed by engineer type equipment for temperature ranges between 32° and 90° in these columns.

j. Engineer Activity, Temperature Higher Than 90° or Lower Than 32° (Columns 41-46). Enter the gallons per hour of fuel consumed by engineer type equipment for temperature ranges higher than 90° and lower than 32° in these columns.

k. Stay Activity, Temperature Between 32° and 90° (Columns 47-52). Enter the consumption of fuel in gallons per hour for activity that takes place in an assembly area or for stationary equipment.

l. Stay Activity, Temperature Higher Than 90° or Lower Than 32° (Columns 53-58). In these card columns enter the consumption of fuel which has ambient temperatures of higher than 90° or lower than 32°.

m. Equipment Items. One card is prepared for each equipment item code identified. As a check use the list of vehicles developed with the mobility classification and the data sheets prepared for the TOE load (see Chapter 3) for equipment items which consume fuel but do not carry a load or are used in combat and require a resupply of fuel, such as tanks.

12. AIRCRAFT FUEL CONSUMPTION RATES. Part of the criteria of whether a mission can be assigned aircraft is a requirement that a specific amount of fuel be aboard. If that quantity of fuel is not already aboard the aircraft or available at the airbase, then the mission may be denied. Thus, the fuel consumption rate by aircraft and the draw on local stocks is important in determining whether that aircraft can take off for mission strikes. The transport system to provide that fuel and similar logistics tasks provide more realism for simulation in the DIVWAG system.

a. Card Format. The card format with card identifier 1405 is illustrated in Figure IV-13-A-14, that portrays the actual punch card layout that records data. It will be referred to frequently in describing the data elements and indicating the exact card columns where the data are to be entered. The variables of which values are to be entered in these card columns are defined as:

(1) The equipment item code in which a specific item is identified as a consumer of fuel.

AIRCRAFT FUEL CONSUMPTION RATES											
CARD TYPE	ITEM CODE	ALTITUDE CUT-OFF (FT)	CRUISE SPEED CUT-OFF (KNOTS)	FUEL CONSUMPTION RATES - GALS/HR						CARD ID	CARD SEC. NR
				CRUISE			STAY				
				1/	2/	3/	4/	TEMP ≤ 90/3	TEMP > 90/32		
				≤ ALT	> ALT	≤ ALT	> ALT				
										1 4 0 3	

1/ Below cut off alt slower than cutoff speed  
 2/ Above alt cause change gas below cut off speed  
 3/ Below cut off alt above cut off speed  
 4/ Greater than cut off alt Greater than cut off speed

Figure IV-13-A-14. Aircraft Fuel Consumption Rates

(2) Altitude at which the fuel consumption rate changes.

(3) Cruise speed beyond which the consumption of fuel changes considerably.

(4) Fuel consumption rates for aircraft in various combinations of variable definitions (2) and (3) above.

(5) Aircraft fuel consumption while parked on runways at varying temperatures.

b. Card Type and Force Designator (Columns 1-2). The printed figure 1 in the first column is not to be changed. In column 2 may be entered either "B" for Blue force or "R" for Red force.

c. Equipment Item Code (Columns 4-6). Enter the code number for this specific aircraft as identified by the number.

d. Altitude Cutoff, Feet (Columns 11-16). Enter the altitude in feet which causes a change in fuel consumption.

e. Cruise Speed, Knots per Hour (Columns 17-22). Enter the cruise speed in knots per hour of the aircraft above which the fuel consumption changes considerably.

f. Gallons per Hour, Below Critical Cruise Speed and Below Critical Altitude (Columns 23-28). Enter the gallons per hour fuel consumption below critical altitude and cruise speed.

g. Gallons per Hour, Below Cruise Speed but Above Critical Altitude (Columns 29-34). Enter the fuel consumption in gallons per hour when the aircraft is traveling below cruise speed but at an altitude above the cutoff point.

h. Gallons per Hour, Greater Than Cruise Speed but Lower Than Altitude Cutoff (Columns 35-40). Enter the gallons per hour fuel consumption when the aircraft is traveling at greater than cruise speed but at an altitude lower than critical.

i. Gallons per Hour, Cruise Speed and Altitude Greater Than Cutoff (Columns 41-46). The gallons per hour consumption of fuel by this aircraft is to be entered when the aircraft is above altitude and speed cutoff limits.

j. Aircraft Parked at Airbase (Columns 47-58). These fuel consumptions in gallons per hour are used when the aircraft is parked on the runway. The fuel consumption is not for in-flight or propulsion needed such as when on air strikes. The consumption varies with the ambient temperature, and the two ranges are between 32° and 90° or higher than 90° and lower than 32°.

k. Aircraft Stay Mode, Temperature Between 32° and 90° (Columns 47-52). Enter the fuel consumption rate in gallons per hour for aircraft parked on the strip at an airfield with the engine running or using the electric generator or other devices.

l. Aircraft Stay Mode, Temperature Higher than 90° or Lower Than 32° (Columns 53-58). Enter the fuel consumed when the aircraft is parked on the runway with engine idling at temperatures of greater than 90° or less than 32°.

13. BREACH OR FORCE DECISION TABLES. A breach/force decision table is required for each movement priority used in the game. If the procedure discussed in subparagraph 2c(7) was followed, the necessary data can be copied directly from the work forms to the data format.

a. The Card. The breach/force decision table data card is identified by the characters 0903 in columns 73-76 as illustrated in Figure IV-13-A-15. Only one card is required for each table.

b. Card Type and Designator (Columns 1-2). The number 1 is preprinted in column 1. Column 2 must contain a "B" if the table applies to the Blue force and an "R" if the table is to be used by the Red force.

c. Movement Priority (Column 4). The movement priority (a numeric value 1-n, where n is the number of tables) with which this table will be associated is entered in column 4.

d. Vehicles Lost (Columns 7-8). The maximum number of casualties which the first row of this decision table will apply to is entered in these columns. The value which would be entered here for the example shown in Figure IV-13-A-4 is "1".

e. Breach/Force Code (Column 10). If the unit should force the barrier when the number of vehicles input in columns 7-8 or fewer will be lost and up to 0.5 hour may be required to breach the barrier, a 2 is placed in this column. Otherwise, a number 1 is entered in column 10.

f. Other Vehicles Lost and Breach/Force Codes (Columns 12-66). Data entered in these fields complete the table and are similar to those described for columns 7-8 or 10. No vehicles lost value is entered for the last row of the table (columns 56-66). This row is assumed to apply to all losses greater than the value entered in columns 39-40.

g. Other Cards. Complete one card for each movement priority used in the game.

14. MOVEMENT MODEL CONSTANT DATA DECK STRUCTURE. This paragraph describes the data deck structure for constant data input used in the Movement Model. The cards making up the deck and the order in which they must be read into the DIVWAG system are discussed.





a. Movement Model Constant Data Input Cards. The cards for the Movement Model constant data input are listed in Figure IV-13-A-16. The figure shows card type, title, and identification. The far right column shows the program used to load the data.

Card Type	Card Title	Card ID	Load Program Name
1	Travel Mode Mobility Category	1401	MOVELD
1	Mobility Category Table	0901	MOVELD
1	Mobility Class Table	0902	MOVELD
1	Mobility Class Exclusion	1402	MOVELD
1	Mobility Category Road Movement Rate	1901	MOVELD
1	Mobility Category Cross Country Movement	1902	MOVELD
1	Mobility Class Road Movement Rate	1403	MOVELD
1	Mobility Class Cross Country Movement	1404	MOVELD
1	Ground Fuel Consumption Rate	1501	MOVELD
1	Air Fuel Consumption Rate	1405	MOVELD
1	Breach/Force Decision Table	0903	MOVELD

Figure IV-13-A-16. Movement Model Constant Data Input Cards

b. Creating Constant Data Files for Movement. The Movement Model constant data input file is created by reading in the data deck structured as illustrated in Figure IV-13-A-17. At the right are shown the subdecks that form the Movement Model data deck, with Blue force data preceding Red force data. At the left side of the figure are 11 groupings of card formats, which are used to assemble the subdecks shown at the right.

(1) Card Groupings. Figure IV-13-A-17 shows in position one the mobility category travel mode, card type 1, ID 1401 grouping. Immediately behind this grouping is the first card of the mobility category, card type 1, ID 0901 grouping. All the Blue force cards are arranged first and assembled

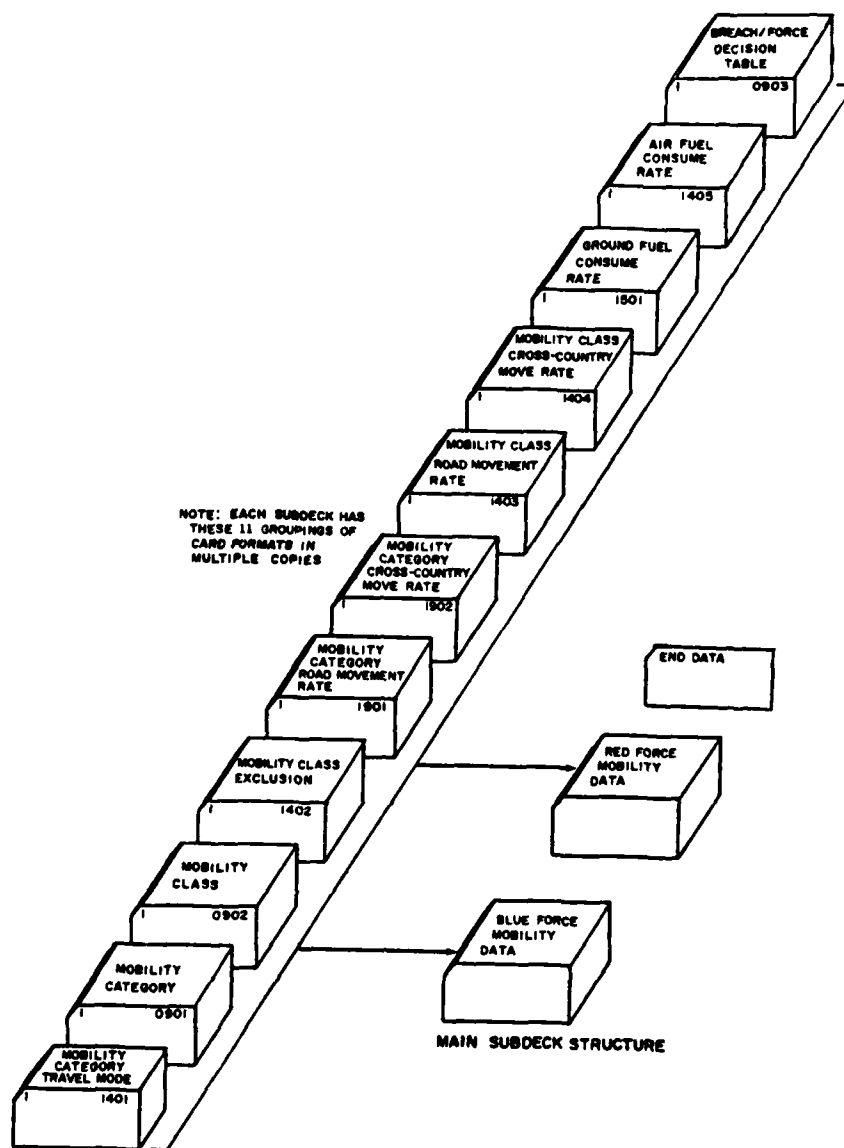


Figure IV-13-A-17. Movement Model Data Deck Structure

as part of the Blue force subdeck. The Red force cards are assembled into their own subdeck, and the two are then submitted for reading by the computer system. A card with the characters END DATA punched in columns 73 through 80 must follow the Red force subdeck.

(2) Subdeck Structure. After the groupings of cards are aligned as shown on the left of Figure IV-13-A-17, all the blue force cards are then assembled for the first subdeck. The Red force movement data are then organized in the 11 groupings as shown at the left of the figure. The data deck is then ready for insertion of the system control cards and submission to the computer system for creation of the Movement Model constant data input files.

c. Updating Movement Model Constant Data Files. Changes to the data read into the constant data files for the Movement Model can be readily accomplished through the use of the retained Movement Model data deck. The updating may consist of correction of an error in one data element, the deletion of information, or the addition of new data.

(1) Correcting an Error. The card with the error or data to be changed is located and a new card produced with the correct or changed data punched in. The old card is removed from the deck, and the new card is inserted in its location. The entire data deck for both Red and Blue forces is then submitted for another run on the computer system. The recreation of the constant data files through reading in the data deck with the changed data on cards constitutes the correction of an error or the changing of a data element.

(2) Deletion of Information. The deletion process may consist of eliminating the entire file or deleting one data element or a record. To delete a data element, select the card or cards having the unwanted data. These cards are removed from the data deck, and the purged deck is then submitted for reread to the computer system. The omission of cards will cause that data to be eliminated from the data base in the process of recreating the constant data files for the Movement Model.

(3) Addition of Data. Data may be added at any time prior to the start of the game. The procedure is to prepare the cards that are to have the data and integrate them into the data deck by placing each of the card formats in the appropriate subdeck as illustrated in Figure IV-13-A-17. When these cards have been accurately integrated into the data deck the completed and expanded data deck is then submitted to the computer system for reread. Each time data are entered in the Movement Model constant data input file printouts are generated showing the new file information.

## APPENDIX B

### MOVEMENT MODEL PROGRAM DESCRIPTIONS

1. INTRODUCTION. The routines MOVESR, MOVEDT, OBSRCH, and MOVE are the component routines of the Movement Model. The first three routines perform all calculations necessary to time sequence the movement events in the DIVWAG system. The routine MOVE is executed at the appropriate time to update the parameters modified by the movement event. The routine OVER13 serves as an interface between routines MINUET, MOVE, and SUPRES. The macro flow of the Movement Model is shown in Figures IV-13-1, IV-13-3, IV-13-4, and IV-13-6.

#### 2. ROUTINE MOVESR:

a. Purpose. This routine determines the endpoint coordinate of the model move segment. This coordinate may be set to the order segment endpoint, the point of segment intersection with a terrain cell boundary, or the point at which a segment intersects a barrier line or facility, whichever is closer to the unit's current location. If the unit is flying, the model move segment will always be identical to the order segment. The routine may also initiate a battle as units of opposing forces approach each other.

#### b. Input Variables:

(1) Standard Common Block Areas. UMAIN, UCOOP, BPOINT, BMPRTY, and RMPRTY.

#### (2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
KOF	DF2	Barrier information.
IBSRCH	ONE	Parameters used to communicate with OBSRCH.
IDEC	DF9	Force/breach decision table.
MVRATE	ONE	Unit movement rate. It is set to zero at the beginning of each order segment and is used by MOVESR to determine if an order segment must be processed.
IBAR	ONE	Code of barrier which unit anticipates crossing. IBAR is set to zero if no known barrier is in the unit's path, is set equal to the barrier code if the unit is expecting to contact a barrier at the end of this model move segment, and is set to the negative of the barrier code if the unit is crossing a barrier.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IBCHIN	ONE	Chaining parameter used to force units crossing a barrier at the same facility to do so in order of priority. IBCHIN is set to zero if the unit is not in a barrier chain, to minus one if the unit is last in the chain, or to the IUID of the next unit in the chain.
FORCTM	ONE	Time required to force an active barrier if the value is positive. If the value is negative, it is the negative of the barrier code of the barrier the unit expects to cross while traveling along this order segment.
FRCEOH	ONE	Item code of the vehicle used to force the barrier if the value is positive. If it is negative, it contains the negative of the barrier code of the barrier the unit expects to avoid by being routed to one of its endpoints.
CBJX, CBJY	ONE	Coordinate of segment intersection with barrier line, or facility or end point unit is being routed to. If there are no barriers, it will be set to the coordinate of the order segment objective.
ATBARX, ATBARY	ONE	Coordinate of facility, barrier endpoint, or point of segment intersection with barrier line.
FORCCU	ONE	The casualties that will be assessed a unit choosing to force an active barrier.
EOHI	DF16	Equipment type codes.

c. Output Variables:

(1) Standard Common Block Variables. MEVTX, MEVTY, NORD, and DELT.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
KOF	DF2	Barrier information.
IENGRQ	DF12	Request for support sent to the Engineer Model.
IBSRCH	ONE	Parameters used to communicate with OBSRCH.
IBAR	ONE	As defined for input variables.

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IBCHIN	ONE	As defined for input variables.
FORCTM	ONE	As defined for input variables.
FRCEOH	ONE	As defined for input variables.
CBJX, CBJY	ONE	As defined for input variables.
ATBARX	ONE	As defined for input variables.
ATBARY	ONE	As defined for input variables.
FORCCU	ONE	As defined for input variables.

d. Logical Flow (Figure IV-13-B-1):

(1) Block 1. If the unit is out of fuel, it will be halted and will remain on a STAY event until it is resupplied.

(2) Block 2. If the unit is flying, barriers and terrain have no effect upon its movement, so the model move segment is set to the order segment and control passes to block 6.

(3) Block 3. At this point, IBAR is interrogated to determine if the unit is at a barrier. If IBAR equals zero, the unit is not at a barrier. If IBAR is positive, the unit is at a barrier and ready to cross. If IBAR is negative, the unit has crossed the barrier and is ready to continue its movement.

(4) Block L5000. If the unit has crossed the barrier, it is removed from the crossing order queue (chain) established for that barrier; the following unit, if any exists, is placed first in the queue. The remainder of the original unit's order segment is again searched for barriers as it continues its movement, and an event initiating the next unit's crossing is set up.

(5) Block L990. If MVRATE equals zero, the unit is beginning its movement along an order segment, and control passes to block L1000; otherwise, control goes to block L2000.

(6) Block L1000. As the unit begins moving along each order segment, that segment is searched for an intersection with barriers known to the unit's force intelligence. This allows early rerouting of the unit to be accomplished or an early request for engineering assistance to be made if either action is appropriate. The end of segment to be searched parameters (ENDPTX and ENDPY) are set equal to the order segment objective point (OBJX and OBJY), the flag used to indicate only force intelligence information is to be used (INACT) is set to 1, and the search routine (OBSRCH) is called.





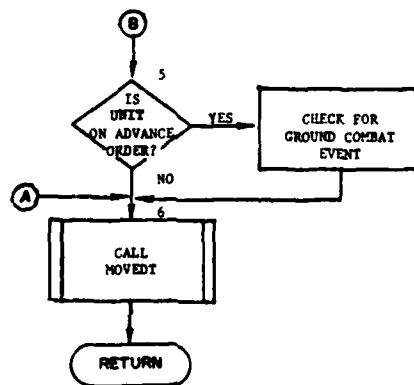


Figure IV-13-B-1. Routine MOVESR (concluded)

(7) Block L1100. If the information returned by OBSRCH (IBSRCH) indicates a barrier line intersects the move segment, a decision is made in block 4 to determine the unit's appropriate action; otherwise, control passes to block L1900.

(8) Block 4. If the facility availability code (NBARF) is greater than zero an existing facility is available, NBARF is equal to its code, and the unit will be routed to it by setting its coordinate of facility parameters (ATBARX and ATBARY) and its coordinate of segment intersection parameters (CBJX and CBJY) to the coordinate returned by OBSRCH (FACX and FACY). FORCTM will be set to negative NBARF. If NBARF is less than zero, the values returned in FACX and FACY are the coordinates of the endpoint of the barrier the unit may be routed to. This routing is accomplished by setting ATBARX, ATBARY, CBJX, and CBJY as described above and setting FRCEOH to the negative of NBARF. If NBARF equals zero, no facility or endpoint is available and control goes to block L1115. If passage is possible, control passes to block L1900.

(9) Block L1115. If the barrier intersected is active, the unit may choose to force it rather than suffer a delay waiting for it to be breached. IDEC is a decision table which is a function of the unit's movement priority, the number of casualties that will be assessed the unit if it forces the barrier, and the length of time that will be required to breach it. IDEC is interrogated to determine which course of action the unit is to pursue: force, go to block L1900, not force, go to block L1500.

(10) Block L1500. If the unit cannot bypass the barrier or make use of an existing facility, it will request the Engineer Model to construct a facility at the point of intersection by setting parameters in the array IENGRO and calling EVTSET.

(11) Block L1900. If the barrier search just completed was an order segment search, the movement path must be searched for barriers again using actual information. This is accomplished by passing to block L2000; otherwise, control goes to block 5.

(12) Block L2000. The model move segment endpoint coordinates (MEVTX and MEVTY) are set to CBJX and CBJY. If CBJX and CBJY are not in the same terrain cell as the unit, MEVTX and MEVTY are reset to the coordinates of the point of intersection of the model move segment and the terrain cell boundary. This new segment is then searched for barriers by setting INACT equal to minus one, ENDPTX and ENDPTY to MEVTX and MEVTY, and calling OBSRCH. Giving INACT the value of minus one indicates to OBSRCH that actual barrier information is to be used, and the flow starting at block L1100 is rejoined.

(13) Block L3000. When the unit arrives at a barrier it is placed in the barrier's crossing order queue. The units are ordered by move priority (MVPRTY) and, within priority, on a first-in-first-out basis.

(14) Block L4000. If another unit is crossing the barrier at this point or the engineers are in the process of constructing the facility when the unit arrives, the facility is not available and the unit must wait. If neither of the above is so and the unit decided to force the barrier, it constructs its own facility and is assessed casualties caused by forcing the barrier.

(15) Block L4300. The time required to cross the facility is calculated by multiplying the crossing rate by the number of vehicles in the unit and is assessed to the unit by giving it a STAY order for that length of time.

(16) Block L3400. If the facility is not available, the unit is given an order to STAY until the end of the period. This order will be interrupted and the unit will continue its movement if the facility becomes available before the end of the period.

(17) Block 5. Routine MOVESR also initiates a battle when a unit listed in a battle scenario and executing an ADVANCE order moves within 3000 meters of an appropriate enemy unit. At this time the unit's ADVANCE order is terminated, and control is passed from the Movement Model to the Ground Combat Model. As the battle is initiated, the ADVANCE, WITHDRAW, or PREPARE orders of all units listed in its battle scenario are terminated, and control of those units is assumed by the Ground Combat Model. Units listed in the battle scenario that begin execution of an ADVANCE, WITHDRAW, or PREPARE order after the battle has begun have those orders terminated and their control is assumed by the Ground Combat Model at that time.

(18) Block 6. The MOVEDT routine determines the unit's rate of movement and calculates the time required by the unit to traverse the model segment described by MOVESR.

### 3. ROUTINE MOVEDT:

a. Purpose. This routine determines the unit's rate of movement and calculates the time required to travel along the model move segment.

#### b. Input Variables:

(1) Standard Common Block Areas. UMAIN, TERAIR, WEATHR, TCLOCK, LGTPER, HOUR, MINUTE, BMNT, BMCMT, EENT, RCMRT, RFTMT, BFTMT, and IBFOOD.

#### (2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IVDU	DF9	Mobility class indices.
MAXRAT	DF14	Mobility class maximum move rates.
IDS	DF14	Mobility class exclusion table.
MRTN	DF19	Unit movement rate.
ITLOST	ONE	Time lost during move.

c. Output Variables:

(1) Standard Common Block Variables. MVRATE, DELT, XKK, YKK, and IOUT.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
ITLOST	ONE	Time lost during move.

d. Logical Flow (Figure IV-13-B-2):

(1) Block 1. Calculate the unit's distance moved in the X and Y directions (XKK and YKK) by subtracting the unit's current location parameters (XACT and YACT) from the unit's model move segment parameters (MEVTX and MEVTY). The length of the model move segment (DIST) is equal to the square root of XKK squared plus YKK squared.

(2) Block 2. If the unit is flying, the movement rate (MVRATE) is calculated by converting the airspeed given in the order from knots to meters per minute.

(3) Block 3. A unit's ground movement rate depends upon type of move, type of route, unit's formation, light level, weather, and terrain. The unit's route type index (RRRCD, characters 2 and 3) may be RA, RG, RD, or CC; and the route type code (IROUT) is assigned a value of 1, 2, 3, or 4 respectively. The allowed formation types are M, R, or D (RRRCD, character 4) with the formation type code (IFORM) being assigned a value of 1, 2, or 3 respectively. The day-night code (IDORN) is set to 0 if the time is between BMNT and EENT; it is set to 3 otherwise. The precipitation index (PRECIP) has a value of 0, 1, or 2 for none, light, or heavy precipitation respectively, and the fog index (FOGIDX) is set to 0 for no fog or to 1 for presence of fog. The precipitation code (IPRECP) is set equal to the precipitation index unless fog is present; in that case it is set equal to 2. If the route type is CC, the movement rate table index (IRATE) is calculated using the trafficability index contained in characters 3 and 4 of RFSC by the equation:

$$\begin{aligned} \text{IRATE} &= 10 * \text{RFSC}(3) + \text{RFSC}(4) \\ &+ (\text{IDORN} + \text{PRECIP}) * 20 \end{aligned} \quad (\text{IV-12-B-1})$$

If the unit is moving on a road, the roughness-vegetation code (ITER) must be calculated. It is set to 2 if the roughness-vegetation index [RFSC(1)] is greater than 5 and set to 1 otherwise. The move type code must also be set. It is equal to 4 if the move type index (RRRCD, character 1) is equal to T; it is 0 otherwise. The road movement rate table index is then calculated by the equation:

$$\begin{aligned} \text{IRATE} &= (\text{IDORN} + \text{IPRECP}) * 10 + \text{IAT} \\ &+ (\text{IROUT} - 1) * 2 + \text{ITER} \end{aligned} \quad (\text{IV-12-B-2})$$

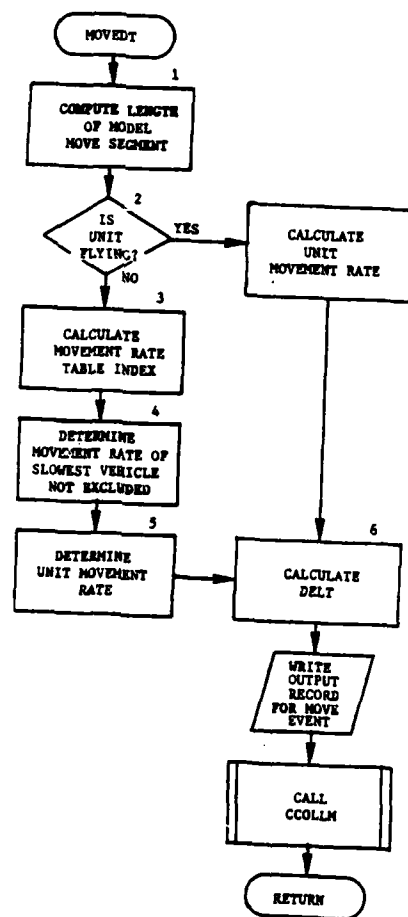


Figure IV-13-B-2. Routine MOVEDT

(4) Block 4. A unit's movement rate may not be greater than the rate of its slowest vehicle that has not been excluded. The list of vehicular rates (MAXRAT) is obtained from data file 14 using the movement rate table index calculated in block 3. The exclusion table (IDS), also from data file 14, is used to determine which, if any, of the vehicular rates will not be allowed to restrict the unit's movement. The slowest vehicle movement rate (MRT) is set to the slowest nonexcluded value in the vehicular rate list applying to a vehicle in the unit.

(5) Block 5. The movement rate table index is used to obtain the unit's movement rate (MRTN) from the tables on data file 19. If the table requested has not been loaded, the table containing tank data is used. If the travel mode mnemonic supplied cannot be used with the unit's mobility category, data from the dismounted infantry table are used. If the movement rate of the slowest vehicle (MRT) is less than the unit movement rate (MRTN), the movement rate (MVRATE) is set equal to MRT; otherwise, it is set to MRTN.

(6) Block 6. The time required by the unit to travel the length of the model move segment (DELT) is calculated by dividing the length of the model move segment by the movement rate.

(7) Block 7. The record of the movement event is written on the period history tapes at this point.

(8) Block 8. The routine CCOLLM, which determines whether the unit will be detected by an opposing force sensor while it is moving, is called before returning. Routine CCOLLM is described in the Intelligence and Control Model.

#### 4. ROUTINE OBSRCH:

a. Purpose. This routine determines if a move segment will intersect a barrier line. If an intersection is found, an attempt will be made to locate an existing facility or the endpoint of a barrier line that the unit may be routed to. The resulting information is returned to MOVESR.

##### b. Input Variables:

(1) Standard Common Block Areas. UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IBIG1	DF16	Quadrature description.
OBFACC	ONE	Unit/barrier status flag: = 0, unit is not aware of any barrier; > 0, unit is at this barrier and needs information about it; < 0, unit has crossed this barrier, and do not pick it up this search.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IBIG	DF22	List of barrier code numbers and their locations.
IOF	DF2	Data describing the barrier.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IDUM(120)	TWO	Barrier information requested by MOVESR.

d. Logical Flow (Figure IV-13-B-3):

(1) Block 1. Scratch common is stored on data file 36, the basic quadrature information necessary is retrieved from data file 16 and stored in IBIG1, and other variables used by the routine are given initial values. The move segment OBSRCH which is being requested to search is broken into search segments at this point.

(2) Block L21. If the parameter OBFACC has a value greater than zero, it is assumed to be a barrier code, and information concerning that barrier will be returned. In this case, control passes to block L191.

(3) Block 2. The routine CRTQD is called to generate the quadrature code associated with this particular search segment. The quadrature code is an eight-character code describing the location of a line segment. Routine CRTQD is described in the Engineer Model.

(4) Block L65. The quadratures are screened to determine which ones may contain barrier segments intersecting this search segment. Of the 17 quadratures, 6 to 13 are eliminated by this screen.

(5) Block L60. The 17 records of data file 22 correspond to the 17 quadratures. Each record contains the barrier codes and quadrature codes of the barriers associated with the corresponding quadrature. The appropriate record is retrieved from data file 22 at this point.

(6) Block L61. If this quadrature contains no barriers and another quadrature remains to be searched, control is transferred to block L70.

(7) Block L70. If other quadratures are to be searched, parameters aiding in the barrier line and search segment intersection checks are set, and control is transferred to block L60.

(8) Block L72. If OBFACC is negative, it is the negative of the barrier code of the barrier segment the moving unit has just crossed. This barrier segment will not be considered to intersect the move segment.

(9) Block L500. The quadrature code of the barrier is compared to the quadrature code of the search segment to determine if they intersect.

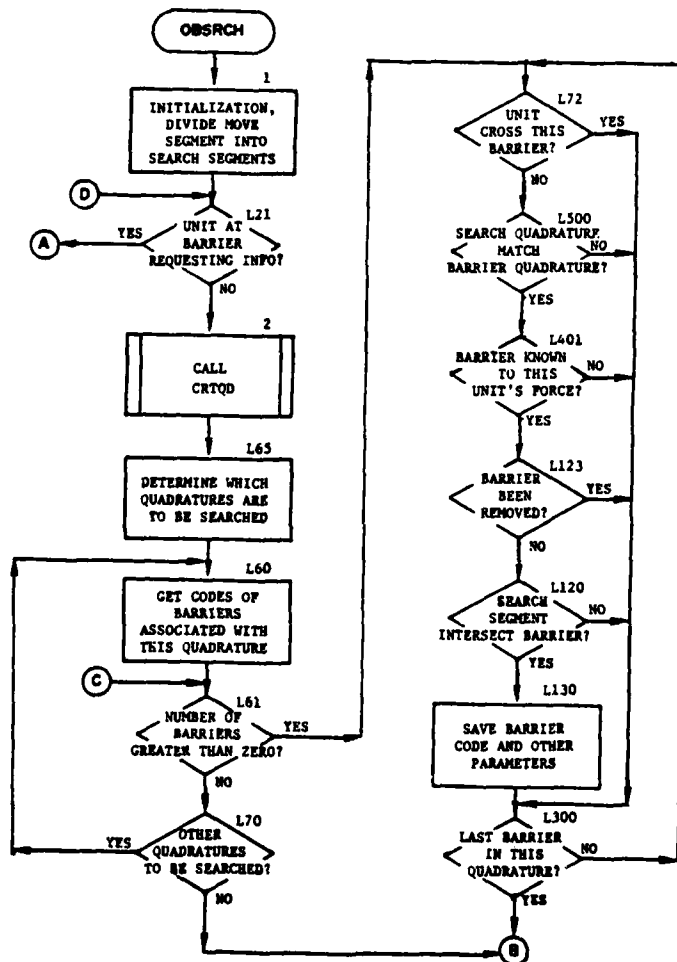


Figure IV-13-B-3. Routine OBSRCH (continued next page)



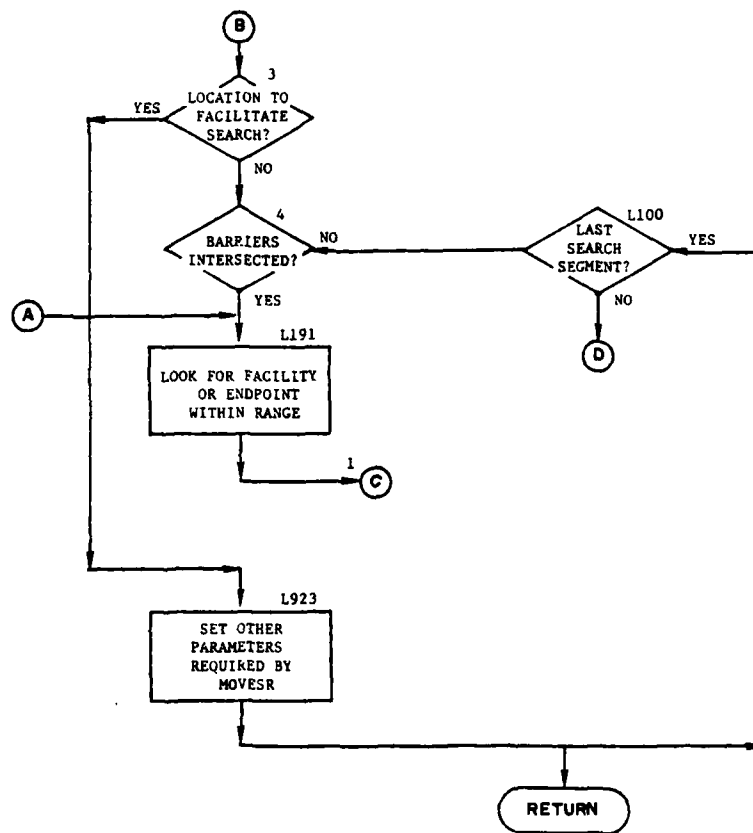


Figure IV-13-B-3. Routine OBSRCH (concluded)

(10) Block L401. If the actual intelligence information flag (INACT) is equal to one, indicating that only force intelligence information is to be used, barriers not known to the unit's force will not be detected. If INACT is less than one, information on all barriers will be used.

(11) Block L123. Barriers which have been removed are assumed to cause no delay to moving units and are ignored.

(12) Block L120. The utility routine INTSPT is used to determine if the barrier line and search segment intersect. If they do, the coordinates of the point of intersection are returned.

(13) Block L130. If this barrier is nearest the unit's current location (i.e., would be encountered first by the moving unit), its barrier code and coordinates are stored.

(14) Block L300. If other barriers are associated with this quadrature, they are processed.

(15) Block 3. If the segment being checked for intersection with barriers is described by the unit's current location and a potential facility and no barriers are discovered, the facility is accepted and control is transferred to block L923. If a barrier does exist between the unit and this facility, OBSRCH will proceed to search for another facility.

(16) Block 4. If no barrier lines are intersected by the search segment, control is transferred to block L100.

(17) Block L191. If the move segment being searched intersects a barrier segment, OBSRCH attempts to locate an existing facility or the endpoint of a barrier line within reasonable distance of the intersection point of the move segment and barrier line. Reasonable distance is defined as one-half the sum of the unit's width and depth. If a facility (or endpoint) is found, the new segment described by the unit's current location and the facility is searched to determine if it intersects with other barriers.

(18) Block L923. At this point all remaining parameters requested by MOVESR are set. If the barrier is active (e.g., a minefield), an estimate of the time required to breach it, type vehicle that might be used to force it, and number of casualties that would be assessed a unit forcing it are required. A crossing rate in terms of vehicles per centiminute is required for all facilities. The barrier code, coordinates of the intersection point, and the facility indicator were set elsewhere in this routine.

(19) Block L100. If the last search segment has been searched and no barriers have been detected, parameters indicating this are set and control returns to the calling routine.

##### 5. ROUTINE MOVE:

a. Purpose. The routine updates the unit's coordinates, calculates the amount of food and fuel consumed en route, and subtracts these amounts from the unit's supplies on hand.

b. Input Variables:

(1) Standard Common Block Areas. UMAIN, NXTC, and NYTC.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
C3	DF15	Class III consumption rates.
RTEMV	DF14	Class IIIA consumption rates.
KEOH	DF9	Equipment item codes of aircraft for which fuel consumption rates have been defined.

c. Output Variables:

(1) Standard Common Block Variables. XACT, YACT, XACTL, YACTL, EOH, and ACTVTY.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
UNTLOC	TWO	Unit location table.

d. Logical Flow (Figure IV-13-B-4):

(1) Block 1. Set unit's last location parameters (XACTL and YACTL) to unit's current location parameters (XACT and YACT). Update current location parameters to the model move segment parameters (MEVTX and MEVTY).

(2) Block 2. The route type may be cross country (CC), asphalt surface road (RA), gravel road (RG), or dirt road (RD). The route type code (IROUT) is given a value of 1, 2, 3, or 4 respectively if the unit is moving on the ground, or a value of 5 if the unit is flying.

(3) Block 3. If the unit's updated current location is outside the defined battle area, the unit's current location parameters are set to the unit's last location parameters.

(4) Block 4. Consumption of Class I supplies is modeled by multiplying the unit's personnel strength (PRESTR + SUPSTR) by the force Class I consumption rate (IBFOOD for Blue, IRFOOD for Red) and subtracting this value from the amount of Class I on hand, EOH(1).

(5) Block L2010. If the unit is moving on the ground, Class III supplies are consumed. The consumption rate is a function of route type; therefore, the route type code is used in selecting the correct consumption rate table from data file 15. The sum of the consumption rates for various types of vehicles multiplied by the number of vehicles of that type in the unit is subtracted from the amount of Class III on hand, EOH(2).

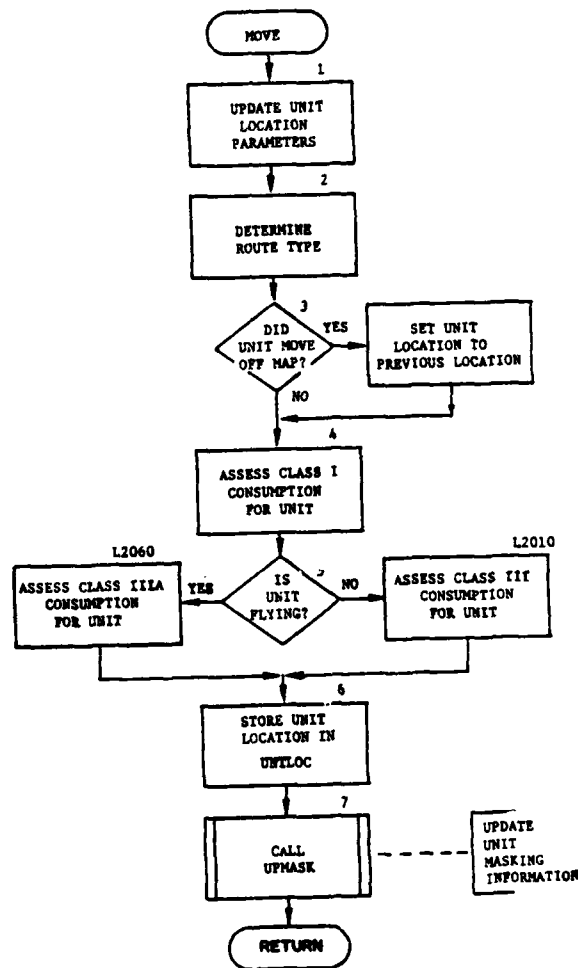


Figure IV-13-B-4. Routine MOVE

(6) Block L2060. If the unit is flying, it consumes Class IIIA supplies. This consumption rate is dependent upon aircraft type, flight speed, and altitude. The amount consumed is computed by summing the products of consumption rates of aircraft types and the numbers of aircraft of each type in the unit. This value is then subtracted from the amount of Class IIIA on hand, EOH(3).

(7) Block 6. The current location of the unit is stored in UNTLOC where it may be easily accessed by other routines in the DIVWAG system.

(8) Block 7. Parameters describing the masking effect of the terrain surrounding the unit's current location (MASKF) are updated by the routine UPMASK.

6. ROUTINE OVER13. This routine routes a call to routine MOVE if ETTAB(1) in Common ONE equals 2. It routes a call to routine SUPRES if ETTAB(1) equals 8.

## APPENDIX C

### MOVEMENT MODEL OUTPUT DESCRIPTIONS

1. INTRODUCTION. This appendix contains samples and detailed descriptions of printed output from routines within the Movement Model of the Period Processor. A figure depicts the format of each routine printout. In the figures an alphabetical descriptor designates an appropriate line or group of lines that is explained in the following paragraphs.

2. ROUTINE MOVE. The printout from this routine, presented in Figure IV-13-C-1, lists those variables involved in the consumption of fuel and the updating of the unit's location. The explanation is as follows:

<u>Output Descriptor</u>	<u>Explanation</u>
A	This printout lists the unit's identification and identification record number; location at the beginning of the move segment (X,YACT); location at the end of the move segment (MEVTX,Y); NORD; amounts of class I, class III, and class IIIA supplies on hand at the beginning of the move; and the length of time, in centiminutes, required to traverse this move segment.
B	This list is identical to that in descriptor A with the exception that the travel mode mnemonic rather than delta time is printed as the last item. X,YACT equals MEVTX,Y showing the unit's location, has been updated; the amounts of class I and class III have decreased by the amount consumed; and NORD is now negative, indicating movement to a coordinate input in the DSL order has been accomplished.

3. ROUTINE MOVEDT. The printout from this routine (shown in Figure IV-13-C-2) lists those parameters involved in the selection of the movement rate and calculation of the time required to complete the designated movement segment. The print is controlled by print switch 3.

<u>Output Descriptor</u>	<u>Explanation</u>
A	UID = Unit's identification. IUID = Unit's identification record number. UTD = Unit's type designator. MOVE CODE = Travel mode mnemonic input in the DSL order. TRAF. INDEX = Soil/slope/trafficability index associated with the terrain cell the unit is moving in. FOG = Fog index at this time. RAIN = Precipitation index at this game time.

AD-A112 653 ARMY COMBINED ARMS COMBAT DEVELOPMENTS ACTIVITY FORT--ETC F/G 15/7  
DIVNAS MODEL DOCUMENTATION, VOLUME II, PROGRAMMER/ANALYST MANUA--ETC(U)  
JUL 76  
UNCLASSIFIED CACDA-TR-8-76-VOL-2-PT-4 NL

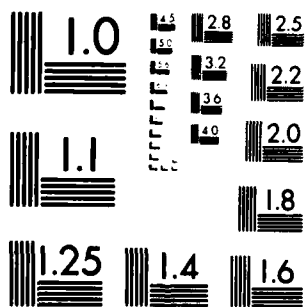
ARMY COMBINED ARMS COMBAT DEVELOPMENTS ACTIVITY FORT--ETC F/G 15/7  
DIVVMS MODEL DOCUMENTATION. VOLUME II. PROGRAMMER/ANALYST MANUA--ETC(U)  
JUL 76  
CACDA-TR-8-76-VOL-2-PT-4

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12653



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS 1963 A



①——MOVE010112AR 116 X,YACT( 98001. 99076.1,MEVTX,Y( 98300. 99300.0,MORD= 3  
CLASS1.3,3A= 4646.2 28022.1 0.0,DELT= 102

②——MOVE010112AR 116 X,YACT( 98300. 99300.1,MEVTX,Y( 98300. 99300.1,MORD= -3  
CLASS1.3,3A= 4642.9 28766.6 0.0,MOVE CODE=TRCH

Figure IV-13-C-1. Printed Output Sample from Routine MOVE



Output  
Descriptor

Explanation

- MOB. CATG. = Mobility category assigned the unit in the constant data input.
- EXCLU. INDEX = Index to the list of mobility classes not allowed to slow unit movement. This is also assigned in constant data input.
- RATE PT. = Pointer to the record containing the unit movement rates to be used with the current conditions.
- B This table of mobility class versus equipment on hand (EOH) allows the mobility classes effecting the unit is movement rate to be determined. The mobility classes are integer and are printed with an I2 format. The EOH array is floating point and is printed with an I1 format, giving an X if the quantity of a particular item is not zero. The amount of the item is not important, but it's presence is. In the example shown, the circled items indicate vehicles that belong to mobility classes 2, 3, 5, and 6 are present in the unit, and their rates may be considered as a limiting rate of unit movement.
- C The vehicular or mobility class rates are listed with a zero indicating the rate is to be considered as a limiting movement rate of the unit shown. The exception to this is the first pair (3 0) that contains the foot movement rate which is never considered to be a restriction. For example, the vehicular limiting rate is 32 if the vehicles in mobility class 6 were not allowed to limit the movement rate of the unit, the 6M pair (32 0) would be 32 1, and the limiting rate would be 36.
- D
- UID = Unit's identification.
- IUID = Unit's identification record number.
- MOVE RATE = Movement rate selected for unit from the tables (the minimum of slowest vehicular rate and the unit rate).
- UNIT RATE = Unit movement rate selected from the tables.
- RATE = Floating point equivalent of unit rate, or if the movement is by road, it is equal to the unit rate divided by 1.1.
- UPDATE PT. = Pointer to the record that the unit movement rate was selected from.
- TIME LOST = Amount of time that the unit has lost during this move as the result of barriers, suppression, or having its rate restricted by a vehicle.
- DIST = Number of meters the unit is to move this segment.

#### 4. ROUTINE MOVESR:

a. The printout from this routine (shown in Figure IV-13-C-3) lists those parameters required in the selection of the next model move segment, the barrier interface parameters, and battle entry information.

<u>Output Descriptor</u>	<u>Explanation</u>
A	UID = Unit's identification. IUID = Unit's record number identification. IBAR = Code of barrier that unit anticipates crossing. MOVRATE = Unit's movement rate. FORCTM = Time required to force an active barrier. FRCEOH = Item code of the vehicle used to force the barrier. IBCHIN = Chaining parameter used to force units crossing a barrier at the same facility to do so in order of priority.
B	NBARL = Code of the barrier encounter which does not contain a facility. CPX,Y = Coordinates of the point at which the barrier may attempt to be breached or forced. NBARF = Code of the barrier encountered which contains a facility permitting the unit to cross. FACX,Y = Coordinates of the facility. BRCHTM = Time required to break the barrier. FORCTM = Time required to force the barrier. CROSKT = The number of vehicles per minute which may cross the facility.
C	This message indicates the unit involved in this movement is advancing to battle MECH1.
D	The units listed in this statement may be involved in the battle listed above.
E	SEPARATION = This is the distance, in meters, between the units initiating the battle.
F	X,YACT = See Chapter 2, DIVWAG Data Files, of Section VII. MEVTX,Y = See Chapter 2, DIVWAG Data Files, of Section VII. CBJX,Y = Coordinate of segment intersection with barrier line, or facility or end point unit is being routed to. OBJX,Y = Chapter 2, DIVWAG Data Files, of Section VII. IBAR = Code of barrier which unit anticipates crossing. DELT = The time, in centiminutes, required to traverse this model move segment (described by X,YACT and MEVTX,Y).



Output  
Descriptor

Explanation

G IBCHIN = See descriptor B.  
ICHAR = See descriptor B in Section VII-2-A (File 2).  
IBAR = Code of barrier that unit anticipates crossing.  
RQUIID = The IUID of the unit requesting activity by the  
Engineer Model.  
BUID = The six-character mnemonic identifier of the barrier.

H UID = Unit's identification.  
IUID = Unit's record number identification.  
IBAR = Code of barrier unit anticipates crossing.  
MAXD = The maximum dosage accumulated by the unit to date.  
MVRATE = Unit's movement rate.  
D = The distance the unit would be subjected to radiation.  
TDDS = The total of the nuclear radiation dosage the unit has  
received to date and the dosage which will be received if  
the unit traverses this barrier.  
IRAD = This is the pointer to the smallest radius which may  
be used to access the unit.  
RADIUS = The radius of the nuclear barrier.

5. ROUTINE OBSRCH. The printout from this routine (presented in Figure IV-13-C-4) shows whether a move segment will intersect a barrier line. If so, a facility or end point of a barrier line that a unit may be routed to is found.

Output  
Descriptor

Explanation

A The first print from OBSRCH gives the width and depth of the unit whose path is being examined for barriers/facilities. The 5001 print then gives the eight-character quadrature code defining the location of the line segment given by XLOC4, YLOC4 and XLOC3, YLOC3. Each print will trace part of the larger line from the first XLOC4, YLOC4 given to the last XLOC3, YLOC3 listed provided no 3008 print is encountered, or the last XLOC3, YLOC3 listed, if a 3008 print occurs, will indicate the last point of access for the unit before it encounters an obstacle. The 3008 print indicates a barrier was encountered requiring some consolidation or redirection of forces to bypass it.

B If no 3008 print occurs this line of output will also not be present. This print identifies the barrier or facility giving the record numbers of the adjacent barriers/facilities which form part of the same barrier line, the coordinates which define this segment, the barrier mnemonic, the size or density (for minefields), the eight-character

[ 5241 X101M. DEPTH 25 6360  
 5001 ALOC = 31312195 XLOC1 = 122201.0 VLCC4 = 153613.9 XLOC3 = 122667.7 VLCC3 = 153617.3  
 5001 ALOC = 31312142 XLOC4 = 122667.7 VLCC4 = 100397.6 XLOC3 = 123334.3 VLCC4 = 19117.7  
 5001 ALOC = 31312149 XLOC4 = 123334.3 VLCC4 = 191176.7 XLOC3 = 124601.0 VLCC3 = 15455.7  
 3008 ]

[ PUNYCO PLMCO XCORD1 XCORD2 VCC452 QUID SIZE CHARIC DMTS LORTS  
 B C 123500.0 105005.0 123500.0 94000.0 XMA005 1 0000220 0032 0032  
 XINT 123500.6 YINT 101246.0 ]

[ 3610 DIST. SRCHRG. 6.0 7246 3262 5.5 N3ARF = 0 CPX = 123500.0 CPY = 101245.0 N3AR0 = 2330 LCRIP = 2  
 FACX = ]

Figure IV-13-C-4. Routine OBSRCH Print Statements

Output  
Descriptor

Explanation

status code for the barrier, and its task and troop type requirements for both Red and Blue. The XINT print gives the exact location of intersection of the barrier and line segment of movement for the unit.

C           The 3610 print identifies the search as now attempting to look for facilities in following segments of the same line. The DIST print gives the distance to the following end point of the barrier and the maximum search radius allowable for bypassing the barrier. The FACX = print identifies the type of action required of the unit; i.e., whether a facility is available for crossing or whether the barrier must be breached or forced. If a facility is available, its coordinates are printed as FACX = \_\_\_\_ and FACY = \_\_\_\_, with the record number of the facility as NBARF = \_\_\_\_\_. Should a decision to breach or force be necessary, the coordinates of intersection are printed beside CPX = \_\_\_\_ and CPY = \_\_\_\_ with the barrier record number on data file 2 given as NBARC = \_\_\_\_\_. Whether this is a bridge or barrier is then identified by the IBARTP value.

Additional prints from OBSRCH occur as SRCHRO = \_\_\_\_\_ SRDIST = when a preceding segment to the one intersected is an existing bridge. The meanings of the two values are just reversed from the DIST print mentioned above. The 3641 print identifies the facility found as an end of a barrier line in the direction of the following barrier segments to the one intersected.



APPENDIX D

SOURCE LISTINGS FOR PERIOD PROCESSOR MOVEMENT MODEL

(AVAILABLE UNDER SEPARATE COVER)

## CHAPTER 14

### ENGINEER MODEL

#### 1. MILITARY ACTIVITY REPRESENTED:

a. General. The Engineer Model represents combat engineer activities in support of a division in combat.

b. Engineer Missions. The generalized missions of the division engineer battalion are:

- . To increase the combat effectiveness of the division by means of engineer combat support
- . To carry out an infantry combat mission when required.

The Engineer Model addresses only the first mission.

c. Engineer Functions. Functions performed by the division engineer battalion to carry out the engineer combat support mission fall into two broad categories, termed hard support functions and soft support functions.

(1) Hard Support Functions. These functions have the objective of facilitating or enhancing friendly force mobility and impeding or degrading hostile force mobility; they include such activities as breaching of minefields and bridging of gaps.

(2) Soft Support Functions. These functions influence combat power only indirectly; they include such activities as supply of potable water, providing technical advice, and supplying locally available construction materials.

d. Model Constraints and Capabilities. The Engineer Model is limited to portrayal of those hard support functions related to the mobility element of combat power.

(1) The model is capable of simulating three types of functions or activities:

(a) Build. The build function is defined as the construction of a new barrier or facility. It also includes maintenance or improvement of an existing barrier or facility and repair or rebuilding of a breached barrier or facility.

---

1. A barrier is defined as any feature, natural or man-made, which tends to reduce the mobility of military forces. A facility is defined as any feature, natural or man-made, which tends to reduce the effect of a barrier (e.g., defiles or passes in a ridge line), or to neutralize or negate the barrier (e.g., roads, bridges, and fords).

(b) Breach. The breach activity is defined as the disruption of the functional mission of a barrier or facility. To breach a barrier is to clear a passageway through or across the barrier. To breach a bridge is to disrupt its function as a facility. (A bridge is a facility because it provides a passageway across a stream or gap or other form of barrier.) To breach implies functional disruption only and does not imply total elimination; the latter is covered by the remove activity.

(c) Remove. The remove function is defined as the 100 percent clearance or neutralization of a barrier or facility. Removal as played by the model is only of a destructive nature. Destructive removal implies total destruction rendering the facility useless for reconstruction or reuse.

(2) Engineer tasks in the model are limited to minefields, fords, bridges, and rafts/ferries. The combinations of task activities and facilities on which they may be performed are shown in Figure IV-14-1.

Facility	Task Function/Activity		
	Build	Breach	Remove
Minefield	X	X	X
Ford	X	X	
Bridge	X	X	X
Raft/Ferry	X		X

Figure IV-14-1. Engineer Task Activities

## 2. MODEL DESIGN:

a. General. The Engineer Model simulates the scheduling and execution of engineer tasks and assesses delays incident to the tasks and the related barriers and facilities. The model accepts engineer tasks, assigns priorities to them, determines task feasibility, assigns resources according to task priority, mobilizes task forces, executes the tasks, reports results, demobilizes the task forces, and maintains current status information on barriers and facilities.

(1) Task Basis. Engineer tasks are based upon pregame gamer-prepared barrier plans and controller-prepared barrier guidance. Such plans and guidance are updated as required at the beginning of each game period.

(2) Task Initiation:

(a) Engineer tasks may be initiated by either of two methods:

1. Gamer DSL orders issued at the beginning of a game period.
2. Automatic orders generated during a game period by the Movement Model when a unit in movement encounters a barrier.

(b) Although it is not strictly an engineer task initiation, the Engineer Model is also triggered automatically by the Nuclear Assessment Model when a nuclear event results in the creation of a barrier or affects the status of an existing barrier or facility.

(3) Task Priority Assignment. The allocation and scheduling of resources for engineer tasks is based upon model assignment of a three-digit task priority indicator. One of the indicator digits is fixed and is based upon preset game rules; the other two digits are variable and partially gamer-controlled.

(4) Task Feasibility. Based upon assigned priority, each task is checked for feasibility in two areas, resources and manpower. Resource and manpower feasibility are determined from a comparison of resources/manpower required (preestablished data base specifications) and resources/manpower available.

(5) Resource Allocation. When a task has been passed for feasibility, resources are allocated or committed, and expendable equipment and supplies are reordered.

(6) Task Force Mobilization. An available engineer troop unit is selected, required equipment and supplies are added to the unit, and the unit is moved to the task site.

(7) Task Execution. When sufficient resources are on site, engineer task work is started and delay times are calculated. When the task has been completed, work is stopped, barrier/facility files are updated, and, if other models are directly concerned with task completion, those models are notified of the completion results.

(8) Task Force Demobilization. Upon completion of the engineer task, the engineer troop unit, with residual task equipment and supplies, is returned to its parent unit, if possible; otherwise, it is placed in a stay mode at a suitable location. If the unit is returned to its parent unit, residual equipment is returned to the source unit from which it was originally extracted.

b. Design Philosophy. The Engineer Model has been designed on the basis of integrated performance of functions which can be described best in terms of its six functional components:

(1) An executive routine (ENGR), which provides a means for entering the Engineer Model, guides the action into the proper subelement of the model,

diverts engineer resources that arrive at the task site after task termination, and handles miscellaneous tasks related to game period termination.

(2) A priority routine (EPRIOR), which assigns task priority to each engineer task, maintains a dynamic ordered list of task priorities for each force (Red and Blue), calculates the required starting time for each task, calculates task execution (including delays) and the resultant task completion time, passes task priorities to the feasibility and update routines, and advises the release routine of reasons for termination of engineer tasks.

(3) A feasibility routine (EFEASI), which determines the feasibility of performing an engineer task as a function of task priority, proximity to the FEBA, and resources and time available, commits available resources to feasible tasks in order of priority, and generates movement orders for troop units allocated to the engineer tasks.

(4) An update routine (EUPDAT), which sets a task-in-process flag when resources at the task site are sufficient for starting work, provides resource update information for task units, updates manpower on a task site and mobilizes more manpower if the current amount is inadequate for the task, calculates task performance rates and the related portion of the task completed each clock period, enters updated task information in the barrier-facility file, advises the release routine of each task completion, and triggers the release of engineer forces upon completion of each task.

(5) A release routine (ERELEA) which, upon completion or termination of an engineer task, effects the demobilization of engineer resources including the generation of movement orders, notifies the Movement Model of completion or termination of tasks requested by that model, updates the facility status in the barrier-facility file, and provides period status for end-of-period barrier report. This routine also precludes reinitiation of a completed task.

(6) A nuclear routine (ENUCLE), handles the engineer aspects of radiological barriers created by nuclear events and nuclear effects damage to existing barriers/facilities.

c. Engineer Model Interfaces with Other Models. The Engineer Model interfaces with the Movement Model and the Nuclear Assessment Model. It also makes use of various elements of the DIVWAG system and, in particular, the environmental characteristics of the battle area.

(1) Interface with Movement Model:

(a) General. Since the objective of barriers/facilities is to influence the mobility of troop units, an interface between the Engineer Model and the Movement Model is essential. Through this interface, the Movement Model interrogates the Engineer Model to determine if a mobility

move segment intersects a barrier line. If it does, the Engineer Model provides additional information about the barrier line to permit the Movement Model to make one of the following choices:

1. Reroute the movement around the barrier segment if feasible.
2. Reroute the movement to an existing facility if feasible.
3. Force the barrier if it is an active type.
4. Request the Engineer Model to neutralize the barrier by building a facility or by breaching the barrier at the point of intersection.

(b) Interface Subroutine:

1. When a unit starts to move along an order segment, the Movement Model requests the Engineer Model to check the segment for barriers (segment look-ahead procedure). Based on intelligence status information only, the Engineer Model examines the order segment starting from the near end and continuing until a barrier is found or until the destination end is reached. If a barrier is found, the examination is terminated and the Engineer Model provides the necessary barrier information to the Movement Model. The Movement Model then makes its decision, continues the unit movement along the new route or along the original route toward the barrier, and requests the Engineer Model for an engineer task if appropriate. (In the case of rerouting, the new routing is used for further checking purposes.) If no barrier is found, the Movement Model continues the unit movement toward the destination end of the order segment.

2. Each time the moving unit enters a new terrain cell, the Movement Model requests the Engineer Model to check the cell for barriers (cell look-ahead procedure). Based on physical status information only, the Engineer Model examines that cell portion of the move segment starting from the entry point and continuing until a barrier is found or until the exit point is reached. If a barrier is found, the procedure in the previous subparagraph is followed. If no barrier is found, the Movement Model continues the unit movement to the exit point of the terrain cell.

3. When a barrier is found and rerouting is not feasible, the Movement Model continues the unit movement to the point of intersection with the barrier. There, the unit either executes forcing action on the barrier and continues movement, or it goes into a stay mode until receipt of further orders or advice from the Engineer Model that the engineer task is completed. If the Engineer Model is unable to accomplish the task and the unit lacks conditional orders, the unit will remain in a stay mode until the end of the game period.

(2) Interface with Nuclear Assessment Model:

(a) General. Two major factors requiring interface between the Engineer Model and the Nuclear Assessment Model are the following:

1. The employment of nuclear weapons creates radiological barriers; for economy in modeling, it is preferable that all barriers be handled in a single model (in this case, the Engineer Model).
2. Nuclear effects may easily damage or otherwise modify existing barriers/facilities. Barriers/facilities must be updated as required to reflect their current status.

(b) Handling of Radiological Barriers:

1. When a nuclear event creates a radiological barrier, the Nuclear Assessment Model advises the Engineer Model that a nuclear event has occurred, identifies the coordinates of ground zero, and specifies the radius of the effective circular radiological barrier. The Engineer Model then establishes two barrier segments tangent to the circular barrier and perpendicular to the initial slope of the battlefield.<sup>2</sup> Two other barrier segments are then added connecting the endpoints of the first two and forming a square to encompass the barrier. Each barrier segment is centered on its point of tangency and is of a length equal to twice the radius of the radiological barrier.<sup>3</sup>
2. When the Movement Model encounters a barrier, it requests information from the Engineer Model; if the barrier is a radiological barrier, the Engineer Model so advises the Movement Model and indicates the extent of the barrier encountered. The Movement Model then requests information from the Nuclear Assessment Model and is advised of the radiation dose that will be assessed if the troop unit is moved through the radiological barrier. The Movement Model then decides either to go through and accept the assessment or to bypass the barrier if conditions so permit.
3. At specified periodic intervals the Nuclear Assessment Model advises the Engineer Model of the decay-reduced radius of the radiological barrier, and the Engineer Model updates the location and extent of the barrier segments. When the decayed radius of the radiological barrier is less than 50 meters,<sup>4</sup> the barrier is considered of negligible effect and is removed.<sup>4</sup>

---

2. Determined by a line connecting the center of mass of the Blue force with the center of mass of the Red force (see Chapter 5 of this section).

3. This length was selected as an arbitrary starting point. Future operational sensitivity tests should be conducted to determine the proper magnitude.

4. Fifty meters was selected as an arbitrary starting point. Future operational sensitivity tests should be conducted to determine the proper magnitude.

(c) Handling of Nuclear Effects Damage to Existing Barriers/  
Facilities:

1. When a nuclear event occurs, the Nuclear Assessment Model advises the Engineer Model, identifies the coordinates of ground zero, and specifies the maximum radius of effects pertinent to existing barriers/facilities. The Engineer Model checks the location of existing barriers/facilities with respect to the radius of effects and identifies those lying partially or wholly within this radius. The Engineer Model then identifies these existing barriers/facilities to the Nuclear Assessment Model, including type and end-point coordinates.

2. The Nuclear Assessment Model considers each reported barrier/facility, assesses damage, and advises the Engineer Model as to the revised status of each such barrier/facility. The Engineer Model records the damaged barriers/facilities and the revised status of each. At the end of the game period, these data are output with barrier/facility records for report purposes.

3. Gamers examine the damage list and update the status of these barriers/facilities, as follows: If the character identification of a barrier has been changed; e.g., a forest changed to a forest fire or to tree blowdown, the gamer replaces the original barrier identification with a new mnemonic to indicate the new character of the barrier. If only a portion of a barrier has changed character, the gamer divides the original barrier segment into two or more segments to fit the new status and defines these new segments.

(3) Interface with Environmental Characteristics. The Engineer Model interfaces with the following characteristics of the environment.

(a) Terrain:

1. The Engineer Model uses the trafficability indexes to determine rate modifiers to be applied to engineer task performance rates to account for degradation due to variability of terrain at task sites.

2. The Engineer Model supplements the Environment Model by permitting identification of terrain features, forestation, and man-made facilities which significantly hinder or facilitate force mobility in the context of barriers and facilities. The gamer can integrate natural features having appreciable effect on mobility (e.g., mountains, dense forests, unfordable streams) into barrier lines of significant extent. Barriers may be breached by facilities through engineer tasks. For example, a river barrier segment may be breached by constructing a bridge, a raft/ferry, or possibly a ford. Barrier segments which are unsuitable for construction of facilities are designated as unbreachable; e.g., cliffs and rivers through marshlands or those with steep rocky banks.

(b) Light Condition. The Engineer Model considers light effects and uses day/night conditions to determine a rate modifier to be applied to engineer task performance rates to account for degradation due to night conditions.



### 3. SUBMODEL SPECIFICATIONS:

a. General. This paragraph examines each of the major routines of the Engineer Model and presents the related logical flow, generally at the first level of detail, but at lower levels if required for clarity. Two general files are created by the Engineer Model and used by various routines in processing engineer task requests and tasks.

(1) Barrier-Facility File. The barrier-facility file provides the data base for engineer operations as well as working information for the Engineer Model routines. In addition, it provides an information base for other models and for reports required by the DIWAG system. A barrier or facility is described in the file in terms of its sequential location in the barrier line (previous and following segments), coordinates of its two end points, a mnemonic identifying its type and its unique number within that type, its size if not a minefield, its density if a minefield, whether or not it is radioactive or has been damaged as the result of a nuclear event, its task-related requirements parameters, and its task status parameters.

(2) Unit Equipment File. The unit equipment file serves as a holding file for sources of equipment used on engineer tasks. It provides a means for returning equipment to sources when a task is completed or terminated.

#### b. Engineer Driver Routine, ENGR (Figure IV-14-2):

(1) Purpose. The driver routine serves as access to the Engineer Model; it performs the following specific functions:

- (a) Guides the action into the proper subelement of the model.
- (b) Checks terminated tasks and intercepts and diverts troop units which are en route to the task site at the time the task is terminated.
- (c) Handles miscellaneous tasks related to game-period termination.

(2) Relationship to Other Major Components. See Figure IV-14-2.

#### (a) Inputs Received:

- 1. DSL orders from gamers.
- 2. Requests for engineer tasks from Movement Model.
- 3. Barrier information related to nuclear events from Nuclear Assessment Model.
- 4. Engineer operating instructions from EFEASI.

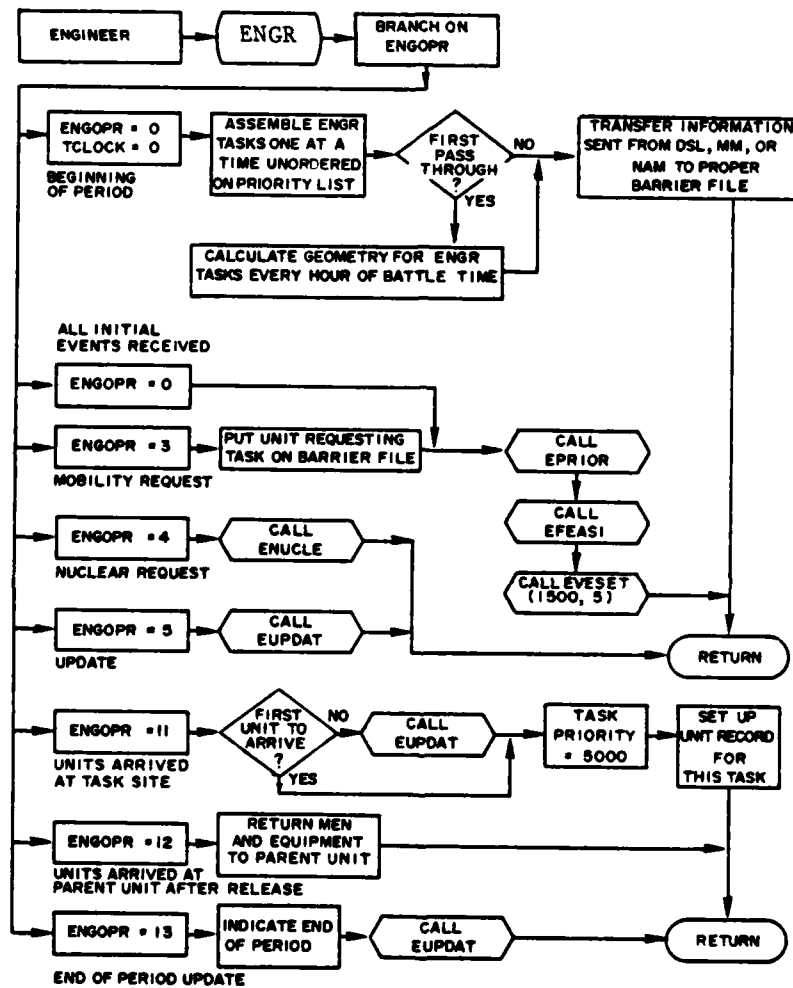


Figure IV-14-2. Engineer Driver Routine, ENGR

(b) Outputs Produced:

1. Unranked task and priority list to EPRIOR.
2. Indication of type action required to ENUCLE.

(3) Accessories. The driver routine uses data file 12 as a means for breaking down DSL orders and other communications, both external and internal, into elements that can be handled by the model.

c. Engineer Priority Routine, EPRIOR (Figure IV-14-3):

(1) Purpose. The priority routine functions as the first stage of the task filter by computing the priority of all scheduled and unscheduled tasks and integrating these into a ranked priority list. It performs the following specific functions:

- (a) Assigns a task priority to each engineer task.
- (b) Maintains a dynamic list of task priorities for each force (Blue and Red).
- (c) Calculates the required starting time for each task.
- (d) Calculates task execution time, including delays, and calculates the resultant task completion time.
- (e) Provides to other routines information on the current relative priorities of tasks.
- (f) Provides to the release routine information on task terminations.

(2) Relationship to Other Major Components. See Figure IV-14-3.

- (a) Inputs Received. Unranked task and priority list from ENGR.
- (b) Outputs Produced:

1. Current ranked task priority list to EFEASI.
2. Current task priority information to EUPDAT.
3. Indication of reason for task termination (i.e., DSL stop order or violation of FEBA constraint) to ERELEA.

(3) Priority Determination. The allocation and scheduling of resources for engineer start tasks are based upon model comparison of three-digit task priority indicators as shown in Figure IV-14-4. Stop tasks automatically receive top priority as they release engineer resources for start tasks. Each of the three indicator digits is considered individually.

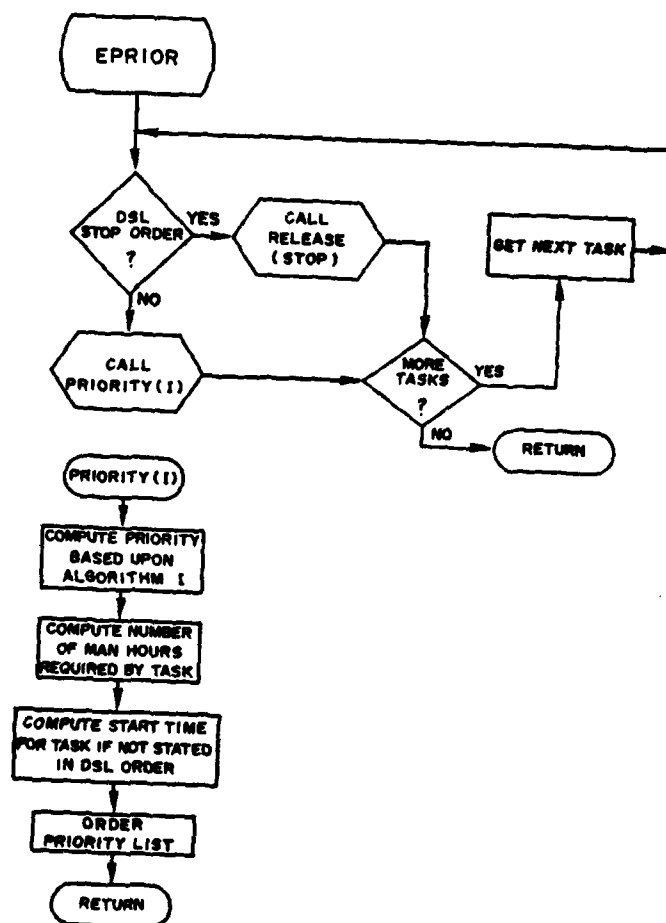


Figure IV-14-3. Engineer Priority Routine, EPRIOR

Task	Priority Indicator		
	Structure and Function (A)	Time Preference <sup>a</sup> (B)	Task Preference <sup>a</sup> (C)
Priority Scale	1 <sup>b</sup> 2 3 4 5	1 2 3 4	1 2 3 4
Offense			
Facility Build Breach Remove	3 4 4		
Barrier Build Breach Remove	5 2 2		
Defense			
Facility Build Breach Remove	5 2 2		
Barrier Build Breach Remove	3 4 4		
a. Gamer specified each game period. b. Reserved for mandatory tasks.			

Figure IV-14-4. Engineer Task Priority Indicators for Start Tasks

(a) Structure and Function Indicator (A): This indicator is preset and is model-controlled during the game; its purpose is to provide the gross priority basis for all engineer start tasks. The value of this indicator is determined primarily by the urgency of the task. If the task is classified mandatory, this indicator is given a value of 1; if the task is classified desired, this indicator is given a value ranging from 2 to 5 as shown in Figure IV-14-4, depending on three secondary conditions as follows:

1. The posture of the military force; i.e., offense or defense.
2. The type of structure involved; i.e., barrier or facility.
3. The nature of the task function involved; i.e., build, breach, or remove.

(b) Time Preference Indicator (B). This indicator is a variable and is based on the amount of time remaining until the scheduled clock time of the start of a task. Its purpose is to permit a shifting upward of the priority of a task as the need for the task becomes more imminent.

(c) Task Preference Indicator (C). This indicator is designated by the gamer. Its purpose is to function as tie-breaker and establish task priority when the A and B priority indicators are identical; e.g., when two or more barriers are to be constructed at or near the same time. The gamer decides which task should have priority for resources.

(d) Priority Algorithm. The priority routine uses the following algorithm to compute an overall task priority for ordering the task priority listing:

$$PRTY = 16 * (FCNPRTY - 1) + 4 * (TIMPRTY - 1) + DSLPRTY \quad (IV-14-1)$$

where:

PRTY indicates total or overall priority

FCNPRTY indicates the value of the structure and function indicator from column A, Figure IV-14-4

TIMPRTY indicates the value of the time preference indicator from column B, Figure IV-14-4

DSLPRTY indicates the value of the task preference indicator from column C, Figure IV-14-4.

This algorithm was designed to provide a basis for ranking tasks in consonance with the general priority scheme.

(e) Man-hour Requirement Algorithm. The priority routine uses the following algorithms to compute man-hour requirements for a task:

1. If the task type is a minefield:

$$MHR = TSKSIZ * TSKRAT \quad (IV-14-2)$$

where:

MHR = total man-hours required

TSKSIZ = task size: length of minefield computed by using the distance formula between the two end points of the minefield segment

TSKRAT = task rate taken from engineer task file.

2. If the task type is other than a minefield:

$$MHR = TSKSIZ * TSKRAT * PLATMEN * PLATNBR \quad (IV-14-3)$$

where:

TSKRAT = defined above

PLATMEN = standard number of men in a platoon (taken in the model as 120 for troop type 5, and 30 for all other troop types)

PLATNBR = standard number of platoons required for this task size, taken from engineer task file.

(f) Task Starting Time. The priority routine uses the following algorithms to establish task starting time:

1. If the task is generated by a DSL order which includes the modifier START BY DDTTTT:

$$TSTART = DDTTTT \quad (IV-14-4)$$

where:

TSTART = task starting time

DDTTT = date-time group indicating start time

2. If the task is generated by a DSL order which includes the modifier COMPLETE BY DDTTTT:

$$TBASIC = (60 * MHR) \div (PLATMEN * PLATNBR) \quad (IV-14-5)$$

if task type is a minefield, otherwise:

$$TBASIC = 60 * TSKSIZ * TSKRAT \quad (IV-14-6)$$

where:

TBASIC = basic time required for accomplishing task  
under conditions applicable to standard rates

$$TDELTA = TBASIC \div (RATMODTER * RATMODNIT) \quad (IV-14-7)$$

where:

TDELTA = time required for accomplishing task under  
actual conditions with degraded rates

TBASIC = defined above

RATMODTER = terrain rate modifier from engineer task file

RATMODNIT = night rate modifier from engineer task file;  
equals 1.0 if night conditions are not involved.

$$TSTART = TCOMPL - TDELTA - TBUFFER \quad (IV-14-8)$$

where:

TSTART = defined above

TCOMPL = DDTITT = date-time group specifying  
completion time

TDELTA = defined above

TBUFFER = arbitrary buffer time allocated to cover contingency  
delays; equals 45 minutes if task is mandatory,  
otherwise equals 30 minutes.

### 3. If the task is generated by the Movement Model:

TSTART = earliest time task is found to be feasible.

#### d. Engineer Feasibility Routine, EFEASI (Figure IV-14-5):

(1) Purpose. The feasibility routine functions as the second stage  
of the task filter and commits resources to feasible tasks in accordance with



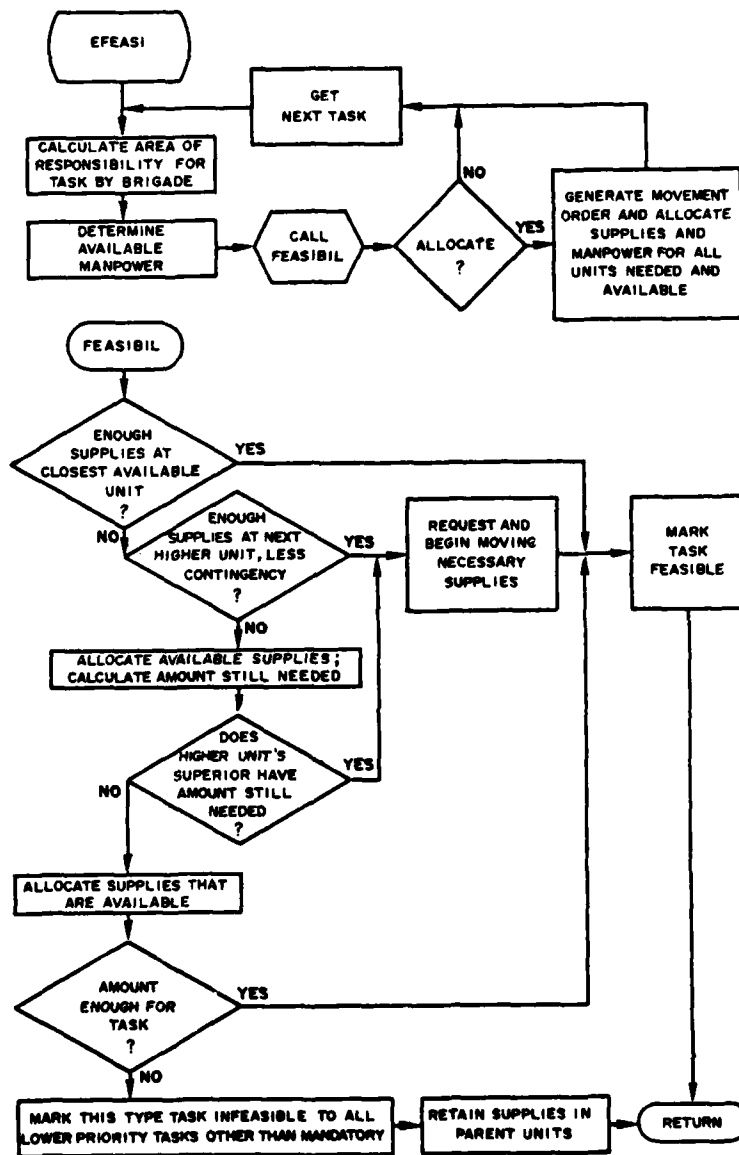


Figure IV-14-5. Engineer Feasibility Routine, EFEASI

the requirements of the task. It performs the following specific functions:

(a) Determines the current feasibility of performing an engineer task based on the current status of task priority.

(b) Commits available resources to specific feasible tasks in order of priority when the task commitment is triggered.

(c) Generates movement orders for troop units committed to tasks.

(2) Relation to Other Major Components. See Figure IV-14-5.

(a) Inputs Received. Current ranked task priority list from EPRIOR.

(b) Outputs Produced:

1. Information on depletion of resources to unit status file.

2. Engineer operating instructions to ENGR.

3. Movement orders for troop units committed to tasks to Movement Model.

(3) Feasibility Determination. EFEASI takes each task from the priority list by priorities from highest to lowest and, based upon task information in the barrier-facility file, computes the resources required for each particular task. It then compares resources required with resources available; when the latter are adequate, feasibility is established.

(a) EFEASI determines the troop requirement by examining the troop type number (from barrier-facility file), and the standard number required (from engineer task file), and using the following algorithm:

$$TRREQ = (TRUNITA + TRUNITB) * STDNR \quad (IV-14-9)$$

where:

TRREQ = troops required for task

TRUNITA = troop unit A: one bridge platoon if troop type number is 5; otherwise, this is a null unit

TRUNITB = troop unit B: one combat engineer company if troop type number is 5; otherwise, one combat engineer platoon

STDNR = standard number of units required for this task type.

(b) EFEAS! determines the equipment and supply requirements by examining the task size and the current physical status of the barrier or facility and using the following algorithms:

$$\text{EQPMULT} = \text{TSKSINR} \div \text{PROPFAC} \quad (\text{IV-14-10})$$

where:

EQPMULT = equipment or supply multiplier, a multiplying factor relating quantity of type equipment or supply required for this size task to the quantity required for a standard size task (this is determined for each item code involved)

TSKSINR = task size number determined by comparing task size value with task sizes found on scale of task sizes in engineer task file

PROPFAC = proportionality factor, a weighting factor used for adjusting equipment and supplies to fit variable task sizes; taken from engineer task file.

$$\text{EQPREQ} = \text{EQPSTD} * \text{EQPMULT} * \text{CONFAC} * \text{RESRAT} * \text{FACFRAC} \quad (\text{IV-14-11})$$

where:

EQPREQ = total quantity of a line item equipment or supply required for this task

EQPSTD = standard quantity of this line item equipment or supply required for basic size task

EQPMULT = defined above

CONFAC = contingency factor to provide a cushion for losses due to enemy action; taken as 1.05 in the model

RESRAT = task restart ratio:  $1 - (\text{MHRMPLTD} / \text{MHRREQ})$

MHRMPLTD = total man-hours completed on task

MHRREQ = total man-hours required for task

FACFRAC = fraction of total facility or barrier comprising task; following values are used:

<u>Task Function</u>	<u>Facility Does Not Exist</u>	<u>Facility Exists Intact</u>	<u>Facility Exists Breached</u>
Build	1.00	0.00	0.33
Breach	0.00	1.00	0.00
Remove	0.00	1.00	0.67

(4) Resource Allocation:

(a) EFEASI selects and disperses the necessary resources for the task, including troops, equipment, and supplies. It locates the nearest suitable troop units and generates the movement orders. The Movement Model moves the units to the task site.

(b) If a task has been found to be infeasible because resources are inadequate to meet total requirements, but the resources are adequate to meet minimum requirements for starting the task, EFEASI allocates available resources; this task then has first priority over similar tasks for new resources when they become available.

(c) If a task has been found to be infeasible because resources are inadequate to meet minimum requirements for starting the task, EFEASI sets an insufficiency flag which prohibits allocation of resources to any other task of this type, except a task specified as mandatory, until the requirements of this flagged task have been met.

e. Engineer Update Routine, EUPDAT (Figure IV-14-6):

(1) Purpose. This routine evaluates every engineer activity in progress and updates the status. It performs the following specific functions:

(a) Sets task-in-process flag when resources on hand at a task site are adequate for starting work.

(b) Provides resource update information for task units.

(c) Updates manpower on a task site and mobilizes more manpower if current manpower is inadequate for the task.

(d) Calculates task performance rates and the related portion of the task completed each clock period.

(e) Enters updated task information into the barrier-facility file.

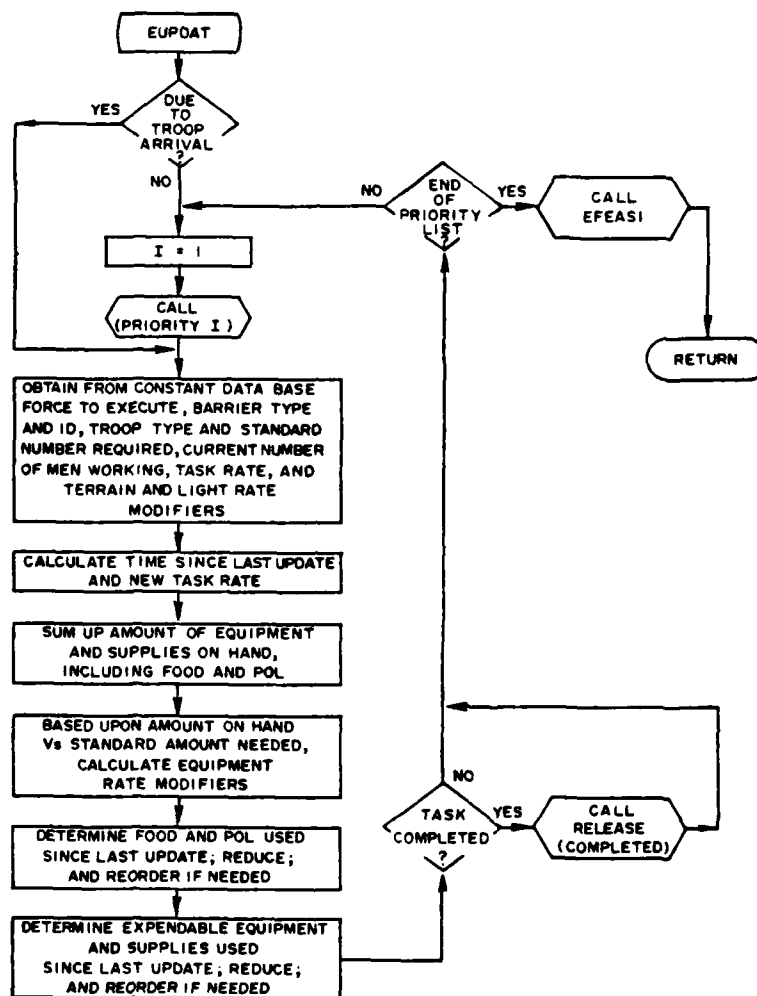


Figure IV-14-6. Engineer Update Routine, EUPDAT

(f) Advises the release routine of each task completion and triggers the release of engineer forces upon completion of each task.

(2) Relation to Other Major Components: See Figure IV-14-6.

(a) Inputs Received. Resources allocated to a task from EFEASI (indirectly through the Movement Model).

(b) Outputs Produced:

1. Update information on task status to unit status file, unit equipment file, and barrier-facility file.

2. Task completion information and triggering for demobilization of task units to ERELEA.

(3) Update Procedures:

(a) EUPDAT reevaluates the priorities of all tasks the model has requested except those with priority 5000, examines resources versus time remaining to complete the task, and reallocates resources to tasks in progress until they have their full quotas of resources.

(b) EUPDAT decrements, in most cases, the proper item codes by the amount expended since the last previous update and outputs updated information to the barrier-facility file.

(4) Update Algorithms. The update routine uses the following algorithms to compute man-hours expended for updating of the barrier-facility file:

$$\text{TSKRATAD} = \text{TSKRAT} \div (\text{RATMODTER} * \text{RATMODNIT} * \text{RATMODEQP}) \quad (\text{IV-14-12})$$

where:

TSKRATAD = adjusted task rate

TSKRAT = task rate taken from engineer task file

RATMODTER = terrain rate modifier from engineer task file

RATMODNIT = night rate modifier from engineer task file;  
equals 1.0 if night conditions are not  
involved

RATMODEQP = product of equipment rate modifiers for equipments  
involved in task; individual modifiers are  
taken from engineer task file.

$$TPROP = TELAP \div TSTDPD \quad (IV-14-13)$$

where:

TPROP = time proportion; i.e., fraction of a standard time  
period that has passed since last update

TELAP = elapsed time since last update

TSTDPD = standard time period; 15 minutes is taken  
in Engineer Model.

$$MHREXP = \frac{TPROP * TSKSIZ * MENNBR}{TSKRATAD * PLATNBR * PLATMEN * STDPPHR} \quad (IV-14-14)$$

where:

MHREXP = total man-hours expended since last update

TSKSIZ = task size (as computed for minefields, or  
as taken from barrier-facility file for  
other type tasks)

MENNBR = actual number of men in units assigned to  
task site

TSKRATAD = defined above

PLATNBR = standard number of platoons required for this  
task size, taken from engineer task file

PLATMEN = standard number of men in a platoon (taken in  
the model as 120 for troop type 5, and 30  
for all other troop types)

STDPPHPR = number of standard time periods per hour, taken  
as 4 in the model.

f. Engineer Release Routine, ERELEA (Figure IV-14-7):

(1) Purpose. This routine demobilizes mission units and resources whenever there is reason for stopping a task. it performs the following specific functions:

(a) Terminates tasks when tasks are completed, when a DSL stop order is received, or when a specified FEBA condition exists.

(b) Generates movement orders for demobilization of task troop units when a task is completed or terminated.

(c) Notifies Movement Model of completion or termination of tasks requested by that model.

(d) Updates facility status in barrier-facility file on completion or termination of task.

(e) Provides period status for end-of-period barrier report.

(f) Removes completed tasks from the task priority list.

(2) Relation to Other Major Components. See Figure IV-14-7.

(a) Inputs Received:

1. Indication of reason for task termination; i.e., DSL stop order or violation of FEBA constraint from EPRIOR.

2. Task completion information and triggering for demobilization of task units from EUPDAT.

(b) Outputs Produced:

1. Facility status update, both physical and intelligence to barrier-facility file.

2. Removal of completed task from task priority list to EPRIOR.

3. To Movement Model:

a. Movement order for task troop units requiring demobilization.



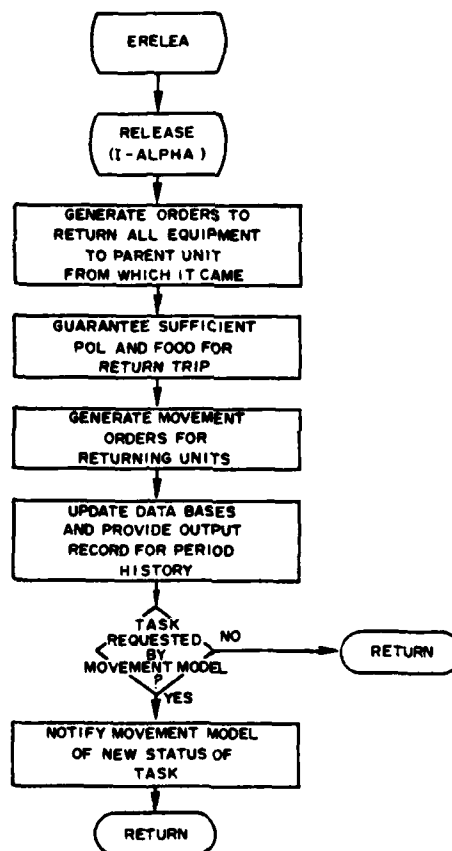


Figure IV-14-7. Engineer Release Routine, ERELEA

b. Task completion notice for tasks requested by the Movement Model.

4. Period status to end-of-period barrier report.

(3) Release Procedures:

(a) Two conditions are cause for release action: a task is completed, or a DSL order is a stop order. In either of these cases, immediate priority is given to ERELEA with the reason for termination.

(b) ERELEA generates movement orders for released units; Movement Model returns these units to their parent units.

(c) ERELEA incorporates the task status information into the barrier-facility file and, if the task was one requested by the Movement Model, advises that model of the task status.

g. Engineer Nuclear Routine, ENUCLE (Figure IV-14-8):

(1) Purpose. This routine handles the Engineer Model aspects of radiological barriers created by nuclear events and nuclear effects damage to existing barriers/facilities. It performs the following specific functions:

(a) Establishes, updates, or removes radiological barriers as appropriate when furnished nuclear event information or update information.

(b) Notifies Nuclear Assessment Model of existing barriers lying partially or wholly within the radius of effects of nuclear events.

(c) Records reported nuclear effects damage to existing barriers/facilities and outputs this information for report purposes.

(2) Relation to Other Major Components. See Figure IV-14-8.

(a) Inputs Received:

1. Indication of type action required from ENGR.

2. From Nuclear Assessment Model:

a. Notification of nuclear events and their descriptions.

b. Update information for radiological barriers.

c. Assessed nuclear effects damages to existing barriers/facilities.

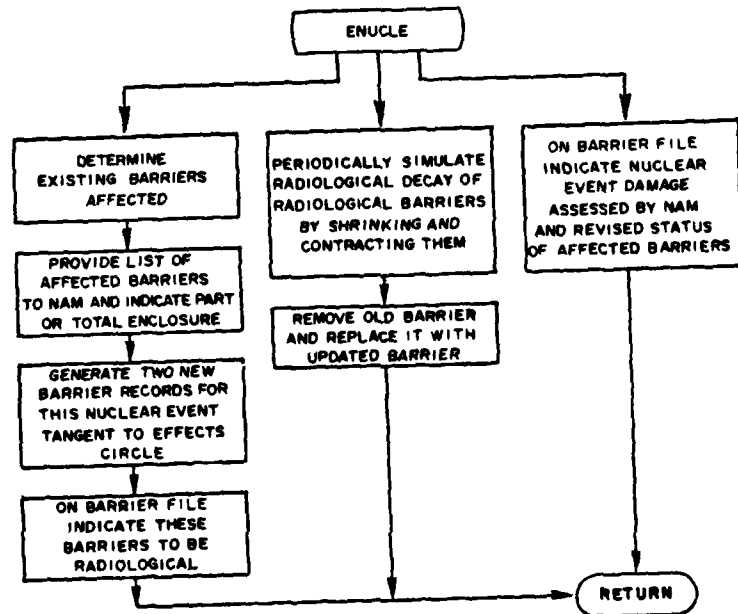


Figure IV-14-8. Engineer Nuclear Routine, ENUCLE

(b) Outputs Produced:

1. List of barriers/facilities lying partially or wholly within the radius of effects of a nuclear event to Nuclear Assessment Model.

2. Status of barriers/facilities damaged by nuclear effects for end-of-period barrier report.

(3) Procedures. Details of the procedures involved are covered in the discussion of the interface between the Engineer Model and the Nuclear Assessment Model, subparagraph 2c(2) above.

## APPENDIX A

### ENGINEER MODEL INPUT REQUIREMENTS

1. INTRODUCTION. This appendix describes the data input requirements for the Engineer Model, which is concerned with barriers and facilities that influence troop movements, the time delays resulting therefrom, and the engineer troops and equipments that create or modify these barriers and facilities. The loading of the Engineer Model data base is not dependent on the loading of any other data base.

a. Data Requirements. The general types of data required by the Engineer Model include: locations and characteristics of existing and planned barriers, locations and characteristics of existing and planned facilities for neutralizing the barriers, type and magnitude of engineer tasks related to the barrier and facilities, equipment and personnel requirements for the engineer tasks, and rates of task performance by different types of engineer troops.

b. Appendix Contents. The contents of this appendix are intended to facilitate understanding of the requirements and procedures for preparing the constant data base for the Engineer Model. Paragraph 1 provides an overview of this appendix and the data base requirements. Paragraph 2 provides detailed instructions for loading data related to barriers and facilities, and paragraph 3 provides instructions for loading data related to engineer tasks. Paragraph 4 describes the Engineer Model data deck structure.

c. Data Base Files. The Engineer Model uses five data files as follows:

(1) Barrier and Facility File (Data File 2). This file serves as the repository for information on barrier and facility characteristics, locations and status. This information is also used by the Movement Model and the Nuclear Assessment Model, and for the end-of-point barrier and facility report.

(2) Engineer Task File (Data File 17). This file identifies engineer tasks (minefields, fords, bridges, and rafts/ferries) and contains such engineer task information as size, equipment and troops required to perform the task, and rates of performance. This information is for internal use of the Engineer Model only.

(3) Engineer Task Priority File (Data File 18). This file contains engineer task priorities and priority related factors. This information is for internal use of the Engineer Model only.

(4) Engineer Task Site File (Data File 22). This file is created from data file 2 and serves as the repository for eight-character mnemonics comprising the task site quadrature for searching for and locating task sites. This information is also used by the Movement Model.

(5) Engineer Equipment File (Data File 37). This file serves as the repository for information as to the source of equipment mobilized at engineer task sites. This information is for internal use of the Engineer Model only.

2. DATA BASE FOR BARRIERS AND FACILITIES. The barrier and facility data base serves as the basic information source for engineer operations and tasks and is derived from barrier planning. At the division level this planning is based on guidelines and information provided in corps and field army barrier plans. Barrier and facility data include the characteristics and location of each barrier segment, the type of engineer tasks associated therewith, and the current status of the segment. The player teams of opposing forces prepare barrier lines appropriate to the tactical situation. If the game to be played is an open game, preparation of barriers common to both forces is facilitated if the two player teams prepare their barrier line cooperatively. The load routine for barriers and facilities involves three cards. Preparation of each card is discussed in the following subparagraphs.

a. Barrier System Location (Card ID 0200). This card, illustrated in Figure IV-14-A-1, sets up a quadrature system for the model to use in keying in all barrier and facility locations. One card is prepared pregame, normally by the Control Team, and the data therein remain fixed throughout the game. All numbers in the card are to be right justified.

(1) Card Type and Force Designator (Columns 1-2). In column 1 the number 1 is preprinted to indicate the card type. In column 2 enter "B" since the quadrature system is force independent.

(2) Geographical Area (Columns 4-19). Enter maximum X and Y coordinates (not to exceed seven numerals for each X and Y coordinate) of the geographical area representing the gaming area of interest.

(3) Battle Area (Columns 23-38). Enter X and Y coordinates of the geographical point estimated to be the center of the battle area at the start of the game; i.e., the approximate center of the FEBA.

b. Barrier Line Identification (Card ID 0201):

(1) Card Description. This card, illustrated in Figure IV-14-A-2, provides an identification for each barrier line and a structure for joining and manipulating the barrier segments. Standard naming of all barriers to be played with all pertinent information to barriers is prepared pregame. The information is put into the proper input format to be loaded. Updating and removal of barrier lines, as well as loading new lines, may be externally effected between game periods.

(2) Preliminary Preparations. Display all barrier lines on the operations map. Select a scheme for naming the lines that will facilitate easy reference during gaming. Assign a name not exceeding eight characters to each continuous barrier line. For barrier continuity reasons, intersecting



**Figure IV-14-A-2. Barrier Line Identification Card Format**



barrier lines should not be terminated or segmented on the intersection. To avoid leaving a gap, a line that would normally terminate at an intersection must be carried through the intersection and terminated on the far side of the intersection. A gap in the barrier line will create a discontinuity; hence, unique names will be required for the barrier lines on opposite sides of the gap. One method that can be used to avoid such a discontinuity gap is to provide for a minefield task in the gap. The physical status code in card ID 0202 (subparagraph c below) shows that the field is empty and permits units to pass through unaffected unless the minefield is actually built at some later time. If gaps do occur, it is recommended that the basic line name be retained and uniqueness be attained with numbers; for example, a line with two gaps might have subline names as follows:

ALPHA-01 (gap) ALPHA-02 (gap) ALPHA-03

(3) Card Type and Force Designator (Columns 1-2). The number 1 is preprinted in column 1 to indicate card type. In column 2 enter "R" for Red force or "B" for Blue force.

(4) Action (Columns 3-6). Select and enter one of the following action codes: LOAD, REMV (remove), UPDT (update).

(a) LOAD:

1. Identification (Columns 9-16). Enter the name selected for each unique barrier line.

2. Game or Period Load (Columns 19-24). If this line is to be loaded between game periods, PERIOD should be entered; if this is the pre-game load, nothing need appear.

(b) REMV. Columns 9-14 should contain the mnemonic of the first barrier segment of the line to be removed. No differentiation is made between game or period removal.

(c) UPDT. Again columns 9-14 contain the mnemonic of the particular barrier segment to be updated. This is followed by only one card type 0202, then by an end-of-data card or another card type 0201.

(5) Identification (Columns 9-16). Enter the name selected for each unique barrier line.

c. Barrier Segment Details (Card ID 0203):

(1) Card Description. This card, illustrated in Figure IV-14-A-3, provides details as to the location and nature of barrier segments, related tasks, and the status of such tasks. One card is prepared pregame for each segment of a barrier line the Control Conflicting aspects of barriers on the borderline between opposing forces are coordinated. Task status is updated by the model. External update or removal of data may be effected between game periods with the same constraint as indicated in subparagraph b(1) above.

BARRIER SEGMENT TRIPPOINT COORDINATES															CARD NO.			
CARD TYPE		FIRST TRIPPOINT				SECOND TRIPPOINT				BLUE TASK		STATUS		RED TASK		CARD NO.		
		X <sub>1</sub>		Y <sub>1</sub>		X <sub>2</sub>		Y <sub>2</sub>		TASK SIZE	PROP. 1/2	PHYSICAL	MATH.	TASK NO.	TASK SIZE			
BFX001		0156350		0089700		0156700		0089500		11	80	4	2	3	11	20	4	0.2
LDL001		0156700		0089500		0157900		0089100		0			2	3	0			
BFX002		0157900		0089100		0158200		0089100		12	80	4	2	3	12	20	4	
RIV001		0158200		0089100		0158400		0089100		0			2	3	0			
BFX003		0158400		0089100		0158700		0089250		11	80	4	2	3	11	20	4	
FRS001		0158700		0089250		0160100		0089400		0			2	3	0			
BFX004		0160100		0089400		0160500		0089600		12	80	4	2	3	12	20	4	
BFX005		0160500		0089600		0161300		0089700		7	18	2	0	3	7	20	2	
LDL002		0161300		0089700		0162800		0089800		0			2	3	0			
WTA001		0162800		0089800		0163400		0089800		0			2	3	0			
BFX006		0163400		0089800		0163800		0089750		12	80	4	2	3	12	20	4	
BFX007		0163800		0089750		0164300		0089650		13	120	4	2	3	13	30	4	
LDL003		0164300		0089650		0164700		0089500		0			2	3	0			
BFX008		0164700		0089500		0165200		0089400		13	120	4	2	3	13	30	4	
HUM001		0165200		0089400		0165400		0089400		0			2	3	0			
BFX009		0165400		0089400		0165400		0089200		13	120	4	2	3	13	30	4	
BFD001		0165400		0089200		0165100		0088300		10	50	2	0	3	10	50	2	
MHA001		0165100		0088300		0164900		0087900		3	1	2	0	3	3	1	2	

Figure IV-14-A-3. Barrier Segment Details Card Format

(2) Preliminary Preparations. Divide each barrier line into segments that are homogeneous within the segment.

(a) Two conflicting objectives are encountered in this process: the objective of having the line approximate closely the real terrain features, which tends to shorten the segments and increase their numbers; and the objective of minimizing the effort and time involved in game preparation, which tends to lengthen the segments. Judgment should be used in reaching a reasonable compromise between these objectives.

(b) Each facility, such as a bridge, requires a unique line segment in order that a movement segment in the Movement Model may intersect a finite facility line segment rather than trying to intersect a point location. If the movement segment intersects the facility segment anywhere, and the facility exists, the unit being moved is permitted to utilize the facility and pass the barrier which the facility is neutralizing. The length of the facility segment will be influenced by the character and requirements of the adjacent segments. If conditions permit, the length of a facility segment should be not less than 100 meters and not more than 400 meters.

(c) River lines that constitute barriers offer more complexities than other types of natural features. A river line segment may be classified in several different ways depending upon its crossing suitability or the type of facility; only one designator may be used for a segment:

- . Fords and fording sites - mnemonic BFDXXX
- . Floating bridges and floating bridge sites - mnemonic BFLXXX
- . Rafts/ferries and raft/ferry sites - mnemonic BFRXXX
- . Fixed bridges and fixed bridge sites - mnemonic BFXXXX
- . Unsuited for crossing - mnemonic RIVXXX.

(d) All numbers entered in the card form are to be right justified.

(3) Card Type and Force Designator (Columns 1-2). The number 1 is printed in Column 1 to indicate card type. In column 2 enter "R" for Red force or "B" for Blue force.

(4) Barrier Segment Mnemonic (Columns 3-8). Select one barrier line. Starting at one end of the barrier line and progressing sequentially one segment at a time to the other end, enter the mnemonic for each barrier segment (see Figure IV-14-A-4 for a list of mnemonics). In this way, the second end point coordinates ( $X_2$ ,  $Y_2$ ) for one segment will become the first end point coordinates ( $X_1$ ,  $Y_1$ ) for the next succeeding segment. (Do not exceed seven numerals for each X and Y coordinate.) After the last segment in this barrier line, an end card is used to signal the end of the barrier line. This card is prepared

Mnemonic <sup>a</sup>	Description	Status <sup>b</sup>	DSL <sup>c</sup>	Unbreach <sup>d</sup>	Maximum <sup>e</sup> Number
ARHXXX	Helicopter Pad	0			50
ARLXXX	Air Landing Strip	0			50
BFDXXX	Ford	X	X		100
BFLXXX	Floating Bridge	X	X		100
BFRXXX	Raft	X	X		250
BFTXXX	Foot Bridge	0	X		50
BFXXXX	Fixed Bridge	X	X		350
CRTXXX	Crater	0	X		100
DFLXXX	Defile	0			100
FRDXXX	Tree Blow-down	X	X		100
FRFXXX	Forest Fire	X		X	100
FRJXXX	Jungle	X		X	50
FRSXXX	Forest	X		X	500
FRUXXX	Undergrowth	X		X	25
HUMXXX	Town, Built-up Area <sup>f</sup>	X			200
LDAXXX	Mountain, Hill, Depression	X		X	100
LDLXXX	Linear Land Barrier (Cliff, Canyon, etc.)	X		X	100
MNAXXX	Minefield, Antitank-Antipersonnel	X	X		500
MNPXXX	Minefield, Antipersonnel	X	X		200
MNTXXX	Minefield, Antitank	X	X		200
MUNXXX	Munition, Atomic Demolition	0			100
NUCXXX	Radiological Barrier	0			150
PTHXXX	Road or path	0			100
RIVXXX	Unbreachable River Segment	X		X	300
SWPXXX	Swamp	X		X	50
WTAXXX	Ocean, Sea, Lake	X		X	100
WTLXXX	Linear Water Barrier (Canal, etc.)	X		X	50

- a. Enter unique numerical identifier in spaces marked XXX.
- b. X indicates available in model and may be used in current phase play.  
0 indicates available in model but will not be used in current phase of play.  
Blank indicates not yet fully programmed.
- c. X indicates requirement for explicit DSL order.
- d. X indicates a barrier segment unbreachable for surface mobility.
- e. Maximum number of this type provided by the model for one game.
- f. Towns are barriers to surface movement. Roads through towns provide constricted surface travel at reduced rates, hence the normal physical status of a town is that of a breached barrier; i.e., code 1 (see subparagraph 2c(7)).

Figure IV-14-A-4. Barrier Segment Mnemonics Applicable to Engineer Model

by making an entry of minus one (-1) in the  $X_1$  coordinate, with the minus sign in column 16 and the 1 in column 17. (End cards do not have any other entries except a card ID and a card sequence number.) After completion of the first barrier line, repeat the above procedures for successive barrier lines until all segments of all barrier lines have been entered.

(5) Barrier Segment End Point Coordinates (Columns 11-44). This field defines the location and length of the barrier segment by listing the coordinates of the two end points of the segment. The field is divided into four equal subfields of seven columns each. The first two subfields provide space for the  $X_1$  (Columns 11-17) and  $Y_1$  (Columns 20-26) coordinates of the first end point of the barrier segment, and the third and fourth subfields provide space for the  $X_2$  (Columns 29-35) and  $Y_2$  (Columns 38-44) coordinates of the second end point. Do not exceed seven numerals for each X and Y coordinate. When the first end point of a segment is identical to the last end point of the previously defined segment, no entry is required in columns 11-26.

(6) Blue Task (Columns 46-55). This field defines a Blue task related to the barrier segment. The field is divided into three subfields.

(a) Task Type Number (Columns 46-47). If the barrier segment is an unbreachable natural barrier, enter zero in these columns and leave the other two subfields blank; otherwise, enter the appropriate task type number (see subparagraph 3a(2), below, for an explanation of task type numbers).

(b) Task Size (Columns 49-53). For all tasks except minefields, enter the task size. Task size for fords is total length of the ford (one vehicle lane assumed unless otherwise specified); task size for bridges is total length of the bridge (one vehicle lane assumed unless otherwise specified); and task size for rafts and ferries is the total length of the number of rafts or ferries. For minefields the model calculates task size from the coordinates; therefore, in lieu of task size, enter the number corresponding to the density of mines in the minefield (see subparagraph 3a(8), below, for an explanation of density numbers).

(c) Troop Type (Column 55). This data item is the troop type associated with task. Enter the corresponding unit number, from 1 to 5, associated with the troop type (see subparagraph 3c(2)(b), below, for an explanation of troop type numbers).

(7) Status (Columns 58-60). This field provides the current status of the engineer task or facility related to the barrier segment. The model updates the physical status as appropriate during the game. The field provides two single column subfields, the first being for the current physical status of the task or facility, and the second being for the **current intelligence status**.

(a) Physical Status (Column 58). In this column enter code 2 if the task type is 0; otherwise, enter the appropriate code number from the following list:

<u>Code</u>	<u>Definition</u>
0	Facility does not currently exist. This code includes four possible cases: <ul style="list-style-type: none"><li>. Task has not been started</li><li>. Task has been started but is still in process.</li><li>. Task has been started but has since been stopped by a stop order. (In this case, a new build order will be able to complete the task based upon the percentage of the original task remaining incompleted at the time the stop order became effective.)</li><li>. Task was completed but facility was subsequently removed completely by a completed remove order.</li></ul>
1	Facility has been completed and subsequently disrupted (breached); it is currently disrupted. A disrupted facility may be restored to completeness by a new build order. (This will require 33 percent of the original task effort.) A disrupted facility may be removed completely by a remove order. (This will require 67 percent of the task effort for removal of the complete facility.) The model effects calculation of the percentage task requirements in both cases.
2	Facility has been completed and is currently intact and serviceable.

(b) Intelligence Status (Column 60). In this column enter code 3 if the task type is 0; otherwise, enter the appropriate code number from the following list:

<u>Code</u>	<u>Definition</u>
0	Neither force knows the current status of the barrier or facility
1	Blue force knows but Red force does not know the current status of the barrier or facility
2	Red force knows but Blue force does not know the current status of the barrier or facility
3	Both forces know the current status of the barrier or facility.

The model will update the intelligence status as appropriate during the game. Knowledge of the status implies knowledge of existence.

(8) Red Task (Columns 63-72). This field defines a Red task related to the barrier segment. Instructions for completing these data items are analogous to those for Blue (Columns 46-55).

3. DATA BASE FOR ENGINEER TASKS. The engineer task data base serves to scale resource requirements to fit engineer tasks encountered. The data base is derived from analyses of engineer TOE unit equipment, missions, functions, and capabilities, and from other military publications delineating engineer equipment, tasks, and task rates. Engineer task data consist of engineer task types, including sizes and densities; troop, equipment, and supply requirements for task execution; and task performance rates and rate modifiers. If a game using the DIVWAG System is to be an open game, analysis and comparative evaluation of engineer operations is facilitated if Red and Blue engineer tasks are prepared cooperatively and simultaneously, using the same task type numbers for like tasks and, insofar as practicable, making the type operations of one force the mirror image of those of the other force. The load routine for engineer tasks involves seven cards. Preparation of each card is discussed in the following subparagraphs.

a. Task Identification (Card ID 1701):

(1) Card Description. Card ID 1701, illustrated at Figure IV-14-A-5, identifies all engineer type tasks that the model will be capable of simulating and establishes a grid matrix of sizes and densities to function as a control scale. One card for each type task is prepared pregame, and the data therein remain fixed throughout the game.

(2) Preliminary Preparations. Determine constraints on engineer operations and make a working list of the type task that will be permitted. Arrange tasks in a logical order with grouping of similar type tasks; e.g., all minefield types, and all gap and stream crossing types. Assign a task type number to each task according to the following guidelines:





- . Numbers from 1 through 25 may be used.
- . Numbers from 1 through 4 are reserved as follows:
  - 1 - Minefield, antitank (AT)
  - 2 - Minefield, antipersonnel (AP)
  - 3 - Minefield, AT plus AP
  - 4 - Open, reserved for special type of mines or minefields

. Other numbers need not be consecutive.

All numbers in the card are to be right justified.

(3) Card Type and Force Designator (Columns 1-2). The number 1 is printed in Column 1 to indicate card type. In column 2 enter "R" for Red force or "B" for Blue force.

(4) Task Type Number (Columns 3-4). Enter task type number from 1 to 25 as determined in preliminary preparations.

(5) Task Description (Columns 5-25). Enter description of task; e.g., BRDG FLTG MAB CL60, or RAFT M4T6 CL50.

(6) Basic Task Size (Columns 26-29). Enter size of a basic unit of measure for each engineer task type such that any engineer task may be described in multiples of the basic unit of measure. As an example, if the unit length of one bay of a mobile assault bridge is 8 meters, enter "8", indicating that the length of any mobile assault bridge may be described in multiples of the basic task size. Selection of basic task size should be based upon careful consideration of equipment sizes, employment practices, the probable maximum size task that will be encountered, and the number of size increments desired between minimum (basic) size and a maximum size. Intermediate sizes will be integral multiples of the basic size. If equipment dimensions do not govern, use rounded increments such as tens or hundreds when appropriate. For minefields, note that only barrier minefields are considered; local defensive minefields are excluded. If the basic unit length of minefield selected is 100 meters, enter 100. The measurement unit may be different for each task, but must be consistent with task rate units specified in subparagraph (8) below.

(7) Number of Sizes (Columns 30-31). Enter the number of sizes which, when multiplied by the basic size, will provide the maximum magnitude required for the task; e.g., if the basic size is 100 and the maximum required is 1200, enter 12. Gamers may assign any number from 1 through 60 (see restriction in columns 32-33).

(8) Number of Densities (Columns 32-33). This field is intended to handle the second dimension of task size for tasks which require a second variable dimension to describe adequately the task magnitude. For minefield tasks, enter the number of different mine densities required; e.g., if six different densities of mines are to be playable, enter 6. Gamers may assign any number from 1 through 60, but the product of the numbers in the basic task size (columns 26-29) and number of sizes (columns 30-31) must equal 60. For task types not requiring variable densities or a variable second dimension of size, enter 1; otherwise, enter the appropriate number.

(9) Constricted Movement Rate (Columns 36-42). For facilities which tend to act as defiles and constrict movement; i.e., fords, bridges, rafts/ferries, and lanes through breached minefields, enter the capacity of the facility in vehicles per hour.

b. Task Performance Rates (Card ID 1702). The Task Performance Rates card series provides a basis for modifying task rate performance as affected by the quantity of equipment on site, the quantity of troops on site, and the site environment. The card also provides rate and loss factors for vehicles attempting to force passage through minefields. Four card types are prepared pregame, and the rate and loss data therein remain fixed throughout the game. All numbers entered in the cards are to be right justified.

(1) Task Performance Rates (Card ID 1702, Card Type 1). This card type, illustrated in Figure IV-14-A-6, identifies all equipment items and supply items required for each type of engineer function for each type of engineer task, and provides a means of adjusting task rate performance when the equipment and supplies on site are less than the standard quantity required.

(a) Card Type and Force Designator (Columns 1-2). The number 1 is printed in column 1 to indicate card type. In column 2 enter "R" for Red force or "B" for Blue force.

(b) Task Type Number (Columns 3-4). Enter task type number (see subparagraph (4) above, Card ID 1701, for explanation). Repeat the task type number as many times as necessary to cover the entire spread of entries in function (columns 5-12) and item code (columns 13-15) applicable to this task type. Then enter the next task type number and repeat it in a similar manner. Continue until all task type numbers have been entered. If neither equipment nor supplies is required for a task function, that function is omitted from the listing for that particular task type.

(c) Function (Columns 5-12). If the build function is applicable to this task type, enter BUILD and repeat it as many times as necessary to cover the entire spread of entries in item code (Columns 13-15) applicable to the build function for this task type. Repeat BUILD once more to serve as a terminal card for the build function. (Terminal cards do not have any other entries except a card ID and a card sequence number). If the breach function is applicable to this task type, enter BREACH and repeat it in the same manner as the build function, ending with an entry for a terminal breach

ENGINEER DATA LOG - EQUIP - TASK PERFORMANCE RATES																			
CARD TYPE	LAST TIME	FUNCTION	ITEM CODE	MINIMUM AMOUNT	STANDARD AMOUNT	PRODUCTION FACTOR	EQUIP CODE	EQUIPMENT RATE MODIFIERS										CARD SEQ. NR.	
								LEVEL 1		LEVEL 2		LEVEL 3		LEVEL 4		LEVEL 5			CARD ID
								AVG	STD	AVG	STD	AVG	STD	AVG	STD	AVG	STD		
1	3	BUILD	161	1	4	20/161													
1	3	BUILD	101	5000	6000	10/161								15000	100	6000	100		
1	3	BUILD																	
1	3	BREACH	5	100	100	0/160								100	100	100	100		
1	3	BREACH																	
1	3	REMOVE	5	1000	2000	10/161								1000	100	2000	100		
1	3	REMOVE																	
5	5	BUILD	136	10	10	10/136								10	100	10	100		
5	5	BUILD																	
6	6	BUILD	137	16	16	10/161								16	100	16	100		
6	6	BUILD	135	4	4250	163								4	100	4	100		
6	6	BUILD	163	1	2250	163								1	100	2	100		
6	6	BUILD	161	16	16250	161								16	100	16	100		
6	6	BUILD																	
6	6	BREACH	5	500	500	0/160								500	100	500	100		
6	6	BREACH																	
6	6	REMOVE	135	1	2	10/163										2	100		
6	6	REMOVE	161	16	16250	161								16	100	16	100		
6	6	REMOVE																	

Figure IV-14-A-6. Task Performance Rates for Equipment and Supplies Card Format

card. If the remove function is applicable to this task type, enter BREACH and repeat it in the same manner as the build function, ending with an entry for a terminal remove card.

(d) Item Code (Columns 13-15). Enter assigned item code for each type of equipment and each type of supply required for the type task and type function under consideration (exclude supply classes I, III, and IIIA).

(e) Minimum Amount (Columns 16-20). Enter minimum amount (quantity) of each type of equipment and each type of supply required for threshold performance of this type task and this type function (exclude supply classes I, III, and IIIA). When an item is in short supply, the model uses this quantity as a final decision point in determining the equipment feasibility of starting a task. If the quantity of any item of equipment or supply is less than the minimum amount herein specified, the model will not start the task.

(f) Standard Amount (Columns 21-25). Enter standard amount (quantity) of each type of equipment and each type of supply normally associated with this type task and this type function under average conditions (exclude supply classes I, III, and IIIA). The model uses this quantity as a first decision point in determining the equipment feasibility of starting a task. If the quantity available equals or exceeds this number, the task is feasible from the standpoint of this item, and the model allocates the standard amount of this item to the task. If the quantity available is less than this number, the model checks for the minimum quantity as indicated in columns 16-20.

(g) Proportionality Factor (Columns 26-28). The purpose of this entry is to provide a proportionality factor which will serve to scale the quantity of an equipment or supply item to fit any engineer task size. Two proportionality value ranges are used to store data in this field: 0-120 for expendable and 121-250 for nonexpendable supplies, and equipment. If the amount of supplies and equipment to execute an engineer task type is constant, independent of task size and density, and expendable, set  $PF_e$  equal to 0; where  $PF_e$  is the proportionality factor for expendable supplies and equipment. If the amount of equipment and supplies is constant, independent of task size and density, and nonexpendable, set  $PF_n$  equal to 250; where  $PF_n$  is the proportionality factor for nonexpendable supplies and equipment. If the supplies and equipment to execute an engineer task are not constant, select a value of  $i$  such that  $AMT_i \geq 2AMT_1$ , where:

$AMT_1$  = standard amount of supplies and equipment to execute engineer basic task size.  
( $AMT_1$  is derived from engineer field manuals or military engineer judgment and is identical to standard amount in columns 21-25).

$AMT_i$  = standard amount of supplies and equipment to execute the desired engineer task type and size  $i$ .

Calculate:

$$X_i = \frac{AMT_1}{AMT_i - AMT_1} \quad (IV-14-A-1)$$

Calculate:

$$PF_e = 10 (i-2) + 10 X_i \quad (IV-14-A-2)$$

If the equipment item is expendable, enter calculated  $PF_e$  in columns 26-28; if equipment is nonexpendable, calculate

$$PF_n = PF_e + 120 \quad (IV-14-A-3)$$

and enter  $PF_n$  in columns 26-28.

For minefields,  $AMT_1$  and  $AMT_i$  will vary by task size and density.

(h) Transport Item Code (Columns 29-31). Enter item code of the vehicle type that will normally transport this type accountable equipment during a move. If this equipment is self-propelled and normally transports itself independently, enter the same item code as in columns 13-15.

(i) Equipment Rate Modifiers (Columns 33-72). The purpose of this field is to provide a basis for modifying the rate of task performance when the quantity of this equipment type varies and the size of the task varies. Provision is made for five levels for each equipment type, with eight columns for each level, the first five columns of which are used for the quantity of equipment and the last three columns for the rate modifier. Columns 33-40 are for level 1; columns 41-48, for level 2; columns 49-56, for level 3; columns 57-64, for level 4; and columns 65-72, for level 5. The user specifies as many of the five levels as desired. Enter equipment quantities and rate modifiers in appropriate columns in accordance with the following guidance:

- . At least one level must be specified.
- . If fewer than five levels are used, they must be right justified.
- . Quantities will be in ascending order from left to right.
- . The left-most quantity will be interpreted to be the minimum required for the task; hence, the entry must be identical to the quantity indicated in the related columns 16-20.

- . Intervals between levels may be variable.
- . Rate modifiers will be used as multiplying factors and must be specified in terms of 100 for the standard.

(2) Task Performance Rates (Card ID 1702, Card Type 2). This card type, illustrated in Figure IV-14-A-7, identifies the quantity of troops required for each type of engineer function for each type of engineer task, and provides a means of adjusting task rate performance when the troops on site are less than the standard quantity required.

(a) Card Type and Force Designator (Columns 1-2). The number 2 is printed in column 1 to indicate Card Type 2. In column 2 enter "R" for Red force or "B" for Blue force.

(b) Task Type Number (Columns 3-4). Enter task type number (see subparagraph a(4) above, Card ID 1701, for explanation). Repeat the task type number as many times as necessary to cover the entire spread of entries in the next three fields applicable to this task type. Then enter the next task type number and repeat it in a similar manner. Continue until all task type numbers have been entered.

(c) Function (Columns 5-12). If the build function is applicable to this task type, enter BUILD and repeat it as many times as necessary to cover the entire spread of entries in the next two fields applicable to the build function for this task type. (For this card type no terminal cards are used for the function.) If the breach function is applicable to this task type, enter BREACH and repeat it in the same manner as the build function. If the remove function is applicable to this task type, enter REMOVE and repeat it in the same manner as the build function.

(d) Size Number (Columns 13-14) and Density Number (Columns 15-16). These two fields present all combinations of the task size numbers and density numbers shown in card ID 1701 as an index to the matrix of task performance rate values provided by the next two fields of this card. These entries are made as follows. In column 14 enter the task size number 1 (smallest task size), and in the same row in column 16 enter density number 1. Keep repeating task size number 1 in column 14 until all density numbers have been entered opposite it once in columns 15-16. Then enter task size number 2 and start once again with density number 1, repeating task size number 2 until all density numbers have been entered opposite it once in columns 15-16. Continue with task size number 3, number 4, etc., until all task size numbers have been used. Illustration a below shows a sample with four task size numbers and three density numbers. If the number of density numbers is one, then enter each task size number only once in columns 13-14, and enter density number 1 once in column 16 opposite each entry in columns 13-14, as shown in Illustration b below.

ENGINEER DATA LOAD INPUT - TASK PERFORMANCE RATES													
CARD TYPE	TASK ID	FUNCTION BUILD BREACH REMOVE (SELECT ONE)	STRENGTH	CLASS	MINIMUM TROOP LEVEL		STANDARD TROOP LEVEL		CARD ID	CARD SEQ. NR			
					# UNITS	RATE	# UNITS	RATE					
2	3	BUILD	1	1	1	50000	1	50000	1702				
1	3	BUILD	2	1	1	50000	2	50000					
1	3	BUILD	3	1	1	50000	3	50000					
IV	3	BREACH	1	1	1	400	1	400					
	3	BREACH	2	1	1	400	1	400					
	3	BREACH	3	1	1	400	1	400					
	3	REMOVE	1	1	1	5000	1	5000					
	3	REMOVE	2	1	1	5000	1	5000					
	3	REMOVE	3	1	1	5000	1	5000					
	5	BUILD	1	1	1	400	1	400					
	5	BUILD	2	1	1	400	2	400					
	5	BREACH	1	1	1	3000	1	3000					
	5	BREACH	2	1	1	3000	1	3000					
	5	REMOVE	1	1	1	400	1	400					
	5	REMOVE	2	1	1	400	2	400					
IV	6	BUILD	1	1	1	2400	2	2400					
	6	BUILD	2	1	1	2400	2	2400					
	6	BREACH	1	1	1	15000	1	15000					

Figure IV-14-A-7. Task Performance Rates for Troops Card Format

<u>Columns 13-14</u>	<u>Columns 15-16</u>	<u>Columns 13-14</u>	<u>Columns 15-16</u>
1	1	1	1
1	2	2	1
1	3	3	1
2	1	4	1
2	2	5	1
2	3	6	1
3	1	7	1
3	2	8	1
3	3	9	1
4	1	10	1
4	2	11	1
4	3	etc.	1

Illustration a

Illustration b

(e) Minimum Troop Level (Columns 18-27). This data entry provides a lower bound on the feasibility of starting a task, to provide a basis for allocation of troops to tasks when resources on hand are inadequate to allocate the standard quantity, and to relate these quantities to task performance rates. Two types of entry are required; the first for the minimum quantity of troop units required, and the second for the rate of task performance.

1. Number of Units (Columns 18-19). Enter the minimum number of engineer platoons required. One special case needs separate consideration; this case involves tasks requiring more than one type of engineer platoon; e.g., bridge platoons and combat platoons. In this case, enter the minimum number of platoons of the type other than the combat platoons; the model computes the corresponding number of combat platoons.

2. Rate (Columns 20-27). Enter the corresponding rate of task performance using the indicated number of troop units. An implied decimal point is located between columns 24 and 25. The units for this rate will vary by task type; units to be used for these task rate data are shown in Figure IV-14-A-8.

(f) Standard Troop Level (Columns 29-38). This data entry provides a basis for allocation of troops to tasks when resources on hand are adequate to allocate the standard quantity, and relates these quantities to task performance rates. If the quantity available is less than this number, the model checks for the minimum quantity as indicated in the previous field. Two types of entry are required; the first for the standard quantity of troop units required, and the second for the rate of task performance.



Task Type			Function	Rate Unit To Be Used
Common Name	Blue Type	Red Type		
Minefield (Any Type)	-	-	BUILD BREACH REMOVE	Man-hours/meter (of minefield front) <sup>a</sup> Man-hours/meter (of depth of minefield) Man-hours/meter (of minefield front)
Ford	-	-	BUILD BREACH	Platoon-minutes/meter (of ford length) Platoon-minutes/lane width <sup>b</sup>
Raft or Ferry	MAB	GSP and Ponton PMP	BUILD	Minutes/meter (of raft or ferry emplaced)
			REMOVE	Minutes/meter (of raft or ferry removed)
Bridge, Floating	M4T6 and MAB	Ponton PMP	BUILD	Minutes/meter (of bridge emplaced)
	M4T6	Ponton PMP	BREACH	Platoon-minutes/lane width <sup>c</sup>
	MAB	-	BREACH	Platoon-minutes/lane width <sup>d</sup>
	M4T6 and MAB	Ponton PMP	REMOVE	Minutes/meter (of bridge removed)
	AVLB	Tank-Launched M-1967	BUILD	Platoon-minutes/meter (of bridge emplaced) <sup>e</sup>
Bridge, Fixed, Military	-	-	BREACH	Platoon-minutes/lane width <sup>f</sup>
			REMOVE	Platoon minutes/lane width <sup>g</sup>
			BREACH	Platoon minutes/lane width <sup>h</sup>
Bridge, Fixed, Local Masonry	-	-	BREACH	Platoon minutes/lane width <sup>h</sup>

a. Based on standard lane width of 8 meters for single flow vehicle lane, standard minefield depth of 300 meters.

b. Based on standard lane width of 8 meters for single flow vehicle lane and a double row of cratering charges, three charges per row, and charge depth of 3 meters.

c. Based on placement of charges to cut full width of decking in two places and to rupture each ponton of section isolated for destruction (at least four pontons).

d. Based on time required for equipment operators to disengage two interbay connections and to remove resulting multibay raft (at least two bays).

e. Based on 2 minutes to emplace a bridge, giving a rate of 0.111 minute per meter for an 18-meter AVLB and 0.100 minute per meter for a 20-meter M-1967. Task size is taken as constant at 18 meters for AVLB and 20 meters for M-1967.

f. Based on placement of two satchel charges, one over each main girder.

g. Removal time taken equal to emplacement time, hence rates same as note e above.

h. Based on placement of a minimum of six major charges per lane width.

Figure IV-14-A-8. Engineer Task Rate Units

1. Number of Units (Columns 29-30). Enter the standard number of engineer platoons required. The special case is the same as that for the previous field, substituting the word "standard" for the word "minimum" wherever the latter occurs therein.

2. Rate (Columns 31-38). Enter the corresponding rate of task performance using the indicated number of troop units. The units for these rates are the same as those for columns 20-27. An implied decimal point is located between columns 35 and 36.

(3) Task Performance Rates (Card ID 1702, Card Type 3). This card type, illustrated in Figure IV-14-A-9, provides a means of adjusting task performance to reflect the influence of the environmental conditions of the task site and the influence of reduced visibility at night. If no data of this type are entered, all functions are accomplished using the basic rates provided on card ID 1702 type 2.

(a) Card Type and Force Designator (Columns 1-2). The number 3 is printed in column 1 to indicate card type 3. In column 2 enter "R" for Red force or "B" for Blue force.

(b) Task Type Number (Columns 3-4). Enter task type number (see subparagraph a(2) above, Card ID 1701, for explanation. Repeat the task type number as many times as necessary to cover the spread of entries in the next field applicable to this task type. Then enter the next task type number and repeat it in a similar manner. Continue until all task type numbers have been entered.

(c) Function (Columns 5-12). Every function applicable to this task type will have its separate entry. If the build function is applicable to this task type, enter BUILD. If the breach function is applicable, enter BREACH. If the remove function is applicable, enter REMOVE.

(d) Rate Modifiers (Columns 14-32). This data entry provides rate modifiers to reflect degradation in task rate performance due to environmental conditions. Six types of entry are required.

1. Night (Columns 14-16). This entry covers degradation due to night conditions. Based on a visibility value of 100 for average daylight conditions, enter a value less than 100 to represent the average proportional visibility value for night conditions. The model recognizes night conditions from the end of evening nautical twilight (EENT) to the beginning of morning nautical twilight (BMNT).

2. Terrain (Columns 18-32). The other five entries cover degradation due to terrain trafficability factors. Based on a rate modifier of 100 for bare, smooth, flat terrain, enter in each of these fields a value equal to or less than 100 to represent the average proportional rate modifier for engineer task sites. The terrain designators correspond to trafficability indexes defined in Chapter 4 as follows:

ENGINEER DATA LOAD INPUT - TASK PERFORMANCE RATES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
CARD TYPE	CARD NO.	FUNCTION	RATE MODIFIERS							CARD ID	CARD SEQ NR	CARD NO.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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Figure IV-14-A-9. Task Performance Rates for Environment Card Format

<u>Terrain Designator</u>	<u>Trafficability Index</u>
A	01-04
B	05-08
C	09-12
D	13-16
E	17-20

All terrain rate modifiers can be identical for a type task; and, if the battle area is homogeneous, can be uniform for all task types.

(4) Task Performance Rates (Card ID 1702, Card Type 4). This card type, illustrated in Figure IV-14-A-10, provides rates for vehicles when forcing passage of minefields and provides means of assessing vehicle losses.

(a) Card Type and Force Designator (Columns 1-2). The number 4 is printed in column 1 to indicate card type 4. In column 2 enter "R" for Red force or "B" for Blue force.

(b) Task Type Number (Columns 3-4). Enter task type number. See subparagraph a(4), Card ID 1701, for explanation. Task type number is restricted to tasks involving minefields; i.e., types 1, 2, and 3. Repeat the task type number as many times as necessary to cover the spread of entries in the size and density fields (columns 13-16) applicable to this task type. Then enter the next task type number and repeat it in a similar manner. Continue this until all pertinent task type numbers have been entered.

(c) Function (Columns 5-12). Enter task function, FORCE.

(d) Size Number (Columns 13-14) and Density Number (Columns 15-16). These two fields present all combinations of the task size numbers and density numbers shown in card ID 1701 as an index to the matrix of crossing rates and equipment losses provided by the next two fields of this card. Preparation of these entries is analogous to that for card type 2.

(e) Forcing Rate (Columns 17-23). Enter permissible vehicle velocity (meters per minute) while forcing a crossing of minefields.

(f) Forcing Losses (Columns 26-50). This field provides a matrix of types of vehicles which may force minefields and the related assessed losses of such vehicles while so forcing. Only tracked-type combat vehicles are permitted to effect the forcing breach. Five identical type entries are required, each of which is divided into two areas: the first area (three columns) is for the assigned item code for a vehicle type permitted to force minefields, and the related second area (two columns) is for the assessed quantity of that type of vehicle lost while forcing such minefields. Enter in the first area the item code and in the second area the related amount of that type vehicle lost. The bases for loss assessment are density of mines and ground contact width of tracks.

ENGINEER DATA LOGS L-OUT - TASK PERFORMANCE RATES													
CARD TYPE	TASK TYPE	FUNCTION	SIZE #	DENSITY	FORCING RATE	FORCING LOSSES					CARD ID	CARD SEQ NR	
						VEH A	VEH B	VEH C	VEH D	VEH E			
						ITEM CODE	ITEM CODE	ITEM CODE	ITEM CODE	ITEM CODE			
1	3	FORCE	1	1	50	37	3	41	2/85	2/86	2	17 02	
2	3		2	1	50	37	3	41	2/85	2/86	2		
3	3		3	1	50	37	3	41	2/85	2/86	2		
4	3												
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47	3												
48	3												
49	3												
50	3												

Figure IV-14-A-10. Task Performance Rates for Vehicles Crossing Minefields  
Card Format

c. Contingency Levels (Card ID 1703). This card series provides a means to hold some engineer resources in reserve for conditional or contingency tasks so that the model does not commit all of the resources simultaneously and thereby leave the force devoid of resources pending completion of tasks. It also provides a means for controlling critical items. Two card types are prepared pregame. The contingency data generally remain fixed throughout the game but may be altered between game periods if desired. All numbers entered in the cards are to be right justified.

(1) Contingency Levels (Card ID 1703, Card Type 1). This card type, illustrated in Figure IV-14-A-11, provides a means for the gamer to specify contingency levels for equipment he desired to hold in reserve for mandatory tasks which are scheduled or may arise; e.g., tasks resulting from Movement Model operation, or conditional DSL orders. The model cannot allocate contingency equipment to desired tasks but can allocate them to mandatory tasks.

(a) Card Type and Force Designator (Columns 1-2). The number 1 is printed in column 1 to indicate card type 1. In column 2 enter "R" for Red force or "B" for Blue force.

(b) Contingency Levels - Equipment (Columns 3-66). This field provides a means for listing the equipment to be withheld for contingencies. Eight identical subfields are provided, each of which is divided into two areas: the first area (four columns) is for the assigned item code for an equipment type, and the related second area (four columns) is for the amount of that equipment type to be held in contingency reserve. Enter in the first area the item code and in the second area the amount. If no entries are made, the model interprets all contingency levels at zero.

(2) Contingency Levels (Card ID 1703, Card Type 2). This card type, illustrated in Figure IV-14-A-12, provides a means to specify contingency levels for troop units which he desires to hold in reserve for mandatory tasks. The model cannot allocate contingency units to desired tasks but can allocate them to mandatory tasks.

(a) Card Type and Force Designator (Columns 1-2). The number 2 is printed in column 1 to indicate card type 2. In column 2 enter "R" for Red force or "B" for Blue force.

(b) Contingency Levels - Troop Units (Columns 3-43). This field provides a means for listing the troop units to be withheld for contingencies. Six identical subfields are provided, each of which is divided into two areas: the first area (four columns) is for the type of troop unit, and the related second area (two columns) is for the number of such units to be held in contingency reserve. Enter in the first area the code for the unit type and in the second area the amount. If no entries are made, the model interprets all contingency levels at zero. Codes to be used for unit types are specified in Figure IV-14-A-13 in terms of Blue unit types; these same codes will be used for equivalent Red unit types:



LEADER DATA LOG - UNIT - CONTINGENCY LEVELS																
CONTINGENCY LEVELS - TROOP UNITS																
CARD TYPE	1	2	3	4	5	6										
	TYPE	SLING	TYPE	SLING	TYPE	SLING	TYPE	SLING	TYPE	SLING	TYPE	SLING	TYPE	SLING	CARD ID	CARD SEQ NR
RED OR BLUE	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4
1	ENVY	0	ENOR	2	ADM	0	MAD	1	FLOR	0					1703	
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Figure IV-14-A-12. Contingency Levels for Troops Card Format



Unit	Code	Type Unit
1	MNVR	Maneuver unit (company)
2	ENGR	Combat engineer unit (platoon)
3	ADM	Atomic demolition munition unit (platoon)
4	MAB	Floating bridge unit (heavy raft, platoon, MAB)
5	FLBR	Floating bridge unit (bridge platoon, M4T6)
6		Open

Figure IV-14-A-13. Unit Type Codes

4. ENGINEER CONSTANT DATA DECK STRUCTURE. Two different data deck structures are required, one for the barrier and facility file and one for the engineer task data base; each deck has a separate load program.

a. Engineer Constant Data Input Cards. Ten types of cards are used, as indicated in Figure IV-14-A-14. The first three types pertain to the barrier and facility file and the remaining seven types to the engineer task data base.

b. Creating Barrier and Facility File. The barrier and facility file is created by reading in the data deck structured as shown in Figure IV-14-A-15. In this figure are a series of subdecks, each of which pertain to a specific barrier line. The first block of these subdecks covers Blue force barriers, and the second block covers Red force barriers. Each subdeck is headed by a barrier line identification card, ID 0201, type 1, and is followed by a barrier line end card which carries only the initial identifier 1B or 1R in columns 1 and 2, the minus one (-1) designator in columns 16 and 17, and the card ID number 0202 in columns 73-76. Within the barrier segment details subdeck, the cards are arranged from front to rear, in the consecutive order of the barrier segments, starting from one end of the barrier line and progressing to the other end.

c. Creating Engineer Task Constant Data File. The engineer task constant data file is created by reading in the data deck structured as shown in Figure IV-14-A-16. In this figure are a series of subdecks, each of which contains specific types of data and is preceded by a header card. There are two identical blocks of these subdecks, the first one containing engineer tasks for Blue forces and the second one for Red forces. Within the subdecks, individual cards are arranged from front to rear as follows:

Card Type	Card Title	Card ID	Load Program Name
1	Barrier System Location	0200	BARLOAD
1	Barrier Line Identification	0201	BARLOAD
1	Barrier Segment Details	0202	BARLOAD
1	Task Identification	1701	ENGLD
1	Task Performance Rates (Equipment)	1702	ENGLD
2	Task Performance Rates (Troops)	1702	ENGLD
3	Task Performance Rates (Environment)	1702	ENGLD
4	Task Performance Rates (Forcing)	1702	ENGLD
1	Contingency Levels (Equipment)	1703	ENGLD
2	Contingency Levels (Troops)	1703	ENGLD

Figure IV-14-A-14. Engineer Constant Data Card Types

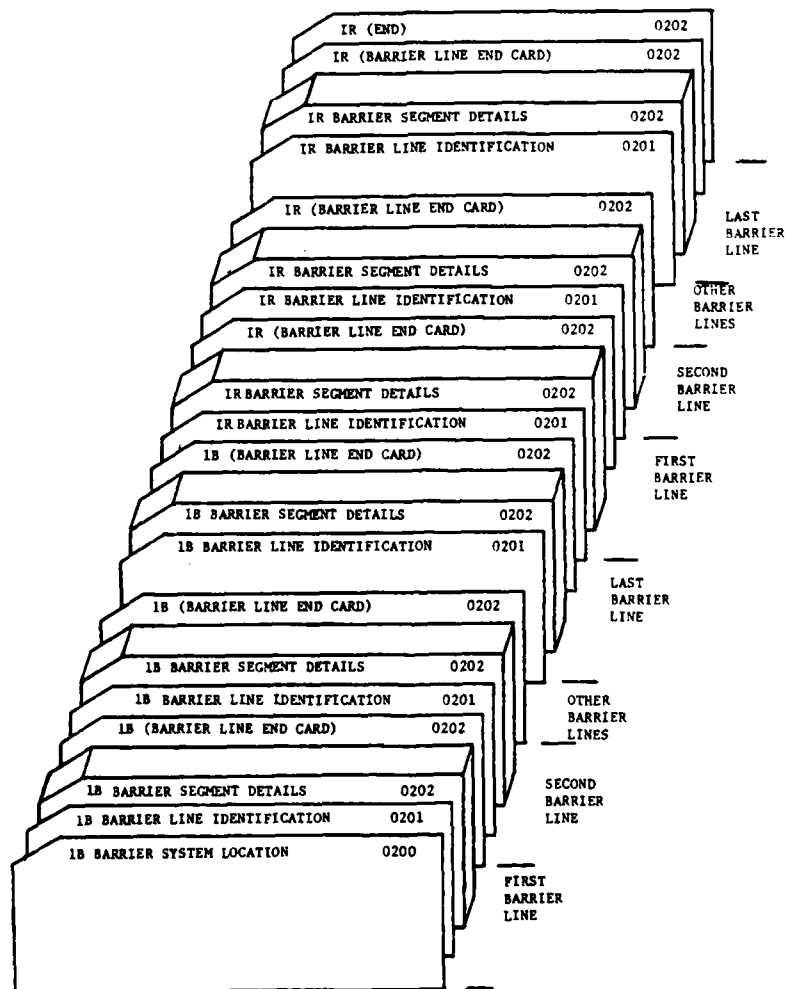


Figure IV-14-A-15. Barrier and Facility Data Deck Structure

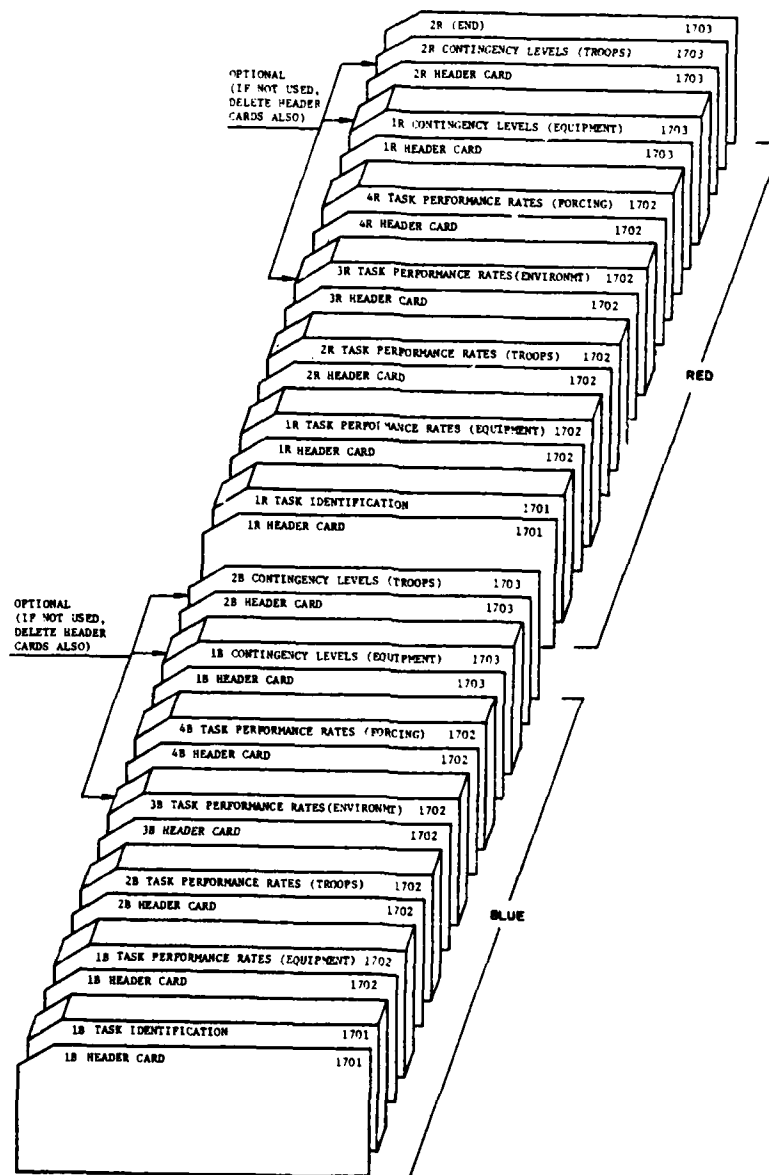


Figure IV-14-A-16. Engineer Task Data Deck Structure

(1) Task Identification Subdeck. Arrange cards in numerical order on task type numbers; some numbers may not be in use, e.g.:

Task type 1  
Task type 2  
.  
.  
.  
.  
Task type 25

(2) Task Performance Rates (Equipment) Subdeck. Arrange cards so that task type numbers are in numerical order, and all cards within a task type number and with like function are grouped together in each function order, build, breach, and remove. Function end cards are prepared with all initial entries through function (columns 1 through 15) with nothing else except the card ID 1702 in columns 73-76; e.g:

Task type 1	Function BUILD	Item Code XXX
Task type 1	Function BUILD	Item Code YYY
Task type 1	Function BUILD	Item Code ZZZ
Task type 1	Function BUILD	(End Card)
Task type 1	Function BREACH	Item Code RRR
Task type 1	Function BREACH	Item Code SSS
Task type 1	Function BREACH	(End Card)
Task type 1	Function REMOVE	Item Code XYZ
Task type 1	Function REMOVE	(End Card)
Task type 2	Function BUILD	Item Code YYY
Task type 2	Function BUILD	Item Code XXX
Task type 2	Function BUILD	(End Card)
Task type 2	Function BREACH	Item Code SSS

(3) Task Performance Rates (Troops) Subdeck. Arrange cards so that task type numbers are in numerical order and all cards within a task type number and with like function are grouped together in each function order, build, breach, and remove. Within a function, size numbers are in numerical order, and cards with the same size number are grouped together, with densities in numerical order; e.g:

Task type 1	Function BUILD	Size 1	Density 1
Task type 1	Function BUILD	Size 1	Density 2
Task type 1	Function BUILD	Size 1	Density 3
Task type 1	Function BUILD	Size 2	Density 1
Task type 1	Function BUILD	Size 2	Density 2
Task type 1	Function BUILD	Size 2	Density 3
Task type 1	Function BREACH	Size 1	Density 1
Task type 1	Function BREACH	Size 1	Density 2
Task type 1	Function BREACH	Size 1	Density 3

Task type 1	Function BREACH	Size 2	Density 1
Task type 1	Function BREACH	Size 2	Density 2
Task type 1	Function BREACH	Size 2	Density 3
Task type 1	Function REMOVE	Size 1	Density 1
Task type 1	Function REMOVE	Size 1	Density 2
Task type 1	Function REMOVE	Size 1	Density 3
Task type 1	Function REMOVE	Size 2	Density 1
Task type 1	Function REMOVE	Size 2	Density 2
Task type 1	Function REMOVE	Size 2	Density 3
Task type 2	Function BUILD	Size 1	Density 1
Task type 2	Function BUILD	Size 1	Density 2

(4) Task Performance Rates (Environment) Subdeck. Arrange cards so that task type numbers are in numerical order and functions in order, build, breach, and remove:

Task type 1	Function BUILD
Task type 1	Function BREACH
Task type 1	Function REMOVE
Task type 2	Function BUILD
Task type 2	Function BREACH
Task type 2	Function REMOVE
Task type 3	Function BUILD

(5) Task Performance Rates (Forcing) Subdeck. Arrange cards so that task type numbers are in numerical order, and within a task type number, size numbers are in numerical order and cards with the same size number are grouped together, with densities in numerical order:

Task type 1	Function FORCE	Size 1	Density 1
Task type 1	Function FORCE	Size 1	Density 2
Task type 1	Function FORCE	Size 1	Density 3
Task type 1	Function FORCE	Size 2	Density 1
Task type 1	Function FORCE	Size 2	Density 2
Task type 1	Function FORCE	Size 2	Density 3
Task type 2	Function FORCE	Size 1	Density 1
Task type 2	Function FORCE	Size 1	Density 2
Task type 2	Function FORCE	Size 1	Density 3
Task type 2	Function FORCE	Size 2	Density 1

(6) Contingency Levels (Equipment) Subdeck. No special arrangement of cards is required in this subdeck; however, if any card has fewer than eight equipment columns filled, that card is placed last in the deck. If no equipment contingency levels are specified, such levels default to zero; in such cases, both this deck and its header card are omitted.

(7) Contingency Levels (Troops) Subdeck. This deck consists of a single card. If no troop contingency levels are specified, such levels default to zero; in such cases, both this card and its header card are omitted.

## APPENDIX B

### ENGINEER MODEL PROGRAM DESCRIPTIONS

1. INTRODUCTION. Routines accomplishing the engineer functions modeled in DIVWAG are included in overlay 12. Overlay segmentation is for running efficiency and is not generally related to logical sequence of the model. The macro flow of the Engineer Model is shown in Figures IV-14-2 through IV-14-8.

a. Routines. The controlling routine of overlay 12 is ENGR, which serves as the interface with the system. Major routines within the overlay are EPRIOR, PRORTY, EFASI, FESBIL, ERELEA, and EUPDAT. Supporting routines within the overlay include BUIDRC, CREAL6, EQPT, EQPTUP, GEOM, IRECN1, MPRACL, MPRUPD, SGI201, STUNIT, SET37, and UNTORG. CRTQD, which also appears in overlay 3, is described in this appendix.

b. Variables. Routines within overlay 12 use a limited set of variables, appearing with the same variable names throughout the overlay. These include standard common block areas UMAIN, UCOOP, and TCLOCK. Additional variables general to the overlay are listed below. Within the routine descriptions, variables other than these standard engineer overlay data are specified where appropriate.

<u>Name</u>	<u>Source/Destination</u>	<u>Contents</u>
IOF(35)	DF2	Barrier file record.
PTYLST(6)	DF18	Priority list, unique to each task in queue.
IARRAY(60)	DF37	Borrowed equipment file.
JARRAY(3)	DF16	Three-word array: WORD1 = number of tasks in queue. WORD2 = flag indicating new game. WORD3 = flag indicating new period.
IDUM(94 through 129)	TWO	Data file 12 record for automatic event sequencing.
NORD1		IDUM(94). Engineer NORD.
STRSTP		IDUM(96). DSL stop task.
BARBRI		IDUM(97). Bridge/barrier flag: 1 = bridge 0 = barrier
UIDB		IDUM(98). Task mnemonic.
IBARNM		IDUM(99)

<u>Name</u>	<u>Source/Destination</u>	<u>Contents</u>
PRTY		IDUM(100). DSL priority.
CMPBGN		IDUM(101). Complete-by-begin-by flag: 1 = begin by; 0 = complete by.
MNDPTY		IDUM(102). Mandatory-desired flag: 1 = mandatory; 0 = desired.
ENGRTM		IDUM(103). Time engineer event begins.
BLUFRC		IDUM(104). Blue/Red force to execute: 0 = Red; 1 = Blue.
ENGOPR		IDUM(105). Operation code to allow proper branching in parts of model.
BARIDX		IDUM(106). Barrier record number passed only by mobility with ENGOPR=3.
IUIDRQ		IDUM(107). IUID of unit requesting task passed only by mobility with ENGOPR=3.

## 2. ROUTINE ENGR:

a. Purpose. ENGR is the controlling routine of the Engineer Model overlay, that calls the various routines in response to event codes passed to it by data file 12, the automatic event file, and sets up reentry to the overlay through data file 12. The routine is also the point of entry for all DSL orders to the model and, as a utility function, decomposes engineer mission units upon task completion.

b. Major Variables. The routine uses all variables listed in paragraph 1b.

c. Logical Flow (Figure IV-14-B-1):

(1) Block 1. If this is not a DSL start-of-period instruction, control branches to block L100; otherwise, control goes to block 2.

(2) Blocks 2, 7, and 8. If this is not the first DSL instruction to enter the model and not the start of a new period, control goes to block L40; otherwise, control goes to block L80.

(3) Blocks L80, 4, 5, 6, 9, and 10. Blocks L80, 4, 5, 6, and 9 generate the necessary returns to the Engineer Model throughout the period. ENGOPR is reset to its original value. If ENGOPR is equal to 3, control goes to block L70.

(4) Block L40. The barrier record number corresponding to the mnemonic input through DSL is calculated by routine BUIDRC.



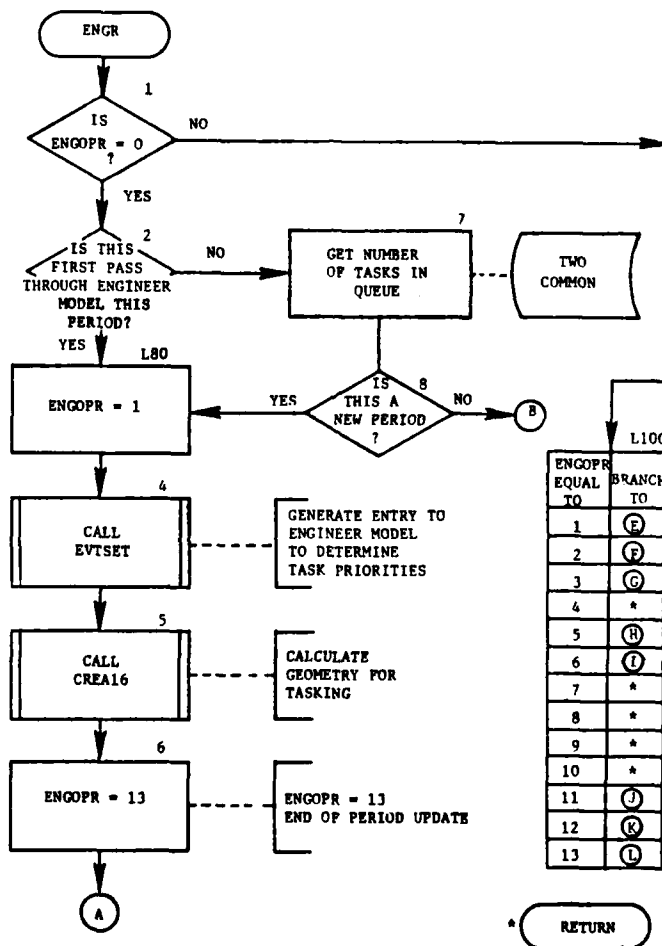


Figure IV-14-B-1. Routine ENGR (Continued on Next Page)

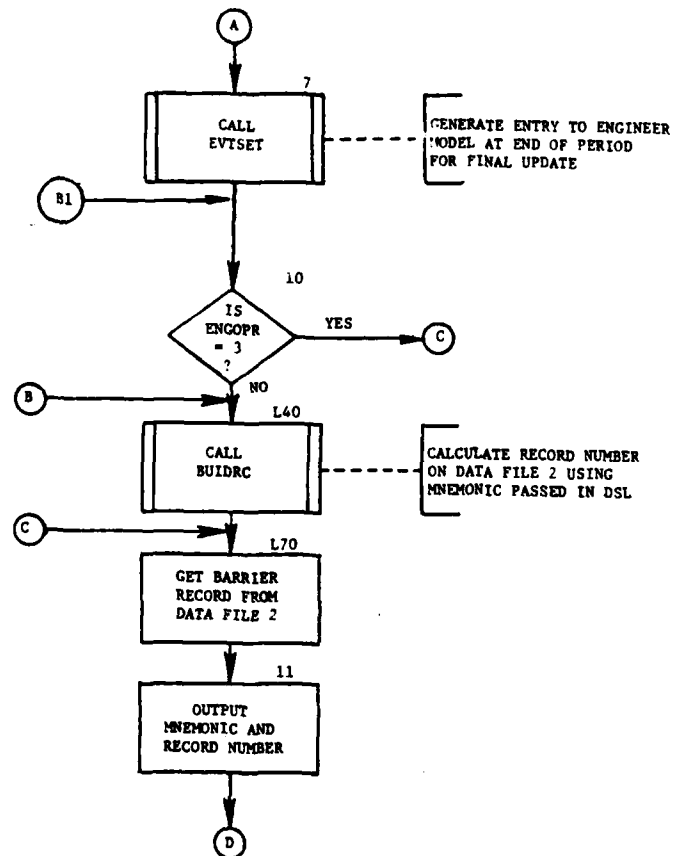


Figure IV-14-B-1. Routine ENGR (Continued)

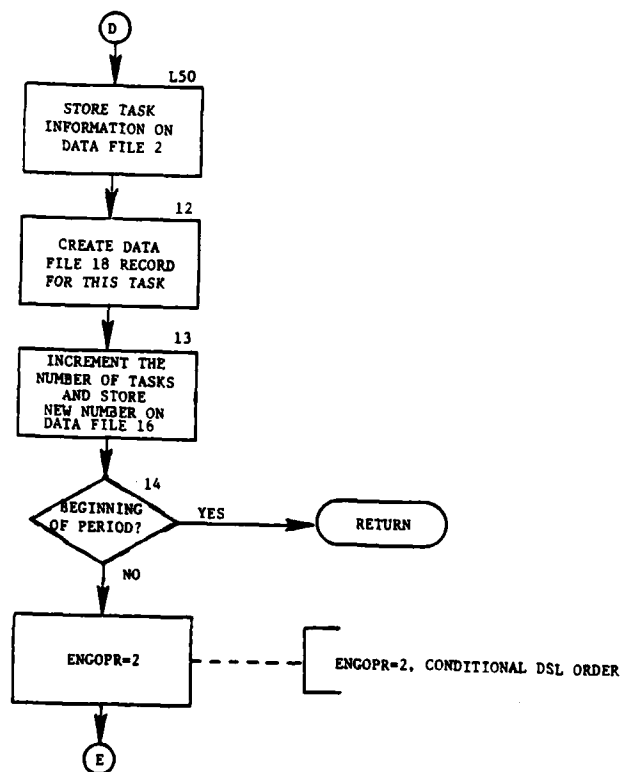


Figure IV-14-B-1. Routine ENGR (Continued)

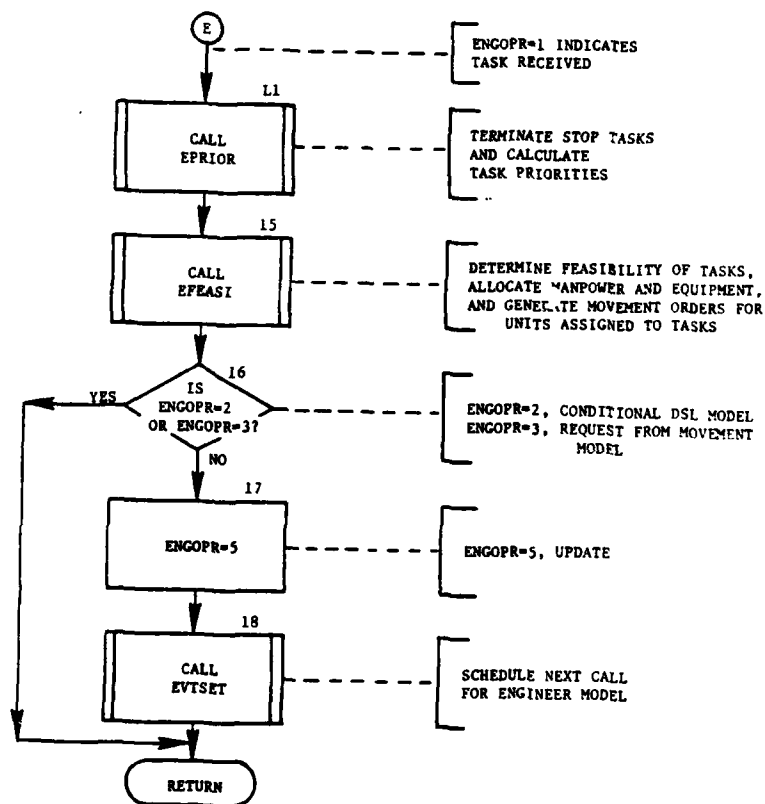


Figure IV-14-B-1. Routine ENGR (Continued)

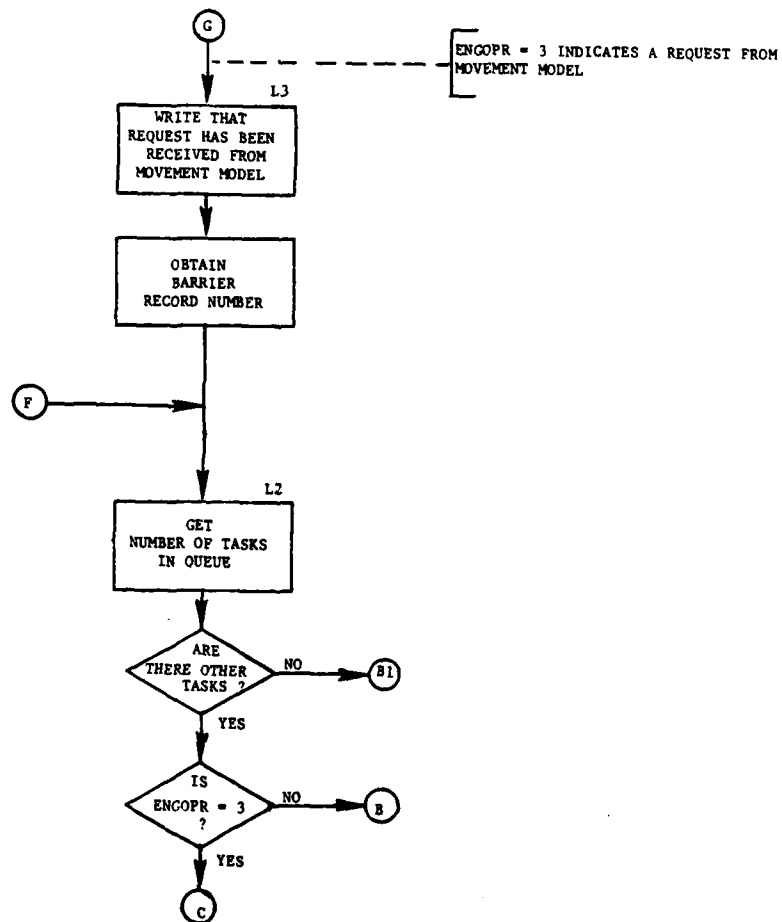


Figure IV-14-B-1. Routine ENGR (Continued)

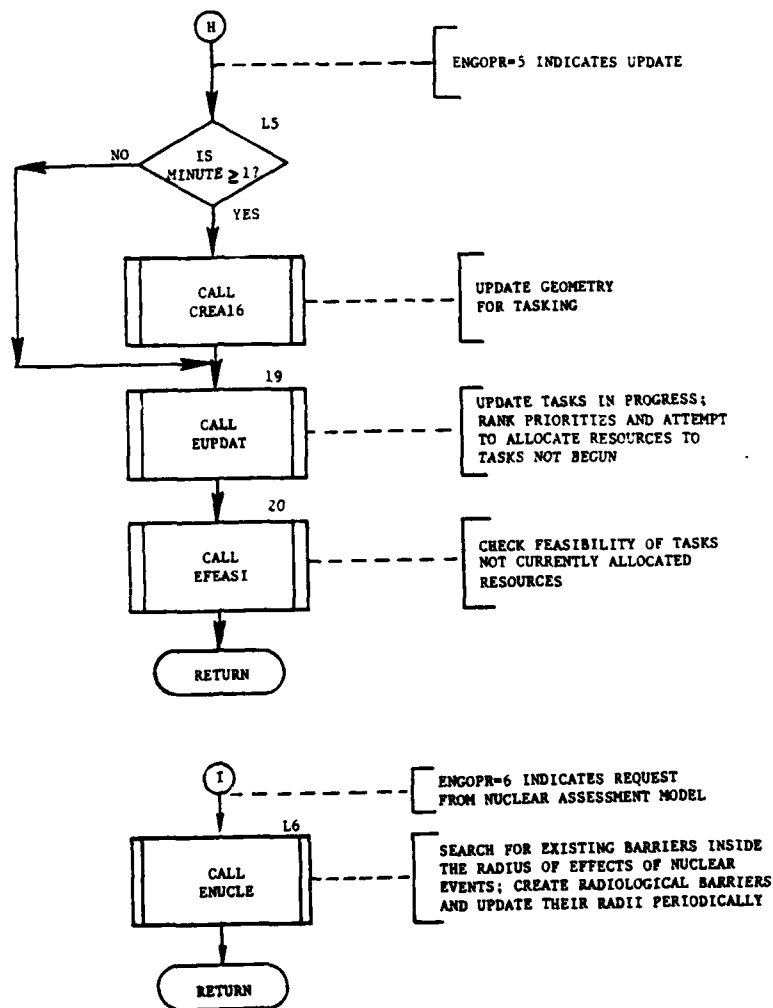


Figure IV-14-B-1. Routine ENGR (Continued)

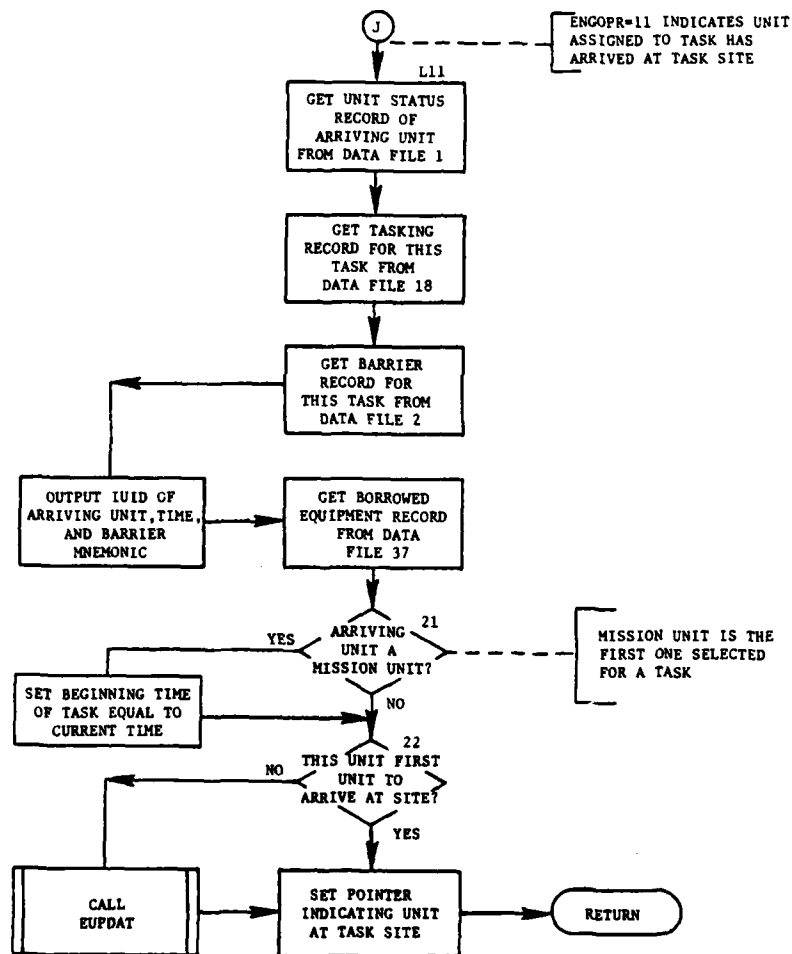


Figure IV-14-B-1. Routine ENGR (Continued)

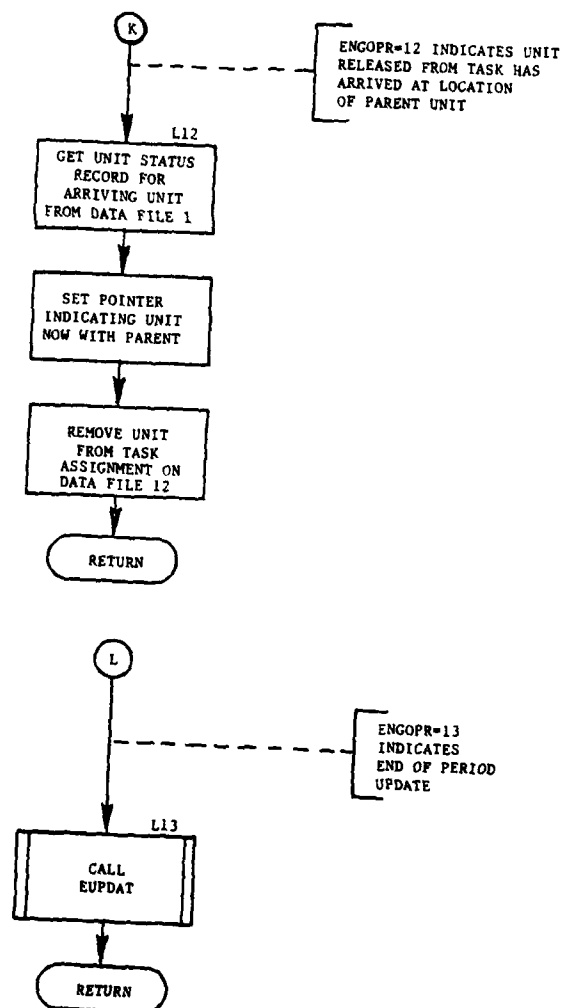


Figure IV-14-B-1. Routine ENGR (Concluded)



(5) Block L70. After the record number has been determined, bring in the barrier record from data file 2.

(6) Blocks 11, L50, 12, and 13. Store task information on barrier file 2 and create a data file 18 record corresponding to the task. Increment the number of tasks in the queue and return this value to data file 16.

(7) Block 14. If there are more tasks control returns to the calling routine. If not and this is a conditional task, set ENGOPR equal to two and transfer control to block L1.

(8) Block L1. If the task need not be terminated due to the proximity to the FEBA or a DSL stop order, the task priority, manhours required to complete the task, and the starting time are determined in routines EPRIOR and PRORTY. Priorities are also ranked according to battle significance.

(9) Block 15. If a task is feasible, manpower and resources are allocated, and movement orders are generated by routine EFEASI.

(10) Blocks 16, 17, and 18. Generate the next entry to the Engineer Model to update allocated tasks and to allocate other tasks. Control returns to the calling routine.

(11) Blocks L3 and L2. Get the barrier record number from data file 2 and the current number of tasks in the queue. If this is a mobility request, transfer control to L70; otherwise, transfer control to L40.

(12) Blocks L5, 19, and 20. CREA16 updates the engineer geometry each 60 minutes, on the hour. Expenditures for equipment and supplies since previous update are calculated. Routine EUPDAT increases the number of expended manhours and releases units if the task is complete; if not, the routine allocates necessary manpower and supplies for completion. Routine EFEASI allocates manpower and supplies to tasks not underway. Control returns to the calling routine.

(13) Block L6. ENUCLE finds barriers within nuclear effects radius and creates and updates radiological barriers. Control returns to the calling routine.

(14) Block L11. Bring in data for the unit arriving at the task site and place it on the barrier record for this task.

(15) Block 21. If the arriving unit is the mission unit for this task, set beginning task time equal to current time.

(16) Block 22. If this unit was not the first unit to arrive at the task site, call routine EUPDAT to process activity at the site since the previous update, and the unit's supplies and manpower are added to others at the site. Control is returned to the calling routine.

(17) Block L12. When a unit returns to the parent unit location after being released from a task, its equipment and manpower are also returned to the parent unit, and the task unit is dissolved.

(18) Block L13. EUPDAT updates all engineer tasks prior to the completion of a period which allows the report processor to more closely describe the tasking status at the end of a period.

### 3. ROUTINE EPRIOR:

a. Purpose. The routine EPRIOR determines if a task must be terminated due to the proximity to the FEBA, or because of a direct DSL command. If a task passes both criteria, it is passed to routine PRORTY. Control returns to EPRIOR to process tasks in the queue.

b. Input Variables. In addition to the variables standard to the overlay, EPRIOR requires the following input:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FCEPT	DF16	Y intercept of FEBA.
SLOPE	ONE	Slope of line perpendicular to FEBA.

c. Output Variables. Output includes variables standard to the overlay and the following:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
PTYLTO	DF18	Zero record to clear file area.

#### d. Logical Flow (Figure IV-14-B-2):

(1) Block 1. After routine ENGR has placed all engineer tasks on the priority record of data file 18 with each task having a separate record, routine EPRIOR brings in the number of records on data file 18 which was stored in data file 16.

(2) Blocks 2 and 3. Obtain the intercept of the FEBA (intersection of forward battle line with the X axis), and calculate where the FEBA will intersect the Y axis (YCEPTF).

(3) Blocks 4, L200, L11, and L21. If this task is a conditional task or a Movement Model request, it is the only task to be examined at this time. Control bypasses the loop established in block L200 to bring in only this task's priority record. Control then transfers to block 5. Otherwise, begin the loop with block L200 and bring in the data file 18 record for each task.

(4) Blocks 5, 6, and 7. After bringing in the appropriate barrier record, routine PONTLN determines the distance from each endpoint to the FEBA. The closer distance will be used.

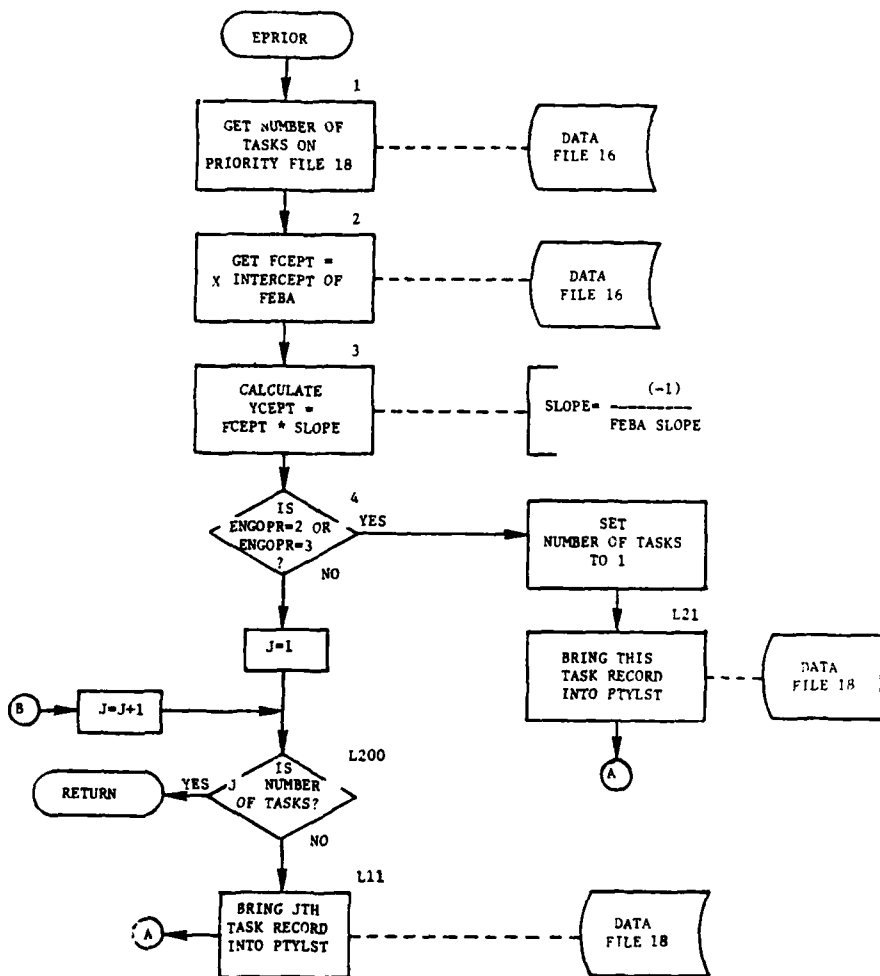


Figure IV-14-B-2. Routine EPRIOR (Continued on Next Page)

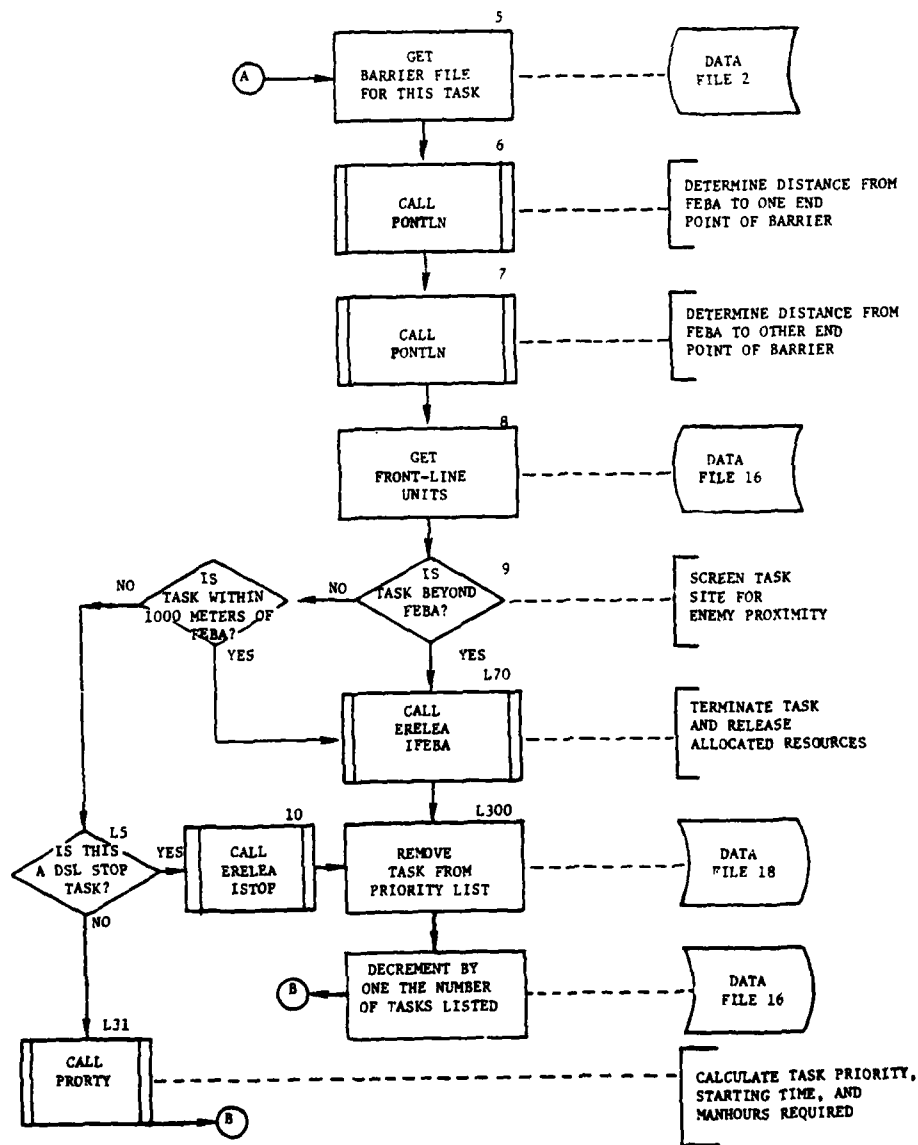


Figure IV-14-B-2. Routine EPRIOR (Continued)

(5) Blocks 8, 9, and L70. To determine if the task is beyond the FEBA, get a front-line unit from data file 16 to determine Red and Blue orientation to the FEBA. If the task is within 1000 meters of, or beyond the FEBA, transfer control to ERELEA to release equipment, supplies, and manpower for other tasks and control goes to block L300. If not, the flow continues at block L5.

(6) Blocks L5 and 10. If the task was a DSL-ordered stop task, transfer to routine ERELEA. If not, control transfers to L31.

(7) Block L300. To prevent further action on this task, remove the task from data file 18 and move each task priority forward one. Reduce the number of records on data file 18 by one and place it on data file 16. Continue processing each task by transferring control to block L200.

(8) Block L31. Routine PRORTY calculates manhours required, priority of task, and starting time. Control transfers to block L200.

#### 4. ROUTINE PRORTY:

a. Purpose. Within this routine, the task starting time is calculated if not specified by DSL, the manhours required are approximated, and a task priority is assigned.

b. Input Variables. Standard overlay variables and the following other variables are input.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IFORCE	DF16	Indicator designating the advancing force.
SUNRIS	DF4	Beginning morning nautical twilight (BMNT).
SUNSET	DF4	Ending evening nautical twilight (EENT).
J	Call	Current data file 18 record.

c. Output Variables. Standard overlay data.

d. Logical Flow (Figure IV-14-B-3):

(1) Block L1. Determine task priority. If this is a mandatory task, control transfers to block L10.

(2) Blocks 1 and 2. If it is not a mandatory task, compute the first-digit priority based on which is the advancing force which force is to execute the task, whether the structure is a bridge/facility or a barrier, and whether it is a build or breach task. The advancing force is obtained from data file 16. Control transfers to block 3.

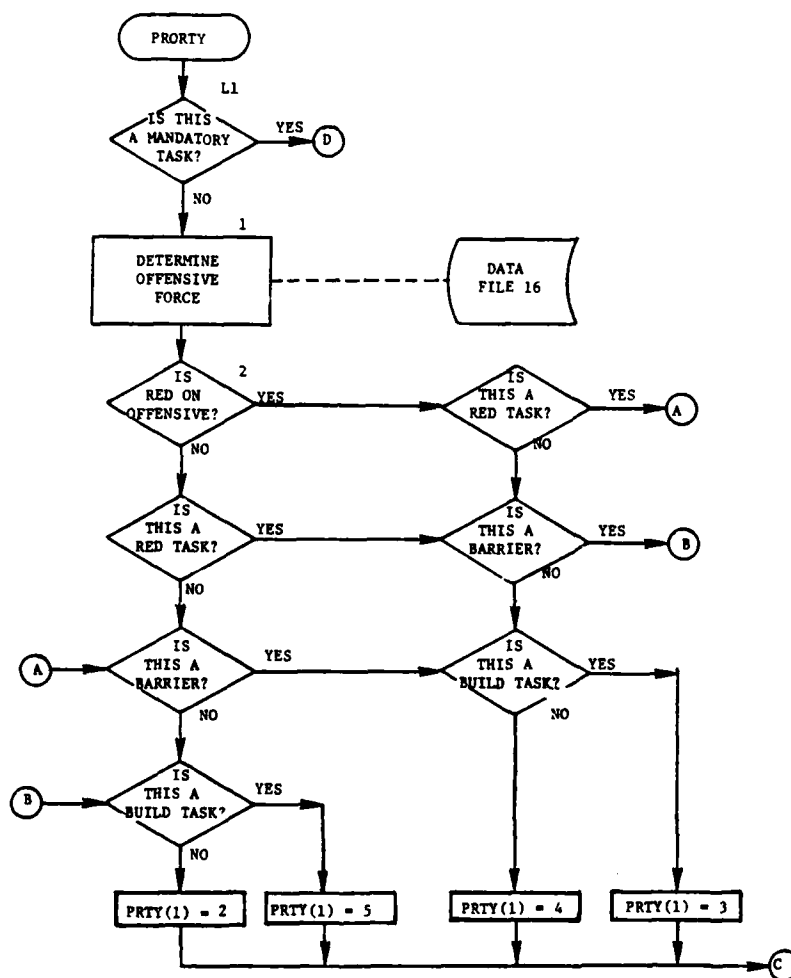


Figure IV-14-B-3. Routine PRORTY (Continued on Next Page)

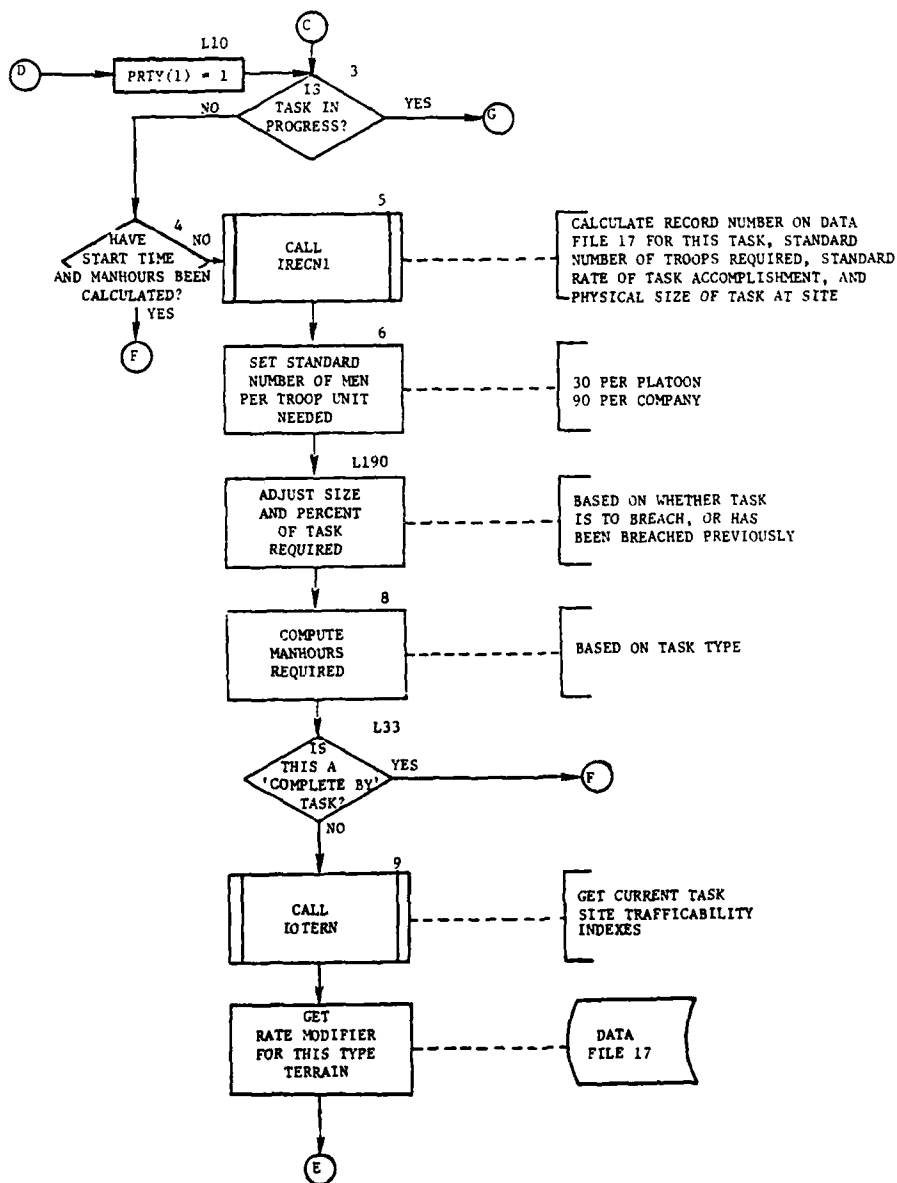


Figure IV-14-B-3. Routine PRORTY (Continued)

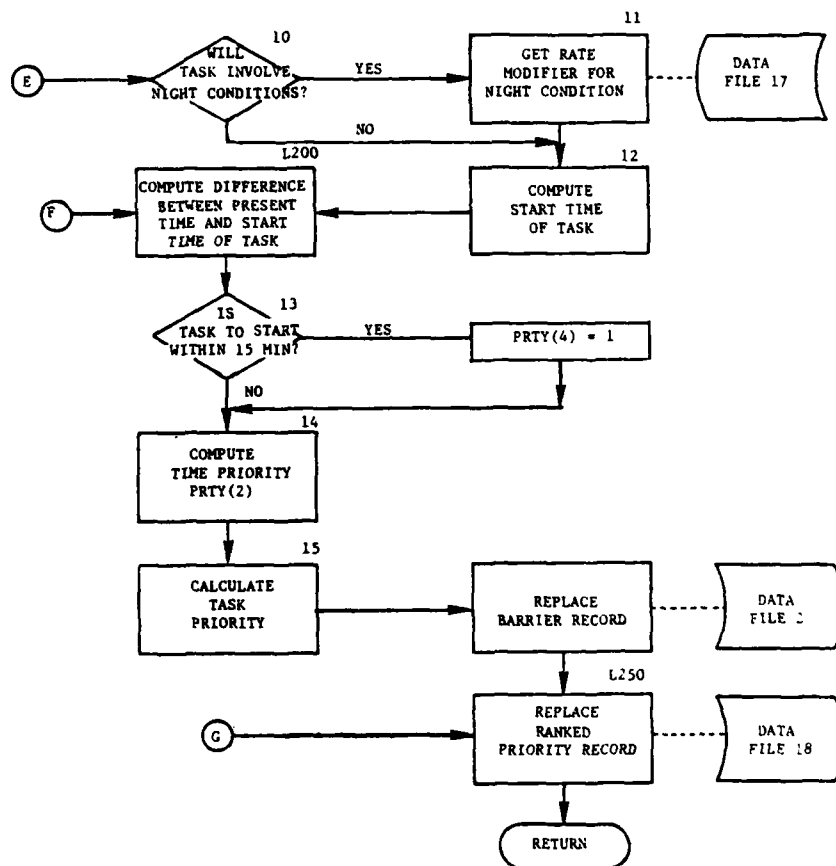


Figure IV-14-B-3. Routine PRORTY (Concluded)



(3) Blocks 3 and 4. If the task is in progress, control transfers to block L250. If not, determine if required manhours and starting time have been calculated. If so, control transfers to block L200.

(4) Block 5. Routine IRECN1 calculates the standard required number of troop units, the standard accomplishment rate, and the physical task size for this task, and determines the task record number.

(5) Blocks 6, L190, and 8. To compute the total manhours required for this task, first determine an average number of men per unit as specified in the troop unit type that is consistent with the unit rates specified with the associated unit rate loaded on data file 17. Because smaller amounts of equipment are required to finish a breached structure or to breach an existing structure, the size magnitude of the task will be internally diminished to lessen the task requirements. The manhours required are determined.

(6) Blocks L33, 9, 10, 11, and 12. Compute the starting time for the task. If this task's starting time is DSL specified, control transfers to block L200; otherwise, determine the standard time required to complete this task, trafficability rate modifier from data file 17 (given the current terrain data from routine IOTERN), and nighttime modifier, if applicable. Modify the standard time by these modifiers to gain an adjusted time required. Subtract this adjusted time from the DSL specified completion time.

(7) Blocks L200, 13, and 14. To compute the time priority code, subtract the current battle time from the task start time just calculated, and divide this time into 60-minute increments, with each increment increasing the priority code by one (up to four). If the task is to be executed during this pass through the Engineer Model, an appropriate flag is set to be checked later in routine FESBIL.

(8) Block 15. Compute task priority based on force priority from block 2, time priority, and DSL priority. Return barrier record to data file 2.

(9) Block L250. Rank tasks on the priority record from highest priority to lowest, with mandatory tasks in progress ranked prior to desired ones in progress. When the priority record has been reranked and all records replaced in data file 18, control returns to the calling routine.

#### 5. ROUTINE EFEASI:

a. Purpose. This routine determines the brigade area of responsibility where the task is located, and drives the routines for selecting manpower for the task and for allocating the necessary equipment and supplies required from the company/or the battalion. EFEASI issues movement orders to get task units and equipment to the site.

b. Input Variables. In addition to the overlay data, other variables are:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
SLOPE	ONE	Slope of line perpendicular to FEBA.
IGEOM	DF16	Y intercepts and IUIDs ranked and increasing monotonically for both Blue and Red forces.
II	DF16	Number of tasks in queue for Engineer Model.
KL	DF16	Number of front-line brigades.
IUNTLC	TWO	Location table for all units.
IUTD	TWO	UTDs of all units.
JARRAY	DF51	List of UTDs linking movement information on data files 8 and 9.
MOBCAT	DF9	Variables used by the Movement Model in generating logic for movement segments.
INDEXEX	DF9	
IREC8	DF8	

c. Output Variables. Standard overlay data and the following other variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IXACT	TWO	X coordinate of resolution unit.
IYACT	TWO	Y coordinate of resolution unit.

d. Logical Flow (Figure IV-14-B-4):

(1) Blocks L1, 1, L201, and 2. On data file 16 is stored the current number of engineer tasks that have been requested by the Movement Model and through DSL. If entry to this routine is not start-of-period initiation or regular updating, only one specific task is examined; otherwise, all tasks are examined. The one particular task record on data file 18 will be passed in common, from which the priority record is obtained; otherwise, examine all tasks on data file 18 sequentially.

(2) Blocks L1001 and L203. After bringing in the proper barrier record from data file 2, EFEASI checks the requested task to guarantee no errors have occurred; e.g., requesting a build task where the structure already exists, or requesting a task at an unbreachable task site.

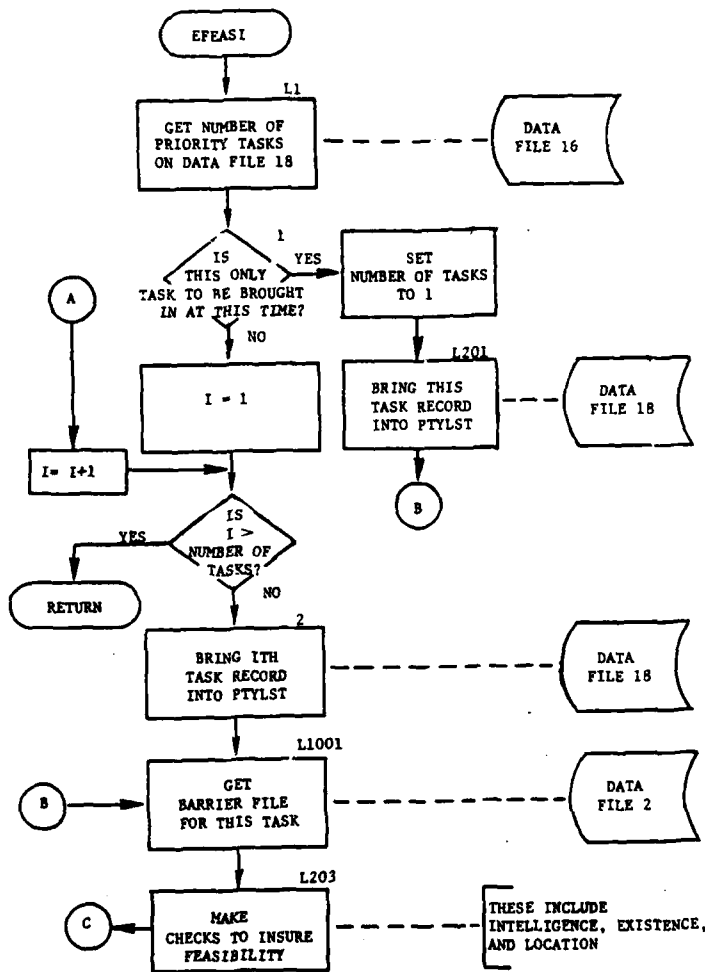


Figure IV-14-B-4. Routine EFEASI (Continued on Next Page)

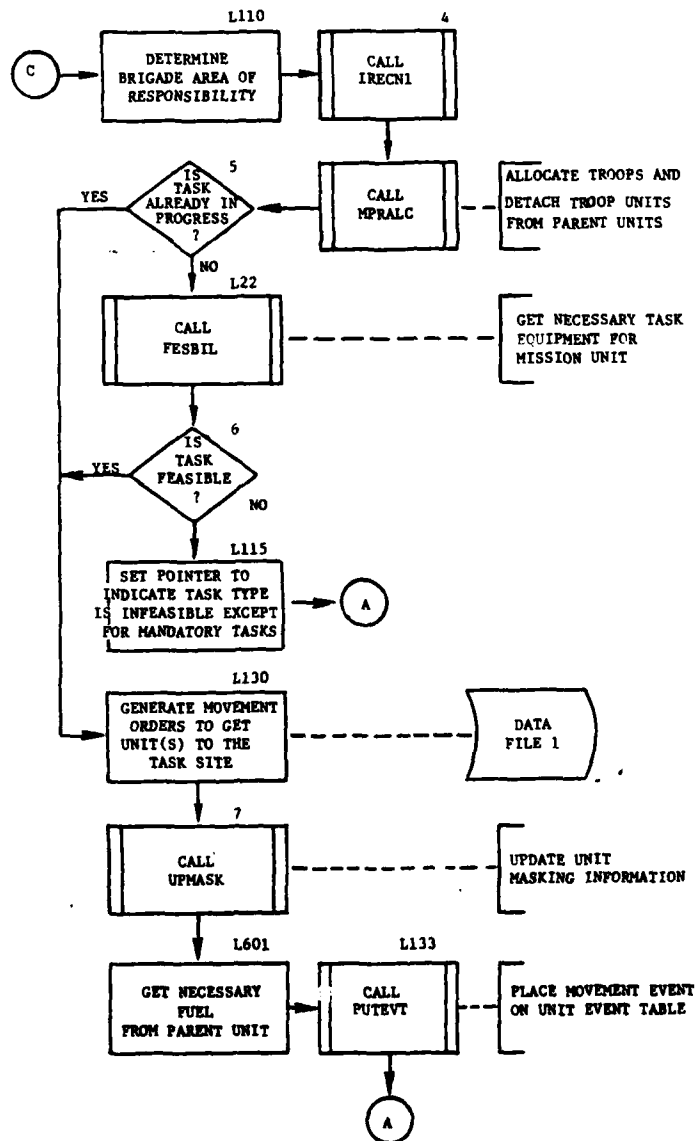


Figure IV-14-B-4. Routine EFEASI (Concluded)

(3) Block L110. After bringing in the brigade areas of responsibility for Red or Blue force, search this list to locate the area where most of the task is to be performed. If no area of responsibility is found, default is automatically made to the division area as a whole.

(4) Block 4. After determining where to begin searching for units, routine MPRALC selects the necessary units; if some units have been previously assigned, available units that bring the troop level up to the required number are selected. If the unit selected to be record does not exist on data file 1, the unit's status record is created.

(5) Block 5. If the task is in progress, control transfers to block L130.

(6) Block L22. If the task is not begun, or unit has not been directed toward the task, allocation of necessary equipment is made by routine FESBIL.

(7) Blocks 6 and L115. Control transfers to Block L130 if troops or equipment were allocated. If not, a flag is set to allow no allocation of equipment to desired tasks of lower priority.

(8) Blocks L130, 7, and L133. A pseudo DSL movement order is generated for the Movement Model to include establishing actual coordinates for the unit, objective point, and proper movement codes and rates, and transferring control to routine UPMASK to develop a masking function for this unit, placing its present location into common, and placing the movement event into the unit's event table.

(9) Block L601. Allocate fuel for movement of this unit to and from the task site and during performance. Replace the unit's status record on data file 1. Repeat this process, transferring control to block L130 until movement orders have been generated for all task units; then, return to block 2 to process next task.

#### 6. ROUTINE FESBIL:

a. Purpose. This routine allocates the equipment and supplies to perform the requested task. It determines whether contingency requirements apply to this particular task, and allocates available supplies from the parent unit at company level. If this is insufficient, it allocates what is available, up to the amount required, from the battalion level. It then creates the proper entries for this task's data file 37 record and updates the mission unit's data file 50 record for authorized strength, based on the amount of each item code required.

#### b. Input Variables.

(1) Standard overlay data.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
ITYPIC	DF17	Item code array for this task type.
IOUT	DF50	Authorized strengths by item code.
ICNTGY	DF17	Contingency amount for each item code type.

c. Output Variables:

(1) Standard overlay data.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IXLFT1	DF37	Amount of equipment borrowed.
IOVT	DF50	New authorized strengths record.

d. Logical Flow (Figure IV-14-B-5):

(1) Blocks 1, 2, and 3. Bring in the status record of the mission unit and its borrowed equipment array from data file 37. Bring in the task equipment array based on the record number on data file 17 returned from routine IRECN1.

(2) Block L45. Determine equipment and supplies currently on hand in all task units, then return the status record of the mission unit to core.

(3) Blocks L50, L41, and 5. Begin looping on all item codes required for the task. Calculate the quantity of equipment needed for this task, then subtract the amount currently on hand from the amount needed. If enough equipment is on hand for this item code, control transfers to block 14.

(4) Blocks 6 and 7. If sufficient quantity of equipment is not on hand, determine whether contingency applies, and based on this contingency calculate the amount of equipment available in the company and battalion levels. If the amount available in the company meets the requirement, control transfers to block 10.

(5) Blocks L5002 and 8. If there is insufficient equipment at company level, allocate what is available, keep contingency in reserve from the company, and determine if the remaining required amounts can be obtained from the battalion level. If the battalion has enough equipment, less contingency, control transfers to block 10.

(6) Block 9. If the battalion does not have the required equipment, allocate what is available and transfer control to block L38.

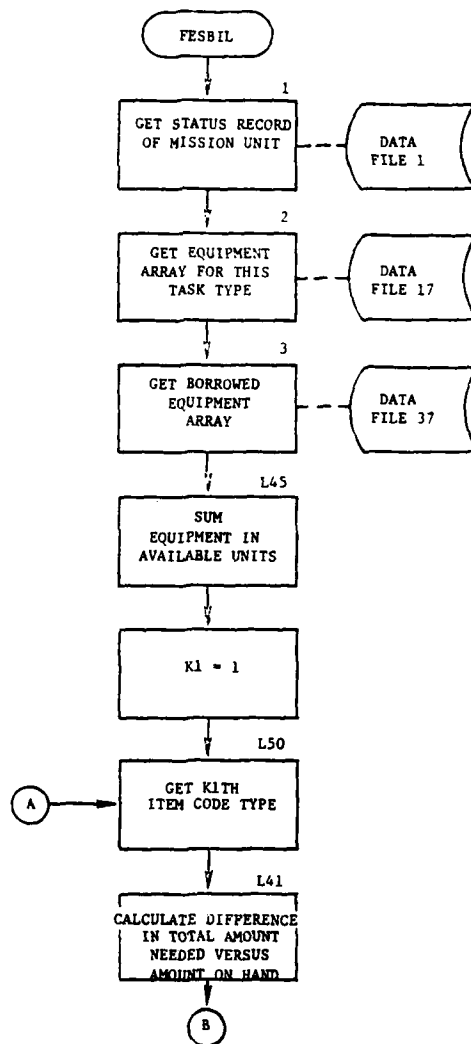


Figure IV-14-B-5. Routine FESBIL (Continued on Next Page)

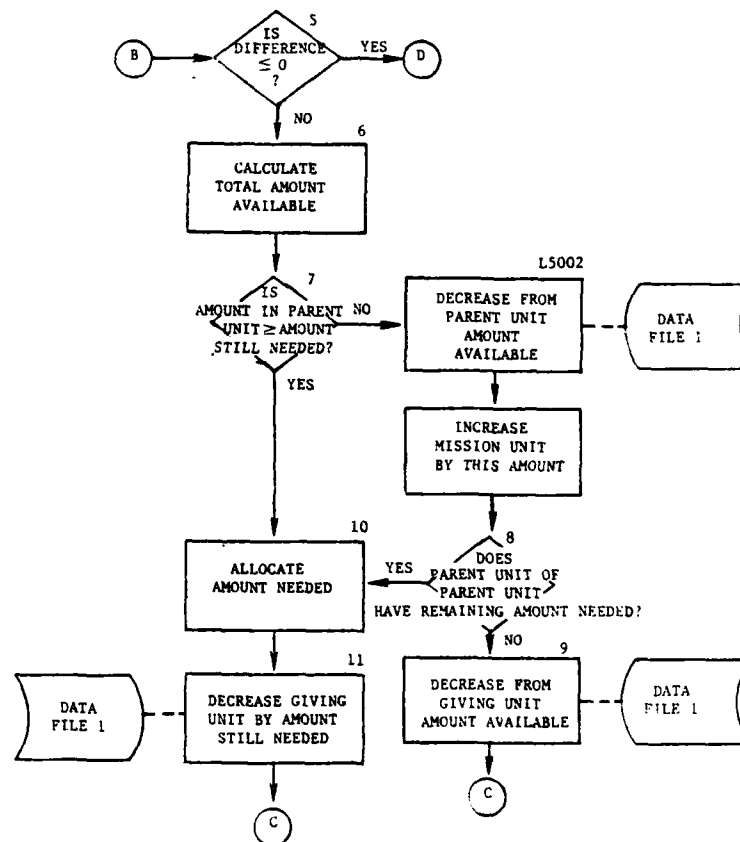


Figure IV-14-B-5. Routine FESBIL (Continued)



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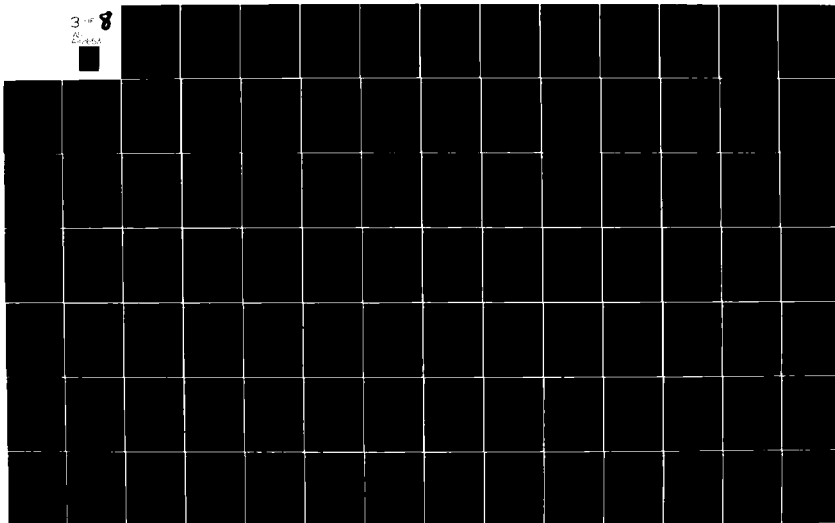
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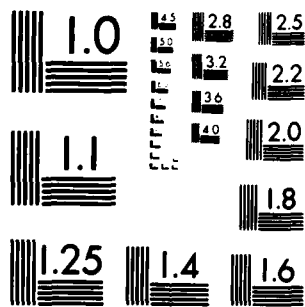
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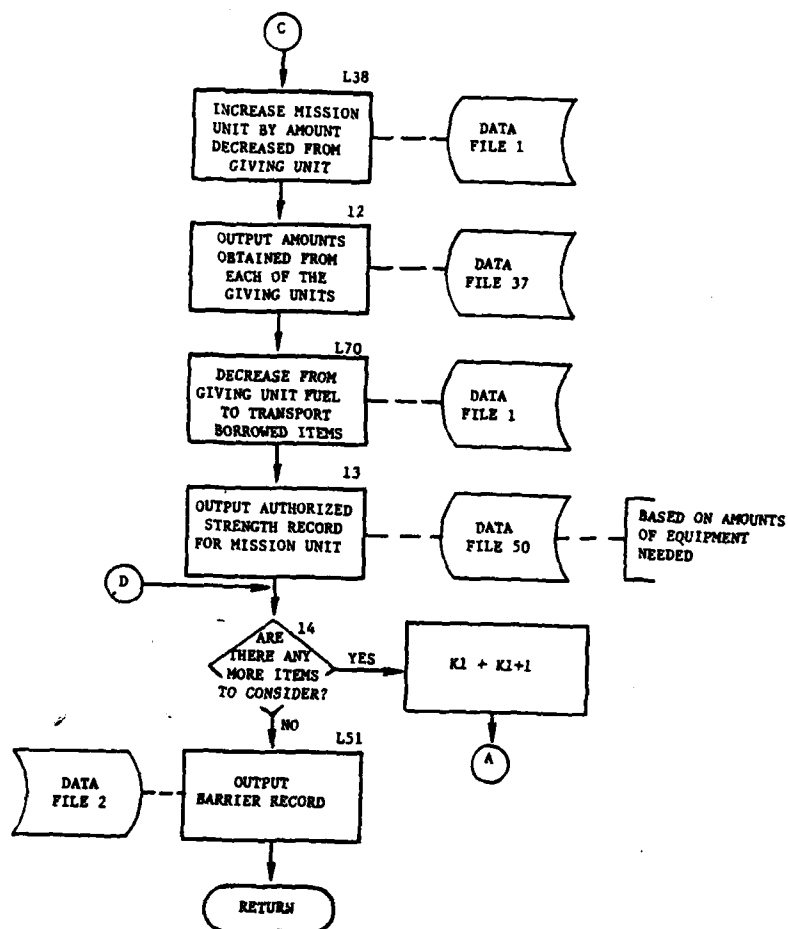


Figure IV-14-B-5. Routine FESBIL (Concluded)

(7) Blocks 10, 11, and L38. Allocate the equipment still needed and continue the loop.

(8) Blocks 12, L70, and 13. If there are no more item codes to consider, return the status record of the mission unit and status records of the company and battalion where supplies were obtained to data file 1, output the borrowed equipment array, and generate an authorized strength record for data file 50.

(9) Block L51. Return the barrier record for this task to data file 2. Return control to the calling routine.

7. ROUTINE ERELEA:

a. Purpose. ERELEA is called when termination of a task is required, due to completion, stop order through DSL, or proximity to the FEBA. This routine updates information concerning tasking and current existence and intelligence information on the barrier file, and generates movement orders to return task units to parent units.

b. Input Variables:

(1) Standard overlay data.

(2) Other variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IALFA	Call	Reason for task termination.
ITYPIC	DF17	Item codes used by this activity and this task type.
JARRAY	DF51	List of UTDs providing link to word locations on data files 8 and 9.
MOBCAT	DF9	
INDEXEX	DF9	Used by Movement Model as qualifier for
IREC8	DF8	type of movement desired.

c. Output Variables: UMAIN and IARRAY.

d. Logical Flow (Figure IV-14-B-6):

(1) Block 1. Update barrier record to indicate reason for termination of task.

(2) Block L23. Bring in unit status record of mission unit from data file 1.

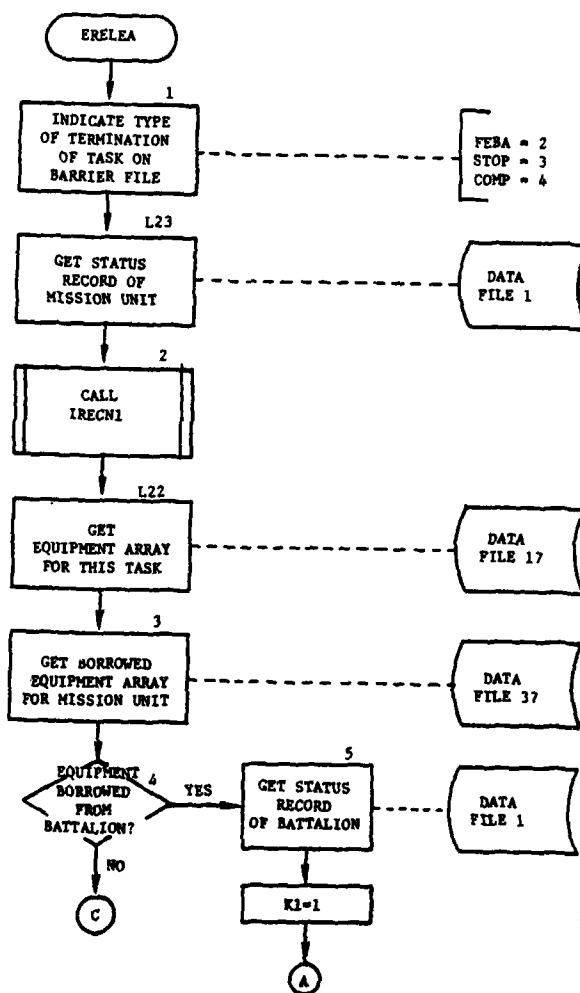


Figure IV-14-B-6. Routine ERELEA (Continued on Next Page)

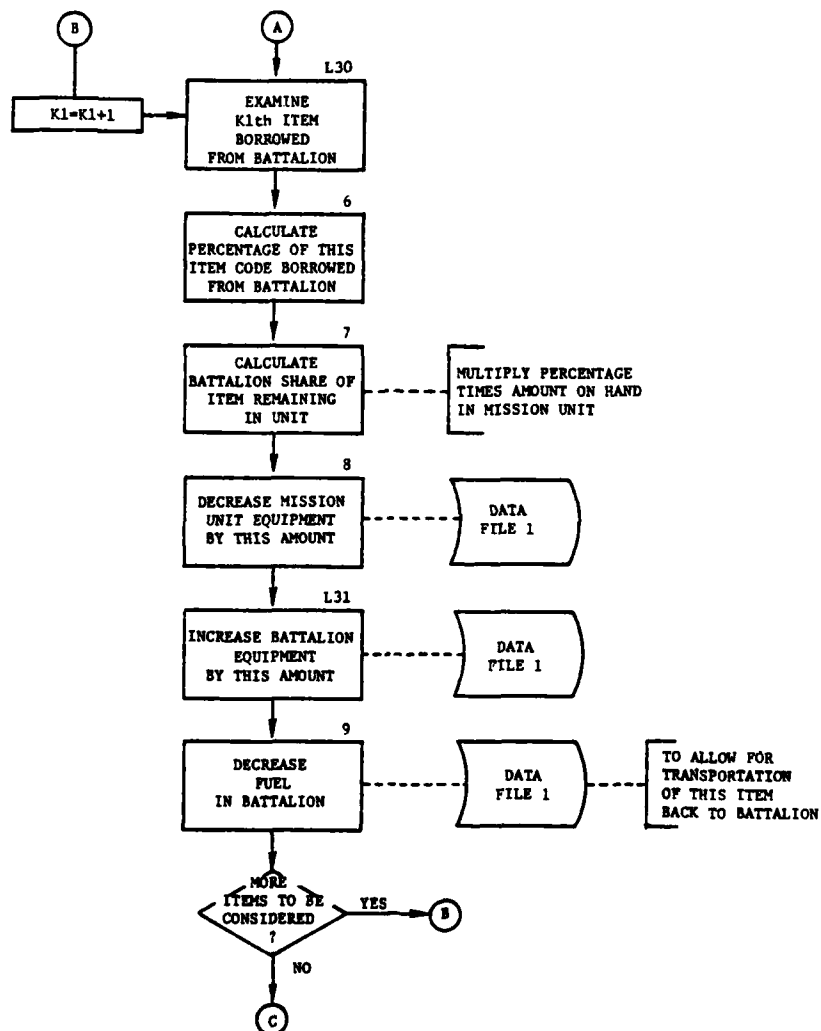


Figure IV-14-B-6. Routine ERELEA (Continued)

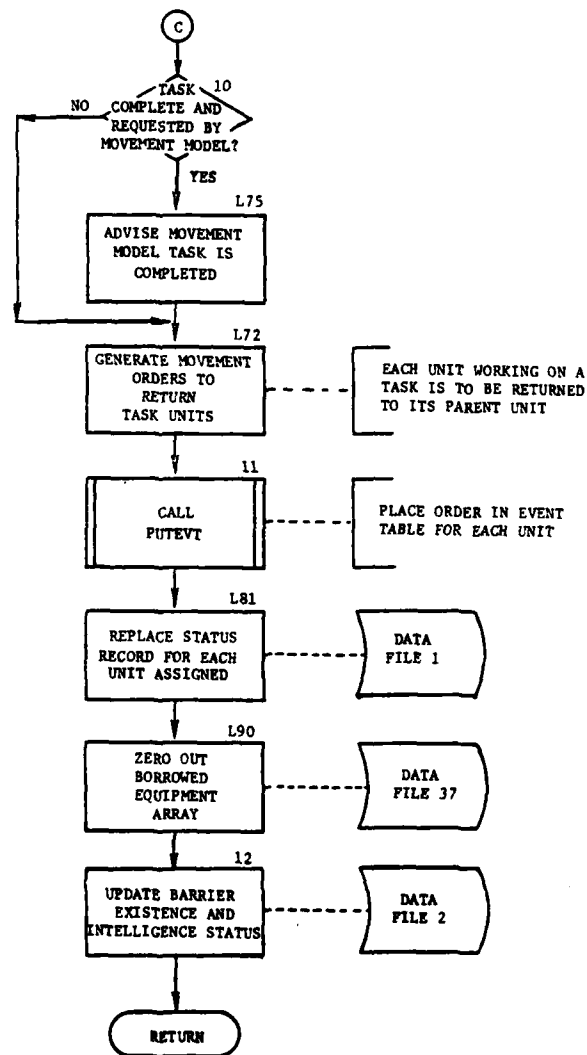


Figure IV-14-B-6. Routine ERELEA (Concluded)

(3) Blocks 2, L22, 3, and 4. After determining the proper record number on data file 17, bring in the task's equipment requirement from data file 17 and the borrowed equipment array from data file 37. If no equipment for this task was obtained from the battalion, transfer control to block 10; otherwise, processing continues to block 5.

(4) Block 5. Bring in unit status record for battalion.

(5) Blocks L30, 6, 7, 8, and L31. Based on the ratio between the amount of an equipment item borrowed from company level and the amount of the same equipment item borrowed from the battalion, return that proportion of equipment still on hand in keeping with this ratio to the battalion and remove this amount of equipment from the mission unit's supply.

(6) Block 9. Decrement appropriate amount of fuel to allow equipment to be returned to parent unit. If additional items are to be considered, transfer control to block L30.

(7) Blocks 10 and L75. If Movement Model has requested this task, advise the model so that movement may continue.

(8) Blocks L72 and 11. A simulated DSL movement order is generated for each task unit on site. If a parent unit cannot accept the task unit, each task unit is given a stay order and becomes available for additional engineer tasks.

(9) Blocks L81, L90, and 12. Return unit status record for each unit to data file 1, zero the appropriate data file 37 record, and update existence, intelligence, and troop status on the barrier record. Return control to the calling routine.

#### 8. ROUTINE EUPDAT:

##### a. Purpose:

(1) After general task initiation and allocation at the start of a period, routine EUPDAT becomes the overall controller of the Engineer Model. After EUPDAT is notified a tasked unit has reached its destination, it calculates the modified task rate due to terrain, night, and lack of equipment. From this modified rate, the routine calculates the total manhours expended since the last update and proportions loss of expendable equipment among all units on site. The routine prorates the amount of expendable equipment and determines the amount of nonexpendable equipment still required to complete the task. It resupplies the mission unit with supplies still needed by inquiring at the company level and the battalion level. If a task, after being updated, is completed, the manpower and supplies are released for other tasks. This task is removed from the priority table, and remaining priority tasks are reranked.

(2) For a task not underway, EUPDAT transfers control to the PRORTY routine to determine the priority for the considered task and rank the



priority table. Units still moving to task sites are given adjusted pointers to respective priority records. EUPDAT generates the next entry into routine PRORTY in 15 minutes.

b. Input Variables.

(1) Standard Engineer Model variables.

(2) Other variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
II	DF16	Number of priority tasks on data file 18.
JREC37	DF1	Pointer on status record of mission unit to its data file 37 record.
ITRRIG	DF17	Terrain rate modifier for this task type.
ISNRSE	DF4	Beginning morning nautical twilight (BMNT)
ISNSET	DF4	Ending evening nautical twilight (EENT)
IOYRTE	DF17	Night rate modifier for this task type.
ITYPIC	DF17	Data file 17 record for this task type.
IPOL	DF15	Fuel consumption rate for the particular item code.
LGTPER	ONE	Length of period.

c. Output Variables:

(1) Variables standard to the Engineer Model.

(2) Other variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IPTYLO	DF18	A zero-filled priority record to free and rank data file 18.

d. Logical Flow (Figure IV-14-B-7):

(1) Blocks 1 and L110. Obtain the number of valid priority tasks on data file 18. If this is an update interruption caused by a unit arriving first at the task site, only one task priority record on data file 18 must be examined; otherwise, begin looping on all records on data file 18.

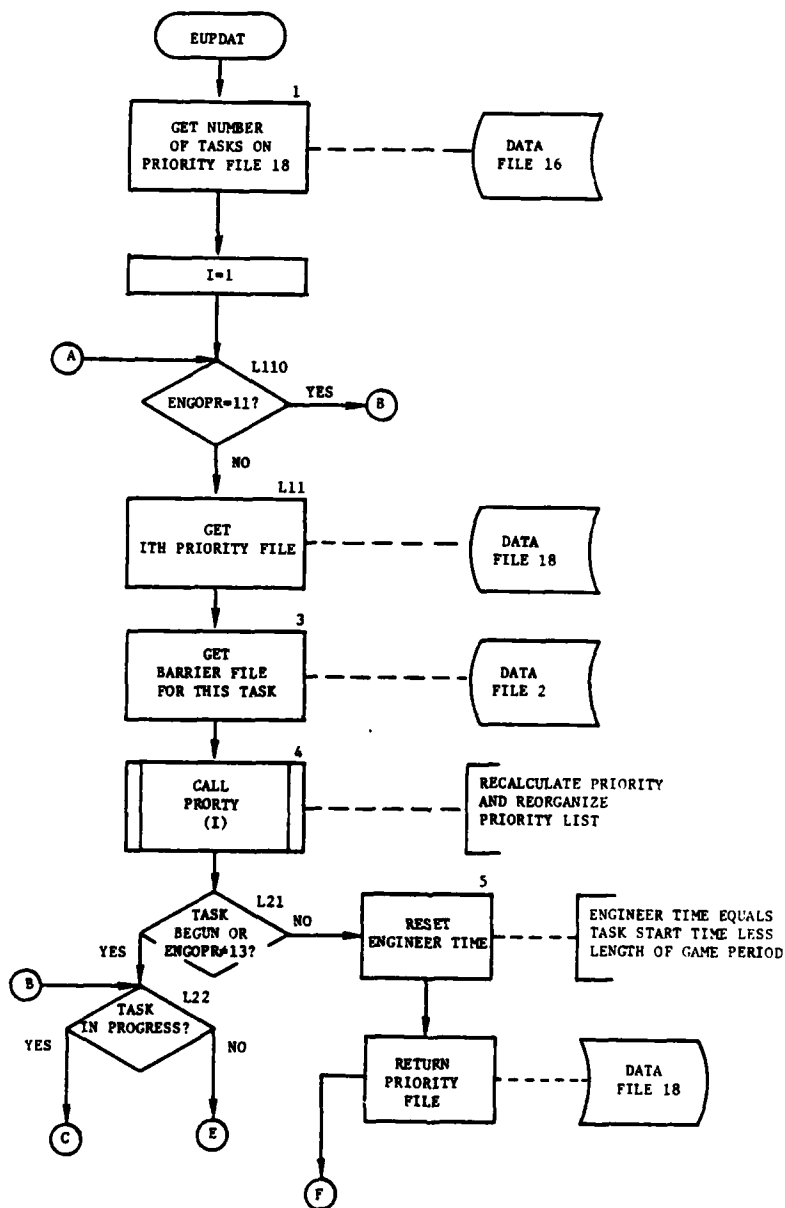


Figure IV-14-B-7. Routine EUPDAT (Continued on Next Page)

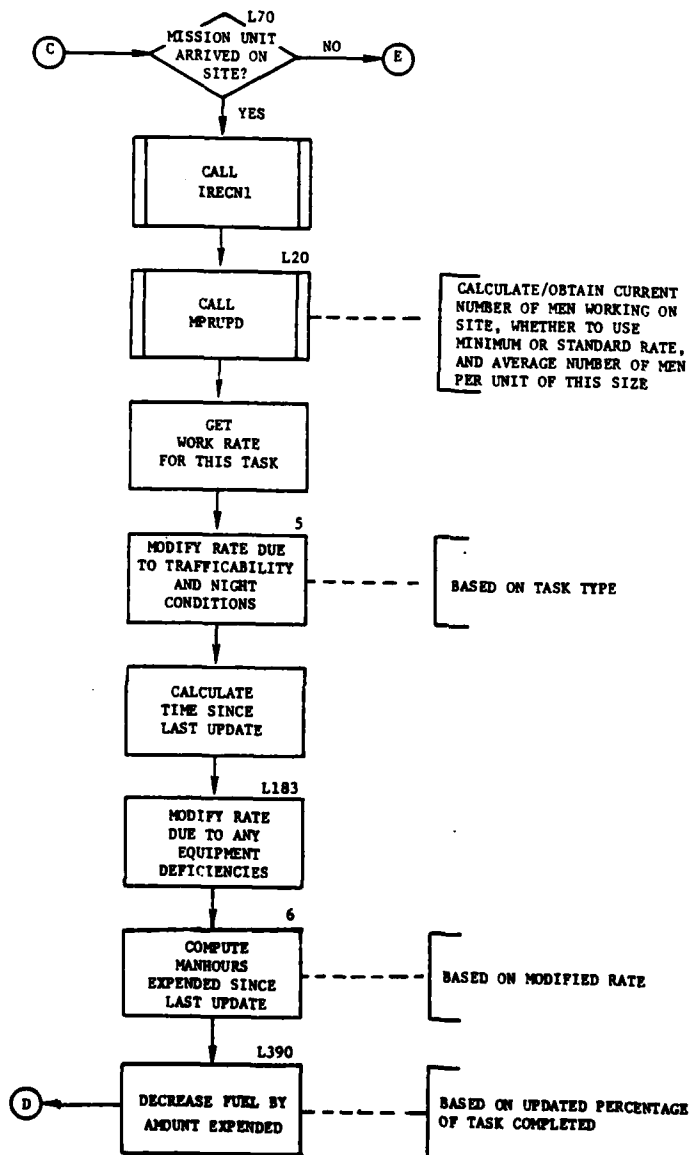


Figure IV-14-B-7. Routine EUPDAT (Continued)

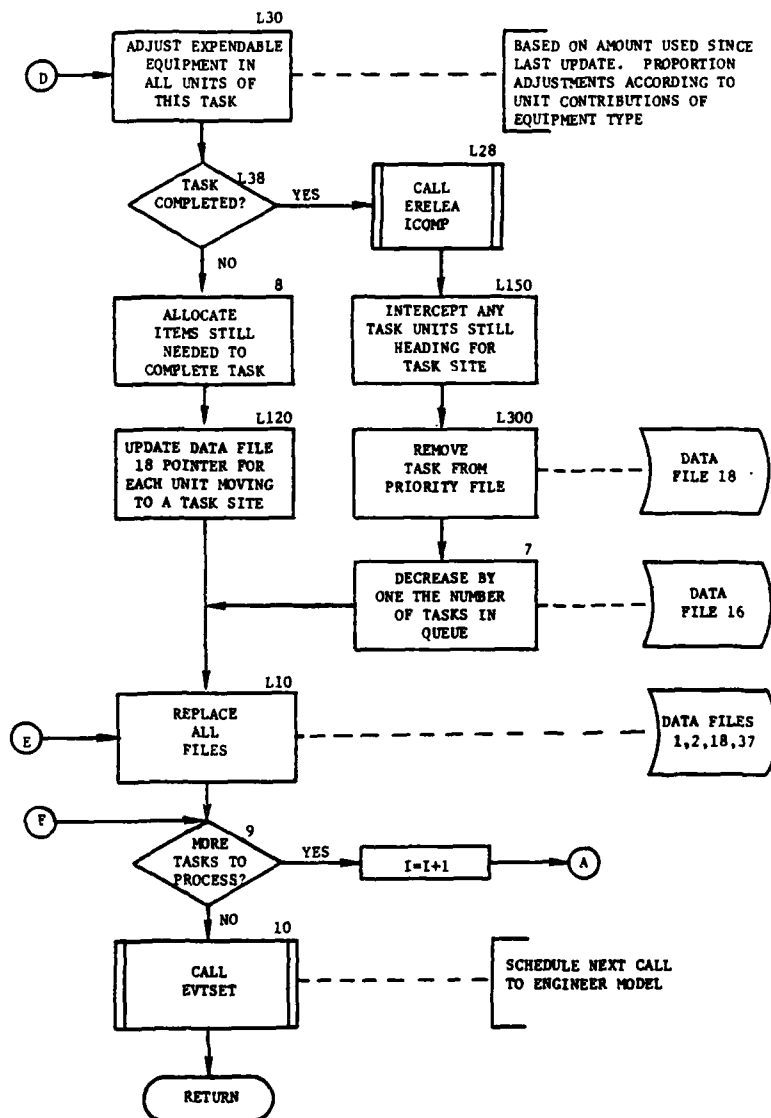


Figure IV-14-B-7. Routine EUPDAT (Concluded)

(2) Blocks L11, 3, and 4. After bringing in the priority record for the task to be analyzed and the barrier record for this task, routine PRORTY determines the priority of this task and reorganizes priorities on data file 18.

(3) Blocks L21 and 5. If entry has been made into EUPDAT for the end-of-period update, the starting times of engineer tasks not begun are reset to indicate tasks have been held over from the previous period; control is transferred to block 9 after the priority table has been returned to data file 18.

(4) Blocks L-2 and L70. Having recalculated this task's priority, control transfers to block L10 if the task is not yet in progress and continues to the next task. If the task is in progress, but the mission unit has not arrived at the task site, control again transfers to block L10; otherwise, control transfers to routine IRECNI where the proper record on data file 17 and task size are calculated.

(5) Block L20. Routine MPRUPD returns the number of personnel currently working at task site, the decision whether to use the minimum or standard troop rate, and the average number of personnel per unit of this size. Get the task rate from its proper location in array ITYPIC from data file 17.

(6) Blocks 5 and L183. Modify this rate by terrain or nighttime limitations to working conditions, and multiplicatively calculate the modifier due to smaller amounts of equipment available than needed. Calculate the time since last update.

(7) Block 6. Using the modified rate obtained above, calculate the manhours expended since the last time this task was updated.

(8) Blocks L390 and L30. Given the new modified task rate, decrease the fuel and expendable supplies to allow for consumption since the update, and proportion among units at the task site.

(9) Blocks L38, L28, L150, L300, and 7. If a task has not been completed, control transfers to block 8. If it is completed routine ERELEA releases manpower and supplies for other tasks and the barrier record for this task is updated. Units that may still be moving to this task site are intercepted and freed for other tasks. This record is removed from the priority file, the number of tasks on the file is reduced by one, and the new value is returned to data file 16. Control transfers to block L10.

(10) Block 8. Examine the amount of equipment on hand and the amount required to complete the task. If the amount on hand is insufficient, allocate what is still required first on the company level, then on the battalion level, by prorating the expendable equipment still needed versus the amount on hand and using the difference for nonexpendable equipment.

(11) Block L120. Reset all pointers for units moving to task sites to point to the proper data file 18 record for this unit.

(12) Blocks L10, 9, and 10. Replace data files 1, 2, 18 and 37 for this task and determine if there are more tasks to be analyzed. If there are, control goes to block L110. If not, the next entry into the Engineer Model is scheduled and control returns to the calling routine.

9. ROUTINE BUIDRC. Routine BUIDRC converts the mnemonic associated with any barrier into the record number on data file 2. This is an alphabetic scheme that assigns to each type of mnemonic a certain number of locations on data file 2, regardless of whether they are used. The logic in assigning the current number of records per mnemonic has been designed to best utilize the space available.

10. ROUTINE CREAL6:

a. Purpose. To establish areas of responsibility for front-line brigades assigned engineer tasks, it is necessary for the Engineer Model to follow the movement of these front-line brigades to constantly know the flanking boundaries of these units; therefore, routine CREAL6 periodically ranks the front-line brigades of both forces by their Y intercepts (intercept of a line denoting flanking boundaries with the Y axis) from smallest to largest and stores this information for reference by routine EFEASI in data file 16.

b. Input Variables:

(1) Standard variables to the Engineer Model.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IUDFNT	DF16	Blue front-line brigades or Red front-line brigades.
RPOINT	ONE	Identification of last Red unit.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IGEOMB	DF16	List of Blue front-line brigades and their Y intercepts (YCEPT).
IGEOMR	DF16	List of Red front-line brigades and their Y intercepts.

d. Logical Flow (Figure IV-14-B-8):

(1) Block 1. Bring in a maximum of eight front-line brigades from data file 16 for both Blue and Red forces. Total the number of actual front-line brigades of each force.

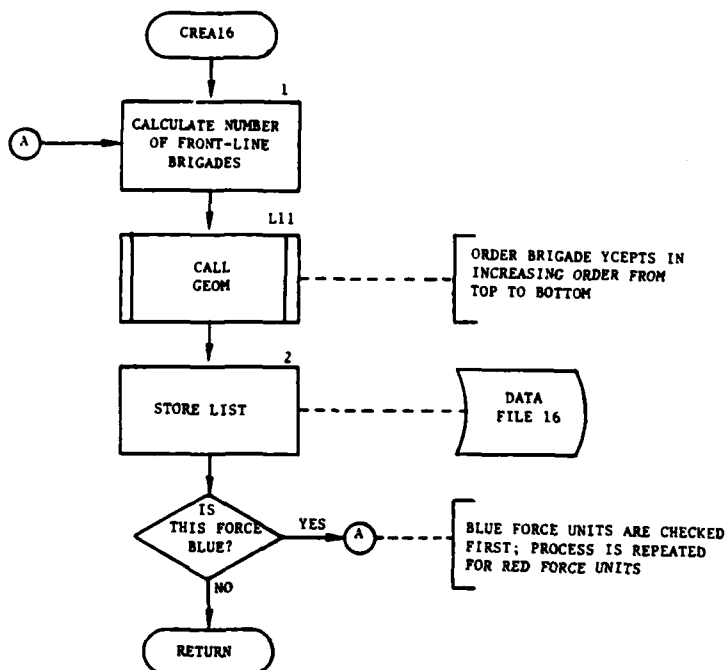


Figure IV-14-B-8. Routine CREA16

(2) Block L11. Routine GEOM examines each front-line brigade, gets its YCEPTs, and compares the YCEPTs with those on the list, ranking the brigade from lowest to highest YCEPT.

(3) Block 2. Store the brigades and their Y intercepts onto data file 16.

11. ROUTINES EQPT and EQPTUP. Routine EQPT allocates equipment that is still needed. It is called by EQPTUP which sets the level of resolution from where the equipment will be sought; i.e., the first call to EQPT is for company level, the second is for the battalion. EUPDAT passes EQPTUP the item code needed (IK), the amount needed (EOHDLT), which force is to execute the task (JI), the battalion level unit from which equipment can be obtained (IBOSS1), with the company level unit passed in UCOOP and the mission unit in UMAIN, and the transportation item code of this equipment type. EQPTUP calls EQPT, first with the company level unit in UCOOP, and second with the battalion level unit in UCOOP. EQPT goes to any applicable contingency for this item code and allocates to the mission unit any available equipment considering the contingency. EQPT allocates all that is available if the unit has insufficient supplies and returns the amount allocated in EOHOLT. It deducts fuel that will be expended in moving the equipment to the mission unit from the unit from which the equipment was obtained.

12. ROUTINE GEOM. Routine GEOM is passed the list of front-line brigades of each force. It brings the designated unit status record into UMAIN and compares its Y intercepts with those previously brought in. Based on this comparison, the brigades are ranked by YCEPTs, in ascending order, and the brigades and their YCEPT values are returned in IGEOM.

13. ROUTINE IRECN1. The force to execute a task and the task type are passed to IRECN1. It calculates the record number for this task on data file 17 and gets the basic size of this task. It returns the standard number of troop units required (ISTTRP), standard rate for this task, and the physical size of this task (SIZE1).

14. ROUTINE MPRALC:

a. Purpose. This routine allocates the units necessary for a task by checking the brigade area and the entire division. It ranks available units for the task on a nearest-to-task-site basis, and assigns units to the task until the required number is met.

b. Input Variables:

(1) Variables standard to the overall Engineer Model.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
JI	Call	Force to execute task.
ISTTRP	Call	Standard number of task units required.



<u>Name</u>	<u>Source</u>	<u>Contents</u>
IBRDE1	Call	Brigade unit in area of responsibility.
INORD	DF1	Order code of units subordinate to each subordinate unit of IBRDE1.
JUTD	TWO	Unit type designator of units subordinate to each subordinate unit of IBRDE1.
IIUID	DF37	Engineer unit assigned to atomic demolition munition (ADM) tasks.
RPOINT	ONE	Pointer to last Red unit on data file 1.

c. Output Variables:

(1) Standard Engineer Model variables.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IPNTR	Call	Flag for insufficient troop units found.
IIUID	DF37	Engineer unit assigned to ADM tasks.

d. Logical Flow (Figure IV-14-B-9):

(1) Blocks 1, 2, and 3. If this task was requested by the Movement Model, examine those units subordinate to the unit requesting the task for a suitable unit available for the task. If there are no units available, control goes to routine SET37 to create a data file 37 record for this task. If this satisfies the troop requirements, control goes to block L501.

(2) Blocks L1205, L1230, L1270, and 5. If this was not a Movement Model request, or the number of units required is not satisfied, examine the task for its location within a front-line brigade's area of responsibility. If it is not the responsibility of a brigade, control transfers to block L1300. If it is, check the units subordinate to the brigade for the proper type unit. If any are found, control goes to routine SET37 and block 3. If no suitable units subordinate to the brigade are found, check for complex units that are available for the task. If any are found, control transfers to routine UNTORG, that detaches the complex unit from its parent and creates a unit status record, data file 1, for this unit. If the required number of units are now allocated, control transfers to block L501.

(3) Block L1300. If the proper number of troop units are still not allocated, check the remainder of the division. From those units that are suitable and available for the task, rank them from closest to farthest from the task site.

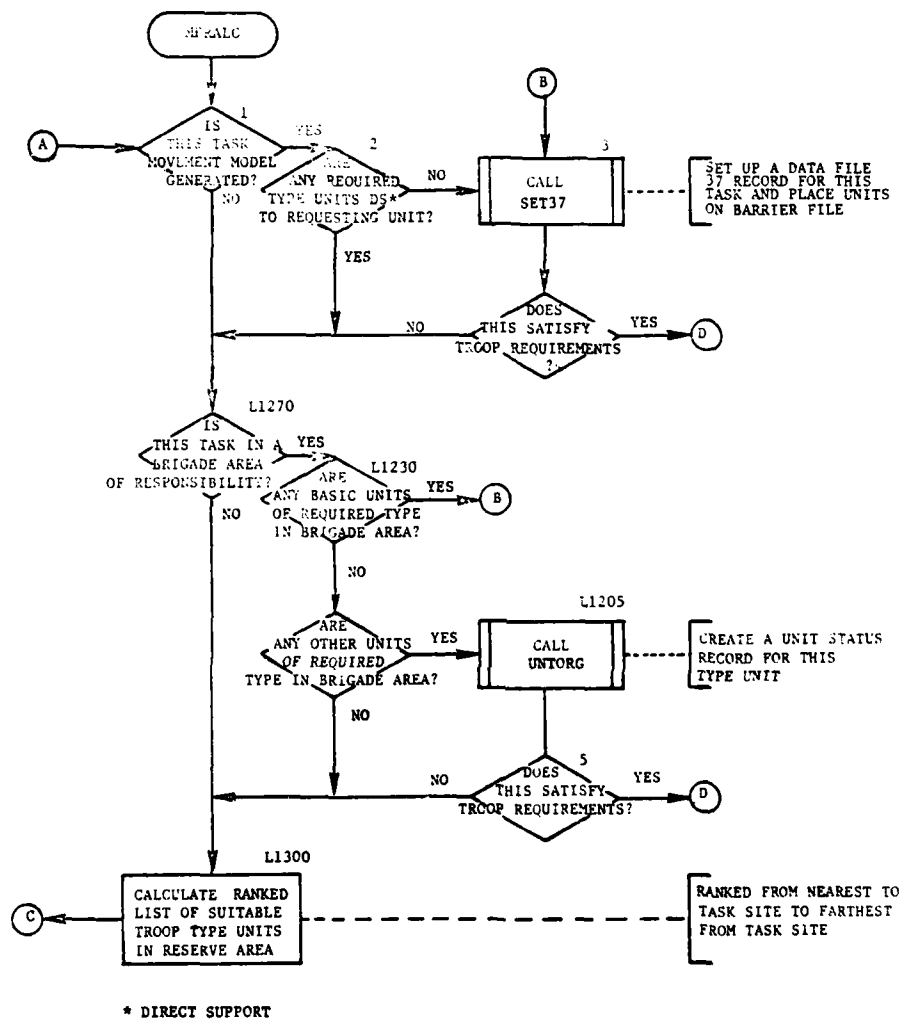


Figure IV-14-B-9. Routine MPRALC (Continued on Next Page)

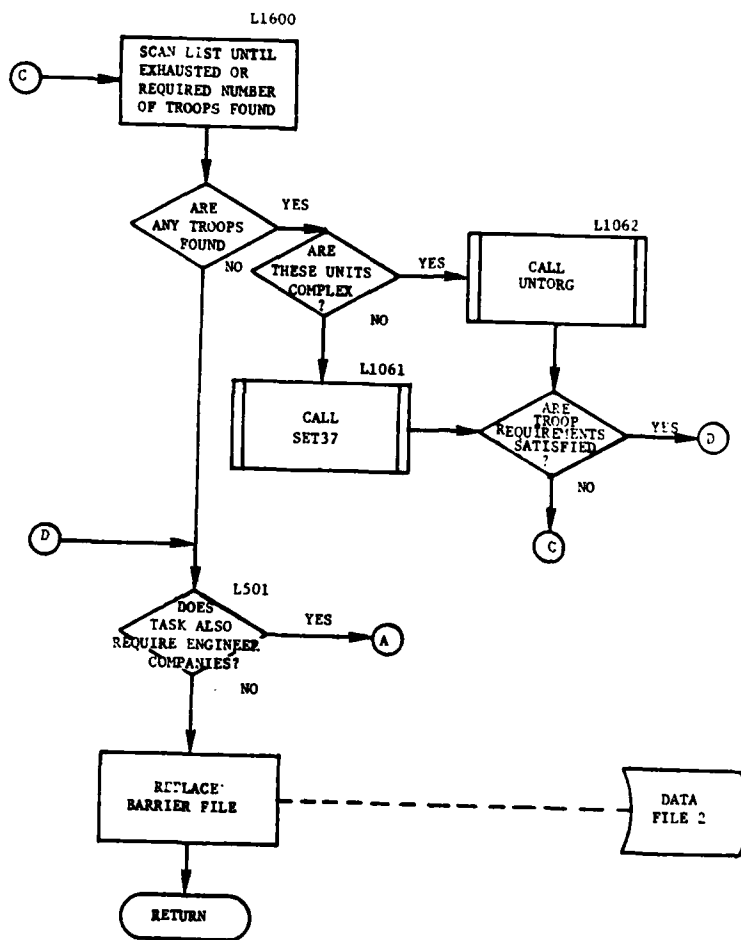


Figure IV-14-B-9. Routine MPRALC (Concluded)

(4) Block L1600. Examine and allocate units beginning at top of list until either the requirements are met or the list is exhausted.

(5) Blocks L1061 and L1062. If units are found to be available, and they are not complex, control transfers to routine SET37. If it is a complex unit, routine UNTORG is called. If troop requirements are still not met, continue looking and control goes back to block L1600.

(6) Block L501. Upon allocating the required number of troops, examine the troop type required to see if engineer companies are required with bridging platoons. If so, control returns to block 1 and the above process is repeated; if not, replace the barrier file and return control to the calling routine.

15. ROUTINE MPRUPD. MPRUPD is called from EUPDAT and sums the current number of personnel (NUMCUR) in all units assigned at the task site. It also sets ITRTYP, the troop type indicator, and NNUM, the average number of personnel per unit. If there are fewer units at the site than required, IRATE is set to indicate that the minimum task rate is to be used. These four variables are returned in the calling sequence.

16. ROUTINES STUNIT and SET37. Routine SET37 examines units that are ready for allocation to guarantee that no unit is selected for tasking unless it has at least 50 percent of its authorized strength. If the unit passes this test and is to be the mission unit allocated, control goes to routine STUNIT. If not, the pointer to data file 37 for this task is obtained from the status record of the mission unit and placed on this unit's status record and control returns to the calling routine. Routine STUNIT goes to the first word on the first record of data file 37 to find the next vacant record on data file 37 to affiliate with this task. It places this record number in word 421 of the mission unit's status record and increases by one the first word of the first record of data file 37 and returns control to the calling routine.

17. ROUTINE UNTORG. If a unit is suitable for the task, but is still inherent to its parent unit, the routine UNTORG detaches the unit from its parent, creates a new unit status record for it, places this record on data file 1, adjusts BPOINT or RPOINT, and places all related information, such as UID, UTD, and location, in common. If the parent unit is not a resolution unit, UNTORG also gives the parent unit coordinates and personnel and distributes its equipment. UNTORG then calls SET37 for this newly created unit's status record and puts the record on data file 1.

18. ROUTINE CRTQD. This routine creates an eight-digit code based on the location of either a line segment or a circle. If a circle is passed to the routine by giving the coordinates of the center of the circle and its radius, two perpendicular lines are created, each line the length of the diameter of the circle and intersecting at its center; if a line is passed by giving its two endpoints, that line is used. By continuing to divide a rectangle into four equal parts, once the center of action is determined, the location of each line in relation to these quadrants is obtained. The nine

possible areas where a barrier line or circle could lie in one quadrant are shown below. A barrier intersecting both quadrants 1 and 2 is said to lie in area 5. A line in area 5, 6, 7, 8, or 9 would allow no further refinement to be made on the eight-digit code; so, the quadrature code would be complete. If, however, the barrier was to lie in area 1, 2, 3, or 4, this value would be entered in the quadrature code, and this region would continue to be subdivided as in the illustration. When the eight-digit code has been completed or cannot continue, control returns to the calling routine.

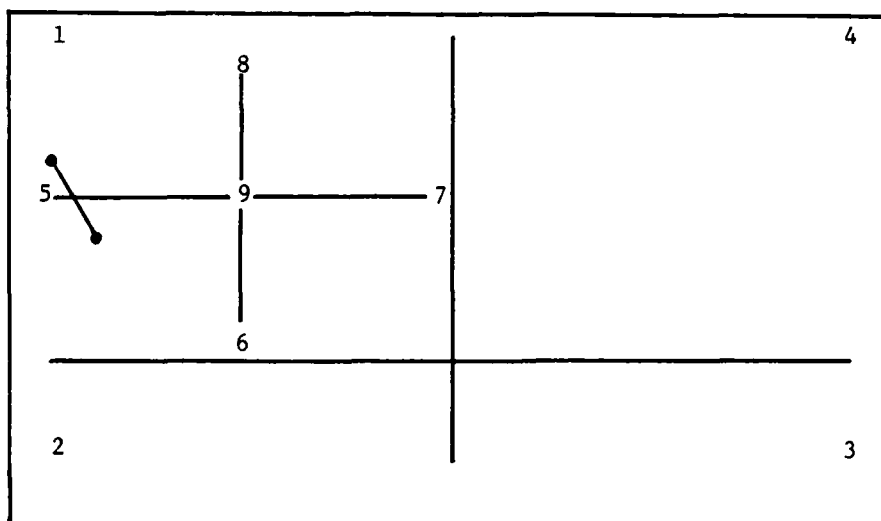


Figure IV-14-B-10. Barrier Quadrature Example

#### 19. ROUTINE NUCSCH:

a. Purpose. This routine determines if the radius of effects input from the Nuclear Assessment Model will intersect a barrier line. If an intersection is found and the effects of the Nuclear Assessment Model could alter the structure of the barrier the intersection is returned in common to the Nuclear Assessment Model.

#### b. Input Variables:

(1) Standard Common Block Variable. UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IBIG1	DF16	Geometry for quadrature initiation.
RAD	TWO	Radius of effects to be searched.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
XCNT	TWO	X coordinate of ground zero.
YCNT	TWO	Y coordinate of ground zero.
IBIG	DF22	List of barrier code numbers and their locations.
IOF(35)	DF2	Data describing the barrier.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
OBFLST	DF16	List of barriers intersecting radius of effects.
INTNUM	DF16	Number of barriers intersected.

d. Logical Flow (Figure IV-14-B-11):

(1) Block 1. The routine CRTQD is called to generate the eight-digit quadrature code associated with this radius of effects. The quadrature code describes the location of the circle of the radiological detonation.

(2) Block L65. The quadratures are screened to determine which contain barrier segments intersecting this search area. Of the 17 possible quadratures, 6 to 13 are eliminated by this method.

(3) Block L60. The 17 records of data file 22 correspond to the 17 quadratures. Each record contains the barrier records and quadrature codes of barriers located within the corresponding quadrature. The appropriate record is retrieved from data file 22.

(4) Block L61. If this quadrature does contain barriers to be further examined, control transfers to block L500.

(5) Block L70. If other quadratures are to be searched, parameters aiding in the barrier-line/blast-area intersection check are reinitialized and control returns to block L60; otherwise, control goes to block 3.

(6) Block L500. If the quadrature code of the blast area does not correspond to the quadrature code of this barrier, control transfers to block L300.

(7) Block L123. Natural barriers that will not be affected by the blast will be ignored.

(8) Blocks L120 and 2. The utility routine INCRCL is used to determine if the barrier line and blast area intersect. If they do, the barrier record number is stored.



(9) Block L300. If other barriers are to be examined in this quadrature, control transfers to block L500.

(10) Blocks 3 and 4. If any barriers are intersected, place them in common. Control is returned to the calling routine.

20. ROUTINE ENUCLE:

a. Purpose. Routine ENUCLE generates the physical structure to be associated with a radiological barrier.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
SRCHRD	TWO	Radius of effects of blast.
MEDSR1	TWO	Middle radius of effects.
SMLSR1	TWO	Small radius of effects.
XCNT	TWO	X coordinate of ground zero.
YCNT	TWO	Y coordinate of ground zero.
RECNUM	TWO	Record number of barrier to be updated.
IHOB	TWO	Height of burst.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IOF	DF2	Radiological barriers description.

d. Processing Description. Passed the radius of effects and ground zero of the blast, routine NUCSCH determines all barriers intersected by the blast area. A four-sided barrier is constructed and placed on the barrier file. Another entry to this routine decreases the size of radiological barriers due to time decay. The current four-sided barrier is removed and replaced by a new one of smaller diameter.



## APPENDIX C

### ENGINEER MODEL OUTPUT DESCRIPTIONS

1. INTRODUCTION. This appendix contains detailed descriptions of the printed output within the Engineer Model of the Period Processor. Figure IV-14-C-1 depicts the format of the printout. In the figure an alphabetical character (descriptor) designates an appropriate line, group of lines, or column that is explained as follows.

<u>Output Descriptor</u>	<u>Explanation</u>
A	If the DSL for any period contains orders for engineer tasks, entry is made to the Engineer Model at TCLOCK = 0 designated by the second number in the first line. During the first pass through--for the first task--the brigade/regiment boundaries are calculated. The 3001 print gives the number of Blue brigades first and then the number of Red regiments on the first line as determined by ZONES. The 3040 print shows the lower Y-intercept boundary on the left and the brigade unit identification record number on the right for Blue first and then the regiment unit identification record number for Red on the right. The last brigade/regiment lists its upper boundary beneath its lower boundary. These prints occur in routines CREAL6 and GEOM.
B	Also at TCLOCK = 0, all DSL tasks get a BUID print giving the mnemonic of the barrier and record number on data file 2 containing this task. The 8000 print gives the engineer operation code, the begin/complete code, the eight-character code identifying the status of the barrier, the record number, the DSL given priority, the time to either begin or complete the task based on the begin/complete code, and whether the task is mandatory or desired.
C	After all tasks have been initially examined with each given a data file 18 record, entry is made at TCLOCK = 1 to begin ranking priority tasks and allocating troops and equipment based on the assigned priority. When control transfers to routine EPRIOR, two lines of output occur for each DSL task. The first print gives the record on data file 18 initially associated with this task following J =, then gives the six words contained on this record for the task: word one contains the task priority soon to be assigned; word two is the record number of this task on data file 2; word three is the force to execute the task; word four is the immediacy of the task, also to be assigned; word five is the DSL provided time for the task; and word six is the mandatory or desired status of the task. The 2005 print identifies the barrier mnemonic,







IV-14-C-5

**Figure IV-14-C-1. Engineer Model Sample Output (Concluded)**

Output  
Descriptor

Explanation

the task and troop type packed into one word following IDNT and the pass through the loop. After entering routine IRECN1 (prints are defined in the following paragraph), routine PRORTY generates the RTY print giving the trafficability index, the task type, the data file 17 record associated with this task, and the standard number of personnel associated with a unit of this troop type.

- D Routine IRECN1 returns the data from data file 17 for this task. The 7001 print gives the data file 17 record number, the word on the record containing the standard number of troops, the number of times larger this task is than the basic size, the task type, the number of minefield densities played, and the basic task size. The 7012 print gives the standard rate and the number of troops required for the task.
- E After priorities have been assigned, routine EFEAS1 prints the brigade/regiment responsible for tasking with the BDGE print, and calls routine MPRALC which prints the BRDE print which gives the brigade examined for tasking. The 8302 print gives the distance any unit qualified for tasking is from the task site and gives its data file 1 record number (IUID). Following that array of prints, the units are ordered by nearness to task site and are then printed with the unit identification record number and its ranking based on nearness to the site. The next line gives this unit's unit type designator. Keyed to print switch 4 is the ordered array should its contents be desired. Should this unit pass final qualification checks, an ST37 print occurs indicating that either this unit or its subordinate has been tasked. Should two or more ST37 prints occur under one UTD, a tally of the number of such prints will indicate the number of subordinates tasked from this unit. When all available units have been examined or the required number of units are assigned, the IUIDMU print lists the mission unit unit identification record number, and any other unit identification record numbers of units selected for the task.
- F After returning from MPRALC for this task, routine FESBIL is called which allocates the necessary equipment for the task. The MH print gives the item code being considered the minimum and standard amounts of this equipment specified by constant data, the proportionality factor, this item's transportation item code, the task size, the equipment multiplier, and the percent of the task to be accomplished. The RATIO print gives the amount of unfinished work on the task, the amount of equipment needed plus a five percent surplus, and the amount of equipment on hand in the unit. For minefields to be built, the amount needed is one-third the actual amount required. If the mission unit does not have enough equipment

Output  
Descriptor

Explanation

- on hand to accomplish the task, the HQEOH print appears. This line gives the amount available in the parent of each unit, for first the mission unit and then all other units tasked. On the same line is the total amount of equipment on hand in the two superior units, the amount on hand in the parent's superior unit, the amount of equipment still needed (if negative) or unused (if positive), the total equipment available, and any contingency provided by constant data. The 8111 print specifies the amount of equipment obtained and the unit providing it.
- G After available equipment is allocated, the EOH2 = print gives the amount of fuel allocated to the unit, the added fuel required to carry a full load, the distance to be travelled by the unit, the fuel required to get all vehicles to the task site, the unit being examined, the mission unit, and the pass through the loop currently being processed. This print occurs between calls to the routine UPMASK and is keyed to print switch 4.
- H When an engineer unit arrives at a task site, the ENGR print gives the time, unit, and task mnemonic arrived at.
- I Should a second or successive unit arrive at a task site, routine EUPDAT is called to process the amount of activity completed before each successive unit arrived. The information in the 7002 print is obtained from routine MPRUPD and lists the troop type, whether the minimum or standard troop rate is used, the current number of personnel working on the task (excluding those that just arrived), and the standard number of personnel associated with this troop type. The 7003 print gives the word on data file 17 corresponding to the terrain modifier, the percent effectiveness if hampered by this terrain, and the optional task rate. The 7004 print gives the new rate as modified by terrain and weather modifiers, the weather (day/night) modifier, and the terrain modifier.
- J After giving the time this task was last updated, (TMLSUP) the IK print lists the equipment item code and then the minimum and standard amounts of equipment, the proportionality factor, and the transportation item code. If a RATE print occurs, the total amount of equipment on hand to do the task is less than the second number printed and listed in constant data as a rate modifier for this item code of equipment. The first value printed on this line lists the adjusted rate and the last value is the multiplication factor for equipment of this size task. The 7005 print provides the manhours expended. The first three values are the manhours completed

Output  
Descriptor

Explanation

- to date, the manhours completed since the last update, and the total manhours completed as a sum of the first two values. The fourth value is the total manhours required; the next value is an approximate number of fifteen minute cycles required to complete the task using the standard task rate; then, the number of manhours remaining to be completed; and the last value is the amount of time from this update to the next that the task will be worked on.
- K      The 3131 print gives the amount of fuel on hand in all units. The XTEMP print gives the amount of the equipment the item code listed in the 7006 print when first listed less the amount used on the task. Subsequent XTEMP prints give the amount of equipment on hand after any resupply. The 8030 print gives the total amount of this equipment item in all of the tasked units on site. The 7006 print gives the equipment item code, the multiplication factor, and the amount of the equipment item still needed, (if positive) to be at standard strength for the next fifteen minute period or (if negative), the amount still available on site after next standard update. The fourth value is the amount of equipment still needed to reach a proportioned standard strength based on the amount of the task to be completed. Then listed is the standard amount of equipment required to complete the task as given in constant data. The last value on this line is the standard task rate before modification. The TEMP print lists the accumulative amount of the equipment item code obtained in each of the four possible passes through the equipment resupply routines EQPT and EQPTUP in the first field and the amount obtained from each pass in the last field.
- L      Regular engineer updates occur every 15 minutes after one centiminute into the period. For regular updates the model returns to routine EFEASI in an attempt to allocate any additional troop units that have become available since the previous update. All print statements in the group have been described previously.
- M      Should a maneuver unit encounter a barrier while moving, and be unable to bypass that barrier within the limits implied by its dimensions, the Movement Model generates an engineer request as indicated by the ENGR MOB REQUEST statement. Should this occur, or a conditioned DSL order become true, print blocks B and C occur sequentially without any game time delay as observed for DSL tasks.
- N      When a task is completed, as noticed by equal values three and four of the 7005 print, a 4996 print occurs in the middle of the page from routine ERELEA. This print occurs for each



Output  
Descriptor

Explanation

unit released from activity on this task and given a movement order to return it to its parent unit. Upon return from ERELEA, the 5001 print is made in EUPDAT, listing the data file 18 record removed, the record above it which is shifted downward one record, and the last record on data file 18 which becomes vacant.

- 0 When the unit arrives back at the location of its parent, an ENGR print specifies that this is a return leg and the location of the unit at that time. The ENGMDV print gives the data file 2 record containing the information used by this unit.

2. ADDITIONAL PRINT STATEMENTS. Additional print statements are obtainable from the Engineer Model. The routine, print statement, and reason for its appearance are as follows.

- a. Routine PRORTY Print Statement:

PRTY TKPY REC, BARR

All tasks that have been rejected due to any error condition are printed during the prioritization loop.

- b. Routine MPRALC Print Statement:

8202

If a brigade has any units of platoon size subordinate that are capable of handling a particular task, this print gives the troop type and IUIDs of units selected this far for tasking.

- c. Routine ENUCLE Print Statement:

LTOTAL \_\_\_\_\_

If a nuclear detonation occurs, LTOTAL gives the beginning record number of nuclear mnemonics on data file 2.

8059

Each new barrier created to simulate an area of contamination is denoted by the 8059 print.

- d. Routine NUCSCH Print Statement:

5001 ALOC= XCNT= YCNT= RAD=

IV-14-C-9

This statement lists the "quadrature" code, X and Y coordinates of ground zero of the nuclear detonation, and the radius of effects to examine for barriers.

BLOC \_\_\_\_\_ IRECNM \_\_\_\_\_

This statement will list the corresponding "quadrature" code and data file 2 record number for all barriers with similar codes to that listed in the 5001 print. This information is obtained directly from data file 22.

BUID \_\_\_\_\_

Should a barrier have a near identical code in the above two prints, its mnemonic is printed from data file 2.

BUID \_\_\_\_\_ IRECNM \_\_\_\_\_

Should a barrier actually lie within the circle depicting the radius of effects, this print occurs and signals its placement in Common Two for passage back to the nuclear assessment model.

APPENDIX D

SOURCE LISTINGS FOR PERIOD PROCESSOR ENGINEER MODEL

(AVAILABLE UNDER SEPARATE COVER)

## CHAPTER 15

### AIRMOBILE MODEL

#### 1. MILITARY ACTIVITIES REPRESENTED:

##### a. General:

(1) The Airmobile Model permits the simulation of a variety of airmobile operations; however, the model is considered to be primarily an execution model as distinguished from a planning model. The model relies upon the gaming staff for most of the general planning and decision-making prior to the simulation of an airmobile operation, and these plans are implemented through a set of gamer orders. The model may, however, be used for limited planning purposes.

(2) The principal military activities represented by the Airmobile Model include limited planning based on gamer input, staging and loading of the airmobile task force, air movement to and from the objective area, attrition of the airmobile column in flight, suppression of enemy air defenses by escort helicopters, refueling and rearming of aircraft, release of aircraft upon completion of mission, and the return of the aircraft to the bases for reassignment. These activities are discussed in detail in this chapter. Other activities inherent to airmobile operations which are not discussed herein are simulated by other models. Examples of such related activities are flight reconnaissance (simulated by the Intelligence and Control Model), delivery of preparatory fires (simulated by the Area Fire and Air Ground Engagement Models), employment of the airmobile task force at the objective (simulated by the Ground Combat Model), and resupply of the task force (simulated by the Combat Service Support Model). The model will simulate execution of the gamer's plan as ordered by DSL but will not make decisions changing that plan to reflect new information or enemy responses. Conditionals keyed to other activities may be specified. If resources to execute the airmobile operation become inadequate through either attrition or consumption during the operation, the model will halt the simulation.

b. Planning. Most of the planning, coordination, and preliminary activities for an airmobile operation are performed by the gamers. Information upon which to base this planning is available at the start of the game from the Game Directive and the Game Plan. Additionally, the information upon which to base this planning may be obtained prior to the start of a period from the Force Status and the Intelligence Reports from the preceding game period. With information available, the gamers execute the following activities prior to simulation of the airmobile operation.

(1) Designate the Airmobile Task Force. The required composition of the task force to be lifted is determined by the gamers. The task force is composed of basic units defined in the TOE data load which do not contain

equipment items incapable of being airlifted. The task force for a given airmobile operation may be separated into smaller resolution forces to permit the use of multiple landing zones, staging areas, pickup zones, flight corridors, lift forces, or sequential arrival times. Each resolution force will be treated individually within the model.

(2) Select the Objectives and Designate the Landing Zone. The objective (or objectives) of the airmobile operation is determined by the gamers. Landing zones are designated by coordinates for each resolution force. Intermediate landing zones may be designated in addition to the final landing zone if a series of lift operations is desired.

(3) Establish Airmobile Lift Timing. The time for each lift operation is to be designated. Either the time to arrive at the landing zone or the time to begin the move may be specified by the gamers. The other times are calculated within the model.

(4) Select Staging Areas and Pickup Points. Staging areas or pickup points are determined for each resolution force. These locations are described by coordinates.

(5) Select Flight Corridor. The flight path for each lift operation is to be described by the coordinates of the starting and ending points (pickup and landing zones) and up to three intermediate coordinate locations. The model will route the resolution airmobile force from the starting coordinates over each intermediate point to the ending coordinates.

(6) Designate Forward Refueling and Rearming Areas. Adequate facilities must be provided to refuel transport and escort aircraft and to rearm escort aircraft within the forward area. This is accomplished automatically within the model if forward refueling and rearming units are defined by the pregame data load and are positioned in the proper areas during the game by gamer orders.

(7) Specify Transport and Escort Aircraft Mix. Up to 10 unique mixes of transport and/or escort aircraft types, escort aircraft munition loads, aircraft fuel loads, and aircraft crew can be defined for each force (Red, Blue) in the pregame data load. The optimal mix for transporting each resolution force within the airmobile task force is determined by the gamers.

(8) Develop the Fire Support Plan. Preparatory fire support is planned prior to the airmobile operation. Artillery, missiles, attack helicopter, and close air support may be utilized. The fire missions will be ordered by the gamers and simulated by the Area Fire and Air Ground Engagement Models.

(9) Designate Lift Force. The preferred aviation units to provide the airlift and escort resources are designated. Those units are directed by DSL orders to provide direct support to the airmobile task force. The

model will attempt first to allocate required resources from units in direct support of the airmobile task force before selecting other units. The gamers should ensure that adequate resources (aircraft, crews, munitions, and fuel) are available within the force and, preferably, at the unit designated to support the operation.

(10) Determine the Number of Aircraft or Trips. The number of transport aircraft of the type specified by the selected mix is determined. The number may be specified explicitly by gamer orders or implicitly from the desired number of trips which may alternatively be stated in the gamer orders. If the number of trips is specified, the model will calculate the number of aircraft which would be required to transport the resolution force utilizing the weight, volume, and capacity data contained on the CSS data file. The number of escort aircraft of the type specified by the selected mix is determined by the gamers if escorts are required.

(11) Prepare Gamer Orders. The set of gamer (DSL) orders required to implement the plan is then prepared. The orders are described in subsequent sections of this chapter.

c. Staging. The three steps of the staging phase are described below.

(1) Assembling the Task Force. The assembling and organizing of the airmobile task force is under gamer control, through the use of conventional DSL orders. All elements of the force are ordered to one or more staging areas or pickup points by means of MOVE orders. Elements of the force may be combined or separated as desired by use of the JOIN and DETACH orders. The elements must be composed of basic units defined in the task organization and with a unit type designator (UTD) in the TOE load. Elements are combined into a single task force unit or into individual resolution airmobile task force units as desired. The task force should contain only equipment which can be airlifted. The task force may not contain organic aircraft. The execution of the JOIN and DETACH orders is performed external to the Airmobile Model in the same manner as any other order of that type.

(2) Allocating Lift Resources:

(a) ACCEPT TRANSPORT Order. To accomplish airlift of a ground combat element one of two alternative forms of a DSL ACCEPT TRANSPORT order is employed. The first alternative form is:

ACCEPT TRANSPORT MIX \_\_\_\_\_, NUMBER OF AIRCRAFT \_\_\_\_\_,  
NUMBER OF ESCORTS \_\_\_\_\_, AT TIME \_\_\_\_\_.

The second alternative form is:

ACCEPT TRANSPORT MIX \_\_\_\_\_, NUMBER OF TRIPS \_\_\_\_\_,  
NUMBER OF ESCORTS \_\_\_\_\_, AT TIME \_\_\_\_\_.

1. The number of aircraft in the first alternative refers to transport aircraft. The transport mix refers to the index number in the table of up to 10 mixes per force provided in the constant data load. Each mix is defined in terms of:

- . Transport aircraft type
- . Fuel load per transport aircraft
- . Crew per transport aircraft
- . Escort aircraft type
- . Fuel load per escort aircraft
- . Crew per escort aircraft
- . Up to three escort munition types,  
with quantities per escort aircraft.

2. The AT TIME \_\_\_\_ and NUMBER OF ESCORTS \_\_\_\_ modifiers are optional. If no escorts are required, that modifier clause is omitted. If the indicated mix includes escort aircraft descriptions, but escorts are not requested in the ACCEPT TRANSPORT order, the escort aircraft portion of the mix description is disregarded. The AT TIME modifier causes the aircraft to arrive and land at the pickup zone at the time specified if the aircraft are capable of flying from their bases to that point in the allocated time. If no time is specified or the specified time cannot be met, the aircraft will arrive at the pickup zone as soon as they are capable of flying that distance.

3. If the second alternative is used, specifying the number of trips instead of the number of aircraft, the model calculates the required number of aircraft, based on the lift capacity of the transport aircraft and the weight and volume of the personnel and all equipment in the unit to be lifted, at the time the ACCEPT TRANSPORT order is initiated, using Combat Service Support Model constant data input. The model does not attempt to allow for attrition when calculating the required number of aircraft.

(b) Order Execution:

1. The model executes the order by first selecting the optimal source of both transport and escort aircraft. It initially attempts to locate an airbase which can satisfy the requirements for both transport and escort aircraft with their associated resources. Aircraft are obtained from the nearest friendly airbase containing needed resources, according to the designated support relationship of the airbase to the unit to be lifted. Support categories are chosen in the following order of preference:

- . Direct support to the airmobile task force  
or any superior unit
- . General support
- . Direct support to other units.

2. If a single base cannot supply all resources, then the model searches for an optimal source of each type separately (i.e., transport separate from escort). An airbase will not be selected as a source of escorts, transports, or both unless it can provide the full quantity of aircraft, fuel, crew, and munitions. If the model is unable to allocate the required resources, the period is terminated. If the escort aircraft are from a different base than the transports, the model simulates the flight of the escort aircraft directly to the selected transport base where the two aircraft units are consolidated. The aircraft unit flies from the transport airbase directly to the location of the unit receiving the ACCEPT TRANSPORT order. Fuel is consumed by the aircraft while flying from the bases to the pickup zone.

(c) Penetration Flights. If the consolidated air unit must penetrate enemy airspace to reach the pickup zone, the flight is routed first to a safe point as defined by the Air Ground Engagement Model (Chapter 10 of this section). It is then passed to the in-flight attrition segment which simulates the flight from safe point to the pickup zone while being attrited by air defense fire. A penetration flight is defined as one in which the pickup zone lies across a line perpendicular to the battlefield slope and passing along the forward edge of the most forward enemy front line maneuver battalion.

(3) Forming Airmobile Task Force and Lift Resources. The model automatically joins the aircraft unit into the unit receiving the ACCEPT TRANSPORT order. The aircraft, crews, fuel, and munitions remain with that unit until released by gamer orders. They are attrited by area fire and air attacks along with the remainder of the unit. A unit cannot have more than one ACCEPT TRANSPORT order active at any time. It must release previously assigned transport before accepting any additional transport resources.

d. Loading and Air Movement. Loading and air movement of the airmobile task force or of each resolution airmobile force (if smaller units are assembled) is conducted according to the air movement plan, as expressed by gamer prepared DSL orders of the form:

AIRMOBILE ASSAULT TO  $X_1 - Y_1$ ,  $X_2 - Y_2$ ,  $X_3 - Y_3$ ,  $X_4 - Y_4$ , AT TIME \_\_\_\_.

The AT TIME modifier is optional. The airmobile element to be lifted must have been previously allocated aircraft, by an ACCEPT TRANSPORT order as described in the preceding paragraph. This DSL order causes the transport aircraft to be loaded to their maximum capacities and with the escorts, if any, to fly from the current location of the element receiving the order to the last coordinate listed in the order, traveling over each listed intermediate coordinate. Up to three intermediate coordinate points may be specified in addition to the landing zone coordinates. The time, if specified, is the intended landing time of the first element. If additional lift trips are needed, the aircraft return as a unit along the same flight path for additional trips. Aircraft are subject to possible attrition by the in-flight attrition segment on each flight leg. If aircraft are lost en route, priority



cargoes (pregame input) are loaded first, and additional trips are scheduled in subsequent flight legs. Aircraft units are sent for refueling and rearming between trips if the remaining fuel is insufficient for one more round trip plus 30 minutes to spare, or if the quantity of air munitions of any type is less than 50 percent of initial load. On landing, the lifted element is unloaded. If more than one lift is involved for any element, between unloading of the first and last lifts, the unloaded portion of the force can execute any DSL order except JOIN, DETACH, AIRMOBILE ASSAULT, or RELEASE TRANSPORT. When the entire element is unloaded and assembled, this restriction ceases. Air movement is assumed to occur at nap-of-the-earth altitude. Flight speed is established as the cruise speed of the slowest aircraft in the flight.

e. Release of Aircraft. Upon completion of the airlifting of any airmobile element, the aircraft assigned to that task, including escorts, if any, may be released to return to their respective airbases for maintenance, repairs, and reassignment. If not released, the aircraft remain on the ground with the lifted unit and can be used for subsequent air movement. The release of air transport may be accomplished by a gamer DSL order of the form:

#### RELEASE TRANSPORT.

This order must be provided to a unit which previously received an ACCEPT TRANSPORT order. This order will cause the model to remove previously accepted aircraft with their crews, fuel, and munitions from the unit. A new unit is formed containing those elements. The model then simulates the flight of that unit back to the airbase or airbases from which the aircraft came. If the unit is in enemy airspace, as defined in paragraph c(2)(c) above, the first leg of the returning flight path is flown from the starting point to the safe point as described in the Air Ground Engagement Model (Chapter 10 of this section). Upon reaching the safe point, a check is made to see if sufficient fuel is on board to return to the airbase of the transport aircraft. If fuel is needed, the unit is passed to the control of the forward area refuel and rearm segment for refueling prior to returning to the base. Otherwise, the flight returns directly to the transport base. If the escort aircraft came from a different base, they continue to their base of origin. Aircraft are restored into the resources of their airbase after appropriate time delays, including times for repairs according to damage categories. Those delay times and their application are described in Chapter 10 of this section.

f. Refueling and Rearming. When refueling or rearming of a unit of aircraft is required, the refueling and rearming segment takes over control of the unit. It selects the nearest forward area refuel and rearm (FARR) area in the highest support category which is neither moving nor under attack. The support categories are those listed in paragraph c(2)(b) above. The model simulates the flight of the aircraft as a unit to the selected point. The unit may then be held in a queue until service capacity is available. Service is on a first-come first-served basis. When capacity is available, the unit lands at the FARR area. Time for refueling and rearming then depends on the requirements of the aircraft and the available capacity of the facility.

The aircraft within the unit are serviced individually, first refueled and then rearmed if necessary. If the capacity is being fully utilized, the individual aircraft will remain in a refueling queue and then a rearming queue until their appropriate turns to be serviced. The number of refuel and rearm points at each FARR area is predetermined by the TOE constant data load. Each FARR area must be a resolution unit composed of TOE defined basic units. The support relationships are declared in the task organization but may be altered by DSL orders. The service rates of the rearming points are specified in the constant data load. After all aircraft have been serviced the aircraft unit is flown to a location designated by the segment processing the unit's current order, and the unit is then returned to the control of that segment.

g. In-flight Attrition. Whenever an airmobile flight enters hostile air space, the flight is subject to possible attrition by enemy air defense weapons. This attrition is simulated within the model by considering the flight path in relatively short segments. Only currently undestroyed and unsuppressed air defense weapons within range and having line of sight to a flight segment are able to cause attrition on that flight segment. Line of sight is determined from flight altitude and terrain masking at the weapon, as calculated from terrain elevation input data. Flight altitude varies linearly from a nap-of-the-earth elevation over the terrain at the ends of the flight leg. When the flight first enters range and line of sight of the first enemy air defense capable unit (ADCU), a delay is imposed for probable time for the ADCU to detect the flight. Delays are also imposed for weapon reaction, and for the time of flight of any projectiles that are fired at the flight. Detailed weapon characteristics are used to determine whether the AD gun or missile can fire and how many projectiles will be fired. For projectiles to intercept the flight, the flight must remain in range and line of sight throughout that time. Only the effects of projectiles that can intercept the flight are considered for attrition. Aiming error and round-to-round dispersion are based on slant range to the midpoint of the flight segment and are used to determine hit probability on presented area of the aircraft at the aspect angle to the midpoint. Kill probabilities are determined by considering the aircraft vulnerable area, at the midpoint aspect angle, for the velocity of the AD projectile impacting. Good communications are assumed to exist between all air defense weapons within a given ADCU, so that time delays are not reimposed unrealistically. Communications are also assumed between different ADCUs, again to prevent unrealistic reimposition of detection times. When the flight enters range or line of sight of a second ADCU while a first ADCU is still firing no detection delay is assessed, although other delays may be assessed as described in paragraph 3e. Weapons within an ADCU are considered to be located near the perimeter of the unit for range determinations. No changes in the flight path are automatically made to evade air defense fires.

h. Air Defense Weapon Suppression. The employment of escort aircraft to suppress ADCUs which attempt to engage the airmobile column is simulated by the in-flight attrition submodel. Additionally, air defense weapons are suppressed by artillery, TACAIR, and other attack helicopters resulting from

the effects of the Area Fire and Air Ground Engagement Models. The in-flight attrition submodel, in connection with the Suppression Model, simulates the suppressive effects of such fires. The suppressive effects against an ADCU are reflected in the ability of that ADCU to attrite the airmobile column and are simulated by means of a suppression duration time applied for each attack of an ADCU. The suppression duration delay times are specified in the constant data input for the Suppression Model. Escorts are assumed to remain close to the transport aircraft they are escorting. Escorts are not permitted to divert more than a fixed distance from the flight path centerline in order to attack an ADCU. That distance is specified in the Airmobile Model constant data input. If the ADCU is destroyed or suppressed, it is assumed not to be firing and is not subject to further attack by escort aircraft. If the airmobile flight being escorted has passed beyond the point on its flight path nearest to the center of the ADCU, the ADCU is not engaged by escorts. The model accounts for the escorts engaging ADCUs at all times. If all escorts to an element are currently engaging targets, any additional ADCUs cannot be attacked by escorts. If escorts are available and the ADCU is within the designated escort divert limit of the flight path, escorts are dispatched in pairs at the time the ADCU begins to fire on the airmobile element being escorted. If an ADCU located beyond escort divert limit fires on the element, a request is sent for quick-response suppressive fires from TACAIR or ground-based artillery. While such fires may not be delivered in time to benefit this flight, they may benefit any following flights.

## 2. DESIGN OF THE AIRMOBILE MODEL:

a. Approach. A major objective in design of the Airmobile Model is to keep the model as general as possible, conforming to basic airmobile doctrine and current practice rather than to specific situational or type concepts. This objective precludes the application of automatic decision logic or other modeling sophistications that might be considered. Instead, heavy reliance is placed upon gaming personnel to specifically plan and describe each airmobile operation through the use of DSL orders. Reliance on gamer control is necessary, not only to achieve generality of the model, but also because doctrine is either incomplete or highly flexible in many specific situations. Furthermore, in a single game, only a limited number of airmobile operations is likely to be performed, and their anticipated impact on game results justifies a high degree of gamer control. Another objective of the design is to restrict modeling to those aspects considered essential to realistic gaming of airmobile operations, on the grounds that other features may be added at a later time, if found necessary.

b. Constituent Submodels. The Airmobile Model consists of five submodels. These submodels, each of which constitutes an independent program segment, are:

- . Accept Transport
- . Airmobile Assault
- . Release Transport
- . Refuel and Rearm
- . In-flight Attrition

c. Macroflow. The flow between submodels is sequential, as shown in Figure IV-15-1.

d. Connection with Other DIVWAG Models. Simulation of an airmobile operation requires utilization of a large portion of the overall DIVWAG system. The only major DIVWAG component connected directly to the Airmobile Model is the Intelligence and Control Model. The Intelligence and Control Model, in turn, interacts with the Area Fire and Air Ground Engagement Models, causing fire support to be automatically applied as required. Other important parts of the DIVWAG system necessary to simulation of an airmobile operation are brought into play by indirect connections, primarily represented by coordinated DSL orders.

(1) Intelligence and Control Model. Calls to the Intelligence and Control Model are made by the Airmobile Model in two circumstances. One circumstance is at the beginning of each air movement flight leg. The purpose of this call is to subject the flight to possible acquisition by enemy air defense radars. The second circumstance is when an ADCU fires at an airmobile element from a location beyond the escort aircraft divert limit. In this case, this call is a request for quick-response fire support against this ADCU. If resources are available, the result is response from either the Air Ground Engagement Model (TACAIR or attack helicopters) or the Area Fire Model (ground-based artillery).

(2) Indirect Connections. Coordinated DSL orders are likely to be employed to activate the Intelligence and Control Model for preparatory reconnaissance flights, the Area Fire and Air Ground Engagement Models for preparatory fires, and the Ground Combat Model for task force employment at the objective. Data placed in the unit status file of an ADCU by the Suppression Model (see Chapter 11 of this section) are used to determine whether the ADCU is suppressed by TACAIR or ground-based artillery. Line of sight determination for in-flight attrition is made by the Environment Submodel. The Combat Service Support Model resupplies the airbases, airmobile forces, and the ADCUs. It replaces destroyed aircraft, lost personnel, and expended fuel and ammunition.

### 3. SUBMODEL SPECIFICATIONS:

#### a. Accept Transport (Segment 1):

(1) Purpose. The accept transport segment is executed in response to a DSL order of the form as follows:

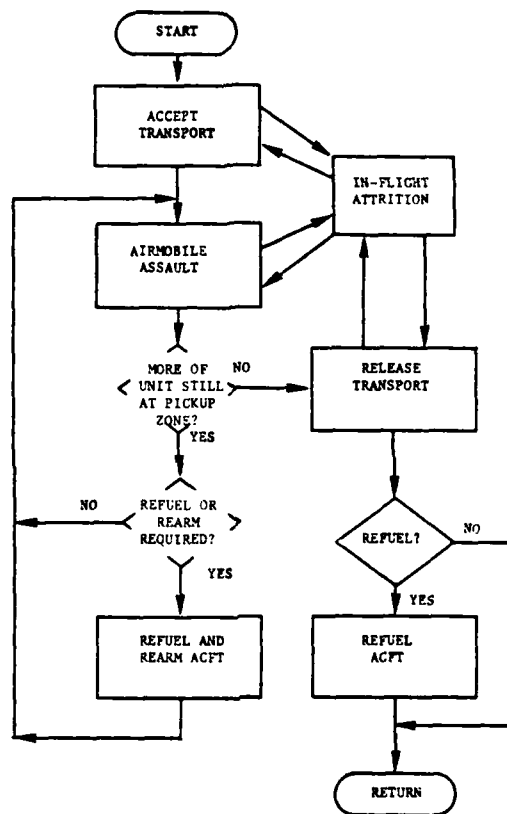


Figure IV-15-1. Macroflow of Airmobile Operation

ACCEPT TRANSPORT MIX \_\_\_\_\_ NUMBER OF  
 AIRCRAFT \_\_\_\_\_ NUMBER OF ESCORTS \_\_\_\_\_  
 AT TIME \_\_\_\_\_.

or:

ACCEPT TRANSPORT MIX \_\_\_\_\_ NUMBER OF  
 TRIPS \_\_\_\_\_ NUMBER OF ESCORTS \_\_\_\_\_  
 AT TIME \_\_\_\_\_.

Such an order is given to an airmobile task force or to each of a group of smaller resolution airmobile forces at some time prior to its AIRMOBILE ASSAULT order. This segment locates available aircraft of the indicated types; loads them with the appropriate munition mix, fuel and crew; and moves them to the pickup zone at the indicated time. The aircraft remain with that task force until explicitly released by a RELEASE TRANSPORT order. The aircraft may be used for a series of airmobile operations.

(2) Operation. The macroflow of this segment is shown in Figure IV-15-2. The following steps are performed:

(a) The DSL order is converted to an automatic event by routine ARCNRL. The event is passed to the Airmobile Model where it is channeled to routine ACCPT1. The unit receiving the ACCEPT TRANSPORT order has thus simulated a request for air transport support, and the unit then proceeds to execute its next DSL order in the normal fashion.

(b) Routine ACCPT1 processes the request and schedules the departure of the air units and their flights to the requesting unit in the following sequence of operations.

1. The mix type specified in the DSL order is an index to the mix table on the airmobile data file. That table is examined to determine the types of aircraft (escort and transport) and munitions, and the quantities of fuel, munitions, and personnel per aircraft.

2. If the number of transport aircraft was not specified in the DSL order it is computed by totaling the weight and volume of all personnel in the requesting unit and all equipment excluding aircraft, class IIIA (fuel), and aircraft munitions. The weights and volumes are obtained from the Combat Service Support Model data file. The capacity of the transport aircraft is also obtained from that file. The number of transport aircraft is calculated using the following formula:

$$\text{Number of Transport Aircraft} = \frac{\text{MAX } \frac{W_u}{W_a}, \frac{V_u}{V_a}}{N_T} \quad (\text{IV-15-1})$$

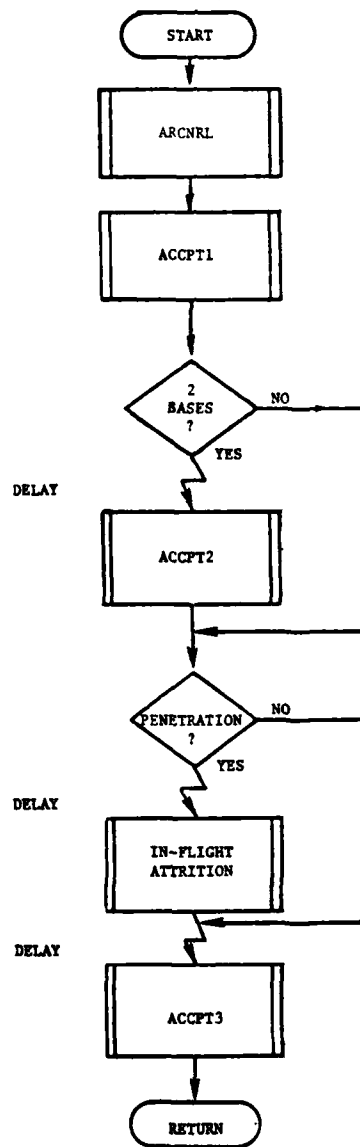


Figure IV-15-2. Macroflow of Accept Transport - Segment 1

where:

$W_u$  is the weight of the unit's equipment and personnel

$W_a$  is the weight capacity of the transport aircraft type

$V_u$  is the volume of the unit's equipment and personnel

$V_a$  is the volume capacity of the transport aircraft type

$N_T$  is the number of trips requested

The number of transport aircraft is rounded up to the next highest integral value.

3. The list of friendly airbases is assembled and sorted into three categories: direct support to the requesting unit; general support; direct support to another unit. The list is further sorted within each category in order of proximity to the requesting unit.

4. The list is searched once to select the airbase which can supply all escorts, transports, fuel, munitions, and personnel ranking highest on the sorted list. If no airbase satisfies the requirement, the list is searched again to select two bases which can supply all escort and all transport resources, respectively. If all resources cannot be found, a message is printed; and the game period is terminated.

5. Mission units are created at the base or bases. These units are temporary resolution units which are loaded with the aircraft, crews, fuel, and munitions provided from each base. The mission units have locations, unit identifications, and unit type designations and are handled within the model as any other resolution unit with two exceptions: (1) they cannot receive DSL orders, and (2) they occupy no physical area.

6. Routine PENRAT is called to determine if the flight is to penetrate enemy airspace. A penetration will occur if the requesting unit is located across a line perpendicular to the battlefield slope and passing along the forward edge of the most forward enemy maneuver battalion. If a penetration is to occur, this subroutine also returns the coordinates of the point along that line which is nearest to the requesting unit. The flight path will be adjusted to fly over that point. The point is called the safe point.

7. The flight speeds and fuel consumption rates of the aircraft are obtained from the Air Ground Engagement Model and Movement Model data files, respectively.

8. The total time required to combine the two mission units (if two bases have been selected) and fly to the requesting unit is calculated



based upon the flight path distances and the flights speeds. This time is compared to the arrival time designated in the DSL order to determine the time that the mission units will depart the airbases. If a time is not specified in the order, the departure is scheduled to begin immediately.

9. An event is scheduled in the automatic event table to simulate the flight of the escort mission unit to the transport aircraft base if two bases were selected. That event will be processed by routine ACCPT2. The escort mission unit is assumed to fly along a straight line from its base to the transport base.

10. The event to simulate the flight of the combined mission unit to the safe point is scheduled at this time if a penetration is to occur. The control will at that time be passed to the in-flight attrition segment which will simulate the flight from the safe point to the requesting unit and then return control to routine ACCPT3.

11. If no penetration is to occur, the event to fly the mission unit to the requesting unit is scheduled at this time. Control goes to routine ACCPT3 at the appropriate game time.

12. The flight speed of the combined unit is equal to the speed of the transport aircraft. The speeds are obtained from the Air Ground Engagement Model data file for the current weather and light conditions.

(c) Routine ACCPT2 is executed in response to an automatic event scheduled by routine ACCPT1. The time of this event was established in ACCPT1 as the time at which the transport mission unit and escort mission unit are to be consolidated into a single mission unit for the flight to the requesting unit. The following sequence of steps occurs.

1. The location of the escort mission unit is updated to that of the transport airbase. The fuel consumption for that leg was assessed in ACCPT1. The objective point of the next flight leg is set to the coordinates of the requesting unit.

2. All fuel, aircraft, and personnel in the transport mission unit are added to the escort mission unit. The transport mission unit is then eliminated.

3. Routine PENRAT is called to determine if a penetration will occur while flying from the transport base to the requesting unit. If a penetration will occur, the flight is rerouted over the safe point and an event is scheduled for the arrival of the flight at that point. Control will then go to the in-flight attrition segment to simulate the flight from the safe point to the requesting unit, after which control will go to routine ACCPT3.

4. If no penetration is to occur, an event to process the arrival of the mission unit at this requesting unit by routine ACCPT3 is scheduled in the automatic event table.

5. Fuel consumption for the next flight leg is assessed using the consumption rates listed in the Movement Model constant data file.

(d) Routine ACCPT3 processes the consolidation of the mission unit into the requesting unit. It is executed in response to an event scheduled by (1) the in-flight attrition segment, if the flight involved a penetration; (2) routine ACCPT1, if there was no penetration and all aircraft came from the same base; or (3) routine ACCPT2, if there was no penetration and the aircraft came from two different bases. The following sequence of operations is performed.

1. All equipment and personnel in the mission unit are transferred to the requesting unit.

2. An array is established on the requesting unit's status file indicating the types of aircraft and munitions which it has received and the identifications of the airbase or bases from which the resources were supplied. This array is used by the release segment to allow the resources to be returned to the proper bases.

3. The mission unit is dissolved and its identity is available for reuse.

b. Airmobile Assault (Segment 2):

(1) Purpose. The airmobile assault segment is executed in response to a DSL order of the form:

AIRMOBILE ASSAULT TO \_\_\_\_\_ - \_\_\_\_\_, \_\_\_\_\_ - \_\_\_\_\_,  
\_\_\_\_\_ - \_\_\_\_\_, \_\_\_\_\_ - \_\_\_\_\_ AT TIME \_\_\_\_\_.

Such an order is given to an airmobile task force to cause it to be airlifted over the coordinate points listed in the order and landed at the last coordinate point in the list. The first element is to arrive at the designated time. Up to four coordinate points can be included. This order must have been preceded at some time during the game by an ACCEPT TRANSPORT order for that task force unit. The task force unit may be any combination of basic units which have been assembled into a single unit by JOIN orders.

(2) Operation. The macroflow of this segment is shown in Figure IV-15-3. The following steps are performed:

(a) The DSL order is converted to an automatic event by routine ARCNRL. The event is passed to the Airmobile Model where it is channeled to routine ASULT1. The unit is taken out of the event cycle

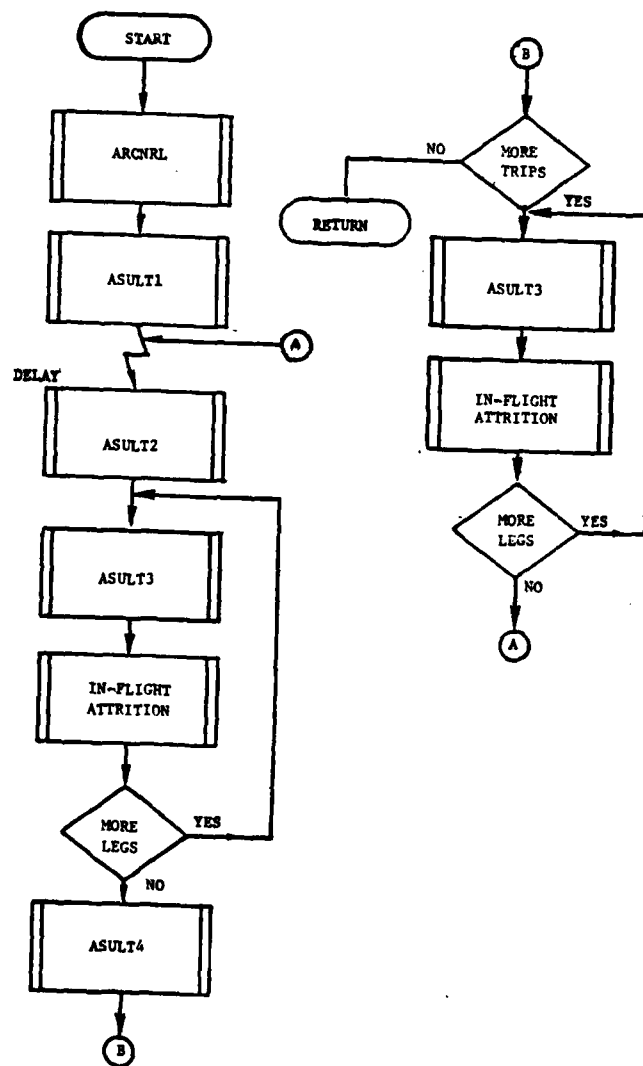


Figure IV-15-3. Macroflow of Airmobile Assault - Segment 2

and will not perform its next DSL order until the initial element has reached the designated landing zone.

(b) Routine ASULT1 builds the initial data file 12 event description record and obtains necessary data from the appropriate data files, which are saved on the data file 12 record. It also schedules the initial departure event. The following sequence of operations is performed.

1. The flight path coordinates contained in the DSL order are read in using the DSL interface routines, and the coordinates are stored on the data file 12 event record.

2. The types of escort and transport aircraft which the unit has previously accepted by an ACCEPT TRANSPORT order are stored on the data file 12 record.

3. The fuel consumption rates, flight speeds, and landing times are obtained from the Air Ground Engagement Model data file for each type of aircraft and are stored on the data file 12 record. The flight speed is that designated for the weather and light conditions existing when the ASULT order is initiated.

4. The total flight time from the unit's current location, over the designated intermediate points, to the landing zone at the speed of the slowest aircraft is added to the landing time contained on the Air Ground Engagement Model data file.

5. The total time calculated in paragraph 4 above is compared to the desired arrival time contained in the DSL order and the time of departure is scheduled. If no arrival time was specified, or the desired time cannot be accomplished due to the flight time, the departure event is scheduled immediately.

6. The departure event is scheduled by passing a data file 12 record to routine ASULT2 using the automatic event sequencing system.

(c) Routine ASULT2 processes the loading of the transport aircraft and the departure of the air unit. It performs the following sequence of operations.

1. The total cargo capacity (weight and volume) of the unit is calculated by multiplying the number of transport aircraft by the weight and volume capacities of that aircraft type which is contained on the Combat Service Support Model constant data file.

2. The amount to move is calculated by totaling both the weight and volume of all personnel and equipment contained in the unit excluding aircraft, class IIIA, and air munitions. The weights and volumes of the items are obtained from the Combat Service Support Model constant data file.

3. The weight and volume of all equipment listed on the secondary priority equipment list are totaled in the same manner.

4. If either the weight or the volume to be moved exceeds the capacity of the transports, additional trips will be required.

5. If additional trips are not required, all equipment and personnel are loaded on the aircraft and an event is scheduled to pass control to routine ASULT3 which controls the movement of the flight. The following steps are not performed when additional trips are not required.

6. A mission unit must be created and left at the pickup zone with all personnel and equipment which cannot be moved. If this is not the first trip, such a unit already exists. This mission unit has the same geometry and location as the unit being transported before the assault began. It can be assessed by air and artillery fire as any other unit. It cannot execute DSL orders.

7. The aircraft are loaded with class IIIA, munition, and crews. The fraction of the remaining first priority items to be moved on this trip is calculated by the following formula:

$$F_{A1} = \frac{W_A}{W_{u1}}, \quad F_{B1} = \frac{V_A}{V_{u1}}$$

(IV-15-2)

$$F_1 = \text{MIN} (F_{A1}, F_{B1})$$

where:

$F_1$  is the fraction of the first priority equipment to be moved this trip

$W_{u1}$  is the weight of all first priority equipment and personnel in the unit

$W_A$  is the weight capacity of all transport aircraft

$V_{u1}$  is the volume of all first priority equipment and personnel in the unit

$V_A$  is the volume capacity of all transport aircraft.

The quantity of all such first priority items loaded on the aircraft is prorated by fraction,  $F_1$ , where  $F_1$  does not exceed 1.0.

8. If fraction,  $F_1$ , exceeds 1.0, there is additional capacity remaining to move some of the second priority equipment. The amount loaded is prorated by fraction,  $F_2$ , where:

$$F_{A2} = \frac{W_{A'}}{W_{u2}}, \quad F_{B2} = \frac{V_{A'}}{V_{u2}}$$

(IV-15-3)

$$F_2 = \text{MIN} (F_{A2}, F_{B2})$$

where:

$F_2$  is the fraction of second priority items to be moved on the trip

$W_{u2}$  is the weight of all second priority equipment in the unit

$W_{A'}$  is the remaining weight capacity of all transport aircraft after loading first priority items

$V_{u2}$  is the volume of all second priority equipment in the unit

$V_{A'}$  is the remaining volume capacity of all transport aircraft after loading first priority items.

9. An event is scheduled to pass control of the flight to routine ASULT3 which controls the movement of the flight.

(d) Routine ASULT3 controls the movement of all airmobile assault units. It updates status, assesses fuel consumption, and schedules the following event. The functions performed are described below.

1. If this is not the initiation of a new flight, the fuel consumption is calculated for the previous leg using the rates specified on the data file 12 record created by ASULT1. The fuel is subtracted from the unit status record of the unit being moved. The coordinates of the unit are updated to the completion of the previous flight leg.

2. The flight leg counter on the data file 12 record is incremented to point to the coordinates of the end point of the next flight leg, and those coordinates are placed on the unit's status record for use by the in-flight attrition segment.

3. If the unit has not yet arrived at either the landing zone or the pickup zone (for subsequent trip loads), an automatic event is scheduled for the in-flight attrition segment. That segment will control the movement within a flight leg and pass control back to ASULT3 when the flight leg has been completed.

4. If the unit has arrived at the landing zone, an event is scheduled which passes control to routine ASULT4. The routine controls the recomposition of the unit at the landing zone.

5. If the unit is at the pickup zone and the landing zone is in enemy territory, the routine determines if refueling or rearming is required. If sufficient fuel is not remaining to make another complete round trip with 30 minutes reserve, or if less than one half of the initial munition load remains, refueling and rearming is performed. The routine passes control to the refuel and rearm segment. After accomplishing that operation, the refueled and rearmed aircraft will be returned to the pickup zone, and control will return to routine ASULT3.

6. If refueling or rearming is not required, an event is scheduled for control to go to routine ASULT2, which loads the aircraft for the next trip.

7. If the unit is departing from a landing zone in friendly territory and returning for another trip load, the refuel/rearm decision process is made at that point.

8. The landing delay time placed on the data file 12 record by ASULT1 is applied to all flights landing at both the pickup and landing zones.

(e) Routine ASULT4 controls the recomposition of the unit at the landing zone. It responds to events scheduled by ASULT3. This routine performs the following sequence of operations.

1. If this is not the first trip, all personnel and equipment are transferred from the arriving unit into the element of the unit which had previously been unloaded.

2. If this is the first trip, the unit being lifted is updated to the location of the landing zone and contains all equipment and personnel contained in the first trip.

3. The routine determines if the landing zone is in enemy territory by comparing the location of the center of the landing zone with the straight line FEBA approximation described in Chapter 5 of this section. If the landing zone lies across that line, the airmobile flag on the assaulting unit status record is set. This flag serves two purposes; (1) the unit will only be resupplied by aircraft within the Combat Service Support Model,

and (2) the unit will not be used for future battlefield geometry calculations. The flag may be cleared during the periodic battlefield geometry update if the FEBA has moved beyond the location of the center of the unit such that it is no longer on the enemy side of the line.

4. If additional trips are required to move elements of the unit remaining at the pickup zone, a mission unit is formed containing the aircraft, crews, class IIIA, and air munitions remaining with the unit. That mission unit is returned to the pickup zone along the same flight path flown to the landing zone. An event is scheduled to pass control back to routine ASULT3, which will control the flight of the mission unit.

5. After the last trip has been completed, all mission units are dissolved and the entire reconstituted unit remains in the vicinity of the landing zone with attached aircraft and associated resources.

6. When the first trip arrives at the landing zone, the resolution task force unit's identity arrives with it. The task force unit's location is updated, and it begins performing its subsequent DSL orders. The width and depth of the unit will be those appropriate for its new activity.

c. Release Transport (Segment 3):

(1) Purpose. The release transport segment is executed in response to a DSL order of the form:

RELEASE TRANSPORT.

Such an order is given only to a unit which had previously been given an ACCEPT TRANSPORT order and provided with transport support. This order allows the supporting aircraft to return to their respective bases for refueling, rearming, and reassignment.

(2) Operation. The macroflow of this segment is shown in Figure IV-15-4. The following steps are performed.

(a) Routine ARCNRL processes the DSL order. It creates a data file 12 event record and passes it to the Airmobile Model where it is channeled to routine RLEAS1. The unit receiving the order then proceeds to execute the next order in its DSL order scenario. The execution of this order does not consume any game time from the unit's planned scenario. It serves only to initiate the process described in the following paragraphs.

(b) Routine RLEAS1 is executed in response to the data file 12 event scheduled by routine ARCNRL lift. Its purpose is to extract the airmobile lift resources from the unit, create a mission unit, and schedule the events to return the aircraft with associated personnel and equipment to the safe point. The following operations are performed.



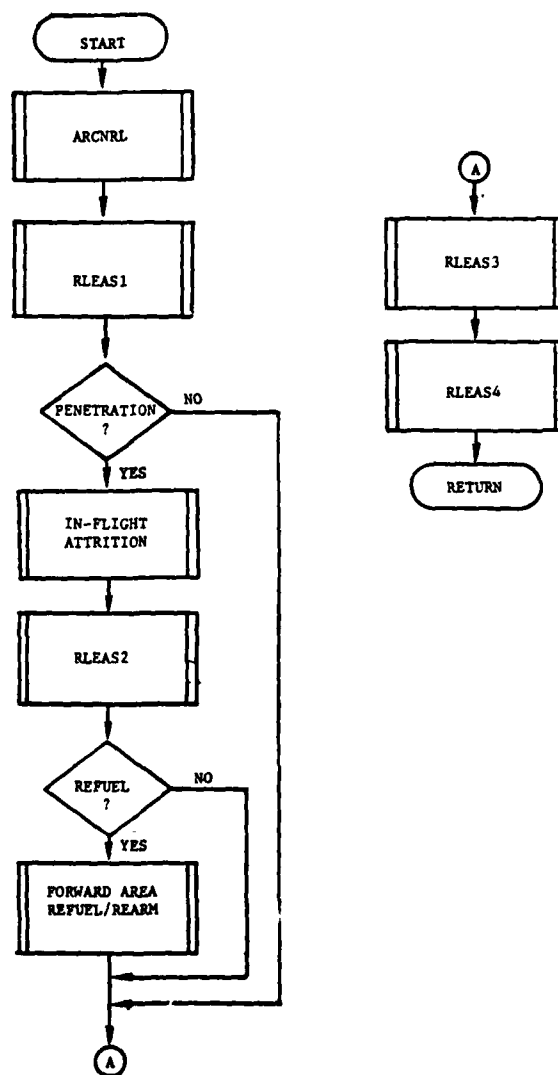


Figure IV-15-4. Macroflow of Release Transport - Segment 3

1. The flight speeds of the transport and escort aircraft types are obtained from the Air Ground Engagement Model data file. The speeds pertaining to the current weather and light conditions are selected and saved on the data file 12 event record.

2. The fuel consumption rates for both aircraft types are obtained from the Movement Model constant data file. Those rates are also saved on the data file 12 event record.

3. Routine PENRAT is called to determine if the return flight will require penetration of enemy air space. A penetration flight is defined, and one in which the aircraft are being released from a unit across the penetration line is described, in paragraph 3a(2)(b) above. If a penetration flight is to occur, this subroutine also returns the coordinates of the point along that line nearest the releasing unit. That point is called the safe point, and the returning flight path will be adjusted to fly directly to that point before returning to the base.

4. If a penetration flight is to occur, or if the transport and escort aircraft are from the same airbase, a single mission unit is created. All transport and escort aircraft with their associated crews, class IIIA, and munitions are extracted from the releasing unit and joined into the mission unit.

5. If the two aircraft types are from different bases, and a penetration flight is not required, two mission units are created. In this case, the escort aircraft and their associated crews, fuel, and munitions are joined into one mission unit while the transport aircraft with their associated crews and fuel are joined into the other.

6. The coordinates of the objective point of the first flight leg are set for each mission unit. If it is a penetration flight, these are the coordinates of the safe point; otherwise, they are the coordinates of the escort and transport aircraft parent bases.

7. Penetration flights are then passed to the in-flight attrition segment which controls the movement of the flight from the releasing unit to the safe point. Upon arriving at the safe point, the mission unit will be passed back to routine RLEAS2. The following steps are not performed for penetration flights.

8. The distance from the releasing unit to the objective is calculated and the time of flight is determined using the flight speeds of the aircraft.

9. The events corresponding to arrival at the bases is scheduled on the data file 12 automatic event table. That event will be processed by routine RLEAS3 at the appropriate time.

(c) Routine RLEAS2 is executed in response to an event scheduled by the in-flight attrition segment which indicates that a released mission unit has arrived at the safe point. This routine schedules the return of the mission units to the appropriate airbases. The following procedure is performed.

1. The distance from the safe point to the transport airbase is calculated and the time to fly to the base is determined using the transport aircraft flight speed saved by routine RLEAS1. The amount of fuel required for the return flight is then determined using the transport aircraft fuel consumption rate saved by routine RLEAS1.

2. If the aircraft are to be returned to different bases, a mission unit is created. The transport aircraft with their associated crews and fuel are joined into that mission unit.

3. If the original mission unit did not have enough for the transport aircraft to return to their base, the unit is passed to the forward area refuel and rearm segment for refueling, after which it will return to the control of routine RLEAS3.

4. The remaining equipment in the original mission unit is associated with the escort aircraft. If there is not enough fuel left for the escorts to return to their base, that unit is then passed to the forward area refuel and rearm segment, after which it will be returned to the control of routine RLEAS3.

5. The mission units not requiring refueling are returned directly to their bases. Events are scheduled on the data file 12 automatic event table for the arrival of the aircraft back at their bases. Those events will be processed by routine RLEAS3.

(d) Routine RLEAS3 is executed in response to events scheduled by routines RLEAS1 and RLEAS2. It updates the mission units for the flight to the base and schedules the restoration of the aircraft for reassignment. The following operations are performed.

1. The fuel, personnel, and munition present in the arriving mission unit are transferred directly to the unit status record of the airbase after subtracting fuel consumed on the return flight.

2. The landing times for the transport and escort aircraft types are obtained from the Air Ground Engagement Model data file.

3. The number of aircraft receiving B-kills is determined from the mission unit's status file. The time required to return an aircraft with a B-kill to service is obtained from the Air Ground Engagement Model data file. The landing time is added to that time, and an event to return B-killed aircraft to service is scheduled on the data file 12 automatic event table.

4. The preceding step is repeated for aircraft with C- and D-kills. (A, E, C, and D-kills are defined in Chapter 10 and in the description of the in-flight attrition segment contained below).

5. An event to return undamaged aircraft to service after the landing time plus the aircraft availability time is scheduled on the data file 12 automatic event table. The availability time is obtained from the Air Ground Engagement Model data file.

6. Mission units are dissolved, and their identities may be used for other missions.

(e) Routine RLEAS4 is executed in response to an event scheduled by routine RLEAS3. This routine is called at the appropriate time to restore aircraft into service after completion of a mission and to record landing and availability times. It increments the quantity of aircraft on hand contained on the airbase unit status record.

d. Refuel and Rearm (Segment 4):

(1) Purpose. The Forward Area Refuel and Rearm (FARR) submodel is designed to simulate the refueling and rearming of US Army aircraft performing airmobile assault operations. The model is designed to simulate the operations of mobile FARR areas during mid-intensity conflicts where there would exist a continuing and frequent requirement for rapid displacement of the FARR area. This mobility is required to ensure continuous aircraft refueling/rearming operations and to avoid destruction from enemy fire. The FARR submodel is based primarily on the results of a US Army Supply Agency study and selected FMs (References 1, 2, and 3).

(2) Operation:

(a) Only the refueling and rearming operations are discussed in this paragraph. Resupply of fuel and ammunition to the FARR area is discussed in Chapter 16, Combat Service Support Model. When the FARR area is in hostile territory, it is always resupplied by unit distribution through an airlift operation.

(b) During airmobile operations, a flight of troop ships and their escorts may be required to make several trips between the pickup zone and the landing zone. A flight, arriving at the pickup zone, is sent to refuel if either of two conditions occur. The first condition is that the escort aircraft (if there are any) have expended 50 percent of any type of ammunition. The second condition is that the aircraft do not have enough fuel to make one more round trip to the landing zone with 30 minutes reserve. All aircraft sent to the FARR area are refueled and, if appropriate, rearmed.

(c) Once a determination has been made to send the flight to a FARR area, a FARR area is chosen. If the flight has a FARR area in direct support, it is sent there. Otherwise, it is sent to the nearest general

support FARR area. If no general support areas are available, the flight is sent to the nearest FARR area which is in direct support of another unit. In the case where the selected FARR area is moving, under attack, or does not have sufficient fuel, an alternative FARR area is chosen.

(d) Figure IV-15-5 shows a schematic of the refueling and rearming process which is simulated. As shown, refueling and rearming tasks are accomplished separately, and both a refuel queue and a rearm queue are simulated. If no rearming is required, the flight leaves the FARR area as soon as all aircraft in the flight have been refueled.

(e) Once the flight arrives at the FARR area, it is put into a refuel queue. No flights are given priority service. A "first-in, first-served" rule is observed at both the refueling and rearming areas to facilitate the queuing process. A particular flight does not land at the FARR area until service capabilities are available. If they are not available, the aircraft are diverted to a holding area to await their turn in the refueling queue.

(f) All aircraft arriving at the FARR area are refueled. Since the Airmobile Model does not simulate fire by transport aircraft, only escort aircraft are considered for rearming. Individual aircraft are refueled and then, if necessary, rearmed, in that sequence. Within a flight, aircraft which require rearming are refueled before aircraft which do not. All aircraft are assumed to accept fuel at 50 gallons per minute at each fuel inlet.

(g) Total refuel service time for a set of aircraft, RFTPS, at a refuel area is:

$$RFTPS = RFT + RFMT \quad (IV-15-4)$$

where:

RFT = refuel time per aircraft set (minutes)

RFMT = refuel maneuver time (minutes)

(h) The refuel time per aircraft set is found by first determining the average amount of fuel required per aircraft inlet. The average fuel amount is then divided by the intake rate of an aircraft fuel inlet. This calculation is expressed by:

$$RFT \text{ (min)} = \frac{TRF \text{ (gal)}}{NI * RATE \text{ (gal/min)}} \quad (IV-15-5)$$

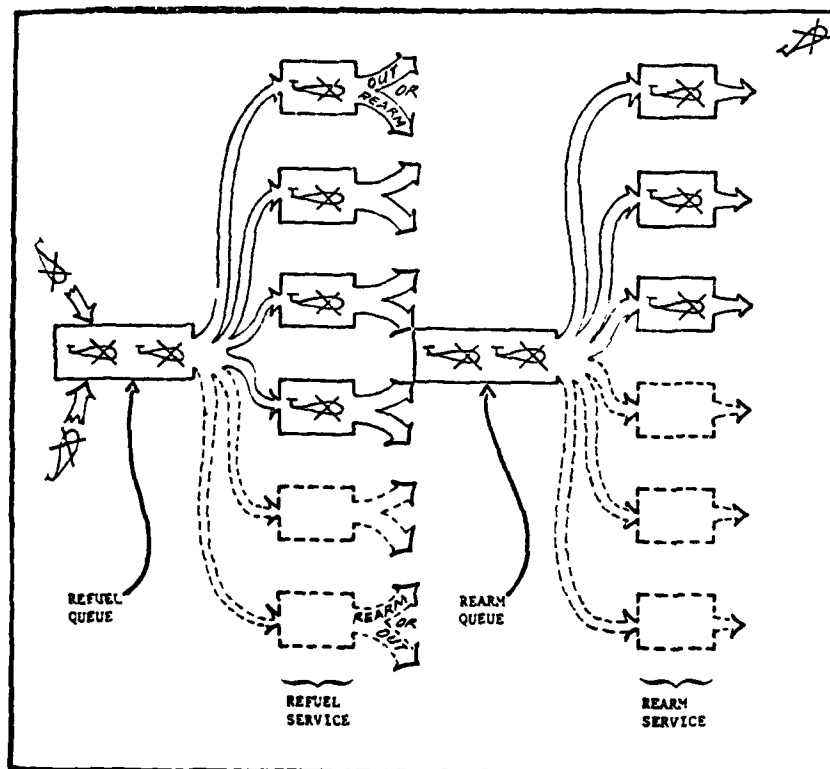


Figure IV-15-5. Schematic Concept of Forward Area Refueling and Rearming System

where:

TFR = total fuel required by all aircraft in a flight (gallons)

NI = total number of aircraft fuel inlets

RATE = assumed rate at which aircraft can accept fuel at an inlet (currently 50 gallons/minutes).

The number of inlets is used rather than the number of aircraft in order to simulate a FARR area with different type refuel devices, each with a different number of nozzles refueling different type aircraft with varying numbers of fuel inlets. A refuel point is defined as containing one nozzle, allowing the number of fuel inlets in the flight to be matched with the refuel points.

(i) A refueling maneuver time is input to account for delays other than the actual refuel time. This includes the time required to maneuver a single aircraft into position for refueling from a position approximately 200 yards from the refuel point, time to insert nozzle(s) and commence (but not conduct) fueling, time to remove nozzles and to maneuver the aircraft clear of the refuel point.

(j) As soon as aircraft are refueled, those which require rearming are maneuvered to a rearm area where they are put in a rearm queue. Aircraft not requiring rearming are put in a holding area.

(k) All aircraft which require any ammunition are rearmed. Rearm time per aircraft set is a function of aircraft and munition type but is considered to be independent of munitions consumed. Rearm time per set of aircraft is input as constant data. The number of rearm points at each FARR area is also constant data and is input as a function of unit type designation (UTD). The number of points will be degraded if the FARR sustains loss of personnel.

(l) A second maneuver time is input to account for the delay created in rearming. This time includes the time for an aircraft to move from the rearm queue area to a rearm point plus the time required for preparing for takeoff. Total service time for a set of aircraft at a rearm area is rearm maneuver time plus rearm time per set of aircraft. Although all aircraft in a flight remain at the FARR area until the whole flight has been processed, the aircraft leave the service point immediately on completion of servicing.

(m) Each type FARR area must be defined as a basic unit with a unique unit type designation (UTD). The number and type of Farr areas which are to be played are defined by the task organization. The amount

and type equipment at each FARR area is described in TOE load. An example of what would be at a typical FARR area located in friendly territory is shown below:

- . 6 refueling systems
- . 20 500 gallon tanks
- . 1 fuel truck
- . 1 ammunition truck
- . 4 rearm points

(n) Since each refueling system has two nozzles, the FARR area has 12 outlets for fuel. Lethal areas are input for the 500 gallon tanks and for the trucks. The amount of fuel in each should be listed as secondary equipment for that item so that fuel may be attrited when the fuel tanks and trucks are hit by artillery fire. Lethal areas of aircraft are also input so that they can be attrited by artillery fire while in the refuel and rearm areas. In determining the number of FARR areas required, the tradeoff between system utilization and waiting time must be considered. A FARR area should have enough service points, personnel, and equipment so that a long waiting line does not develop. On the other hand, the more refueling and rearming points at a forward area, the greater the system's idle time will become. Furthermore, the greater the number of service points, the larger the area to support the refueling/rearming activities must be, causing problems in clearing and securing.

(o) In order to more clearly explain how the model simulates the rearming and refueling activities at a FARR area, an illustrative example is developed below. The situation is shown in Figure IV-15-6. Four flights simultaneously arrive at a FARR area at time  $t$  equals zero. The FARR area has 10 refuel points and five rearm points available. There is a different number of aircraft in each flight. Note that the refuel and rearm service times per aircraft may be different for different flights. These times depend on the type aircraft and their munition loads. In flight 1, only three of a total of 15 aircraft require rearming. The assumption is that this flight consists of three escort aircraft and 12 transport aircraft. The number of escort aircraft in the other three flights are four, zero, and four respectively. Figure IV-15-7 shows the sequence and times at which the four flights would be refueled and rearmed as simulated in the FARR model.

(p) Since the rearming of flight 4 could not begin until time  $t = 22$  minutes, the flight does not land at the FARR area until time  $t = 20$  minutes, at which time it immediately starts refueling. This 2-minute time difference allows the first ten aircraft of flight 4 to complete refueling at the time rearm points in the rearm queue become available. In order to minimize the number of aircraft on the ground at the FARR area at any one time, a flight does not land at the FARR area until it can start refueling. The aircraft are thus vulnerable to artillery fire for a shorter time period.



Flight	Aircraft in Flight	Number Aircraft To Be Rearmed	Refuel Service Time Per Aircraft Set (Minutes)	Rearm Service Time Per Aircraft Set (Minutes)	Number Refuel Points	Number Rearm Points
1	13	3	2	20		
2	4	4	3	15	10	5
3	2	0	4	0		
4	17	4	2	14		

Figure IV-15-6. Illustrative Example of Refuel/Rearm Situation

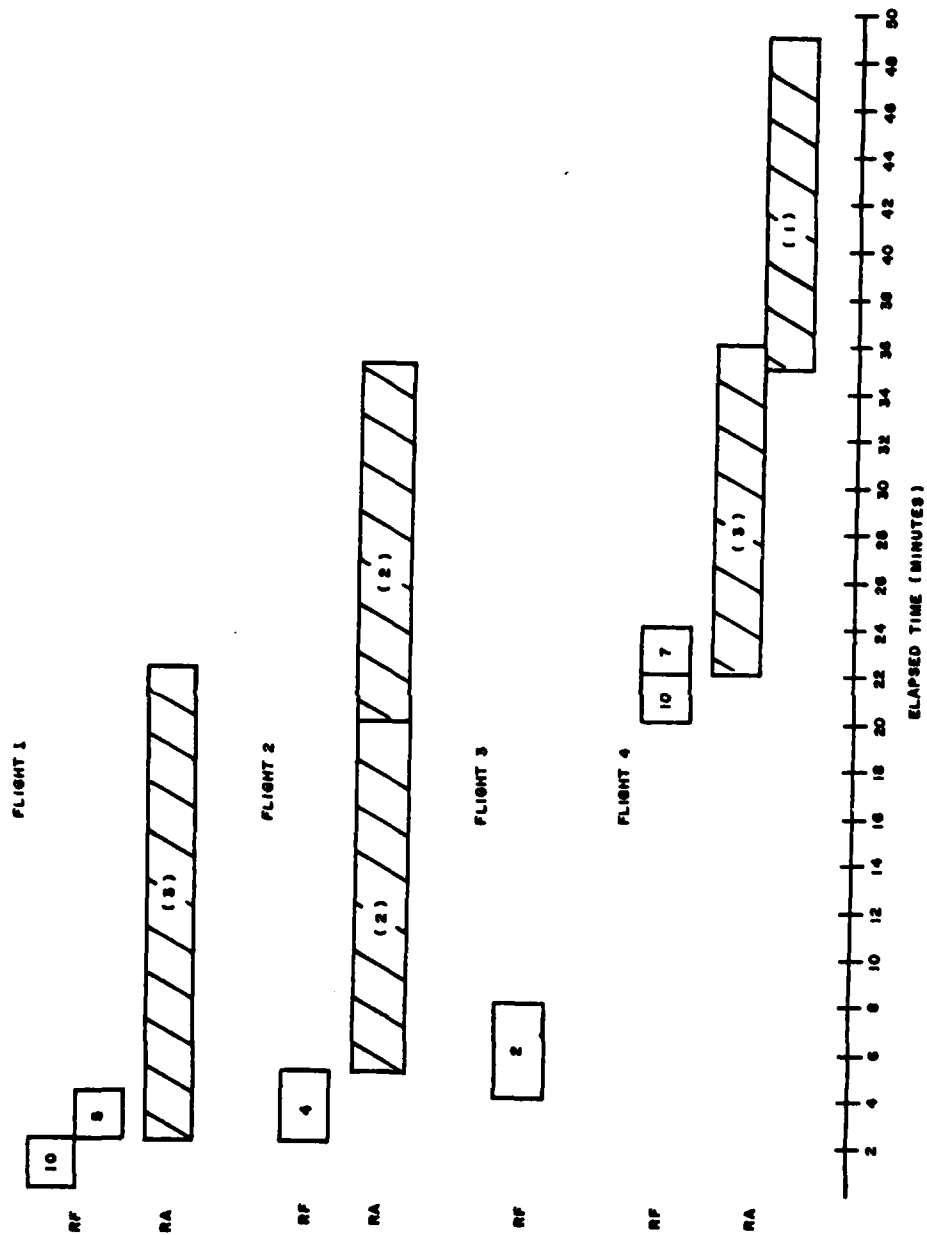


Figure IV-15-7. Example of Refuel and Rearm Scheduling

(q) Since three of the 15 aircraft of flight 1 require rearming, flight 1 departs the FARR area at  $t = 22$  minutes. Flight 3 does not require any rearming; hence, it is refueled as soon as any refueling capability becomes available ( $t = 4$  minutes) and departs immediately after refueling ( $t = 8$  minutes). Note that flight 4 does not leave the FARR area until  $t = 49$  minutes, even though refueling of all aircraft was completed at  $t = 24$  minutes, and only four aircraft in the flight required rearming.

(r) As is illustrated in Figure IV-15-7, each flight arrives at and departs from the FARR area as a complete flight, although some aircraft may be refueling while others are rearming. Only those aircraft which require rearming are sent to the rearm queue. Thus, if no aircraft in a flight require rearming, the entire flight departs the area as soon as refueling is completed.

e. In-flight Attrition:

(1) General:

(a) Purpose. The In-flight Attrition Submodel is designed to simulate the ground-to-air attrition incurred by any aircraft which flies through hostile airspace. This submodel is intended to represent the principal determinants of attrition in sufficient detail to permit realistic simulation of airmobile and other air operations within the DIVWAG system. Rather than depend upon the results of any external high-resolution models, this submodel is designed to use, as input, available basic data on air defense weapons and aircraft.

(b) Capabilities. The In-flight Attrition Submodel can accommodate, for each force (Red and Blue), nine types<sup>1</sup> of aircraft and 15 types of ground-based air defense weapons, including both guns and missiles. Any resolution unit which currently contains any of the specified types of air defense weapons, is considered by this submodel to be an air defense capable unit (ADCU). The submodel considers the air defense capability, size, and location of each such ADCU versus the position and speed of the air unit on its current flight leg. Attrition by ground-based air defense weapons is restricted to aircraft and their contents. Provision exists for addition of an air-to-ground attrition routine at a later date. Suppression of air defense weapons is simulated in terms of input air defense suppression duration times applied for each attack by escort aircraft, TACAIR, or ground-based artillery. This submodel dispatches a pair of escorts, if available, to attack any firing ADCU which is within a limited distance from the air unit. The submodel requests quick-reaction fire support by TACAIR or ground-based artillery against any firing ADCU which is beyond a specified distance from the flight path. Aircraft attrition calculations for guns employ aircraft presented area, weapon accuracy, and aircraft vulnerable areas to each air defense weapon type, based on the average engagement geometry of relatively

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1. Two types in any one flight.

short segments of the flight path. For missiles, accuracy and probability of kill versus miss distance are used. Only unsuppressed ADCUs are permitted to fire. Terrain masking; weapon limitations of range, altitude, slew rate, and/or launch envelope; and delays for acquisition, reaction, and projectile flight are considered in determining whether projectiles can intercept the flight on a particular segment. The number of projectiles which can intercept on the segment is further determined by number of unsuppressed weapons currently on hand, ammunition on hand, and rate-of-fire characteristics of each weapon type. Degradation for weather and visibility conditions, electronic countermeasures (ECM), weapon system reliability, and evasive flight are included. Aircraft losses are recorded in four kill categories; quick kills (Category A), forced landings (Category B), mission aborts (Category C), and other damage (Category D). Cargo and troop losses are proportioned to total aircraft kills.

(c) Approach. The In-flight Attrition Submodel utilizes extensively the DIVWAG event sequencing system. The basic approach used is to consider the future flight path a leg at a time; to start with a limited number of essential criteria; and to use them to identify and isolate, a short distance in advance of the actual air unit, portions of the flight leg where air defense engagement will be possible. Progressively detailed analysis is then applied to narrow the scope of consideration and refine the level of information about anticipated interactions until segments of the flight leg are defined on which unique sets of air defense weapons will intercept the air unit. When the air unit has reached the end of each such segment, final filtering makes use of up-to-date information, and a set of attrition calculations is employed to assess fractional aircraft losses over the entire segment.

(2) Submodel Operation. The submodel is composed of three basic sections. Section 1 identifies segments of the flight leg where aircraft attrition is possible. Section 2 breaks these flight leg segments into sub-segments, termed constant fire subsegments (CFS) within which the air unit is expected to be subject to attrition by a unique and constant set of air defense weapons. Section 3 calculates and assesses to the air unit all losses incurred on a CFS.

(a) Callers. Each of two different DIVWAG models may call the In-flight Attrition Submodel in order to initiate assessment of aircraft losses on a specific flight leg of an overall flight path. These models, termed primary callers, include the Airmobile Model and the Reconnaissance overlay of the Intelligence and Control Model. Also, the DIVWAG event scheduling system may call the In-flight Attrition Submodel as a result of events set during the course of assessment of aircraft losses on a specific flight leg. The latter type of call is termed a secondary call. All primary and some secondary calls go to Section 1. Primary calls carry identification of caller, a specification of the flight leg to be assessed, whether it is the first or subsequent leg of flight, and the identity of the air unit which may incur losses. Secondary calls carry this information plus a key to an additional storage file which can contain details of the assessment in process.

(b) Section 1. This section identifies segments of a flight leg where attrition may occur. In keeping with the event sequencing design of DIVWAG, such segments are identified prior to the time at which the air unit is to actually traverse the flight leg. A logical flow diagram of Section 1 is shown in Figure IV-15-8.

1. A determination is made as to whether the location of the air unit is updated to the end of the flight leg. A second check determines whether the air unit has actually reached the end of the current flight leg. If so, control is returned to the primary caller, so that the next flight leg (if any) on the flight path may be presented for assessment. If the air unit has not reached the end of its current flight leg, the current position of the air unit is taken as the initial point of reference from which to conduct a search for ADCUs which may have an effect upon the air unit.

2. To identify those segments of the flight leg where aircraft attrition is possible, all ADCUs of the opposing force are examined against two basic criteria, from a point which progresses in short steps (1000-meter increments) from the beginning to the end of the flight leg, in advance of the actual air unit. One criterion is whether line of sight exists from the center of the ADCU to the point. The other criterion is whether the point is within maximum effective weapon range of at least some<sup>2</sup> of the longest range weapons on the ADCU. If both criteria are met for any ADCU from a given point, that point is then considered to be within a flight leg segment over which the air unit is subject to possible attrition. If two adjacent points meet both criteria, the step interval between points is presumed also to be within a flight leg segment on which attrition is possible. The first point which fails to meet both criteria marks the end of the possible attrition segment, while conversely the first point which meets both criteria marks the beginning.

3. If the point reaches the end of the flight leg with no possible engagement segments being found, the coordinates of the air unit are updated to the end of the flight leg and an event is set for the time at which the air unit, at its assigned flight speed, should reach the end of the flight leg. This event calls Section 1. After this move event is executed, control returns to Section 1, so that the primary caller may be notified and any subsequent flight legs may be presented for assessment.

4. Section 1 also keeps track of which ADCUs are involved in meeting both of the above criteria as a basis for determining the end of a segment. Whenever an ADCU is added or dropped from the roster of those that meet both criteria, a segment is considered to end. Whenever the end

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2. For purposes of the In-flight Attrition Submodel, all air defense weapons in a given ADCU are assumed to be evenly distributed on the circumference of a circle of which the center is that of the ADCU and the radius is half of the width or depth of the ADCU, whichever is smaller.

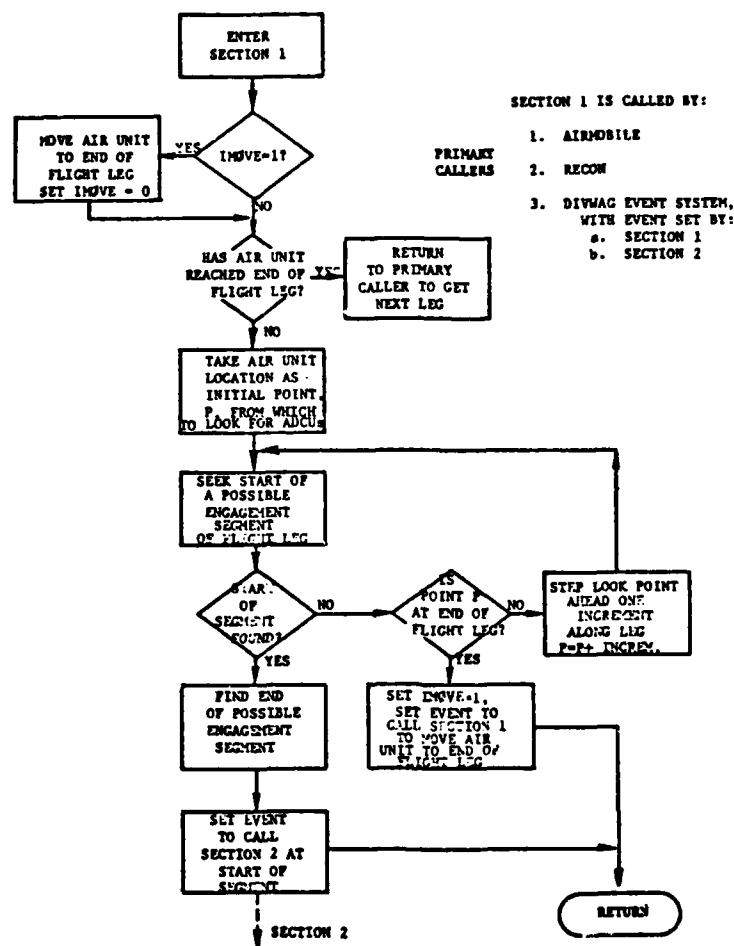


Figure IV-15-8. Macroflow of In-Flight Attrition Submodel (Section 1)

of such a segment is found by this section of the submodel, an event is set to enter the second section of the submodel at the time the flight is anticipated to arrive at the start of this segment, so that more detailed geometric, timing, and related analysis can be performed.

(c) Section 2. Section 2 is called in response to the events set in Section 1 just described. Associated with each such event are data specifying the flight leg and the air unit, and also details from Section 1 describing the segment of the flight leg on which engagement was anticipated to be possible including the identity of the ADCU(s) expected to engage. A logical flow diagram of Section 2 is shown in Figure IV-15-9.

1. The first step in Section 2 is to update the position of the air unit to the location of the start of this segment of the flight leg.

2. To perform its primary task, Section 2 must examine the current status and air defense capability of each air defense weapon system in each ADCU expected by Section 1 to be able to participate on this segment of the flight leg. This detailed examination by weapon type reveals which, if any, weapons are expected to be capable of delivering projectiles which will intercept the air unit on this segment of the flight leg. Since the ADCU has line of sight on this segment, all contained weapons are temporarily assumed, for this examination, also to have line of sight. The range of each weapon type, however, is critical in this examination. Other factors such as ammunition supply and specific weapon capability limits are also considered here. This **examination** also determines when the projectiles fired by each capable weapon are expected to begin intercept and cease intercept of the air unit. This determination of timing requires consideration of the immediately preceding activity of the pertinent weapons, or the time when the air unit will enter range of a given weapon type, as well as any delay times which may be appropriate to the specific circumstances. Delay times which may be appropriate include acquisition delay, reaction time, and projectile time of flight. For example, if the prior activity of a weapon were, for a sufficient period, firing at this air unit, then no delay would apply to intercept by its projectiles on this segment of the flight leg. If, however, a weapon had not yet acquired the flight, then acquisition delay, reaction time, and projectile time of flight would all be applicable. In the latter case, it might be determined that the weapon could not intercept on this segment of the flight leg. In this manner, Section 2 analyzes the capability and timing of all the air defense weapons in the pertinent ADCU(s) and then sorts out the results by weapon type according to anticipated start and end of projectile intercept with the air unit on this segment of the flight leg. These sorted results reveal the flight subsegments within each of which the air unit is expected to be subject to attrition by a unique and constant set of air defense weapons. These flight subsegments will henceforth be referred to as constant fire subsegments (CFS).

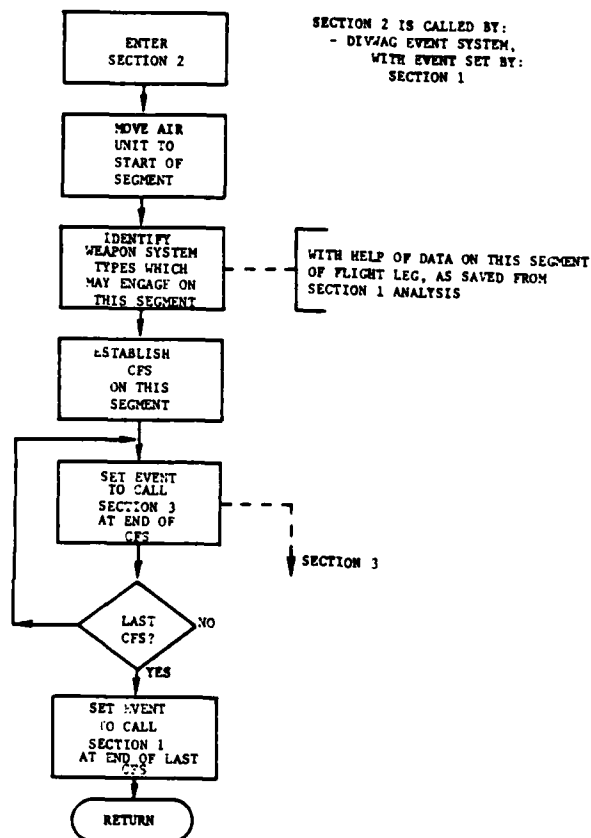


Figure IV-15-9. Macroflow of In-Flight Attrition Submodel (Section 2)



3. For each CFS established, Section 2 sets an event to call Section 3 at the end time of the CFS, for the final attrition calculations. Finally, Section 2 sets an event to call Section 1 at the end of the last CFS defined. If no CFS was defined, this event is set for the end of this segment of the flight leg.

(d) Section 3. Section 3 is called in response to the attrition event scheduled in Section 2. Based on the data on the CFS generated in Section 2, adjustments for status changes are made and weapons capabilities are now elaborated upon to approximate average capability over the CFS, suppressive fire and effects on air defense weapons are accounted for, and the aircraft attrition is calculated. A logical flow diagram of Section 3 is shown in Figure IV-15-10.

1. To prepare for attrition calculations, Section 3 references the current status of the various air defense weapon types which were anticipated (by Section 2) to be participants in the attrition inflicted on the flight during this CFS. Current time (and therefore status) is for the end of the CFS. The attrition calculations must exclude weapons which are destroyed and weapons which are suppressed. The current number of weapons on hand is accepted<sup>3</sup> as adequately reflecting weapons destroyed.

2. Because of the potential impact of suppression on results, a look back is made to CFS start time to evaluate suppressive effects from all sources at all points during the CFS. Air defense suppressive effects are represented by air defense suppression time durations, given in input, applied by Section 3 to the last time at which an ADCU was attacked. The entire ADCU is assumed to be affected uniformly. If a suppression time duration for a given ADCU is not found to overlap any part of the CFS, the ADCU is considered to be firing at CFS start time. In this case, a decision is made by Section 3 as to whether a pair of escorts, if available, would have been dispatched to suppress the ADCU. If the decision is positive, the suppressive effect of the escort action is superimposed, and the overlap of suppression duration with CFS is recalculated. In any case, the fraction of the CFS which is overlapped by the foregoing suppression evaluations, for a given ADCU, is used in the attrition calculation to degrade the amount of fire that any weapons in that ADCU can place on the air unit during this CFS. If escorts are unavailable to attack a firing ADCU, or if the firing ADCU is beyond the limits of attack escorts (to the sides of the flight path), a request for quick-reaction TACAIR or ground-based artillery fire support is made to the Intelligence and Control Model. The suppressive effect of any such external fire support rendered, however, is considered only on subsequent CFS.

3. Ideally, an adjustment should be made to reflect average number on hand over the length of the CFS. Provision is made to add such an adjustment later. As long as the segment is relatively short, however, little distortion should result.

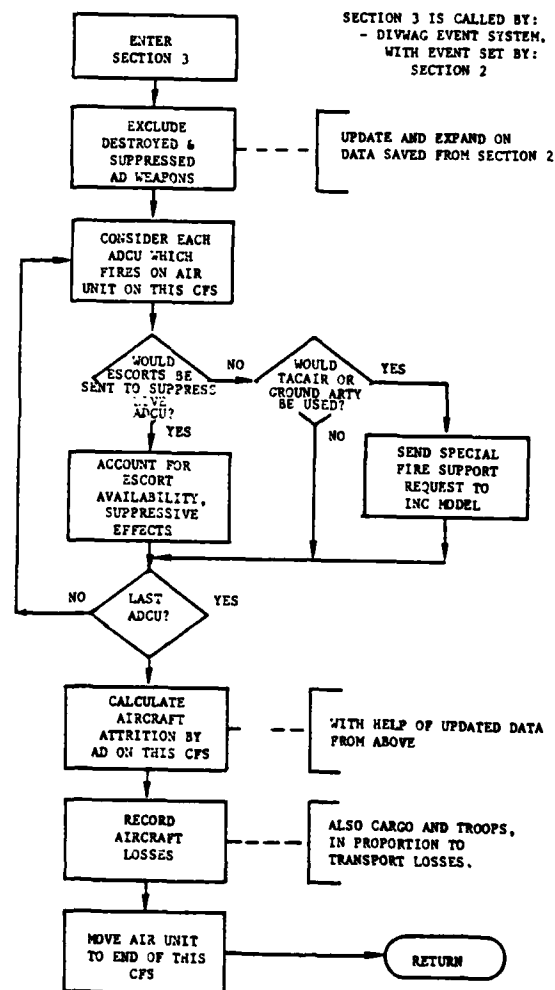


Figure IV-15-10. Macroflow of In-Flight Attrition Submodel (Section 3)

3. Preparatory to attrition calculations, Section 3 establishes the X, Y, and Z coordinates of the mid point of the CFS. The mid point is later used to calculate the aspect angle of the air unit and its slant range from the center of each ADCU participating.

4. If more than one ADCU was determined by Section 2 to be a participant on the CFS currently being processed for attrition, the ADCUs are considered separately; and within an ADCU, those weapon types determined to be participants are also considered individually. For each such weapon type, a series of calculation steps is performed, employing slant range and related geometry of the mid point of the CFS and reflecting the current number of weapons and their capability after adjustment for air defense suppressive effects, weather-visibility, and other current conditions. Different calculation procedures are used for missiles, as distinguished from guns. The result of these calculations is a set of probabilities of kill, by weapon type, by aircraft type in the unit, and by each of four kill-type categories. Each missile is assumed to be targeted against a single aircraft, of the largest type in the air unit; therefore, resultant missile probabilities of kill are considered equivalent to fractional losses. Rounds fired from guns are assumed to be equally distributed over all aircraft in the flight at the start of the CFS. Gun probabilities of kill are, therefore, per aircraft.

5. Probabilities of kill for all gun weapon types in all ADCUs participating are then combined by forming the product of the respective probabilities of survival, for each kill type and aircraft type. The aggregate probability of kill for all gun weapons, by kill type and aircraft type, is then one minus the respective compound probability of survival ( $1-P_s$ ). Missile losses are subtracted first, from aircraft in the air unit. The aggregate gun probability of kill is multiplied by the remaining aircraft of respective type to generate aggregate losses to guns.

6. Finally, losses to aircraft are recorded, and the position of the air unit is updated to that of the end of this CFS.

(3) Section 1 Operating Details:

(a) General. This subparagraph is a supplement to the preceding discussion of Section 1 of the In-flight Attrition Submodel. The general structure, concept, and macroflow of Section 1 was described above. This subparagraph, in contrast, describes how Section 1 performs its principal functions. Description focuses on the key algorithms and logical processes of Section 1.

(b) Incoming Data. Four essential data items are included in the data which accompany a call to Section 1. The first of these items is an operation code which causes the call to be routed to Section 1. The second item is the identity of the air unit (IUID). The third item is a flight continuity code (JPASS) which denotes whether this is the initial or a subsequent pass through the In-flight Attrition Submodel on this flight

path. The fourth item is a code which can be used to return to the primary caller when necessary. Section 1 then obtains additional data as needed. The first such items obtained include the beginning and ending X and Y coordinates of the current flight leg, obtained from the unit status record of the air unit.

(c) Flight Leg:

1. Establishment of Z Coordinates. Since the flight leg is defined so far only in the X, Y plane, the beginning and ending Z coordinates must be established by Section 1. The elevation of the ground at the beginning and ending X,Y coordinates is obtained and the height of the flight above terrain, obtained from the flight altitude variable on the unit status file of the air unit, is added to yield the Z coordinates of the beginning and end of the flight leg, in meters.

2. Orientation of the Flight Leg. The orientation of the flight is established in angular terms, so that coordinates of various points along the flight leg can be readily established. Orientation in the X,Y plane is represented by angle B, in radians. Angle B is calculated by the expression:

$$B = \tan^{-1} (y/x) \quad (IV-15-6)$$

where:

x = difference between beginning and ending  
X coordinates

y = difference between beginning and ending  
Y coordinates

Orientation of the flight leg in the vertical plane is represented by angle R, which is calculated by the expression:

$$R = \tan^{-1} (Z_2 - Z_1)/d \quad (IV-15-7)$$

where:

$Z_2$  = ending Z coordinate

$Z_1$  = beginning Z coordinate

$$d = \sqrt{x^2 + y^2} \quad (IV-15-8)$$

The flight leg is assumed to be a straight line for purposes of establishing position of the air unit. Certain trigonometric functions of these angles are calculated at this time for later use in updating positions.

3. Air Unit Initial Position. The position of the air unit, at the time of primary call to Section 1, is at the beginning of the flight leg. At the time of secondary call, air unit position may have been updated appropriately to some point along the flight leg.

(d) End-of-Flight-Leg Check for Air Unit. In case the air unit position has been updated, through steps taken in other parts of the in-flight attrition process, to the end of the current flight leg, a check is made. If the unit is at the end of the flight leg, control is returned to the primary caller to permit presentation of the next flight leg, if any.

(e) Initial Position of Reference Point P. On the first pass through Section 1, signified by the zero value of the pass code (third item of incoming data), the position of the reference point, P, is set to the location of the air unit, which is at the beginning of the flight leg. On all subsequent passes through Section 1, signified by the value 1 of the pass code, point P is set to the position it held at the end of the last pass, as obtained from the stored X and Y coordinates. The Z coordinate is obtained by use of the utility routine, ELEVAT.

(f) Search for Enemy Units. From the look point, the utility routine, SEARCH, is used to generate a list (list 1) of all enemy units within a specified radius. The radius is limited, to reduce unnecessary computation, depending on the altitude of the flight above the terrain and foliage. If altitude is within 100 feet, the look radius is set to 4000 meters. If altitude is between 100 and 1000 feet, the radius is set to 6000 meters. If altitude is between 1000 and 3000 feet, radius is 10,000 meters, while for over 3000 feet, radius is 20,000 meters.

(g) Developing List of AD Weapon Types Ranked in Order of Decreasing Range. In order to screen the list of enemy units, just obtained, for ADCUs in range, a list of all AD weapon types ranked in decreasing order of maximum effective weapon range is formed. The weapon types specified to have AD capability are obtained, together with their maximum effective ranges, from the input data file.

(h) Screening for ADCUs in Range. The list of enemy units within search radius is screened next for ADCUs whose longest range AD weapon can reach the reference point, P. Each enemy unit is examined to see if it contains any weapons of any AD type, starting with the longest range type, according to the ranked list of types. If any AD weapons are found, the distance, d, between point P and the ADCU is calculated by the expression:

$$d = \sqrt{(X_p - X_u)^2 + (Y_p - Y_u)^2} - 1/2 \text{ the minimum of } \begin{matrix} D \text{ or } W \end{matrix} \quad (\text{IV-15-9})$$

where:

$X_p$  = X coordinate of point P

$Y_p$  = Y coordinate of point P

$X_u$  = X coordinate of ADCU center

$Y_u$  = Y coordinate of ADCU center

D = depth of ADCU, in meters

W = width of ADCU, in meters

The distance, d, is then compared with the maximum effective range of the weapon type to determine if the ADCU is within range.

(i) Screening for Line of Sight. If the ADCU is within range, it is also tested for line of sight. The line of sight function, LOS, is used. The operation of this function is described in Chapter 4. Function LOS is given the X, Y, and Z coordinates of the imaginary reference point, P, plus a flag indicating where to find the X, Y, and Z coordinates of the ADCU. A yes or no answer is returned for existence of line of sight between these two points. While this screening proceeds, the earliest time that line of sight is gained by any ADCU in range is recorded for use in Section 2.

(j) Incrementing Location of Reference Point P. If no ADCU is found within range of, and with line of sight to, the air unit at the start of the flight leg, the reference point, P, is stepped ahead along the flight path by an incremental distance, and the search and screening process is repeated. The incremental distance is a fixed value which is a product of a variable time increment and the flight speed of the air unit. The time increment  $t_1$ , is calculated by the reverse process:

$$t_1 = d_1/s \quad (\text{IV-15-10})$$

where:

$d_1$  = incremental distance

s = flight speed of the air unit

The incremental distance is hard-wired and is chosen to compromise adequately between need for accuracy of results and need to minimize computer running

time. The value currently used is 1000 meters. The new coordinates of point P are calculated, using trigonometric functions of the angular orientation of the flight leg, as described above. The new coordinates are:

$$X = X_0 + D \cdot \cos B \quad (\text{IV-15-11})$$

$$Y = Y_0 + D \cdot \sin B \quad (\text{IV-15-12})$$

$$Z = Z_0 + D \cdot \sin R \quad (\text{IV-15-13})$$

where:

$X_0$  = initial or previous X coordinate of point P

$Y_0$  = initial or previous Y coordinate of point P

$Z_0$  = initial or previous Z coordinate of point P

D = the cumulative distance of all incrementation  
to date on this flight leg

B and R are angles defined in paragraph (c)2 above, Equations IV-15-6 and IV-15-7.

The cumulative distance, D, of all incrementation to date on this flight leg is obtained by the expression:

$$D = s \cdot t \quad (\text{IV-15-14})$$

where:

s = flight speed of the air unit

t = the cumulation of all time increments  
so far on this flight leg.

If the incrementation should push the new coordinates beyond the end of the flight leg, this condition is detected, and the coordinates are reset to those of flight leg end.

(k) End-of-Flight-Leg-Check for Reference Point P. The check to determine whether point P has reached the end of the flight leg is made on each pass through the point P incrementation loop.

(1) Flying Air Unit to End of Flight Leg. If point P was found to have reached the end of the flight leg, no further preparatory processing of this flight leg will occur. Accordingly, the location of the air unit is updated to the end of the flight leg. This is done by resetting air unit coordinates to coordinates of flight leg end. An event is then set to call Section 1 at the time the air unit, flying at its given speed, will reach the end of the flight leg. The time of the event,  $t$ , is found by the expression:

$$t = t_0 + d_r/s \quad (IV-15-15)$$

where:

$t_0$  = current time

$d_r$  = distance between air unit current location  
and end of flight leg

$s$  = flight speed

The distance,  $d_r$ , is calculated by the equation:

$$d_r = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2} \quad (IV-15-16)$$

where:

$X_1$  = current X coordinate of air unit

$Y_1$  = current Y coordinate of air unit

$X_2$  = flight leg end X coordinate

$Y_2$  = flight leg end Y coordinate

When Section 1 is called at this event time, it senses that the air unit is at the end of the flight leg and therefore returns to the primary caller so that any following flight leg may be presented for in-flight attrition.

(m) Establishment of Possible Engagement Segments:

1. Finding First Start. If, for the first time on this flight leg, after the screening steps described above, one or more ADCUs remain within range and line of sight to the reference point, P, then the start of the first possible engagement segment on this flight leg has been found. The coordinates of the start of this possible engagement segment are equated to those of point P. The identity of each ADCU which could possibly engage at this point is placed on a list (list A) which will assist in finding the end of the first engagement segment.



2. Finding First End. The end of the first possible engagement segment on this flight leg is sought as soon as the start has been found. To find the end, the location of reference point P is stepped ahead one increment. From the new point P, a new search for enemy units is conducted, and all units found are screened for AD weapon range and line of sight. The identity of each ADCU which passes the screening is placed on a list (list B). The contents of list B is now compared with the contents of list A. If the same ADCUs are on both lists, the location of point P is again incremented, and the search and screening steps are repeated to generate a new list B. As soon as the contents of lists A and B disagree, then the end of the first possible engagement segment has been found. The end coordinates of this segment are equated to those of point P.

3. Finding Subsequent Start and End. The start and end of subsequent possible engagement segments of the flight leg are found in the same manner as described in the preceding two paragraphs, while the reference point, P, continues to progress along the flight leg. The end of a previous segment will be the start of a subsequent segment only if one or more ADCUs remain able to engage; otherwise, a portion of the flight path will intervene on which no engagement is possible.

(n) Setting Event to Call Section 2. Whenever the end of a possible engagement segment of the flight leg is found, an event is set to call Section 2, so that more detailed analysis of engagement possibilities can be performed. The time at which Section 2 will be called is set to the time at which the air unit should arrive at the start of the possible engagement segment. This time is directly available, since it has been maintained and updated by all time increments used in moving point P since the first call to Section 1.

(o) Data Stored. Whenever an event to call Section 2 is set, data are stored for later use. The items include the total number and identity of each ADCU on list A for the particular segment of the flight leg, the beginning and ending X and Y coordinates of the segment, the start time of the segment, and the time at which line of sight is first gained (air unit mask time), if at all, on this segment.

#### (4) Section 2 Operating Details:

(a) Incoming Data. The same four essential items which are incoming to Section 1 also accompany a call to Section 2. These are the call routing code, the identity of the air unit (IUID), the flight continuity code (JPASS), and the code used by Section 1 to return to the primary caller. Section 2 then obtains additional data, including the data stored by Section 1 (see paragraph (3)(o) above, AD weapon characteristics) and the unit status record of the air unit, containing the X and Y coordinates of the flight leg.

(b) Update of Air Unit Location. An initial step taken by Section 2 is to move the air unit to the X,Y coordinates of the start of the possible engagement segment. These coordinates are included in the data stored by Section 1.

(c) Length of Possible Engagement Segment. The length, L, of the possible engagement segment is calculated by the expression:

$$L = \sqrt{(X_e - X_b)^2 + (Y_e - Y_b)^2} \quad (IV-15-17)$$

where:

$X_e$  = X coordinate of end

$Y_e$  = Y coordinate of end

$X_b$  = X coordinate of beginning

$Y_b$  = Y coordinate of beginning

(d) Setting Flight Continuity Flag. If this is the first time that Section 2 has been called for this air unit's current flight through hostile air space, the flight continuity flag, JPASS, an essential incoming item of data, will enter with a value of zero, which was set by the primary caller. Section 2 checks on the value of JPASS, and if it is found to be zero, resets it to a value of one. The value one remains for all subsequent flight legs and signifies to the various parts of the In-flight Attrition Submodel that any call with this value is a continuation of a flight already in progress, rather than the start of a new flight.

(e) Determining Initial Value of Last Event Time. The time of the end of the last constant fire subsegment (CFS) defined for this air unit flight path is an important reference value throughout Section 2. If this is the first time that Section 2 is called for a given air unit flight path, no prior CFS can have been defined. In this case, Section 2 sets the last event time variable, LASTET, equal to the start time of this possible engagement segment of the flight leg, as stored in Section 1. If, however, this is not the last call to Section 2 for the given air unit flight path, last event time is found from the stored records of CFS found on a previous pass through Section 2. In case no record yet exists, the value generated on the first pass is used.

(f) Processing ADCUs Which Can Possibly Engage. Each ADCU designated by Section 1 as possibly being able to engage the air unit on this segment of the flight leg is put through a series of processing steps.

1. Finding Air Unit Crossover Point Versus this ADCU.

The crossover point is the point on the line through the ends of this possible engagement segment which is nearest to the ADCU. The position of the crossover point is returned in terms of a variable which reflects the fractional position of the point between the begin and end of the segment, or, if the point is beyond an end, the fractional degree of excess, with a sign to indicate the end exceeded.

2. Screening Weapon Type Capability in This Situation.

Within a given ADCU, the capabilities of each AD weapon type are first grossly screened to eliminate from further consideration weapon types which cannot engage in this particular situation. A series of screening checks is employed based on the current status of the ADCU.

a. Weapon Defense Responsibility Radius. If the air unit is outside the input-specified radius of defense responsibility of a given AD weapon type, that type is dropped from further consideration. Distance,  $d$ , between air unit and AD weapon, for this check, is obtained by the equation:

$$d = \sqrt{(X_b - X_u)^2 + (Y_b - Y_u)^2} + 1/2 \text{ the minimum of } D \text{ or } W \quad (\text{IV-15-18})$$

where:

$X_b$  = X coordinate of beginning of possible engagement subportion

$Y_b$  = Y coordinate of beginning of possible engagement subportion

$X_u$  = X coordinate of ADCU center

$Y_u$  = Y coordinate of ADCU center

$D$  = depth of ADCU, in meters

$W$  = width of ADCU, in meters

b. AD Weapons on Hand. If any AD weapons of this type remain on hand (i.e., remain undestroyed), this type is considered further; otherwise, it is dropped.

c. Ammunition on Hand. This weapon type must have some of the proper type of ammunition on hand for the weapon type to be considered further.

d. Weather-Visibility Condition. The current weather-visibility condition is obtained by use of the utility routine WETTHR, which tells whether it is day or night and good or poor weather. Input data for the weapon type specifies whether the weapon is capable of firing effectively in either nighttime or poor weather conditions. If a condition prevails in which the weapon cannot fire effectively, it is not considered further.

e. Aircraft Altitude. Maximum and minimum aircraft altitude capability of the AD weapon type, from input data, is compared with aircraft altitude. If the aircraft altitude is within weapon capability limits, the weapon continues in consideration.

f. Aircraft Speed. Input data also contain maximum and minimum aircraft speed capability of the weapon type. If the aircraft is within weapon capability limits, the weapon type continues to be considered.

g. IR Lock-On Boundary. Input data provide a simplified boundary representation for the capability of infrared-seeking missiles to achieve lock-on. The input is a set of boundary distances as a function of seven horizontal aspect angles of the aircraft trajectory. For comparison with the input data, the horizontal aspect angle of this air unit and its distance from the weapon is calculated. Boundary distance is interpolated linearly, between the nearest two of the seven input aspect angles. Air unit distance from the weapon is the same distance,  $d$ , as calculated for comparison with defense responsibility radius, above. Horizontal aspect angle of the air unit trajectory is calculated with the assistance of the utility routine DISTPL. This routine is given the begin and end X,Y coordinates of the possible engagement segment and the X, Y coordinates of the ADCU, and returns a perpendicular distance,  $b$ , from the ADCU to the line passing through the begin and end coordinates (see Figure IV-15-11). The third side,  $a$ , of the right triangle of sides  $a$ ,  $b$ ,  $d$  is calculated by the expression:

$$a = \sqrt{d^2 + b^2} \quad (\text{IV-15-19})$$

The horizontal aspect angle is defined here as the angle  $A$ , between the sides representing the perpendicular distance,  $b$ , and the ADCU-to-begin distance,  $d$ . The tangent of this aspect angle equals  $a/b$ . This aspect angle,  $A$ , is therefore calculated by:

$$A = \tan^{-1} (a/b) \quad (\text{IV-15-20})$$

If the interpolated boundary distance exceeds distance  $d$ , the weapon continues to be considered.

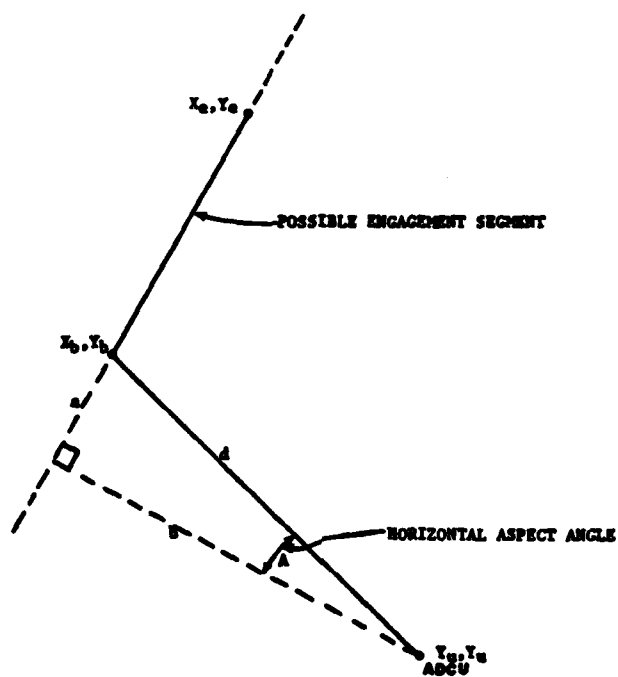


Figure IV-15-11. Horizontal Aspect Angle

h. Slew Rate. The angular rate of the aircraft with respect to the ADCU is calculated and compared with the maximum slew or tracking rate capability of the AD weapon, from input data. Weapon capability must exceed aircraft angular rate for the weapon to be considered further. Aircraft angular rate,  $\dot{\theta}$ , is calculated by the expression:

$$\dot{\theta} = \cosine A \cdot s/d \quad (IV-15-21)$$

where:

A = horizontal aspect angle, as defined in preceding paragraph

s = speed of air unit

d = distance between ADCU and air unit as used in preceding paragraph.

3. Range of AD Weapons. For use in determining the portions of the flight path that each weapon type can reach, the position of weapons in the ADCU must be considered. The AD weapons are assumed to be uniformly distributed on the circumference of a circle of which the diameter is the minimum of the depth and width of the ADCU. Thus half the diameter of that circle is added to the maximum effective weapon range of each weapon type when considering range intercept points on the flight path.

4. Determining Range Intercept Points on Flight Path. To determine where on the flight path the range of any weapon type, in a given ADCU, can begin to intercept and will cease intercepting, the adjusted weapon range as defined in the preceding paragraph is used. These two points of intercept are determined by using the utility routine CHORD. This routine is given the X,Y coordinates of the ADCU, the X,Y beginning and ending coordinates of the possible engagement segment, and the adjusted AD weapon range. This routine returns the X coordinates of the two points where a line extended through the possible engagement segment is intercepted by the range. The X coordinate corresponding to the start of range intercept is identified and so labeled (X1), as is the X coordinate corresponding to the end of range intercept (X2). This identification is accomplished by reference to the order of the X values of the beginning and ending of the possible engagement segment together with those of the two points. The corresponding Y coordinate for each of these two intercept limits is obtained from the line of the possible engagement segment by the expression:

$$Y_p = (Y_e - Y_b) \cdot (X_p - X_b) / (X_e - X_b) + Y_b \quad (IV-15-22)$$

where:

$X_b$  = X coordinate of beginning of possible engagement segment

$Y_b$  = Y coordinate of beginning of possible engagement segment

$X_e$  = X coordinate of ending of possible engagement segment

$Y_e$  = Y coordinate of ending of possible engagement segment

$X_p$  = X coordinate of a range intercept point

$Y_p$  = Y coordinate of a range intercept point

5. Excluding Irrelevant Range Intercept Points. Range intercept points may be generated, by the foregoing process, which are irrelevant to this possible engagement segment of the flight leg. Such point pairs must be excluded from consideration on this segment, since they are considered on either prior or subsequent segments. To identify and exclude such point pairs, it is determined whether the intercept points lie on the engagement segment or on extensions thereof. If both points lie outside the same end of the possible engagement segment they are clearly excludable, since they are properly considered in another segment. If the points straddle this possible engagement segment they cannot be excluded.

6. Calculating Times of Start and End of Range Intercept. If both range intercept points fall within the possible engagement segment, their times can be calculated directly. If, however, one point is within and the other point is outside, or if the points straddle the segment, an adjustment is necessary.

a. Both Intercept Points Within Segment. If both range intercept points lie within the possible engagement segment, the time for each,  $t$ , is calculated by the expression:

$$t = b + f \cdot d/s \quad (IV-15-23)$$

where:

$b$  = time of beginning of this possible engagement segment

$f$  = the fraction of distance, between beginning and end of the segment, at which the point lies

$d$  = the length of the segment (see paragraph e(4)(c) above)

$s$  = speed of the air unit.

b. One Point Within Segment. If only one of the two points lies within the possible engagement segment, time for the inside point is calculated as in the preceding paragraph. Time for the outlying point, however, is set equal to the time of the end of the segment on which the point lies outside.

c. Points Straddling Segment. If the two range intercept points straddle the possible engagement segment, the time of each point is set equal to the time of that end of the segment outside which the point lies.

7. Calculating Time Delays to Start of Projectile Intercept. Depending upon the specific circumstances, a delay may occur which affects the time at which projectiles from the given weapon type intercept the air unit. Up to three types of time delay may be included in the total delay imposed. These types are detection delay, fire/launch delay, and time of projectile flight to target. Means used to calculate these delays are described in this paragraph. The determination of the applicability of and method of applying any or all of these delays is discussed in paragraph 8 below.

a. Detection Delay. In those circumstances where detection delay is applicable, it is calculated from data provided in input tables. The input tables contain data on probability of detection of aircraft by one AD weapon, within some cut-off time, and corresponding data on median time delay, from entry of the target into line of sight until detection of the target. Some of the data can be obtained from Combat Developments Command Experimentation Center test results. Data are provided for three basically different types of an engagement situation that the model may be called upon to simulate. Means of detection used and other conditions are assumed to be inherent to each of the three types of an engagement situation. These types are:

- . AD guns and short range missiles against average type helicopters at nap-of-the-earth altitude, with average background clutter/contrast for the territory being gamed.
- . AD guns and short range missiles against average type fixed-wing aircraft, under average conditions.
- . Medium and long range AD missiles against average type fixed-wing aircraft, under average conditions.

Data are provided for three groups of aircraft, each at four slant ranges. For a specific situation, the model interpolates linearly between the input data points to obtain the specific input median delay value for one AD weapon. Since an ADCU may contain a number of AD weapons which are in a position to detect, the model must adjust the input delay for this number. Also, since the field test data are often subject to a cut-off time and therefore incomplete, adjustment



must be made for the missing data reflected by a probability of detection, within cut-off time, of less than 1.0. These adjustments, and the selection of a specific delay value, assume that detection delays are, in reality, log-normally distributed. Also, it is assumed that the standard deviation (in the log domain) of the distribution can be satisfactorily estimated by the relationship:

$$s = \gamma \cdot \ln(t) \quad (\text{IV-15-24})$$

where:

$s$  = estimated standard deviation (in log domain)

$t$  = median detection delay

$\gamma$  = a constant for the type of data situation being considered. This constant can be derived from field test data. Examination of data from the Combat Developments Command Experimentation Center 43.6 test yields a value of about 0.25.

The adjustment for incomplete field test data is then made by the equation:

$$t_{1a} = t_1 \cdot e^{-S_1 \cdot f_1 (P_d/2)} \quad (\text{IV-15-25})$$

where:

$t_{1a}$  = adjusted median detection delay for one AD weapon

$t_1$  = input median detection delay for one AD weapon

$S_1$  = estimated standard deviation for the field test data (in log domain)

$P_d$  = probability of detection by one AD weapon, within the cut-off time of the field test data.

$f_1$  = a function which returns an approximation<sup>4</sup> of the cumulative area beneath the normal curve corresponding to a position along the curve,

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4. Adapted from Hastings, Approximations for Digital Computers, Princeton University Press, 1955, p. 187.

in standard deviations, represented by the value in the parentheses. Utility function DNORM is used.

The adjustment for the actual number of observing AD weapons is then made by a method of successive approximations, using the following formula for the cumulative lognormal probability distribution:

$$\Phi(x) = \int_{-\infty}^x e^{-\frac{x^2}{2}} \cdot dx \quad (\text{IV-15-26})$$

where:

$$x = \frac{\ln\left(\frac{t_n}{t_{1a}}\right)}{S_1}$$

$t_n$  = median detection delay for  $n$  AD weapons

$t_{1a}$  = adjusted median delay for one AD weapon

$S_1$  = estimated standard deviation for the test data

A trial value of  $t_n$  (actually  $t_{1a/n}$ ) is inserted in this equation. The formula is evaluated, and the resulting value of  $\Phi(x)$ , representing the probability of detection by one weapon within time  $t$ , is then transformed to an estimate of the probability for  $n$  weapons,  $P_{dn}$ , by the formula:

$$P_{dn} = 1 - (1 - \Phi(x))^n \quad (\text{IV-15-27})$$

where:

$n$  = the total number of AD weapons in this ADCU

The value of  $P_{dn}$  is then compared with the desired value of 0.5, representing the probability corresponding to the desired median time delay. By adjusting  $t_n$  in the proper way, several reiterations yield a value of  $\Phi(x)$  acceptably close to (within  $\pm 0.01$ ) the desired 0.5. The latest  $t_n$  value is then used as the median detection delay for  $n$  AD weapons. The detection delay value used to establish the start of the CFS is now selected from the lognormal distribution of delays, based on the median value just derived for  $n$  AD weapons. This selection of delay is made by the equation:

$$\text{Delay} = t_n \cdot e^{S_n \cdot U}$$

(IV-15-28)

where:

$t_n$  = median detection delay for n AD weapons

$S_n$  = estimated standard deviation for n AD weapons

=  $\gamma \cdot \ln(t_n)$  ( $\gamma$  = constant, see above)

U = a random normal deviate

=  $f_2$  (a random number from a uniform distribution between 0.0 and 1.0)

and where:

$f_2$  = a function which returns an approximation<sup>5</sup> of the number of standard deviations corresponding to the cumulative fraction of area beneath the normal curve, as represented by the random number. Utility function FNORM is used.

b. Firing/Launch Delay. Firing/launch delay, when applicable, is obtained from the weapon input data and is a constant for each AD weapon type.

c. Time of Projectile Flight to Target. When applicable, time of projectile flight to target is approximated by a two-step reiteration process. The first step uses the current location of the air unit from which to calculate slant range to the ADCU center. Using this slant range, time of flight to initial target location is calculated or interpolated for the weapon. The target is then moved, according to its flight speed and direction, to the position it would have reached after projectile time of flight to the initial target location. For the second step, time of flight is recalculated or reinterpolated to the new target location. The second time of flight is then used as an approximation for delay applications. Slant range is calculated from the X, Y, and Z coordinates of the air unit and the ADCU. Distance in the X,Y plane is calculated first. Difference in Z coordinates is then used to calculate slant range. Both calculations use the Pythagorean theorem. Given the slant range, time of flight for a missile is interpolated from the input data table of time of flight versus slant range for the weapon type. For guns, time of flight is calculated by the formula:

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5. Adapted from Hastings, Approximations for Digital Computers, p. 192.

$$t = \frac{r}{v - r \cdot c}$$

(IV-15-29)

where:

r = slant range

v = muzzle velocity of the weapon type

c = projectile drag coefficient of the weapon type.

8. Application of Time Delays. The applicability of any of the three types of time delay to projectile intercept, as well as the method of application, depends upon the current nature and history of the engagement situation between the air unit and air defense weapons.

a. Detection Delay. Detection delay is applied whenever this ADCU must acquire the air unit. This ADCU must acquire the air unit when it has been either out of range or masked to all ADCUs immediately prior to the current possible engagement segment of the flight leg. Considered from the reverse standpoint, if another ADCU is currently engaging the air unit, or has recently acquired it and is about to engage it, the model does not apply detection delay to the ADCU currently being processed. Good communication is thus assumed between nearby ADCUs. If this ADCU must acquire the air unit, detection delay is applied directly to only the first CFS on this possible engagement segment. This delay may indirectly affect other CFS, however, since by definition they must follow the first CFS. Detection delay, when applicable, is applied to the time that the air unit enters line of sight of this ADCU. This time was calculated in Section 1 and stored for use here. The determination of whether this ADCU must acquire is made by checking on whether the last possible engagement segment of the flight path is contiguous with the possible engagement segment currently being processed. If they are contiguous, no detection delay is applied. If they are not contiguous, detection delay is applied as just described.

b. Firing/Launch Delay. A firing/launch delay is applied (added) whenever a detection delay is applied. In addition, firing/launch delay is applied if the air unit enters range of this ADCU before line of sight to this ADCU, when other ADCUs are already participating. In the latter case, it is assumed that this ADCU has been continually informed by the other participants as to the course and position of the air unit; therefore, this ADCU knows where to look, but cannot fire until the flight enters line of sight. In this case, it is assumed that detection time is negligible, but that reaction, tracking, or launch time must be applied, as represented by the input firing/launch delay. When applied independent of detection delay, firing/launch delay is added to the time of entry into line of sight, and only on the first CFS, similarly to detection delay.

c. Time of Projectile Flight to Target. Time of projectile flight delay is applied (added) only when firing/launch delay is applied, and similarly is applied only to the first CFS.

d. Total Delay. The total delay applied is the sum of the applicable delays as described above. Three total-delay cases result. Total delay in the first case is the sum of detection delay, firing/launch delay, and projectile time of flight. In the second case, the total is the sum of firing/launch delay and projectile time of flight. In the third case, the total is zero delay.

9. Screening for Intercept Duration. If any delay time is directly applied to a particular weapon type in a given ADCU, the duration of time over which projectiles from this weapon type can intercept the air unit may be affected. Other weapon types may also be indirectly affected. Since total delay is always added to time of entry into line of sight, and since line of sight time in some cases will precede the start of this possible engagement segment the start of projectile intercept time,  $t_s$ , is established for this weapon type as follows:

$$t_s = \text{Max of } (t_m \text{ or } (t_{los} + d)) \quad (\text{IV-15-30})$$

where:

$t_m$  = start time of this possible engagement segment

$t_{los}$  = time of entry into line of sight

$d$  = total delay applied.

This time of projectile intercept start now supersedes the range intercept start time calculated earlier (paragraph 6 above). Next, the time of projectile intercept start is compared with the time of range intercept end, calculated earlier. If there is no positive projectile intercept duration, this weapon type is dropped from further consideration on this possible engagement segment. The time of detection by this weapon is saved, however, for use in considering other weapon types in this ADCU. This time of detection is the base point for determining if any other weapons can, because of possible lower fire/launch and projectile flight times, intercept the target.

10. Storing Intercept Events. As each weapon type in each ADCU which can possibly engage on this subportion of the flight leg is processed, the results are temporarily stored for further processing. For each weapon type that passes the foregoing screening, four items of data are stored for each of the two intercept events, the start of projectile intercept and

the end of projectile intercept. The four items stored are the identity of the ADCU, the identity of the weapon type, the event time, and a flag indicating whether the event is a start or an end event.

(g) Processing Intercept Events. When all ADCUs expected to participate on this possible engagement segment of the flight have been processed, the accumulation of resulting intercept events is sorted and analyzed to establish CFS. Within each CFS a unique set of ADCU-weapon type combinations are anticipated to have projectiles intercepting the vicinity of the air unit.

1. Ranking Intercept Events by Increasing Event Time. The accumulated intercept events are first ranked in order of increasing event time.

2. Finding CFS and Setting Event for Each to Call Section 3. The ranked intercept events, temporarily stored on a list called TEMP1, are considered one at a time, starting with the earliest event time. The first step is to compare the time of this event with the time of the last event. (Initially, before any CFS is established for this flight path, last event time is set to start of the possible engagement segment. Subsequently, last event time is stored with CFS.) If the time of this event is the same as that of the last event, and if this event is a start event, the identity of the ADCU and the identity of the weapon type are entered on a second list, called TEMP2, and the next event on TEMP1 is considered. The entry in TEMP2 signifies that the identified ADCU-weapon type combination is currently intercepting. If the second event on TEMP1 has a time larger than last event time, and if it also is a start event, a check is made to see if any ADCU-weapon combination is currently intercepting (is currently on TEMP2). If there is, a CFS record is built and stored and an event is set in the DIVWAG event scheduling system to call Section 3 of the In-flight Attrition Submodel at the time of this event from TEMP1, which is the end of the CFS. A key is sent with the call so that Section 3 can find the stored CFS record. This record contains four items of data. The items are last event time, event time, identity of ADCU, and identity of the AD weapon type. The ADCU and AD weapon data are copied from TEMP2, to include as many ADCU-weapon type combinations as are currently intercepting. After setting the DIVWAG event, the value of the last event time is updated to that of the event still being processed and, if this event from TEMP1 is a begin event, it is added to TEMP2. If, however, this were an end event, and if its same ADCU-weapon type combination were on TEMP2, then the counterpart on TEMP2, would be removed, signifying that that ADCU-weapon type combination is no longer intercepting. The next event from TEMP1 is then considered. If any event from TEMP1 has an event time which is not larger than the last event time, it is simply added to TEMP2 in the manner already described. All ADCU-weapon type combinations currently intercepting are thus kept listed on TEMP2. Whenever an event with a different time from TEMP1 is encountered, then the resulting CFS record contains all the ADCU-weapon type combinations intercepting on that CFS. This

process is continued until all events on TEMP1 are exhausted, and all CFS are thus established, for this possible engagement segment of the flight path. In case no CFS is found, last event time is set to the end of this possible engagement segment.

(h) Setting Event to Call Section 1 at Last Event Time. When all events on TEMP1 are processed, an event is set in the DIVWAG event scheduling system to call Section 1 at the time of the last TEMP1 event. This event will begin generation of the next possible engagement segment of the flight leg. This pass through Section 2 is now completed.

(5) Section 3 Operating Details. Section 3 of the In-flight Attrition Submodel is the last section. It calculates aircraft losses incurred on a single constant fire subsegment (CFS), which was established at an earlier time in Section 2. The CFS is a relatively short segment of the flight over which projectiles from a unique set of ADCU-weapon type combinations were anticipated to be intercepting the air unit. Section 3 is called by the DIVWAG event-scheduling system at the end time of the CFS.

(a) Incoming Data. Data accompanying the call to Section 3 are the same as for Sections 1 and 2, with one exception. The call to Section 3 carries an additional item, which specifies where to find the stored identities of the ADCU-weapon type combinations anticipated to be participants on the CFS. Section 3 then obtains the additional information it needs. This information includes the unit status record of the air unit, all data stored earlier by Sections 1 and 2, a list of all AD weapon types, the unit status record of each ADCU involved on this CFS, suppression time durations, AD weapon characteristics, and aircraft data.

(b) Establishing Coordinates of Constant Fire Subsegment. Coordinates of the beginning and ending of this CFS are established by Section 3, using from stored data the coordinates of the possible engagement segment, the start time of the possible engagement segment, the speed of the aircraft, and the start and end times of this CFS. First, the length,  $d$ , of the possible engagement segment is calculated by the Pythagorean theorem. Next, the ending time,  $t_{me}$ , of the possible engagement segment is calculated by the equation:

$$t_{me} = t_{mb} + d/s \quad (IV-15-31)$$

where:

$t_{mb}$  = beginning time of the possible engagement segment

$d$  = length of the possible engagement segment

$s$  = speed of the air unit

Then, the fraction,  $f_1$ , of the possible engagement segment between its beginning and the beginning of the CFS is computed by the formula:

$$f_1 = (t_{ib} - t_{mb}) / (t_{me} - t_{mb}) \quad (\text{IV-15-32})$$

where:

$t_{ib}$  = beginning time of the CFS

$t_{mb}$  = beginning time of the possible engagement segment

$t_{me}$  = ending time of the possible engagement segment

The fraction,  $f_2$ , of the possible engagement segment between its beginning and the end of the CFS is calculated by substituting the time of the ending in place of time of beginning of the CFS in the foregoing formula. Using these fractions, the coordinates of the CFS ends are calculated by the equations:

$$X_{ib} = X_b + f_1 \cdot (X_e - X_b) \quad (\text{IV-15-33})$$

$$Y_{ib} = Y_b + f_1 \cdot (Y_e - Y_b) \quad (\text{IV-15-34})$$

$$X_{ie} = X_b + f_2 \cdot (X_e - X_b) \quad (\text{IV-15-35})$$

$$Y_{ie} = Y_b + f_2 \cdot (Y_e - Y_b) \quad (\text{IV-15-36})$$

where:

$X_b$  = beginning X coordinate of the possible engagement segment

$Y_b$  = beginning Y coordinate of the possible engagement segment

$X_e$  = ending X coordinate of the possible engagement segment

$Y_e$  = ending Y coordinate of the possible engagement segment

$f_1$  = fraction of possible engagement segment to start of CFS



$f_2$  = fraction of possible engagement segment to end  
of CFS

$X_{ib}$  = beginning X coordinate of the CFS

$Y_{ib}$  = beginning Y coordinate of the CFS

$X_{ie}$  = ending X coordinate of the CFS

$Y_{ie}$  = ending Y coordinate of the CFS

(c) Processing Each Participating ADCU. More than one ADCU may have been anticipated to be a participant on this CFS. If so, the ADCUs are processed one at a time. This processing considers first those factors common to all AD weapon types within an ADCU. These factors include AD suppression conditions, the dispatching of escort aircraft to suppress this ADCU, and the geometry of the CFS as viewed from this ADCU. Next, each weapon-type anticipated to be a participant, from this ADCU, is processed to determine its effects against the air unit.

1. AD Suppression Check. To determine whether the AD weapons in this ADCU were suppressed during any part of this CFS, two sources of suppression are considered. One source considered is escort aircraft. The other source considered is TACAIR or ground-based artillery. The most recent interval during which all AD weapons in the ADCU are assumed to be suppressed is calculated for each of these two sources. The two intervals are compared with the CFS to see if overlap occurs. If overlap does occur, the fraction of the CFS overlapped is calculated for later use. If the CFS is totally overlapped, the ADCU is considered not to be firing.

a. AD Suppression by TACAIR or Ground Artillery. To establish the most recent interval for AD suppression by TACAIR or ground-based artillery, the time of last assessment by the Area Fire Model is obtained from the unit status record of the ADCU. This time is considered to be the start of the suppression interval. Next, an input ADCU suppression time duration is obtained from the suppression time tables (see Chapter 11), for each of TACAIR and artillery, according to the unit type (UTD), of the ADCU. These two input values are averaged and added to the start of the suppression interval to yield the end of the suppression interval for TACAIR or ground-based artillery.

b. AD Suppression by Escorts. Each time an escort pair is dispatched, as described below, to suppress an ADCU, an input ADCU suppression time duration is applied. This time duration is obtained from the same suppression time tables referenced in the preceding subparagraph. In the case of escorts, however, this suppression time duration is applied at the time of escort dispatch, to generate a time at which escort suppression of the ADCU will lapse,  $t_e$ , by the expression:

$$t_e = t_b + t_s + t_m \quad (\text{IV-15-37})$$

where:

$t_b$  = time at which suppression will begin

$t_s$  = suppression time duration - input (suppression tables)

$t_m$  = suppression mission duration - input for In-Flight Attrition

The time at which suppression will begin,  $t_b$ , is further defined as:

$$t_b = t_d + t_r \quad (\text{IV-15-38})$$

where:

$t_d$  = time of of escort pair dispatch to suppress ADCU

$t_r$  = response time of escorts to reach and attack  
ADCU - input for In-flight Attrition

The times at which escort suppression will lapse,  $t_e$ , and start,  $t_b$ , are stored on the unit status file of the ADCU; therefore, when Section 3 seeks to check the most recent interval for escort suppression, these two values are obtained from the ADCU unit status record.

c. Joint Suppression. The combined suppression for escorts and for TACAIR or ground-based artillery is formed through several logic steps. The simplest case is where the suppression interval for TACAIR or ground-based artillery overlaps the suppression interval for escorts. In this case, a joint suppression interval can be formed, consisting of the earliest of the two interval starts and the latest of the two interval ends. This joint interval is then rectified (truncated, if necessary) so that only that portion which overlaps the CFS is considered further. The fraction,  $f$ , of the CFS overlapped by the joint suppression interval is then calculated by the expression:

$$f = (t_{se} - t_{sb}) / (t_{ie} - t_{ib}) \quad (\text{IV-15-39})$$

where:

$t_{se}$  = rectified ending time of joint suppression interval

$t_{sb}$  = rectified beginning time of joint suppression interval

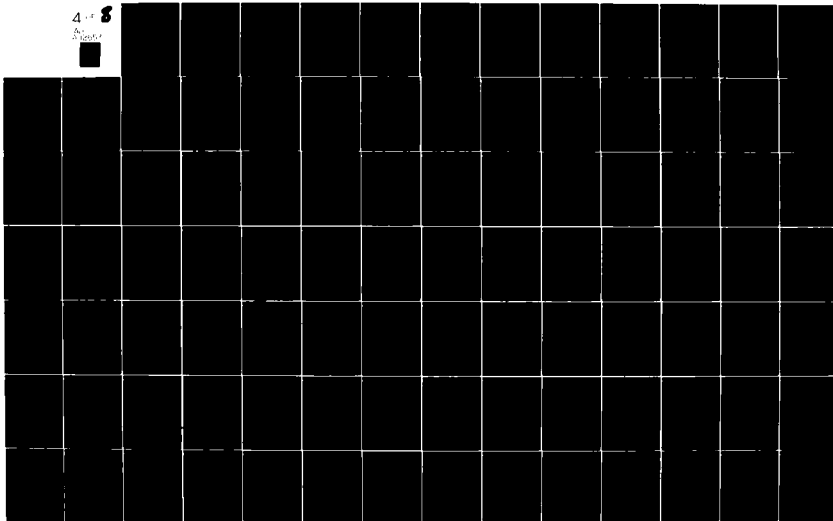
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DIVWAS MODEL DOCUMENTATION. VOLUME II. PROGRAMMER/ANALYST MANUA--ETC(U)  
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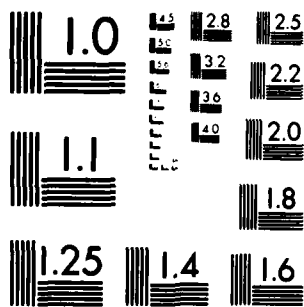
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$t_{ie}$  = ending time of CFS

$t_{ib}$  = beginning time of CFS

If, however, the suppression interval for TACAIR or ground-based artillery does not overlap the suppression interval for escorts, further logic steps are necessary. Each interval is compared with the CFS to see if any overlap occurs. If neither interval has any overlap, the fraction,  $f$ , is set to zero. If one interval has overlap, but the other does not, the former interval is rectified and used in the same way as in the simplest case to calculate the overlap fraction,  $f$ . If both intervals have some overlap, each interval is independently rectified and its overlap fraction calculated as described above. The two fractions are then summed to yield the joint overlap fraction. The joint overlap fraction is used in the suppression check (next subparagraph) and also later in calculating the number of weapons able to fire.

d. Suppression Check. If the joint suppression overlap fraction is 1.0, no AD weapons in this ADCU are considered to fire during this CFS; therefore, since the ADCU is not firing AD weapons, escorts will not be dispatched to suppress it, and the ADCU is not processed further on this CFS.

2. Decision to Dispatch Escorts. If the ADCU is firing, several checks are made to determine whether a pair of escort aircraft should be dispatched to suppress the ADCU.

a. Has Air Unit Passed Beyond No Request Point? If at the beginning of the CFS the air unit has passed beyond the "no request point," escorts are not dispatched. Whether the air unit has passed beyond the "no request point" is determined with the help of utility routine PONTLN. This routine is given the X,Y coordinates of the beginning and ending of this possible engagement segment of the flight path and the X,Y coordinates of the ADCU. PONTLN returns a value,  $T_1$ , which represents the position of the ADCU along the flight path relative to the beginning and ending of the segment. The value of  $T_1$  returned is negative if the ADCU is off the beginning. Between the beginning and ending of the segment, the value of  $T_1$  varies from zero to 1.0, representing the fractional position of the ADCU along the segment. Beyond the ending, the value of  $T_1$  increases in the positive direction. The "no request point," meanwhile, is based on the beginning of CFS. For comparison with  $T_1$ , a value,  $T_2$ , representing the position of the "no request point" is generated by the expression:

$$T_2 = (t_{ib} - t_{mb} - t) / (d/s) \quad (IV-15-40)$$

where:

$t_{ib}$  = beginning time of the CFS

$t_{mb}$  = beginning time of the possible engagement segment

$t$  = the length of time after passing the ADCU beyond  
which escorts would not be sent back to suppress  
it, from input data

$d$  = the length of the possible engagement segment

$s$  = speed of the air unit

The two values are now compared, and if  $T_2 > T_1$ , the air unit is considered beyond the "no request point," and escorts are not dispatched.

b. Is ADCU Too Far Away From Flight Path? If the ADCU is located at a distance from the flight path which exceeds the maximum distance which escorts are permitted to direct to attack plus any stand-off distance of the escort munition to be employed, escorts are not dispatched to suppress this ADCU. The distance from the ADCU perpendicular to the flight path is another value returned by utility routine PONTLN, just employed as described in the preceding subparagraph. The distance which escorts are permitted to direct plus their munition standoff distance are combined in a single input value, used in this comparison.

c. Are Escorts Available? If a pair of escorts does not remain on hand, according to the unit status record of the air unit, escorts are not dispatched. If escorts are dispatched, no adjustment is currently made to the number available.

d. Dispatch of Escorts. If the three preceding questions are all answered positively, a pair of escorts is considered dispatched to suppress the firing ADCU. The suppressive effect of this attack by escorts is recorded on the unit status record of the ADCU, as described in paragraph 1b, above.

### 3. Geometry to Mid Point of CFS:

a. Mid Point of the CFS. The mid point of the CFS is established using the coordinates of the beginning and ending of the CFS as calculated at the beginning of Section 3. The X and Y coordinates of the mid point are each calculated as one-half the sum of the corresponding beginning and ending coordinates of the CFS. The Z coordinate of the mid point is then obtained for the X,Y coordinate by use of the routine ELEVAT.

b. Aspect Angles and Slant Range. Both the horizontal and vertical angles from the ADCU to the air unit are calculated. The horizontal aspect angle has its apex at the ADCU and is measured between the point on the flight path nearest the ADCU (the crossover point) and the air unit. The vertical aspect angle similarly has its apex at the ADCU and is measured between the air unit and the X,Y plane containing the ADCU. To calculate the horizontal aspect angle, the ground track (in the X,Y plane of the ADCU) of the flight path is used. The horizontal distance,  $d_m$ , from the ADCU to the mid point of the CFS is computed by the expression:

$$d_m = \sqrt{(X_{im} - X_a)^2 + (Y_{im} - Y_a)^2} \quad (IV-15-41)$$

where:

$X_{im}$  = X coordinate of midpoint of CFS

$Y_{im}$  = Y coordinate of midpoint of CFS

$X_a$  = X coordinate of ADCU center

$Y_a$  = Y coordinate of ADCU center

The horizontal distance,  $d_c$ , from the ADCU to the crossover point is obtained by use of the utility routine DISTPL, which is given the beginning and ending X,Y coordinates of the CFS and the X,Y coordinates of the ADCU. The horizontal aspect angle,  $H$ , is then:

$$H = \sin^{-1} (d_c/d_m) \quad (IV-15-42)$$

where:

$d_c$  = horizontal distance from ADCU to crossover point, defined above

$d_m$  = horizontal distance from ADCU to air unit point, defined above

To calculate the vertical angle,  $V$ , the Z coordinate of the ADCU is obtained, through the routine ELEVAT, given the X,Y coordinates of the ADCU. For use here and also in later steps, the slant range,  $r_s$ , from the ADCU to the mid point of the CFS is calculated by the expression:

$$r_s = \sqrt{d_m^2 + h^2} \quad (IV-15-43)$$

where:

$d_m$  = as defined above

$h$  = difference in Z coordinates of ADCU and  
mid point of CFS

The vertical aspect angle,  $V$ , is then:

$$V = \sin^{-1} (h/r_s) \quad (IV-15-44)$$

where:

$h$  = as defined above

$r_s$  = slant range, as defined above

c. Angular Rates of Air Unit. The rates of change in the horizontal and vertical angles from the ADCU to the air unit are calculated for comparison with the slew rate or tracking rate capability of AD weapons. The horizontal angular rate,  $H_r$ , is calculated by the expression

$$H_r = s \cdot \cosine(H)/d_m \quad (IV-15-45)$$

where:

$s$  = speed of the air unit

$d_m$  = horizontal distance from ADCU to mid point of CFS

$$\cosine(H) = \sqrt{1 - \sin^2(H)}$$

The vertical angular rate,  $V_r$ , is computed by the similar equation:

$$V_r = s \cdot \sin(V)/r_s \quad (IV-15-46)$$

where:

$s$  = speed of air unit

$r_s$  = slant range

$\sin(v)$  = as defined above



d. Aircraft Direction. Also relative to the mid point of the CFS, a determination is made as to whether the aircraft are approaching or leaving the ADCU. This determination is made with the help of routine PONTLN, which is given the X,Y coordinates of the mid point and the ending of the CFS and the X,Y coordinates of the ADCU. If the value of the variable returned which relates the position of the ADCU to this line segment is negative, the aircraft are leaving; otherwise they are approaching.

e. Presented Area of Each Aircraft Type. For each type of aircraft in the air unit, the area of one aircraft, as presented to the ADCU, is calculated for the mid point of the CFS. Input data provides the face-perpendicular areas of the front or rear, side, and bottom of each aircraft type. The area,  $A_p$ , presented to the ADCU, from the mid point, for a given aircraft type, is calculated by the equation:

$$A_p = A_1 \cdot \cosine(V) \cdot \sine(H) + A_2 \cdot \cosine(V) \cdot \cosine(H) + A_3 \cdot \sine(V) \quad (IV-15-47)$$

where:

$A_1$  = area of front or rear

$A_2$  = area of side

$A_3$  = area of bottom

sines and cosines of angles are as defined above  
or derived therefrom

f. Fraction of ADCU in Line of Sight. To determine the fraction of the ADCU (and its contained AD weapons) which have line of sight to the air unit on this CFS, a method is used which should provide approximate answers of the right magnitude. This method was developed for this model, without benefit of empirical data, and should be considered an interim method. To apply this method, the terrain cell containing the ADCU is identified, and the corresponding values of the terrain indexes, roughness-vegetation, and forestation, are obtained. The environment routine IOTERN is given the X and Y coordinates of the ADCU to provide these values. Next, the vertical angle from the ADCU to the air unit, defined above, is calculated in degrees by the expression:

$$V_d = \tan^{-1} (\sine(V)/\cosine(V)) \cdot 57.3 \quad (IV-15-48)$$

If the vertical angle,  $V_d$ , is greater than 45 degrees, the fraction,  $f_{los}$ , of the ADCU in line of sight is calculated by the formula:

$$f_{los} = 1.05 - 0.05 \cdot RV \quad (IV-15-49)$$

where:

RV = roughness-vegetation index, with values ranging from 1-9 (see Chapter 4)

If the vertical angle is less than or equal to 45 degrees, the fraction in line of sight is computed by the formula:

$$f_{los} = 0.55 + 0.05(1 + V_d/5) - 0.05 \cdot RV \quad (IV-15-50)$$

where:

RV = as defined above

$V_d$  = as defined above

Finally, in either case, if the terrain cell is forested (i.e., if the forestation index value is greater than zero), three fourths of the fraction calculated above is taken for the fraction of the ADCU in line of sight to the air unit.

(d) Processing Each Participating Weapon Type in the ADCU.

Within each ADCU which passes the foregoing tests, each AD weapon type anticipated to be a participant on this CFS is processed to determine its possible effects against the air unit. This processing includes rechecking for weapons on hand, checking the air unit angular rate against weapon slew rate, and determining the fraction of the ADCU in range of the air unit, with subsequent separate processing of missile weapons, as distinguished from gun weapons.

1. Check for Weapons on Hand. The number of weapons on hand of this type is obtained from the current unit status record of the ADCU. If no weapons remain, this weapon type is not considered further, and the next weapon type is considered.

2. Slew Rates Check. If weapons are on hand, the angular rates of the air unit are compared with the maximum slew rates of the weapon type, from the input data. If the rate of change of either the horizontal or vertical angle from the ADCU to the air unit, as calculated earlier, exceeds the respective maximum slew rate of the weapon, this weapon type is not considered further.

3. Fraction of ADCU in Degraded Range. To determine the fraction of the ADCU weapons of this type which are within range of the mid point of the CFS, the maximum effective range of the weapon, from input, is adjusted for any degradation which may be caused by current weather-visibility

conditions, as expressed by the DIVWAG visibility index, of which the value varies from 1 to 9 (see Chapter 4). Input data for the weapon provides capability degradation percentages for five categories of weather-visibility index, WV. These categories are defined as very poor (WV = 1-2), poor (WV = 3-4), intermediate (WV = 5-6), fair (WV = 7-8), and good (WV = 9). The respective degradation percentage,  $d_p$ , is applied to the maximum effective range,  $r_m$ , of the weapon to obtain adjusted effective range,  $r_a$ , by the expression:

$$r_a = r_m \cdot (1 - d_p) \quad (\text{IV-15-51})$$

The Z coordinate of the ADCU is obtained by routine ELEVAT, which is given the X,Y coordinates. The radius of the circle on whose circumference the AD weapons are assumed to be uniformly distributed is calculated as one-half the lesser of ADCU width or depth. The X,Y,Z coordinates of the ADCU and the radius of weapon location in the ADCU is given to geometric routine CIRCLE, together with the X,Y,Z coordinates of the mid point of the CFS and the adjusted effective range of the weapon. CIRCLE returns the fraction of the weapon location circle which lies within a slant distance,  $r_a$ , of the mid point of the CFS. If this fraction is zero, this weapon type is not considered further.

4. Net Number of Weapons Intercepting. This processing step combines a number of factors generated in prior steps with system reliability and electronic countermeasures (ECM) degradation factors to yield the net number of weapons intercepting on this CFS. This processing is based upon the gross number of weapons of this type on hand in this ADCU at the time of the last inventory. The model currently takes the last inventory at the end of the CFS, although ideally the inventory should be taken at the beginning of the CFS and losses during the segment prorated. The various factors are applied to this gross number to yield the net number, according to the equation:

$$W_n = W_g \cdot (1 - f_d) \cdot (1 - f_s) \cdot f_{los} \cdot f_r \cdot R \cdot (1 - f_e) \quad (\text{IV-15-52})$$

where:

$W_n$  = net number of weapons intercepting

$W_g$  = gross number of weapons on hand at last inventory

$f_d$  = fraction of weapons destroyed since last inventory (currently set=0)

$f_s$  = fraction of weapons suppressed during the CFS as defined in subparagraph (c)lc, above

$f_{1os}$  = fraction of weapons in line of sight, as defined in subparagraph (c)3f, above

$f_r$  = fraction of weapons in degraded range, as defined in subparagraph (d)3, above

$R$  = system reliability factor, from input

$f_e$  = ECM degradation percentage, from input

If the net number of weapons intercepting is less than 0.5, this weapon type is not considered further.

(e) Further Processing of Missile Weapons. If a missile weapon type passes the foregoing tests, the probability of kill values, for a single missile, are linearly interpolated from an input table for this missile type, according to a calculated missile miss distance against a single aircraft. The four categories of kill, as defined above, are considered. Each of the net number of weapon systems, as defined in the preceding subparagraph, is assumed to fire one missile. Refinement of this assumption, through consideration of rate of fire limitations, may be added at a later date. The number of missiles fired is then multiplied by the probability of kill values to yield losses. The assumption is made that each missile is directed at a single aircraft, and that a relatively few missiles are fired from this ADCU on this CFS. Missiles fired are subtracted from the unit status record of the ADCU.

1. Calculation of Miss Distance. The model currently uses as input an average missile guidance error for this weapon type. It is assumed that errors in both dimensions are equal and independent; therefore, the standard deviation of the error, for a Rayleigh distribution, is given by the formula:

$$s = \frac{a}{\sqrt{\frac{\pi}{2}}} \quad (IV-15-53)$$

where:

$s$  = one standard deviation

$a$  = average error

A distance is then selected from a normal distribution by the expression:

$$d = S \cdot F(R_n) \quad (IV-15-54)$$

where:

S = as defined above

$R_n$  = a random number between 0 and 1.

F = a function which returns the position on the normal curve, in standard deviations, corresponding to the cumulative area represented by the random number (utility routine FNORM).

The distance selected is then adjusted to miss distance by subtracting a radius extracted from the presented area of the aircraft fired upon.

2. Aircraft Losses. Based on the calculated miss distance, probability of kill values for one missile against one aircraft are linearly interpolated from input for the type of aircraft attacked. The type attacked is assumed to be the type having the largest presented area in the air unit. Losses for each of the four kill type categories are, tentatively, the product of interpolated probability of kill and number of missiles fired, as defined above. Later integration of these values with gun effects limits these loss values to the number of aircraft on hand of that type.

(f) Further Processing of Gun Weapons. If a gun weapon type passes the tests up to this point, it is processed further to yield probability of kill values and to combine these values with the values of other gun systems in the form of cumulative or compound probabilities of survival of a single aircraft to gun systems. This processing includes calculation of the number of rounds intercepting the air unit, the number of rounds per aircraft, the vulnerable areas of the aircraft at the aspect angles and projectile striking velocity of the mid point of the CFS, estimation of gun weapon errors and probable hits, and finally the determination of probabilities of kill and compound probabilities of survival for each of the four kill categories.

1. Number of Rounds Intercepting Air Unit. The number of rounds from this weapon type, in this ADCU, that will intercept the air unit is based on the net number of weapons, defined above, and the rate of fire and possible reload delays that may occur on this CFS. First, an average rate of fire, without reload delay, is calculated by the formula:

$$R = \frac{b_n}{\left(\frac{b_n}{b_r}\right) + b_d} \quad (\text{IV-15-55})$$

where:

$R$  = average rate of fire, without reload delay, for one weapon

$b_n$  = number of rounds per burst, from input for this weapon type

$b_r$  = cyclic rate of fire, rounds per unit time, from input

$b_d$  = delay time between bursts, from input.

Next, the time required to exhaust magazine capacity at the above rate is calculated by the expression:

$$t_{mag} = C/R \quad (IV-15-56)$$

where:

$t_{mag}$  = time to exhaust magazine capacity at rate  $R$

$C$  = capacity of magazine, in rounds, from input

$R$  = rate, as defined above.

the number of reloads required,  $N_{re}$ , is calculated by the equation:

$$N_{re} = t_{is} / (t_{mag} + t_{re}) \quad (IV-15-57)$$

where:

$t_{is}$  = time length of the CFS

$t_{mag}$  = time to exhaust magazine capacity, as defined above

$t_{re}$  = reload delay, from input

Firing time at average rate without reloads,  $t_{fa}$ , is calculated by the expression:

$$t_{fa} = t_{is} - N_{re} \cdot t_{re} \quad (IV-15-58)$$

where:

$t_{is}$  = as defined above

$N_{re}$  = number of reloads required, as defined above

The number of rounds, N, intercepting the air unit is then calculated by the equation:

$$N = R \cdot t_{fa} \cdot W_n \quad (\text{IV-15-59})$$

where:

R = average rate of fire without reload, as defined above

$t_{fa}$  = firing time at average rate without reload, as defined above

$W_n$  = net number of weapons intercepting

The number of rounds, N, is then limited to the number of rounds of ammunition on hand of this type in this ADCU, as obtained from the ADCU unit status record. This same number of rounds is also subtracted from the unit status record to represent ammunition expenditures.

2. Number of Rounds Per Aircraft. For guns, it is assumed that the rounds intercepting are equally distributed over the number of aircraft of all types in the air unit at the start of the CFS. The number of rounds intercepting per aircraft,  $N_a$ , is then:

$$N_a = N/A \quad (\text{IV-15-60})$$

where:

N = number of rounds intercepting air unit, as defined above

A = number of aircraft of all types in the air unit.

3. Vulnerable Areas of Aircraft. Aircraft vulnerable area data are basic input for calculation of gun weapon type probabilities of kill. Currently, Section 3 uses as input the same average vulnerable area data as used by the ENRATA portion of the Air Ground Engagement Model. These data comprise a single vulnerable area value for each of four kill categories, within each weapon type-aircraft type combination. Since the values for the four kill categories are embedded one within another in a cumulative fashion, the individual values must be extracted before use in Section 3. These data are averages, assuming an average aspect angle and an average slant range. Section 3 is designed, however, to utilize, at some later date, detailed vulnerable area data tables. Such tables contain data for seven striking velocities and for each of the faces of the aircraft (front, rear, top, bottom, and side). To interpolate vulnerable area data from such tables, at some later date, striking velocity against a stationary target,  $V_{st}$ , is calculated by the formula:

$$v_{st} = v_m / \left( 1 + f_d \cdot t_f \right)^2 \quad (\text{IV-15-61})$$

where:

$V_m$  = muzzle velocity of the weapon, from input

$f_d$  = ballistic drag coefficient, from input

$t_f$  = time of flight of projectile, calculated as described in Section 2

Striking velocity against the moving target,  $V_{mt}$ , is then derived from the stationary situation by the formula:

$$V_{mt} = V_{st} + f \cdot \text{sine}(H) \cdot \text{cosine}(V) \cdot s \quad (\text{IV-15-62})$$

where:

$V_{st}$  = as defined above

$f$  = either minus 1 or plus 1, depending on aircraft direction

$H$  = horizontal aspect angle, as defined above

$V$  = vertical aspect angle, as defined above

At some later date, interpolated vulnerable areas of each face can be consolidated into one area, using the expression:

$$A = A_{vf} \cdot \text{cosine}(V) \cdot \text{sine}(H) + A_{vr} \cdot \text{cosine}(V) \cdot \text{sine}(H) + A_{vs} \cdot \text{cosine}(V) \cdot \text{cosine}(H) + A_{vb} \cdot \text{sine}(V) \quad (\text{IV-15-63})$$

where:

$A_{vf}$  = front vulnerable area (zero if aircraft leaving)

$A_{vr}$  = rear vulnerable area (zero if aircraft approaching)

$A_{vs}$  = side vulnerable area

$A_{vb}$  = bottom vulnerable area

4. Weapon Error. Four separate sets of equations, from the AM/HI study,<sup>6</sup> are used to approximate the weapon error associated with four types of gun system. These four types of system are, (1) visually sighted 12.7mm or .50 cal mg, (2) optically directed 14.5mm, 23mm, and 57mm systems, (3) range-only radar systems, and (4) full-solution radar systems. These equations

6. Reference 6; Annex F, pp. F-19, F-20, F-21 and F-46.



account for aiming errors and ballistic dispersion errors. Parameters used by these equations include slant range, as defined above, aircraft speed, target angular rate, and projectile time of flight, as defined above. Target angular rate is taken here to be the maximum of the horizontal or vertical rates, as defined above. An item in the weapon input data designates which equation set is used. The result of these equations is a standard deviation in square meters. On an experimental basis another equation, from the ADAFSS study,<sup>7</sup> is used to approximate target maneuver error. This equation uses aircraft speed, projectile time of flight, and a data input representing an average evasive maneuver turn acceleration rate. This equation also yields a standard deviation in square meters. Total error standard deviation used for hit calculations, is then the square root of the sum of the squares of the components in square meters.

5. Probability of Hit. The probability of hit by one round from the gun weapon type is calculated by the equation:

$$P_{h1} = 1 - e^{-A_p / (2\pi \cdot E^2)} \quad (IV-15-64)$$

where:

$P_{h1}$  = the probability of hit by one round against this aircraft type

$A_p$  = presented area of this aircraft type, as defined above

$E$  = total weapon error, in square meters

The probability of hit is calculated against each type of aircraft in the air unit.

6. Probability of Kill. Probability of kill by one round from the weapon type is calculated by the expression:

$$P_{k1} = P_{h1} \cdot \left( \frac{A_v}{A_p} \right) \quad (IV-15-65)$$

where:

$P_{k1}$  = probability of kill, this kill category, this aircraft type, by one round

$P_{h1}$  = probability of hit, as defined above

$A_v$  = vulnerable area of this aircraft type to this weapon, as defined above

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7. Reference 26, p. 4 and addendum.

$A_p$  = presented area of this aircraft type, as defined above.

The probability of kill by the number of rounds per aircraft is evaluated by the expression:

$$P_{kna} = 1 - (1 - P_{kl})^{N_a} \quad (\text{IV-15-66})$$

where:

$P_{kna}$  = probability of kill, this kill category, this aircraft type, by number of rounds per aircraft

$P_{kl}$  = probability of kill by one round, as defined above

$N_a$  = number of rounds per aircraft, as defined above

7. Compound Probability of Survival. The probabilities of survival are compounded, for each gun weapon type intercepting, as each gun weapon type is processed. These compound probabilities of survival, for each kill category and each aircraft type in the air unit, are for use in the final loss calculations. The compound probabilities of survival, starting with a value of 1.0, are calculated by the expression:

$$P_{sp} = 1 - \prod_{\text{all gun types}} (1 - P_{kna}) \quad (\text{IV-15-67})$$

where:

$P_{sp}$  = compound probability of survival, this aircraft type, this kill category, to date

$P_{kna}$  = probability of kill, as defined above.

(g) Final Loss Calculations. Final loss calculations combine missile effects and gun effects. Aircraft losses to missiles, as described in subparagraph (e) 2 above, and limited to the number of aircraft on hand of the type attacked, are subtracted from the aircraft on hand in the air unit, before gun losses are calculated. Losses to guns are then computed by applying the probabilities of survival, compounded over all intercepting gun weapon types, to the remaining aircraft of each type. Gun losses are computed by the equation:

$$L = A \cdot (1 - P_{sp}) \quad (\text{IV-15-68})$$

where:

A = number of aircraft remaining on hand of this type, after prior  
kill subtraction

$P_{sp}$  = compound probability of survival, this aircraft type, this kill  
category, as defined above

Troop and cargo losses are subtracted from the air unit in proportion to  
A and B kills.

## APPENDIX A

### AIRMOBILE MODEL INPUT REQUIREMENTS

1. INTRODUCTION. The Airmobile Model simulates the execution of an airmobile operation, including the staging and loading of aircraft; the airmobile assault to an objective area; the attrition of aircraft in flight to and from the objective area; the rearm and refuel of the aircraft; and the release of the aircraft after the airmobile assault is completed.

a. This appendix provides instructions for entering constant data into the model files prior to commencement of game play. Only the unique data elements that are constant throughout the play of the game and are applicable to the operation of this model are included herein. Other data are necessary for the operation of the Airmobile Model; these are defined and developed as constant data for other models and are indicated in paragraph 2 below.

b. The relative position of this chapter is arbitrary and does not represent the priority with which data must be entered in the constant data base. All DIVWAG system data must be loaded prior to game time, and first priority is accorded to TOE load.

#### 2. DATA INPUT BY OTHER LOAD PROGRAMS:

a. Weight and Volume Capacity of Transport Aircraft. The weight and volume capacities of the transport aircraft are used in determining the number of aircraft and/or trips required to airlift a given unit during an airmobile operation. These values are loaded by the Combat Service Support Model load program (see Chapter 16 of this section) which stores them on data file 11.

b. Weight and Volume of Transported Items. The weight and volume of the items to be transported are also used in determining the number of aircraft and/or trips required to airlift a unit during an airmobile operation. The weight and volume by equipment item code are loaded by the Combat Service Support Model load program on to data file 11.

c. Aircraft Fuel Consumption. The aircraft fuel consumption rates which are used by the Airmobile Model are obtained from File 14. The Movement Model load program (Chapter 13) loads these rates.

d. Aircraft Characteristics. Several aircraft characteristics are used by the Airmobile Model. These include speed, landing times, and mission availability times. These values are loaded on File 26 by the Air Ground Engagement Model load program (Chapter 10).

3. SECOND PRIORITY EQUIPMENT ITEMS. The gamer is permitted to specify which equipment items in a unit to be airlifted are of secondary criticality. When an airlift is executed, all primary items are loaded first. These are items

that must be taken with the first element. The remaining items are those items which are desired to be airlifted but which, due to time or capacity constraints, may be left at the pickup zone until the transport aircraft return for subsequent loads. The card format is shown at Figure IV-15-A-1.

a. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted into card column 1; make no changes. In card column 2, only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

b. Equipment Item Code (Columns 3-71). In these columns, enter equipment item codes of second priority items. Up to 23 second priority item codes may be listed on this card, and the order on the card has no significance since items within the second priority are not assigned a further priority. Additional cards may be used if necessary. Equipment item codes are right justified in the field.

c. Card ID. In card columns 73-76 enter the numbers 0701.

4. MIX TABLE. The gamer must specify the mix of aircraft which is to perform an airmobile operation. The transport and/or escort aircraft typed to be used are specified on card form 0702 (Figure IV-15-A-2.) Each card represents a different mix which may be requested by the gamers through use of DSL.

a. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in column 1. Make no changes. In column 2 only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

b. Mix (Columns 3-4). Each card represents a different mix of aircraft to perform an airmobile mission. The mix specified by the gamer must be unique and have a unique mix number which refers to the numbers entered in these columns. Enter the integer 1 in these columns for the first mix, a 2 for the second mix, and so forth. A maximum of 10 mixes is permitted for each force.

c. Escort Aircraft (Columns 6-52). The aircraft which will escort the transport aircraft during an airmobile operation are described in these columns. This description includes the escort aircraft identification, aircraft crew requirements, fuel capacity, number of fuel inlets on the aircraft, the munition load, and a rearm time. Mixes which do not include escorts may be defined, in which case columns 6-52 are left blank.

(1) Escort Aircraft Identification (Columns 6-8). Enter the equipment item code of the aircraft type which will perform the escort mission.

(2) Escort Aircraft Crew Requirements (Columns 10-11). Enter the number of personnel required to fly a single aircraft of this type. When an airmobile operation is requested, a check is made of all available airbases to determine if at least one airbase has sufficient personnel and equipment to initiate the airlift. If a particular airmobile operation requires four escort aircraft, each aircraft requiring two crew members, then at least one airbase must have a minimum of four escort aircraft and eight personnel or the mission will be automatically terminated.





(3) Escort Aircraft Fuel (Columns 13-16). Enter the initial load quantity of fuel in gallons of the aircraft type specified in columns 6-8. This number should be right justified. For example if the escort aircraft is to be an AH-1G, Cobra, with a full fuel load then the number 251 may be entered in columns 14-16. The internal fuel capacity of the AH-1G is 251 gallons.

(4) Number of Fuel Inlets - Escorts (Columns 18-19). When an aircraft is refueled, the model considers the number of refuel inlets on the aircraft. If sufficient refuel nozzles are available, an aircraft with two inlets will be refueled twice as fast as if it had only one. The number of refuel inlets per aircraft is specified in these columns.

(5) Munitions (Columns 21-49). The amount and type of ammunition to be loaded on each escort aircraft for a given mix is specified in these columns. Up to three munition types may be specified.

(a) Ammunition Identification (Columns 21-23). Enter the equipment item code of one of the ammunition types which is to be loaded on this aircraft.

(b) Ammunition Amount (Columns 25-29). Enter the number of rounds of the ammunition type specified in columns 21-23 which is to be loaded on each escort aircraft of the type specified in columns 6-8.

(c) Additional Ammunition Types (Columns 31-49). If additional ammunition types are to be loaded on the escort aircraft, they should be entered by item code and quantity in these columns.

(6) Rearm Time (Columns 51-52). Enter in minutes the time required to load the specified escort type aircraft with a full load of the ammunition types specified in columns 21-49.

d. Transport Aircraft (Columns 59-72). The aircraft which will be used to transport the units to be airlifted during an airmobile operation (if this mix is specified) is described in these columns. This description includes the transport aircraft identification, aircraft crew requirements, fuel capacity, and number of fuel inlets on the aircraft.

(1) Transport Aircraft Identification (Columns 59-61). If the aircraft mix is specified, enter the equipment item code of the aircraft type which will be the transporting vehicle.

(2) Transport Aircraft Crew Requirements (Columns 63-64). Enter the minimum number of personnel required to fly a single aircraft of this type. As was the case with escort aircraft, at least one airbase must have sufficient aircraft and personnel to fly the required transport aircraft or the airmobile mission will be aborted.



(3) Transport Aircraft Fuel (Columns 66-69). Enter in gallons the desired fuel load of the aircraft type specified in columns 59-61.

(4) Number of Fuel Inlets - Transports (Columns 71-72). Enter the number of fuel inlets in each transport aircraft in these columns [see subparagraph c(4) above].

e. Card ID. In card columns 73-76, the numbers 0702 will be written.

5. FORWARD AREA REARM AND REFUEL (FARR) AREA DEFINITIONS. When the task organization is defined, forward area refuel and rearm (FARR) areas are also specified. These FARR areas are assigned unique unit type designators (UTDs). Card Form 0703 (Figure IV-15-A-3) is used to relay the UTD types for the FARR areas to the Airmobile Model.

a. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in card column 1. Make no changes. In column 2 only one of two entries is permitted, "R" for Red force or "B" for Blue force.

b. Unit Type Designator (UTD) (Columns 4-7). Enter the four-character UTD of the first FARR area.

c. Number of Rearm Points (Columns 9-10). A rearming point is a site of sufficient size with sufficient equipment to rearm one aircraft at a time. If there is more than one rearming point in a FARR area, this number represents the number of aircraft that can simultaneously be rearmed. Enter in these columns the number of rearming points present in a unit of the type designated in columns 4-7.

d. Additional Forward Rearm and Refuel Areas (Columns 12-66). If the FARR areas are represented by more than one UTD, enter the UTD and associated number of rearming points for each in the appropriate columns.

e. Card ID. In card columns 73-76 the number 0703 will be written.

6. REFUEL DEVICE DEFINITION. Each forward rearm and refuel area is equipped with one or more forward area refueling equipment (FARE) systems. Each system contains bulk fuel storage equipment and fuel outlets or nozzles. The number of aircraft that can be simultaneously refueled is directly related to the number of nozzles per refuel device. Card 0704, Figure IV-15-A-4, is used for this purpose.

a. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in card column 1. Make no changes. In column 2, only one of two entries is permitted; "R" for Red force or "B" for Blue force.

b. Refuel Device Identification (Columns 4-6). Enter the equipment item code of the first refuel device.

FERRA DEFINITION		UTD'S THAT MAY BE USED FOR FERRA'S AND THE NUMBER OF REACH POINTS (NRAP) ASSIGNED TO EACH														CARD ID	CARD SEQ. NR
CARD TYPE	REQ OR BLANK	UTD	NRAP	UTD	NRAP	UTD	NRAP	UTD	NRAP	UTD	NRAP	UTD	NRAP	UTD	NRAP	UTD	NRAP
1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
26		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
32		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
33		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
34		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
35		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
36		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
37		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
38		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
39		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
40		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
41		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
42		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
43		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
44		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
46		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
47		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
48		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
49		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
50		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
51		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
52		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
53		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
54		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
55		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
56		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
57		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
58		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
59		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
60		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
61		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
62		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
63		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
64		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
65		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
66		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
67		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
68		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
69		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
70		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
71		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
72		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
73		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
74		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
75		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
76		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
77		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
78		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
79		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
80		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
81		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
82		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
83		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
84		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
85		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
86		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
87		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
88		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
89		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
90		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
91		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
92		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
93		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
94		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
95		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
96		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
97		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
98		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
99		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
100		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Figure IV-15-A-3. FERRA Definition Card Format



c. Number of Nozzles (Columns 9-10). Enter the number of refuel nozzles available in the refuel device given in columns 4-6.

d. Additional Refuel Devices (Columns 13-37). Enter in these columns the item code and number of nozzles for any additional refuel devices. A maximum of 10 devices may be specified.

e. Maneuver Times (Columns 64-72). The total service time of an aircraft at a FARR area includes:

- . time to maneuver into a refuel point from a point about 200 yards away
- . time to refuel
- . time to maneuver out of the refuel point to a point where it may either leave the FARR area or enter a rearm queue
- . time to maneuver into the rearming point
- . time to rearm
- . time to maneuver out of the rearming point to an area where it can either wait for the rest of the flight or it can leave the FARR area.

The refueling time and rearming time are calculated by the model. The other times are input in the constant data base.

(1) Refueling Maneuver Time (Columns 64-67). Enter in minutes the refueling maneuver time. This includes the time required to maneuver into a refuel point from a point about 200 yards away plus the time to maneuver out of the refuel point to a point where the aircraft may either leave the FARR area or enter a rearm queue.

(2) Rearming Maneuver Time (Columns 69-72). Enter in minutes the rearming maneuver time. This includes the time required for the aircraft to maneuver into the rearming point plus the time required for it to maneuver out of the rearming point to an area where it can either wait for the rest of the flight or it can leave the FARR area.

f. Card ID. In columns 73-76, enter the number 0704.

- 7. SUPPRESSION MISSION DATA (GTAA). The gamer must specify the information necessary to establish the effects of suppression against air defense capable units (ADCU) by escort aircraft, high performance aircraft (TACAIR), and ground-based artillery. The distances from an airmobile column and the times for responding to and suppressing air defense units are specified on card form 0740, Figure IV-15-A-5. A single 0740 card is required for each force. All card entries are right justified unless otherwise stated.



a. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in column 1. Make no changes. In column 2 only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

b. Escort Divert Limit (Columns 4-7). The distance, in meters, from an airmobile column that escort aircraft are permitted to divert to suppress air defense capable units is entered in columns 4-7. This distance to be entered is the sum of the actual separation distance of the escort aircraft from the airmobile column and the stand-off distance of the escort aircraft from the target. For example, if an attack helicopter is the escort aircraft with the TOW as its weapon system, then a stand-off distance of 3000 meters (range of the TOW) and a divert distance of 6000 meters yields a divert limit of 9000 meters, which would be entered in columns 4-7.

c. TACAIR/Ground-Based Artillery Fire Response Time (Columns 9-12). The time, in seconds, for either TACAIR or ground-based artillery to provide fire for suppression of air defense capable units is entered in this field. TACAIR or ground-based artillery fire will be requested when escort aircraft cannot be diverted for suppression of air defense capable units. TACAIR as used by the inflight attrition portion of the DIVWAG system assumes an air alert.

d. Duration of Escort Suppression Mission (Columns 24-27). The time, in seconds, that an escort aircraft attacks the air defense capable unit (i.e., remains "on station") on a suppression mission is entered in this field. This datum is used in calculating the total time that an air defense capable unit is suppressed.

e. Escort Suppression Response Time (Columns 29-32). The average time, in seconds, required by escort aircraft in an airmobile flight en route to a landing zone to break formation and take an air defense capable unit under fire is entered in this field.

f. Time After Passing ADCU Beyond Which Escorts Will Not Divert (Columns 24-37). The time, in seconds, after passing an air defense capable unit that the escort aircraft will not be permitted to fly to the rear for suppression missions is entered in this field. This time should be directly related to the escort divert limit distance in columns 4-7 but should not exceed the time the aircraft requires to fly back to a stand-off distance to engage an air defense capable unit.

g. Card ID (Columns 73-76). The number 0740 has been preprinted in this field. Make no changes.

8. ACQUISITION DATA. Two card types are required to record air defense capable unit data. The type data required for these cards are found in field test data, specifically CDCEC 43.6 test. There is currently no known documented source for all required data; therefore, some data entries may have to be derived through sound military logic. In this case it is important that data on opposing forces be carefully reviewed by the gaming staff before the data are entered into the constant data base.

a. Acquisition Data Card ID 0741, Card Type 1. The card type 1, shown in Figure IV-15-A-6, is used to record the slant ranges from air defense weapons to aircraft by acquisition types. Three different acquisition types may be specified; i.e., acquisition type 1 for units with gun type weapons and short range missiles against rotary wing aircraft; acquisition type 2 for units with gun type weapons and short range missiles against fixed wing aircraft; and acquisition type 3 for units with medium and long range missiles against fixed wing aircraft. A separate card is required for each acquisition type.

(1) Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in column 1. Make no changes. In column 2 only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

(2) Acquisition Type (Column 4). Enter the acquisition type in this field. If the aircraft to be detected is rotary wing and the seekers are equipped with gun type weapons or short range missiles, enter 1; if the aircraft type to be detected is fixed wing and the seekers are equipped with gun type weapons or short range missiles, enter 2; if the aircraft type to be detected is fixed wing and the seekers are equipped with medium and long range missiles, enter 3.

(3) Number of Aircraft in Flight (Columns 6-10). In these columns enter the number of aircraft in a flight which could be detected. Enter the minimum number of aircraft in columns 6-7, the maximum number of aircraft in columns 12-13, and an intermediate value for the number of aircraft between the minimum and maximum in columns 9-10. Three values for numbers of aircraft must be entered.

(4) Ranges from Air Defense Weapons to Aircraft (Columns 15-37). In these columns enter the slant ranges (four ranges are required), in meters, at which aircraft may be acquired. Enter the ranges in increasing increments with the shortest range in columns 15-19 and the longest range in columns 33-37.

(5) Card ID (Columns 73-76). The number 0741 has been preprinted in this field. Make no changes.

b. Acquisition Data, Card ID 0741, Card Type 2. The card type 2, shown in Figure IV-15-A-7, is used to record the probability of detection and median time to detect at each of the four ranges specified in card type 1. The card type 2 is required for each number of aircraft (card type 1) which can be acquired by each acquisition type.

(1) Card Type and Force Designator (Columns 1-2). The number 2 has been preprinted into card column 1; make no changes. In card column 2, only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

(2) Acquisition Type (Column 4). Enter the acquisition type in this field.

ACQUISITION DATA - CARD TYPE 1												
CARD TYPE 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	NUMBER OF AIRCRAFT IN FLIGHT			RANGES FROM AIR DEFENSE WEAPONS TO AIRCRAFT (SLANT RANGE IN METERS)				CARD ID	CARD SEQ. NR			
	MIN.	INT.	MAX.	R = 1	R = 2	R = 3	R = 4					
1	0	0	0	0	0	0	0	0	0	0		
2	0	0	0	0	0	0	0	0	0	0		
3	0	0	0	0	0	0	0	0	0	0		
4	0	0	0	0	0	0	0	0	0	0		
5	0	0	0	0	0	0	0	0	0	0		
6	0	0	0	0	0	0	0	0	0	0		
7	0	0	0	0	0	0	0	0	0	0		
8	0	0	0	0	0	0	0	0	0	0		
9	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0	0		
11	0	0	0	0	0	0	0	0	0	0		
12	0	0	0	0	0	0	0	0	0	0		
13	0	0	0	0	0	0	0	0	0	0		
14	0	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0	0	0	0	0	0		
16	0	0	0	0	0	0	0	0	0	0		
17	0	0	0	0	0	0	0	0	0	0		
18	0	0	0	0	0	0	0	0	0	0		
19	0	0	0	0	0	0	0	0	0	0		
20	0	0	0	0	0	0	0	0	0	0		
21	0	0	0	0	0	0	0	0	0	0		
22	0	0	0	0	0	0	0	0	0	0		
23	0	0	0	0	0	0	0	0	0	0		
24	0	0	0	0	0	0	0	0	0	0		
25	0	0	0	0	0	0	0	0	0	0		
26	0	0	0	0	0	0	0	0	0	0		
27	0	0	0	0	0	0	0	0	0	0		
28	0	0	0	0	0	0	0	0	0	0		
29	0	0	0	0	0	0	0	0	0	0		
30	0	0	0	0	0	0	0	0	0	0		
31	0	0	0	0	0	0	0	0	0	0		
32	0	0	0	0	0	0	0	0	0	0		
33	0	0	0	0	0	0	0	0	0	0		
34	0	0	0	0	0	0	0	0	0	0		
35	0	0	0	0	0	0	0	0	0	0		
36	0	0	0	0	0	0	0	0	0	0		
37	0	0	0	0	0	0	0	0	0	0		
38	0	0	0	0	0	0	0	0	0	0		
39	0	0	0	0	0	0	0	0	0	0		
40	0	0	0	0	0	0	0	0	0	0		
41	0	0	0	0	0	0	0	0	0	0		
42	0	0	0	0	0	0	0	0	0	0		
43	0	0	0	0	0	0	0	0	0	0		
44	0	0	0	0	0	0	0	0	0	0		
45	0	0	0	0	0	0	0	0	0	0		
46	0	0	0	0	0	0	0	0	0	0		
47	0	0	0	0	0	0	0	0	0	0		
48	0	0	0	0	0	0	0	0	0	0		
49	0	0	0	0	0	0	0	0	0	0		
50	0	0	0	0	0	0	0	0	0	0		
51	0	0	0	0	0	0	0	0	0	0		
52	0	0	0	0	0	0	0	0	0	0		
53	0	0	0	0	0	0	0	0	0	0		
54	0	0	0	0	0	0	0	0	0	0		
55	0	0	0	0	0	0	0	0	0	0		
56	0	0	0	0	0	0	0	0	0	0		
57	0	0	0	0	0	0	0	0	0	0		
58	0	0	0	0	0	0	0	0	0	0		
59	0	0	0	0	0	0	0	0	0	0		
60	0	0	0	0	0	0	0	0	0	0		
61	0	0	0	0	0	0	0	0	0	0		
62	0	0	0	0	0	0	0	0	0	0		
63	0	0	0	0	0	0	0	0	0	0		
64	0	0	0	0	0	0	0	0	0	0		
65	0	0	0	0	0	0	0	0	0	0		
66	0	0	0	0	0	0	0	0	0	0		
67	0	0	0	0	0	0	0	0	0	0		
68	0	0	0	0	0	0	0	0	0	0		
69	0	0	0	0	0	0	0	0	0	0		
70	0	0	0	0	0	0	0	0	0	0		
71	0	0	0	0	0	0	0	0	0	0		
72	0	0	0	0	0	0	0	0	0	0		
73	0	0	0	0	0	0	0	0	0	0		
74	0	0	0	0	0	0	0	0	0	0		
75	0	0	0	0	0	0	0	0	0	0		
76	0	0	0	0	0	0	0	0	0	0		
77	0	0	0	0	0	0	0	0	0	0		
78	0	0	0	0	0	0	0	0	0	0		
79	0	0	0	0	0	0	0	0	0	0		
80	0	0	0	0	0	0	0	0	0	0		
81	0	0	0	0	0	0	0	0	0	0		
82	0	0	0	0	0	0	0	0	0	0		
83	0	0	0	0	0	0	0	0	0	0		
84	0	0	0	0	0	0	0	0	0	0		
85	0	0	0	0	0	0	0	0	0	0		
86	0	0	0	0	0	0	0	0	0	0		
87	0	0	0	0	0	0	0	0	0	0		
88	0	0	0	0	0	0	0	0	0	0		
89	0	0	0	0	0	0	0	0	0	0		
90	0	0	0	0	0	0	0	0	0	0		
91	0	0	0	0	0	0	0	0	0	0		
92	0	0	0	0	0	0	0	0	0	0		
93	0	0	0	0	0	0	0	0	0	0		
94	0	0	0	0	0	0	0	0	0	0		
95	0	0	0	0	0	0	0	0	0	0		
96	0	0	0	0	0	0	0	0	0	0		
97	0	0	0	0	0	0	0	0	0	0		
98	0	0	0	0	0	0	0	0	0	0		
99	0	0	0	0	0	0	0	0	0	0		
100	0	0	0	0	0	0	0	0	0	0		

Figure IV-15-A-6. Acquisition Data (Card Type 1) Card Format





(3) Number of Aircraft in Flight (Columns 6-7). Enter the number of aircraft in the flight for the acquisition type specified in column 4. One card is required for each of the three values specified for the number of aircraft; therefore, three cards type 2 are required for each acquisition type.

(4) Probability of Detection and Median Time to Detect (Columns 9-39).

(a) Range 1. Enter the probability of detection in columns 9-11 and the median time to detect, in seconds, in columns 13-15 for the first slant range specified in card type 1.

(b) Range 2. Enter the probability of detection in columns 17-19 and the median time to detect, in seconds, in columns 21-23 for the second slant range specified in card type 1.

(c) Range 3. Enter the probability of detection in columns 25-27 and the median time to detect, in seconds, in columns 29-31 for the third slant range specified in card type 1.

(d) Range 4. Enter the probability of detection in columns 33-36 and the median time to detect, in seconds, in columns 37-39 for the fourth slant range specified in card type 1.

(5) Card ID (Columns 73-76). The number 0741 has been preprinted in this field. Make no changes.

9. AIRCRAFT DATA. The data used to describe the presented area of each aircraft by equipment item code and type as well as the average evasive maneuver turn rate are specified on card form 0745 (Figure IV-15-A-8). The aircraft which must be described in these cards are those to be employed in air-mobile operations and reconnaissance flights. Each card represents a single aircraft.

a. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted into card column 1; make no changes. In card column 2, only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

b. Aircraft Item Code (Columns 5-7). In these columns, enter the equipment item code for the aircraft to be described.

c. Aircraft Presented Areas (Columns 9-28). The presented areas, in square meters, for bottom, side, and front/rear are described in these columns.

(1) Bottom (Columns 9-14). Enter the presented area of the bottom of the aircraft. A decimal point must be entered in column 12.

(2) Side (Columns 16-21). Enter the presented area of the side of the aircraft. A decimal point must be entered in column 19.

(3) Front/Rear (Columns 23-28). Enter the presented area of the front/rear of the aircraft. A decimal point must be entered in column 26.

AIRCRAFT DATA									
CARD TYPE RED OR BLUE	AIRCRAFT ITEM CODE	AIRCRAFT PRESENTED AREAS (METERS SQUARED)			AIRCRAFT AVERAGE EVASIVE MANEUVER TURN RATE (g/s)	AIRCRAFT TYPE CATEGORY 1-ROTARY 2-FIXED 3-JET	CARD ID	CARD SEQ NR	
		BOTTOM	SIDE	FRONT/REAR					
1	1	1	1	1	1	1	07	45	
2	2	1	1	1	1	1	07	45	
3	3	1	1	1	1	1	07	45	
4	4	1	1	1	1	1	07	45	
5	5	1	1	1	1	1	07	45	
6	6	1	1	1	1	1	07	45	
7	7	1	1	1	1	1	07	45	
8	8	1	1	1	1	1	07	45	
9	9	1	1	1	1	1	07	45	
10	10	1	1	1	1	1	07	45	
11	11	1	1	1	1	1	07	45	
12	12	1	1	1	1	1	07	45	
13	13	1	1	1	1	1	07	45	
14	14	1	1	1	1	1	07	45	
15	15	1	1	1	1	1	07	45	
16	16	1	1	1	1	1	07	45	
17	17	1	1	1	1	1	07	45	
18	18	1	1	1	1	1	07	45	
19	19	1	1	1	1	1	07	45	
20	20	1	1	1	1	1	07	45	
21	21	1	1	1	1	1	07	45	
22	22	1	1	1	1	1	07	45	
23	23	1	1	1	1	1	07	45	
24	24	1	1	1	1	1	07	45	
25	25	1	1	1	1	1	07	45	
26	26	1	1	1	1	1	07	45	
27	27	1	1	1	1	1	07	45	
28	28	1	1	1	1	1	07	45	
29	29	1	1	1	1	1	07	45	
30	30	1	1	1	1	1	07	45	
31	31	1	1	1	1	1	07	45	
32	32	1	1	1	1	1	07	45	
33	33	1	1	1	1	1	07	45	
34	34	1	1	1	1	1	07	45	
35	35	1	1	1	1	1	07	45	
36	36	1	1	1	1	1	07	45	
37	37	1	1	1	1	1	07	45	
38	38	1	1	1	1	1	07	45	
39	39	1	1	1	1	1	07	45	
40	40	1	1	1	1	1	07	45	
41	41	1	1	1	1	1	07	45	
42	42	1	1	1	1	1	07	45	
43	43	1	1	1	1	1	07	45	
44	44	1	1	1	1	1	07	45	
45	45	1	1	1	1	1	07	45	
46	46	1	1	1	1	1	07	45	
47	47	1	1	1	1	1	07	45	
48	48	1	1	1	1	1	07	45	
49	49	1	1	1	1	1	07	45	
50	50	1	1	1	1	1	07	45	
51	51	1	1	1	1	1	07	45	
52	52	1	1	1	1	1	07	45	
53	53	1	1	1	1	1	07	45	
54	54	1	1	1	1	1	07	45	
55	55	1	1	1	1	1	07	45	
56	56	1	1	1	1	1	07	45	
57	57	1	1	1	1	1	07	45	
58	58	1	1	1	1	1	07	45	
59	59	1	1	1	1	1	07	45	
60	60	1	1	1	1	1	07	45	
61	61	1	1	1	1	1	07	45	
62	62	1	1	1	1	1	07	45	
63	63	1	1	1	1	1	07	45	
64	64	1	1	1	1	1	07	45	
65	65	1	1	1	1	1	07	45	
66	66	1	1	1	1	1	07	45	
67	67	1	1	1	1	1	07	45	
68	68	1	1	1	1	1	07	45	
69	69	1	1	1	1	1	07	45	
70	70	1	1	1	1	1	07	45	
71	71	1	1	1	1	1	07	45	
72	72	1	1	1	1	1	07	45	
73	73	1	1	1	1	1	07	45	
74	74	1	1	1	1	1	07	45	
75	75	1	1	1	1	1	07	45	
76	76	1	1	1	1	1	07	45	
77	77	1	1	1	1	1	07	45	
78	78	1	1	1	1	1	07	45	
79	79	1	1	1	1	1	07	45	
80	80	1	1	1	1	1	07	45	
81	81	1	1	1	1	1	07	45	
82	82	1	1	1	1	1	07	45	
83	83	1	1	1	1	1	07	45	
84	84	1	1	1	1	1	07	45	
85	85	1	1	1	1	1	07	45	
86	86	1	1	1	1	1	07	45	
87	87	1	1	1	1	1	07	45	
88	88	1	1	1	1	1	07	45	
89	89	1	1	1	1	1	07	45	
90	90	1	1	1	1	1	07	45	
91	91	1	1	1	1	1	07	45	
92	92	1	1	1	1	1	07	45	
93	93	1	1	1	1	1	07	45	
94	94	1	1	1	1	1	07	45	
95	95	1	1	1	1	1	07	45	
96	96	1	1	1	1	1	07	45	
97	97	1	1	1	1	1	07	45	
98	98	1	1	1	1	1	07	45	
99	99	1	1	1	1	1	07	45	
100	100	1	1	1	1	1	07	45	

Figure IV-15-A-8. Aircraft Data Card Format

d. Aircraft Average Evasive Maneuver Turn Rate (Columns 30-33). The evasive maneuver turn rate, in gravities (g), which this aircraft will employ on an average basis during the types of employment contemplated is entered in this field. Note that a decimal point must be entered in column 31. This turn rate is not the same as the theoretical turn rate capability of the aircraft, since in practice, such as in an airmobile column, the freedom to employ evasive maneuver may be severely limited. Also the desired value is an average for the entire duration of flight while under enemy fire.

e. Aircraft Type (Column 38). The aircraft type is entered in this column. Enter 1 if the aircraft is a rotary wing aircraft. Enter 2 if the aircraft is a fixed wing aircraft.

f. Card ID (Columns 73-76). The number 0745 is preprinted on this field. Make no changes.

10. AIR DEFENSE WEAPON DATA. The gamer must specify the characteristics of all air defense weapon system by equipment item code and its associated characteristics are specified on card form 0750. Six card types; i.e., card types 1 through 6, are necessary to enter all the data. Before the air defense weapon data cards are completed for a given war game, a thorough analysis must be made of the purpose and objectives of the game to determine the significance attached to air defense play. An objective decision can then be made concerning the various available air defense capable weapons that are to be played. This submodel is time consuming when being executed in the system; accordingly, it is uneconomical to include weapons that make no significant contribution to the game or game results.

a. Card Type 1 (Figure IV-15-A-9). The card type 1 contains 14 data fields.

(1) Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in column 1. Make no changes. In column 2 only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

(2) Weapon Item Code (Columns 5-7). Enter the equipment item code of the air defense weapon in this field. A convention should be established wherein the equipment item codes are listed sequentially.

(3) Fire Control Type Code (Columns 9-11). The type of fire control associated with each air defense weapon is inserted in this field. Four types of fire control are associated with gun type systems, as follows:

- Fire Control Type 1. If the gun system is small caliber; i.e., 12.7mm or 0.50 caliber, and visually sighted, enter the integer 1.
- Fire Control Type 2. If the gun system is mid caliber; i.e., 14.5mm through 57mm, and optically sighted, enter the integer 2.
- Fire Control Type 3. If the gun system, irrespective of caliber, is controlled by a range only radar system, enter the integer 3.



- Fire Control Type 4. If the gun system, irrespective of caliber, is controlled by a full resolution radar system, enter the integer 4.

Fire control type categories are not applied to missile type weapon systems. Each missile type is, instead, assigned a unique number, starting with the integer 11 for each force. In addition to identifying the weapon equipment item code as a missile, the missile type code assigned here is used to simplify access of certain missile characteristics data, in lieu of the weapon item code; therefore, the missile codes must be assigned in continuous progression from 11 upward, in the order that missile weapons appear on this data card. On all subsequent cards, missile weapon item codes should be listed in this same order.

(4) Maximum Effective Slant Range (Columns 13-18). Enter the maximum effective slant range, in meters, of the weapon system being described.

(5) Assigned Radius of Responsibility for Targets (Columns 20-25). Enter the distance, in meters, of the radius of target responsibility for the weapon being described. Some judgment is required in making the entry for this field. The entry is one of the characteristics used to determine if a weapon qualifies for firing against a given aircraft flight that is in progress. Considering the air defense systems organic to a division, a reasonable entry is the maximum effective slant range of the weapon; however, in considering air defense systems that are available to the division (i.e., the long range missile systems) some judgment is in order when making this entry. A case in point could be made of the Nike Hercules. If the slant range were entered in this field it is unlikely that any enemy aircraft could penetrate the division zone without the system being called upon as a firing candidate.

(6) Capability - Night (Column 27). If the weapon system being described has the capability to engage targets at night, enter a value of 1. If the weapon has no nighttime capability, enter 0.

(7) Capability - Poor Weather (Column 30). If the weapon system being described has the capability to engage targets in poor weather, enter a value of 1. If the weapon has no poor weather capability, enter 0.

(8) Target Altitude Capability (Columns 32-42). Enter the maximum altitude, in feet, that aircraft can be engaged by this weapon system in columns 32-37. Enter the minimum altitude, in feet, that aircraft can be engaged by this weapon system in columns 39-42. A point to remember is that nap of the earth is defined within the DIVWAG system as 50 feet altitude.

(9) Target Speed Capability (Columns 44-51). Enter the maximum flight speed, in knots, of an aircraft against which this weapon system can engage in columns 44-47. Enter the minimum flight speed, in knots, against which this weapon system can engage in columns 49-51.

(10) Projectile Drag Coefficient (Columns 53-56). The drag coefficient of gun type projectiles (in meters per second) is entered in columns 53-56. A decimal point must be inserted in column 53 for each gun type system. No entry

is required in this field for missile type systems. If these data are not available for gun systems of both forces being gamed, either the data for each force should be derived judgmentally or Red force data should be a mirror image of Blue force data.

(11) Average Delay From Acquisition to Fire/Launch (Columns 56-60). Enter the delay time, in seconds, between target acquisition and projectile launch for gun and missile type systems.

(12) Air Defense Munition Item Code (Columns 62-64). Enter the equipment item code of the air defense munition delivered by this weapon system in columns 62-64. In instances wherein the weapon and munition may be the same; e.g., the REDEYE, the munition equipment items code will be the same as the weapon equipment item code specified in columns 5-7.

(13) Muzzle Velocity (Columns 66-69). Enter the muzzle velocity, in meters per second, for all gun type systems. Make no entry in this field for missile type systems.

(14) Card ID (Columns 73-76). The number 0750 has been preprinted in this field. Make no changes.

b. Card Type 2 (Figure IV-15-A-10). Data on selected characteristics of air defense missile systems only are entered on card type 2.

(1) Card Type and Force Designator (Columns 1-2).

(2) Weapon Item Code (Columns 5-7). Enter the equipment item code of the missile type weapon system in this field.

(3) Slant Range Points (Columns 9-34). Five slant range entries, in meters, must be specified in this field. The first slant range entry, columns 9-12, must be the minimum slant range capability followed in ascending order to the maximum slant range capability entered in columns 30-34. Do not omit a slant range point, but make an entry for each range point.

(4) Time of Flight (Columns 36-51). Five time of flight entries, in seconds, must be specified in this field. The time of flight entries must be made against the corresponding entries for slant range points.

(5) Missile Guidance Error (Columns 53-59). Enter the missile guidance error, in meters, for the minimum slant range in columns 53-55. Enter the missile guidance error, in meters, at the maximum slant range in columns 57-59. The Period Processor of the DIVWAG system performs a straight line interpolation to find missile guidance errors at ranges between the minimum and maximum slant ranges.

(6) Maximum Slew Rates (Columns 61-69). Enter the maximum elevation rate, in degrees per second, in columns 61-64. Enter the maximum azimuth slew rate, in degrees per second, in columns 66-69.

(7) Card ID (Columns 73-76). The number 0750 is preprinted in this field. Make no changes.





c. Card Type 3 (Figure IV-15-A-11). Additional entries regarding air defense weapon data characteristics are entered on card type 3 for both missile and gun type systems.

(1) Card Type and Force Designator (Columns 1-2). The number 3 has been preprinted in column 1. Make no changes. In column 2 only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

(2) Weapon Item Code (Columns 5-7). Enter the equipment item code of the weapon system in this field.

(3) Infrared Missile Lock-On (Columns 9-45). This field provides for seven entries on boundary ranges for infrared (IR) missile lock-on, as a function of the direction in which the aircraft is flying relative to the missile site. To facilitate entries, first picture an aircraft flying directly away from the infrared missile site. In columns 9-13 enter the maximum distance from weapon site to target at which this infrared missile will still lock on to that target. The "average" aircraft in this field is assumed to be a composite of the types being played. Next, at 30-degree increments, visualize rotation of the aircraft with respect to flight of the missile from the missile site. At 30° enter in columns 15-19 the lock-on boundary range. At 60° enter in columns 21-25 the lock-on boundary range, and so on through 90°, 120°, 150°, and, finally, when the missile approaches the aircraft from head-on with respect to the missile site.

(4) Rounds Per Burst (Columns 47-49). Enter the number of rounds fired per burst for automatic type gun systems in this field. Make no entry in this field for any other type system.

(5) Delay Between Bursts of Missiles (Columns 56-58). Enter the time, in seconds, for delays between bursts for automatic type weapons or single missiles or rounds for other type weapon systems in this field. The time entered in this field must be between 1 and 999 seconds.

(6) Magazine or Launcher Capacity (Columns 60-63). Enter the magazine (for guns) and launcher (for missile) capacity, in rounds/missiles, in the field.

(7) Reload Delay (Columns 65-68). Enter the time, in seconds, required to reload a gun magazine or belt into the gun, or to reload missiles onto the launcher.

(8) System Reliability Factor (Columns 70-72). Enter the system reliability factor, in percent, in this field. These data are readily available from field tests and in technical publications for Blue systems. If Red data are not available, the gaming group will have to determine whether judgmental entries are required or a mirror image of a similar Blue weapon will suffice.

(9) Card ID (Columns 73-76). The number 0750 has been preprinted on this card. Make no changes.

AD WEAPON DATA, CARD TYPE 3																
CARD TYPE	WEAPON ITEM CODE	INFRA-RED-SEEKING MISSILE LOCK-ON BOUNDARY RANGES GIVEN DETECTION, VERSUS ASPECT ANGLE, AGAINST AVERAGE AIRCRAFT TYPE (METERS)						ROUNDS PER BURST IF GUN (ROUNDS/MINUTE)	CYCLIC RATE OF FIRE IF GUN (ROUNDS/MINUTE)	DELAY BETWEEN BURSTS OR MISSILES (SECONDS)	MAGAZINE OR LAUNCHER CAPACITY	RELOAD DELAY (SECONDS)	SYSTEM RELIABILITY FACTOR	CARD ID	CARD SEQ. NO.	
		TAIL-ON 0°	30°	60°	90°	120°	150°									HEAD-ON 180°
RED OR BLUE	1														0750	
	2															
	3															
	4															
	5															
	6															
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Figure IV-15-A-11. Air Defense Weapon Data (Card Type 3) Card Format

d. Card Type 4 (Figure IV-15-A-12). This card type provides data entries that present the degradation to air defense weapons as a result of weather-visibility (WV) conditions and levels of electronic countermeasures (ECM) that are directed at the air defense systems. It also provides an entry that describes the percent damage necessary to silence each system.

(1) Card Type and Force Designator (Columns 1-2). The number 4 has been preprinted into card column 1; make no changes. In card column 2, only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

(2) Weapon Item Code (Columns 5-7). Enter the equipment item code of the weapon system in this field.

(3) Capability Degradation as a Function of Weather-Visibility (Columns 9-27). This field is subdivided into five subfields that are used to enter, in percent, the degrading effect on the air defense weapon system as a result of weather-visibility (WV) conditions. The DIVWAG system allows nine visibility indexes (VI) as described in Chapter 4 to this section. For purposes of the Airmobile Model, the visibility indexes are equated to fire weather-visibility conditions as follows:

<u>Weather-Visibility Condition</u>	<u>Visibility Index</u>
Very poor	1-2
Poor	3-4
Intermediate	5-6
Fair	7-8
Good	9

(a) Very Poor (Columns 9-11). Enter the degradation, in percent, to this weapon system when visibility index equals 1 or 2.

(b) Poor (Columns 13-15). Enter the degradation, in percent, to the weapon system when the visibility index equals 3 or 4.

(c) Intermediate (Columns 17-19). Enter the degradation, in percent, to the weapon system when the visibility index equals 5 or 6.

(d) Fair (Columns 21-23). Enter the degradation, in percent, to the weapon system when the visibility index equals 7 or 8.

(e) Good (Columns 25-27). Enter the degradation, in percent, to the weapon system when the visibility index equals 9.

(4) Degradation Versus Level of Electronic Countermeasures (Columns 29-39). This field is subdivided into three subfields which are used to enter, in percent, the degrading effect on the weapon system as a result of electronic countermeasures (ECM) directed against that weapon system. Three levels of ECM activity are considered and are defined as follows: heavy ECM is assumed to be continuous, concentrated ECM activity against the air defense system for the duration of a possible ground-to-air engagement; moderate ECM is assumed

AD WEAPON DATA, CARD TYPE 4												
CARD TYPE	WEAPON ITEM CODE	CAPABILITY DEGRADATION AS FUNCTION OF WEATHER-VISIBILITY (PERCENT)				DEGRADATION VERSUS LEVEL OF ECH (PERCENT)				PERCENT DAMAGE SUFFICIENT TO SILENCE WEAPON	CARD ID	CARD REQ. NR
		VERY POOR	POOR	INTER-MEDIATE	FAIR	GOOD	HEAVY ECH	Moderate ECH	Light ECH			
1	1											
2	2											
3	3											
4	4											
5	5											
6	6											
7	7											
8	8											
9	9											
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Figure IV-15-A-12. Air Defense Weapon Data (Card Type 4) Card Format

to be concentrated ECM activity, periodically masked or otherwise interrupted, for the duration of a possible ground-to-air engagement; and light ECM is assumed to be routine, intermittent ECM activity on an area basis as opposed to point concentration.

(a) Heavy ECM (Columns 29-31). Enter the degradation, in percent, to this weapon system when there is continuous, concentrated ECM activity against the system for the duration of a possible ground-to-air engagement.

(b) Moderate ECM (Columns 33-35). Enter the degradation, in percent, to this weapon system when there is concentrated ECM activity periodically masked or otherwise interrupted for the duration of a possible ground-to-air engagement.

(c) Light ECM (Columns 37-39). Enter the degradation, in percent, to this weapon system when there is routine, intermittent ECM activity on an area basis as opposed to point concentration.

(5) Percent Damage Sufficient to Silence Weapon (Columns 41-43). Enter the level of damage, in percent, required to silence an air defense weapon system.

(6) Card ID (Columns 73-76). The number 0750 has been preprinted in this field. Make no changes.

e. Card Type 5 (Figure IV-15-A-13). This card type provides kill probabilities as a function of miss distances for missiles against rotary wing aircraft. (See Figure IV-15-A-13.)

(1) Card Type and Force Designator (Columns 1-2). The number 5 has been preprinted in column 1. Make no changes. In column 2 only one of two entries is permitted; "R" for Red forces or "B" for Blue forces.

(2) Weapon Item Code (Columns 5-7). Enter the equipment item code of the missile weapon system in this field.

(3) Fire Control Type Code (Columns 9-11). The fire control type code was discussed in subparagraph a(3) above. As discussed therein, fire control type codes beginning with the integer 11 were assigned for each missile type system. The data entered in card type 1 for a specific weapon item code must be entered correspondingly on these cards.

(4) Kill Category (Column 14). Four kill categories are considered in the DIVWAG system: A-kill (catastrophic kill), B-kill (forced landing), C-kill (mission abort), and D-kill (hit, but minor damage). When an aircraft suffers an A-kill, it crashes because of the damage inflicted by the defending air defense weapons and is not recoverable for future use. Type B-kill forces the aircraft to land (powered or unpowered) because of damage, or forces it to make a precautionary landing because of an automatic warning signal indicating trouble. If the downed aircraft has penetrated enemy airspace, it is not recoverable and is considered destroyed. If no penetration of hostile territory occurred, the downed aircraft is recovered after an appropriate delay time.



It can then be used in future engagements. When a type C-kill occurs, the aircraft is forced to discontinue its mission because of damage to the aircraft or because of a pilot or copilot casualty. In this case, the aircraft immediately breaks off its engagement with the target and returns to its base. Type C-kills are susceptible to additional attrition from air defense weapons on the return trip. Aircraft suffering type D-kills are considered able to complete their mission. A repair time is imposed on them when they return to their airbase. Enter the kill type category (i.e.; A, B, C, or D) in this field; thus, four cards for each weapon item code/fire control types are required to enter data for all four types of kills.

(5) Probability of Kill (Columns 17-48). The probability of kill, in percent, is entered in the 11 subfields shown in Figure IV-15-A-13. The 11 subfields represent equally spaced range points. The distance, in feet, between range points is specified in columns 50-52. For example, given a distance between range points of 10 feet, the 10 subfields would represent miss distances of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 feet respectively. A range point of 0 corresponds to a direct hit. The probabilities of kill for a missile detonating at the miss distances calculated are entered in the respective columns. Annex F to Airmobility in the Mid/High-Intensity Environment (Reference 6) provides some of the data required by this card type.

(6) Distance Between Range Points (Columns 50-52). Enter the distance, in feet, between each of the range points defined in the previous subparagraph.

(7) Maximum Lethal Distance (Columns 54-57). Enter the maximum lethal distance, in feet, of the respective missile identified in columns 5-7 for each kill type.

(8) Card ID (Columns 73-76). The number 0750 is preprinted in this field. Make no changes.

f. Card Type 6 (Figure IV-15-A-14). This card type provides kill probabilities as a function of miss distances for missiles against fixed wing aircraft.

(1) Card Type and Force Designator (Columns 1-2). The number 6 has been preprinted in column 1. Make no changes. In column 2 only one of two entries is permitted; "R" for Red forces or "B" Blue forces.

(2) Weapon Item Code (Columns 5-7). Enter the equipment item code of the missile weapon system in this field.

(3) Fire Control Type Code (Columns 9-11). The fire control type code was discussed in subparagraph a(3) above. As discussed therein, fire control type codes beginning with the integer 11 were assigned for each missile type system. The data entered in card type 1 for a specific weapon item code must be entered correspondingly on these cards.

(4) Kill Category (Column 14). Enter the kill type category (i.e.; A, B, C, or D) in this field; thus, four cards for each weapon item code/fire control types are required to enter data for all four types of kills.





(5) Probability of Kill (Columns 17-48). The probability of kill, in percent, is entered in the 11 subfields shown in Figure IV-15-A-14. The 11 range points is specified in columns 50-52. For example, given a distance between range points of 10 feet, the ten subfields would represent miss distances of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 feet respectively. A range point of 0 corresponds to a direct hit. The probabilities of kill for a missile detonating at the miss distances calculated would be entered in the respective columns. Annex F to Airmobility in the Mid/High-Intensity Environment (Reference 6) provides some of the data required by this card type.

(6) Distance Between Range Points (Columns 50-52). Enter the distances, in feet, between each of the range points defined in the previous subparagraph.

(7) Maximum Lethal Distance (Columns 54-57). Enter the maximum lethal distance, in feet, of the respective missile identified in columns 5-7 for each kill type.

(8) Card ID (Columns 73-76). The number 0750 is preprinted in this field. Make no changes.

11. AIR SCATTERABLE MINE DELIVERY DATA. There may be loaded up to 27 aircraft resources mix tables, nine each for the three respective aircraft types; high performance, helicopter, and "other" aircraft. Mix tables will be loaded to correlate with a 4 character alphanumeric mix designator or code specified in the DSL order. The first character will designate the general aircraft type; A = high performance,  
C = other aircraft types,  
H = helicopter.

The 4th character will be an integer between 1 and 9 designating the mix table within the general aircraft type. The 3rd character, an integer between 1 and 9, points to a desired mission flight altitude.

a. Card Type 1 (Figure IV-15-A-15). This card type provides aircraft mission resource data as a function of mix code. One card must be used for each mix.

(1) Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in column 1. Make no changes. In column 2 enter an R or B representing Red or Blue force respectively.

(2) General Aircraft Type Code (Column 3). The letter A, C, or H must be input to designate the aircraft type; high performance, other, and helicopter respectively.

(3) Mix Code (Column 4). An integer between 1 and 9 must be used to designate a specific resource mix within a general aircraft type.

CARD TYPE  
 4/3 (A-C-H)  
 (6-7) (1-9)

CARD TYPE	FORCE A/C TYPE (A-C-1)	MINE MIX CODE	AIRCRAFT ITEM CODE	OPEN	FUEL	MINE LOAD PER AIRCRAFT						DISPENSING RATE MINES PER MIN	SHIP WIDTH (METERS)
						MINE #1	MINE #2	MINE #3	ITEM CODE	QTY.	ITEM CODE		
1													
2													
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IV-15-A-30a

Figure IV-15-A-15.

(4) Aircraft Item Code (Columns 6-8). Enter the equipment item code of the desired aircraft for this mission mix.

(5) Crew (Columns 10-11). Enter the amount of aircraft crew required for this mission.

(6) Aircraft Fuel (Columns 13-16). Enter the amount of fuel (gal) per aircraft required for mission.

(7) Item Code of Mine Type (Columns 19-21, 29-31, 39-41). Enter the equipment item code of up to 3 mine types to be delivered in this mission.

(8) Scatterable Mine Quantity (Columns 23-26, 33-36, 43-46). Enter the quantity of each mine type loaded for this mission mix.

(9) Dispensing Rate (Columns 50-53). Enter the average aircraft mine dispensing rate (mines/minute/aircraft).

(10) Strip Width (Columns 55-58). Enter the average width (meters) of a strip of mines, on the ground, that were dispensed from a single aircraft.

(11) Card ID (Columns 73-76). The number 0760 is preprinted in this field. Make no changes.

All card entries, except (1), are integers and must be right justified in data field.

b. Card Type 2 (Figure IV-15-A-16 ). This card type provides for up to 9 mission flight altitudes. Each altitude is an integer and must be right justified in its data field.

(1) Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in column 1. Make no changes. In column 2 enter an R or B representing the Red or Blue force respectively.

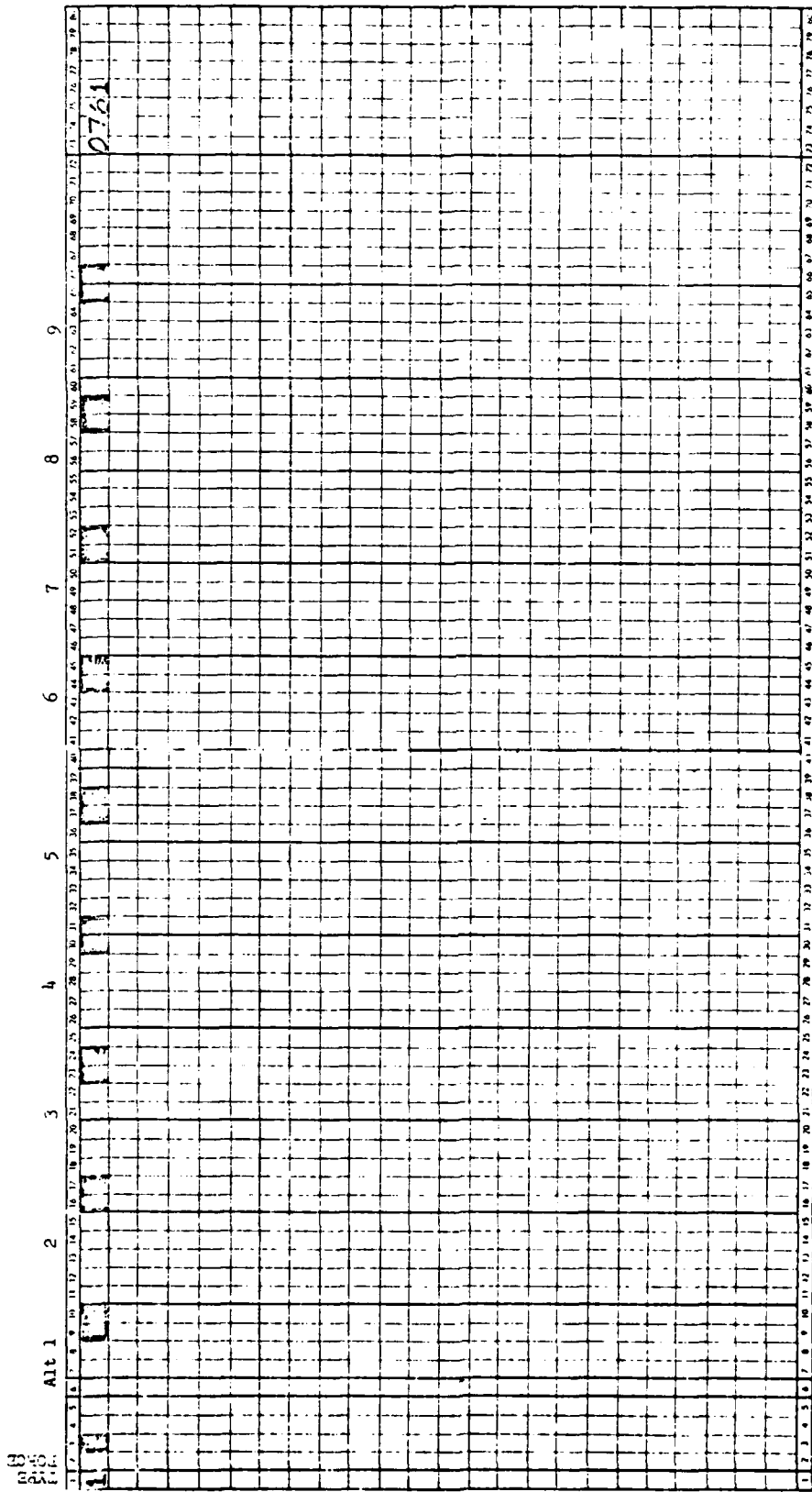
(2) Altitude Data (Columns 4-8, 11-15, 18-22, 25-29, 32-36, 39-43, 46-50, 53-57, 60-64). Enter up to 9 mission flight altitudes (feet).

(3) Card ID (Columns 73-76). The number 0761 is preprinted in this field. Make no changes.

12. AIRMOBILE CONSTANT DATA DECK STRUCTURE. The deck structure required by the Airmobile Model constant data load program and the data listing generated by it are described in this paragraph.

a. Airmobile Constant Data Input Cards. The card types required by the Airmobile Model are listed in Figure IV-15-A-15.

# NINE ALTITUDES FOR ALL AIRCRAFT



IV-15-A-31a

Figure IV-15-A-16.

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Card Type	Card Title	Card ID	Load Program
1	Second Priority Equipment Items	0701	FIL7LD
1	Airmobile Mix Tables	0702	FIL7LD
1	Forward Rearm and Refuel Area Definitions	0703	FIL7LD
1	Refuel Device Definitions	0704	FIL7LD
1	Suppression Mission Data (GTAA)	0740	FIL7LD
1	Acquisition Data (Card Type 1)	0741	FIL7LD
2	Acquisition Data (Card Type 2)	0741	FIL7LD
1	Aircraft Data	0745	FIL7LD
1	Air Defense Weapon Data (Card Type 1)	0750	FIL7LD
2	Air Defense Weapon Data (Card Type 2)	0750	FIL7LD
3	Air Defense Weapon Data (Card Type 3)	0750	FIL7LD
4	Air Defense Weapon Data (Card Type 4)	0750	FIL7LD
5	Air Defense Weapon Data Rotary Wing (Card Type 5)	0750	FIL7LD
6	Air Defense Weapon Data Fixed Wing (Card Type 6)	0750	FIL7LD
1	Air Delivery of Scatterable Mine Mission Resources Data	0760	FIL7LD
1	Aircraft Flight Altitudes for Dispensing Mines	0761	FIL7LD

b. Creating Constant Data Files for Airmobile Model. The Airmobile Model constant data input file is created by reading in the data deck structured as illustrated in Figure IV-15-A-16. The subdecks that form the Airmobile Model data deck, with Blue force data preceding Red force data are shown. At the left side of the figure are 14 groupings of card formats that are used to assemble the subdecks for both Blue and Red forces. After the groupings of cards are aligned as shown in Figure IV-15-A-16, all the Blue force cards are then assembled for the first subdeck. The Red force data are then organized in the 14 groupings as shown at the left of the figure and assembled into their subdeck. The two subdecks and a card with the characters END DATA punched in columns 72-80 are assembled into a deck as shown at right of Figure IV-15-A-16. The data deck is then ready for insertion of the system control cards and submission to the computer system for creation of the Airmobile Model constant data input files.

c. Updating Airmobile Model Constant Data Files. Changes to the data read into the constant data files for the Airmobile Model can be readily accomplished through the use of the retained Airmobile Model data deck. The updating may consist of correction of an error in one data element, the deletion of information, or the addition of new data.

(1) Correcting an Error. The card with the error or data to be changed is located and a new card is produced with the correct or changed data punched in. The old card is removed from the deck, and the new card is inserted in its location. The entire data deck for both Red and Blue forces is submitted for another run on the computer system. The recreation of the constant data files through reading in the data deck with the changed data on cards constitutes the correction of an error or the changing of a data element.

(2) Deletion of Information. The deletion process consists of eliminating the entire file or deleting one data element or a record. The process for deleting the entire Airmobile Model constant data file uses the control card to erase all the disk storage for the Airmobile Model constant data. To delete a data element, select the card or cards having unwanted data. These cards are removed from the data deck, and the purged deck is submitted for reread to the computer system. The omission of cards causes that data to be eliminated from the data base in the process of recreating the constant data files for the Airmobile Model.

(3) Addition of Data. Data may be added at any time prior to the start of the game. Prepare the cards that are to have the data and integrate them into the data deck by placing each of the card formats in the appropriate subdeck as illustrated in Figure IV-15-A-16. When these cards have been accurately integrated into the data deck the completed and expanded data deck is submitted to the computer system for reread. Each time data are entered in the Airmobile Model constant data input file printouts are generated showing the new file information.

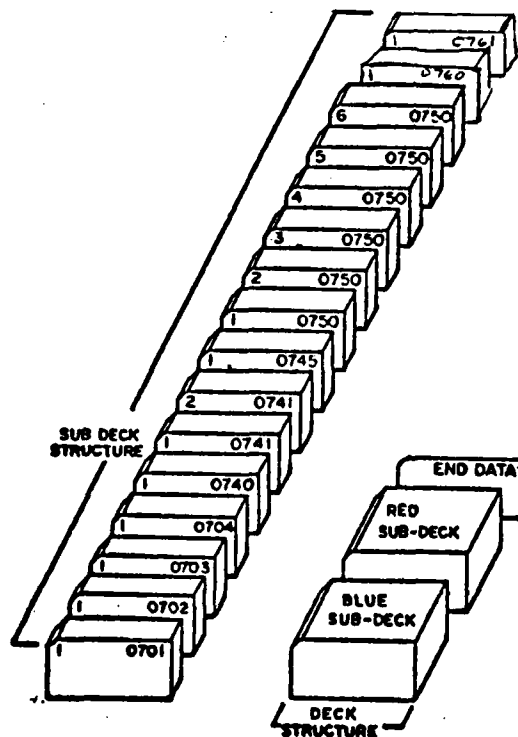


Figure IV-15-A-17. Airmobile Model Data Deck Structure

## APPENDIX B

### AIRMOBILE MODEL PROGRAM DESCRIPTIONS

1. INTRODUCTION. Routines for the Airmobile Model are contained in the DIVWAG Period Processor overlay 17 wherein the main area contains the overlay executive routine, and five segments treat sequential portions of a simulated airmobile operation. The macro flow of the Airmobile Model appears in Figures IV-15-1 through IV-15-4 and IV-15-8 through IV-15-10.

#### 2. ROUTINE AMBLEX:

a. Purpose. Program AMBLEX is the executive driver of the airmobile overlay. It calls the proper segment to process an airmobile event.

b. Input Variables. Standard common block variables: IDUM.

c. Output Variables. None.

d. Logical Flow (Figure IV-15-B-1):

(1) Block L1. The contents of IFNT(56,1) are set to zero.

(2) Blocks 2 and 3. The value of IDUM(94) is divided by 10. If this value is equal to five, routine ATTDVR is called to begin processing an inflight attrition event.

(3) Block L10. The value of IDUM(94) is divided by 10 to determine the segment number to be called, which, in turn, processes the event.

(4) Block 4. If the segment has set the cycle flag [IFNT(56,1)], another airmobile event is to be processed immediately, and control cycles back to block L1.

#### 3. ROUTINE ACCPT:

a. Purpose. ACCPT is the executive driver routine of the resource allocation segment of the Airmobile Model. It calls the proper routine to process each event following a DSL accept transport order.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IOPER	TWO	Operation code.

c. Output Variables. None.

d. Logical Flow (Figure IV-15-B-2):

(1) Block 1. Reduce operation code by 10 to filter airmobile segment code.



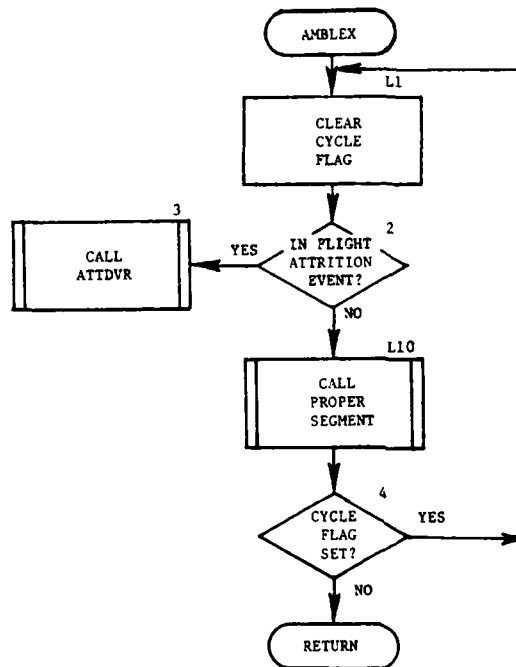


Figure IV-15-B-1. Routine AMBLEX

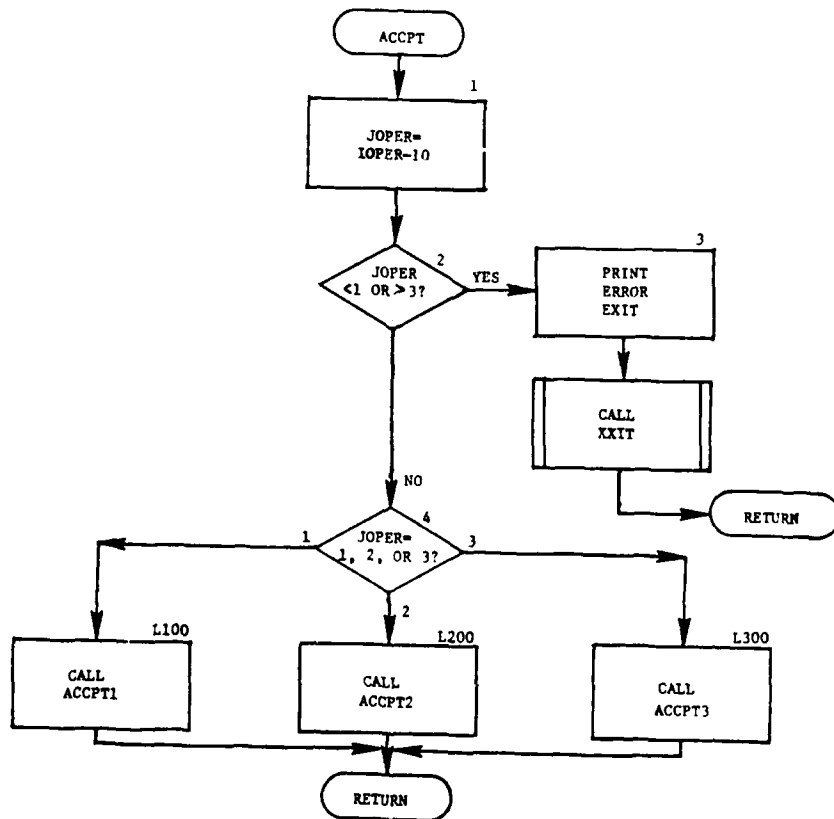


Figure IV-15-B-2. Routine ACCPT

(2) Block 2. Test whether code is within correct range.

(3) Block 3. Print error message if code is incorrect.

(4) Block 4. Control branches to call appropriate routine.

(5) Blocks L100, L200, and L300. Call appropriate routine for the accept transport segment of the Airmobile Model.

#### 4. ROUTINE ACCPT1:

a. Purpose. ACCPT1 is called by program ACCPT at the beginning of each DSL accept transport order. Its purpose is to locate and select the optimum airbase(s) for supplying the airmobile lift with the necessary escort and transport aircraft and related resources. A mission unit is created to fly the aircraft from the airbase(s) to the pickup point. The aircraft are vulnerable to enemy air defense fire if the flight to the pickup point requires penetration of enemy air defense space. If two airbases are chosen, one to supply escort aircraft and the other to supply transport aircraft, an escort mission unit is created to fly to the transport airbase, acquire the transport resources and proceed to the pickup point.

##### b. Input Variables:

(1) Standard Common Block.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IOPER	TWO	Operation code.
IUIDTP	TWO	Unit to be transported.
MIX	TWO	Resource mix code.
ITPNUM	TWO	If positive, number of transport aircraft; if negative, number of trips required.
IPICKT	TWO	Time to be at pickup point.
CONSMP(10)	DF14	Aircraft fuel consumption rates.
FLSPD(36)	DF26	Aircraft flight speeds.
MIXTAB(12)	F07	Mission resources.
IESCAC		MIXTAB(1). Item code for escort aircraft.
ESCPER		MIXTAB(2). Number of personnel per escort aircraft.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
ESCL3A		MIXTAB(3). Gallons of fuel per escort aircraft.
MUNITN(6)		MIXTAB(4). Item code and amount of escort munitions (up to three different types).
ITPAC		MIXTAB(10). Item code for transport aircraft.
TRNPER		MIXTAB(11). Number of personnel per transport aircraft.
TRNC3A		MIXTAB(12). Gallons of fuel per transport aircraft.
ACAVL	DF26	Aircraft item codes.

c. Output Variables:

(1) Standard Common Block.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IDMSTR	TWO	Mission unit containing both escort and transport aircraft.
IDESC	TWO	Escort mission unit only.
IDTRAN	TWO	Transport mission unit only.
FUEL	TWO	Fuel consumed from airbase to pickup point.
TRANAB	TWO	Transport airbase identification.
ESCAB	TWO	Escort airbase identification.

d. Logical Flow (Figure IV-15-B-3):

(1) Block 1. Get the mission resources data from the mix table on data file 7. See MIXTAB definitions in paragraph b above.

(2) Block 2. Get the unit status record of the unit ordered to accept transport.

(3) Block 3. Transfer pertinent resource data from the mix table to an array that will be transferred to the unit status records of the unit accepting transport and of any mission units that may be created.

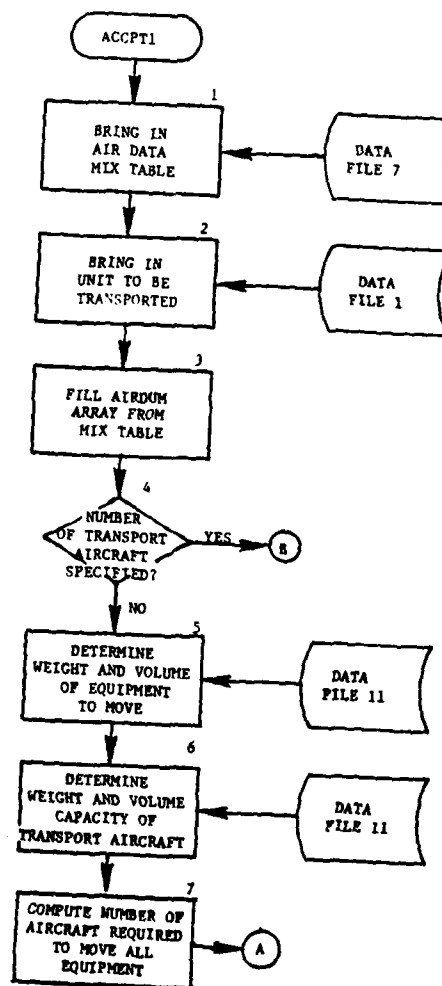


Figure IV-15-B-3. Routine ACCPT1 (Continued on Next Page)

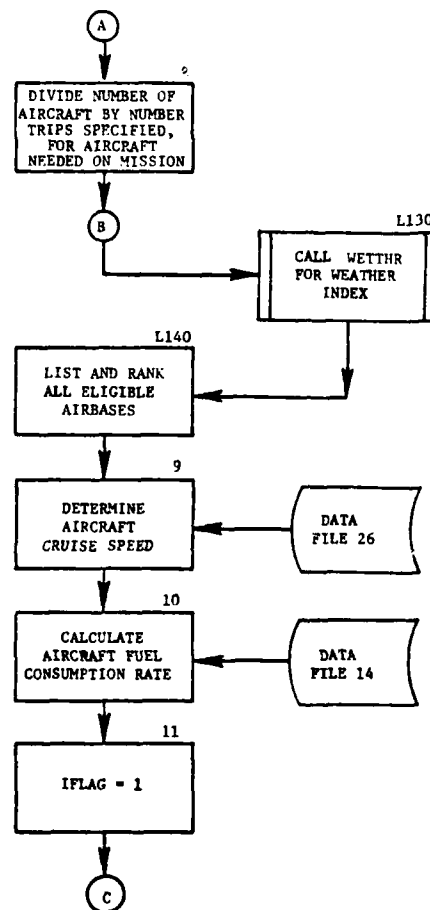


Figure IV-15-B-3. Routine ACCPT1 (Continued)

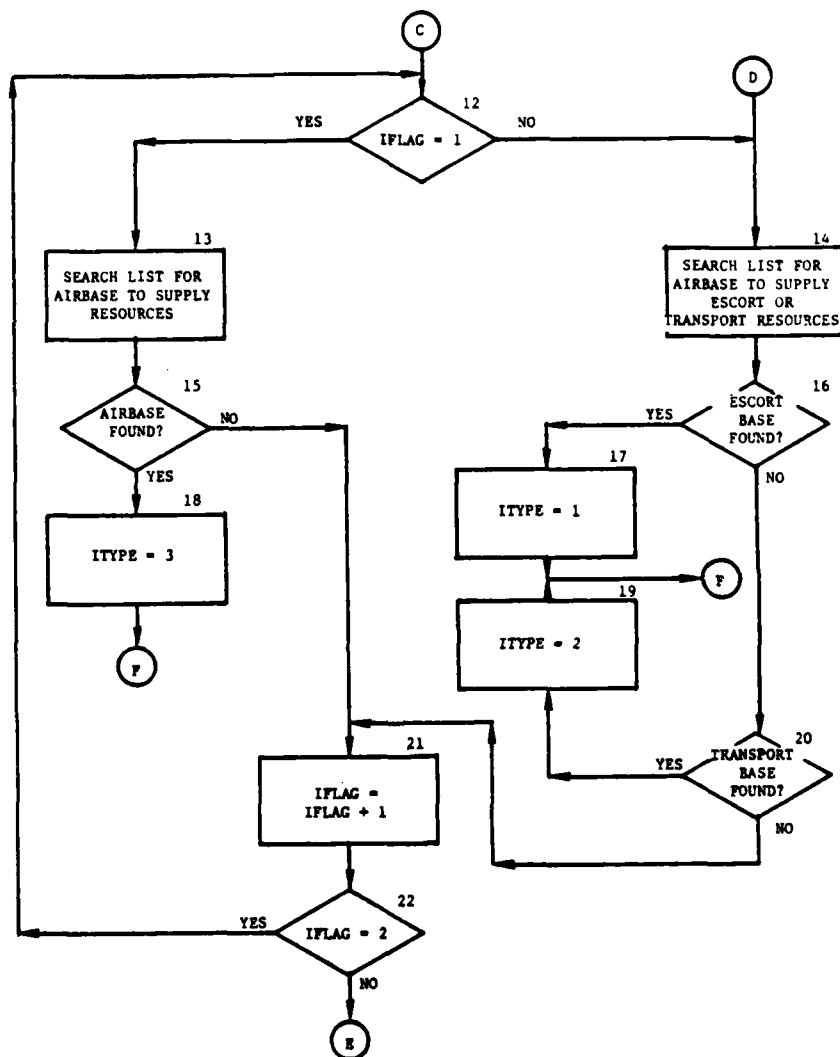


Figure IV-15-B-3. Routine ACCPT1 (Continued)

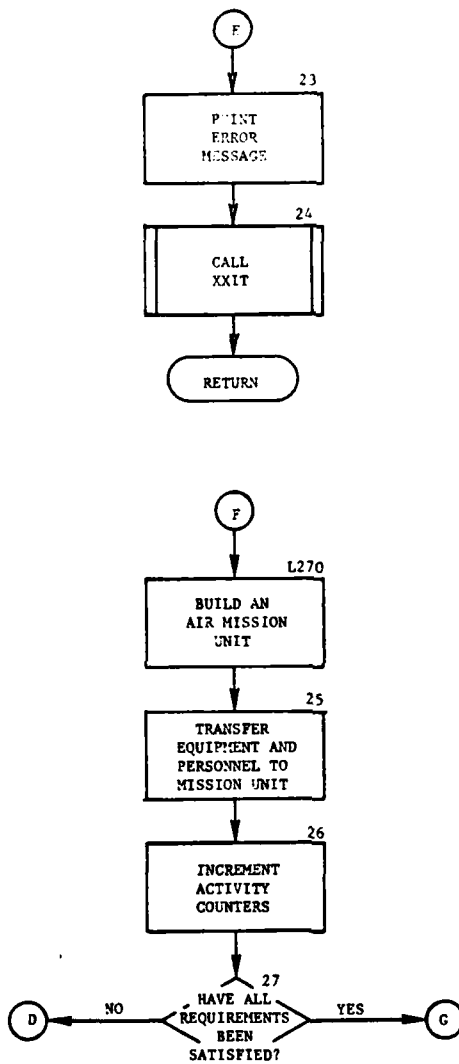


Figure IV-15-B-3. Routine ACCPT1 (Continued)



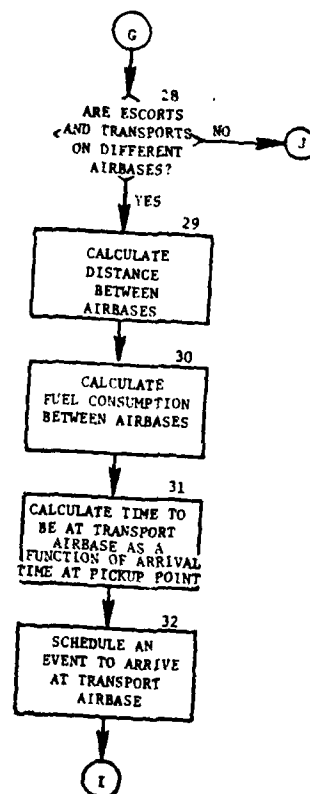


Figure IV-15-B-3. Routine ACCPT1 (Continued)

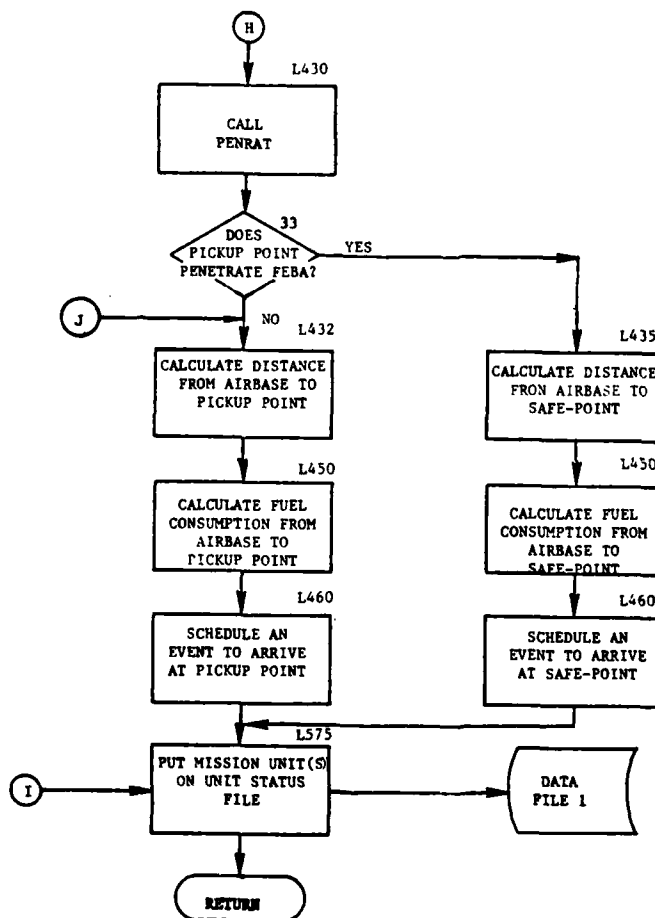


Figure IV-15-B-3. Routine ACCPT1 (Concluded)

(4) Block 4. If the number of transport aircraft is given, control goes to block L130. If the number of trips is specified, control continues to block 5.

(5) Block 5. Determine the weight and volume of the equipment to be moved, excluding any aircraft and class IIIA fuel that the unit to be transported may contain.

(6) Block 6. Determine the weight and volume capacity of the transport aircraft type selected.

(7) Block 7. Compute the number of transport aircraft loads required to move the equipment.

(8) Block 8. Divide the number of trips into the number of aircraft loads to determine the number of aircraft required.

(9) Block L130. Routine WETTHR is called to determine the weather/visibility index (0 to 3) that governs the aircraft flight speed.

(10) Block L140. Determine friendly airbases and store in a list. Rank the list by proximity to the pickup point within each of the three categories:

- . Airbases in direct support to the unit requesting the transport
- . Airbases in general support status
- . Airbases in direct support to other units.

(11) Block 9. Determine the flight speed of the escort and transport aircraft. The flight speed table on data file 26 is used.

(12) Block 10. Calculate the aircraft fuel consumption rates for the escorts and transports. The consumption rates are taken from data file 14.

(13) Blocks 11 through 22. These blocks show a search technique to locate airbase(s) which can satisfy the resource requirements for this airmobile mission. First, a pass is made through the list of eligible airbases to select a single airbase that satisfies all resource requirements. If one does not exist, a second pass is made to select two airbases. One will supply the escort aircraft and associated resources; the other, the transport aircraft and resources. If two airbases cannot be found the airmobile mission is aborted.

(14) Blocks 23 and 24. If all resources have not been located by the previous selection process, an error message is printed and routine XXIT is called.

(15) Block L270. Having selected an airbase to supply at least a portion of the mission resources, a mission unit is created.

(16) Block 25. Transfer resources from the airbase to the air mission unit(s).

(17) Block 26. The activity counters on the airbase unit status record are incremented to record the number of aircraft supplied and the number of operations supported.

(18) Block 27. If this is the first pass, all requirements are satisfied. If this is the second pass and both mission units have been created, all requirements are satisfied. In either case, control goes to block 28; otherwise, control goes to block 14.

(19) Block 28. Check whether aircraft and resources were found on one airbase or two. If from one airbase, go to block L432. If from two airbases, flow continues to block 29.

(20) Block 29. Calculate the distance between the airbases.

(21) Block 30. Calculate the fuel consumed in flight between the two airbases.

(22) Block 31. Calculate the time the escort mission unit must arrive at the transport airbase in order to arrive at the pickup point as scheduled.

(23) Block 32. Schedule an event for the escort mission unit to arrive at the transport airbase.

(24) Block L430. Call routine PENRAT to determine if the pickup point is on the enemy side of the forward edge of battle area (FEBA).

(25) Block 33. If the pickup point penetrates the FEBA, control goes to block L435; otherwise, flow continues to block L432.

(26) Block L432. Calculate the distance from the airbase to the pickup point.

(27) Block L435. Calculate the distance from the airbase to a safe point (penetration) on the friendly side of the FEBA.

(28) Block L450. Calculate the aircraft fuel consumption over the distance to be moved.

(29) Block L460. Schedule an event to arrive at either the pickup point for nonpenetration or the safe point for penetration. If the latter occurred the in-flight attrition routines will be activated to compute aircraft attrition over that portion of the flight in enemy airspace.

(30) Block L575. Place the mission unit(s) unit status record(s) on data file 1.

5. ROUTINE ACCPT2:

a. Purpose. Routine ACCPT2 is called when two airbases were selected to supply the requested airmobile mission resources. Two mission units were created in ACCPT1, one containing escort aircraft and related resources, the other containing the transport aircraft and resources. After the escort mission unit has flown to the transport airbase ACCPT2 merges the two mission units into one and releases the other. The airmobile mission then proceeds toward the pickup point.

b. Input Variables:

(1) Standard Common Block.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IPICKT	TWO	Time to arrive at pickup point.
IDESC	TWO	Escort mission unit.
IDTRAN	TWO	Transport mission unit.
FUEL	TWO	Fuel consumed in flight to the airbase.

c. Output Variables:

(1) Standard Common Block.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IDMSTR	TWO	Mission unit containing both escort and transport aircraft.
FUEL	TWO	Fuel consumed for next leg of the flight.

d. Logical Flow (Figure IV-15-B-4):

(1) Block 1. Read the unit status records of the escort and transport mission units from data file 1.

(2) Block 2. Update the coordinates of the escort mission unit to those of the airbase.

(3) Block 3. Transfer transport aircraft and all related resources from the transport mission unit to the escort mission unit.

(4) Block L100. Release the transport mission unit and put its updated unit status record back on data file 1.

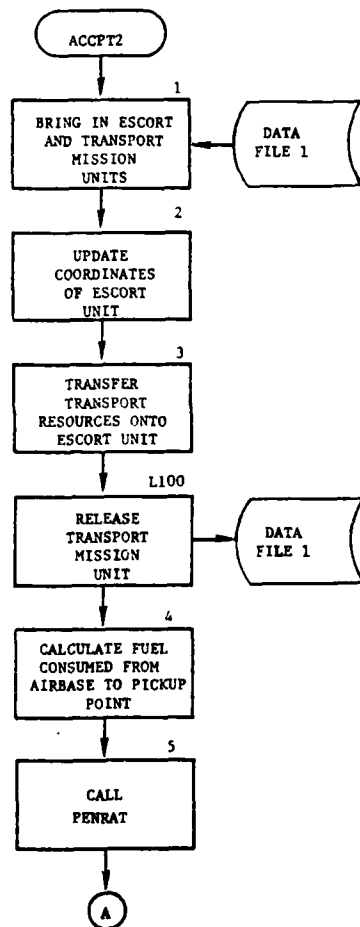


Figure IV-15-B-4. Routine ACCPT2 (Continued on Next Page)

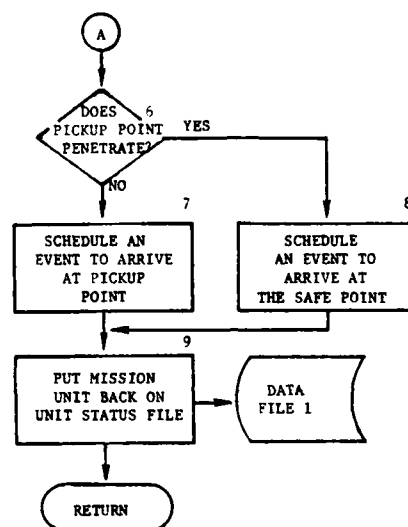


Figure IV-15-B-4. Routine ACCPT2 (Concluded)

(5) Block 4. Calculate the fuel to be consumed during the flight from the transport airbase to the pickup point.

(6) Block 5. A call to routine PENRAT determines whether the pickup point is on the enemy side of the FEBA, which requires penetration of enemy air space by the mission unit.

(7) Block 6. A check is made to determine whether penetration of enemy air space is necessary.

(8) Block 7. If there is no penetration, an event for the mission unit to arrive at the pickup point is scheduled.

(9) Block 8. If there is penetration, an event is scheduled for the mission unit to arrive at a safe point on the friendly side of the FEBA. At this point in-flight attrition will begin and continue until arrival at the pickup point.

(10) Block 9. Put the mission unit's status record on data file 1.

#### 6. ROUTINE ACCPT3:

a. Purpose. ACCPT3 merges the aircraft and related resources from the mission unit, after its arrival at the pickup point, with the unit to be transported.

b. Input Variables:

(1) Standard Common Block Areas. UMAIN, UCOOP.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IUIDTP	TWO	Unit to be transported.
IDMSTR	TWO	Air mission unit.
FUEL	TWO	Fuel consumed during last leg of flight.

c. Output Variables. Standard Common Block Areas. UMAIN, UCOOP.

d. Logical Flow (Figure IV-15-B-5):

(1) Block 1. Read the air mission unit's status record from data file 1.

(2) Block 2. Read the unit status record for the unit to be transported from data file 1.

(3) Block 3. Merge mission unit and unit to be transported.



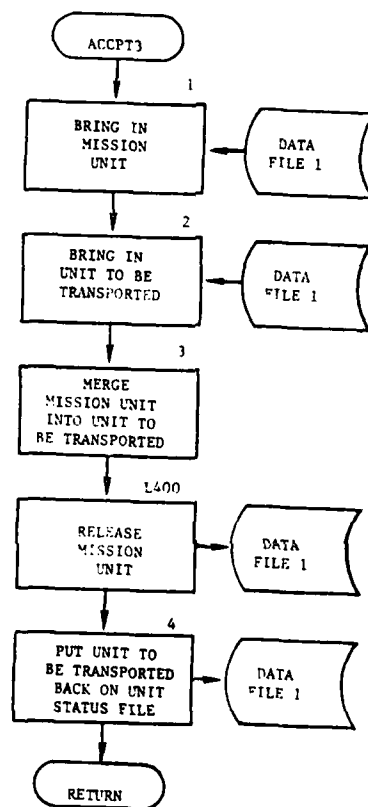


Figure IV-15-B-5. Routine ACCPT3

(4) Block L400. Clear the mission unit's status record and replace it on data file 1.

(5) Block 4. Put transported unit's updated status record back on data file 1.

7. ROUTINE ASULT:

a. Purpose. ASULT is the executive driver routine of the Airmobile Model's assault segment. It calls the proper routine to process each assault event.

b. Input Variables. These variables are common to all ASULT segment routines.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FILE12(35)	DF12	Event description record.
IOPER		FILE12(1). Operation code.
IUIDMU		FILE12(2). Unit identification of assaulting unit.
IUIDMP		FILE12(3). Unit identification of unit at pickup zone.
IUIDMS		FILE12(4). Unit identification of shuttle unit.
IUIDML		FILE12(5). Unit identification of unit at landing zone.
PZX		FILE12(6). Pickup zone X coordinate.
LEGX (4)		FILE12(7). Flight leg end point X coordinates.
PZY		FILE12(11). Pickup zone Y coordinate.
LEGY (4)		FILE12(12). Flight leg end point Y coordinates.
FLTIME		FILE12(16). Total one-way flight time.
LATIME		FILE12(17). Landing time.
ESFUEL		FILE12(20). Escort aircraft fuel consumption rate.
TRFUEL		FILE12(21). Transport aircraft fuel consumption rate.
LEGCNT		FILE12(22). Number of flight legs.
LEGPT		FILE12(23). Flight leg being flown.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
XAFTER		FILE12(33). Refuel/rearm return point X coordinate.
YAFTER		FILE12(34). Refuel/rearm return point Y coordinate.
NXTOPR		FILE12(35). Refuel/rearm and in-flight attrition. Return operation code.

c. Output Variables. None.

d. Logical Flow (Figure IV-15-B-6):

(1) Block 1. The value of the operation code indicates which routine is to be called for the current event.

(2) Blocks L1, L2, L3, and L4. One of the four assault event processing routines is called. After the event has been processed, control returns to routine AMBLEX.

#### 8. ROUTINE ASULT1:

a. Purpose. ASULT1 is called by routine ASULT to initialize each airmobile assault event sequence. Its three principal functions are to:

- (1) assemble the list of flight leg coordinates contained in the DSL airmobile assault order and place them on the data file 12 event record.
- (2) assemble pertinent constant data and place them on the data file 12 record.
- (3) schedule the event to take off from the pickup zone to arrive on schedule at the landing zone.

b. Input Variables:

- (1) Standard Common Block Areas. UMAIN, TCLOCK.
- (2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
ACAVL(72)	DF26	Aircraft type/time code reference.
VELTAB(36)	DF26	Aircraft velocity table. (Same as FLTSPD).
CONSMP(10)	DF14	Fuel consumption rate table.
FILE12(35)	TWO	Event description record.

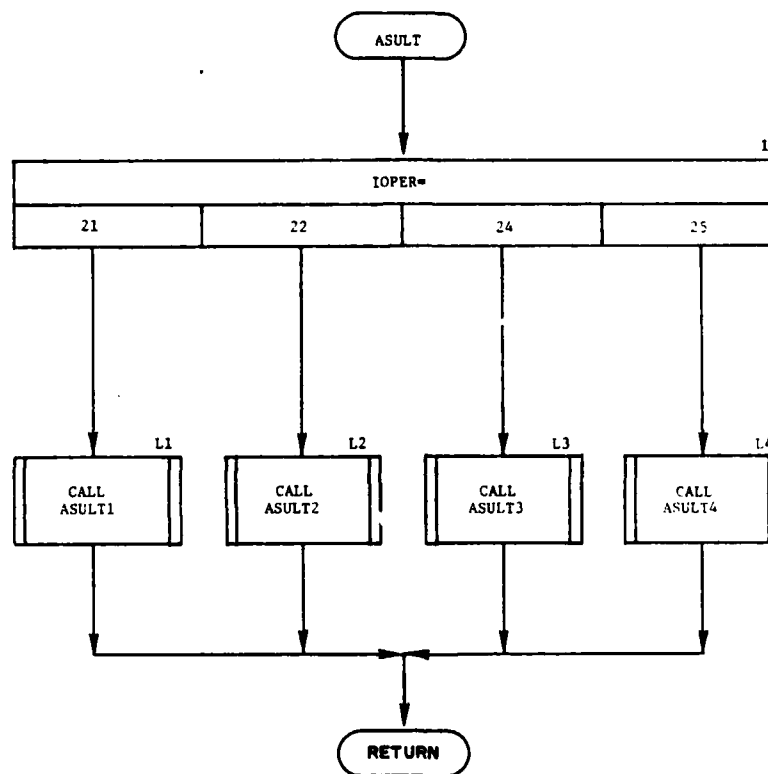


Figure IV-15-B-6. Routine ASULT

c. Output Variables:

(1) Standard Common Block Area. UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
FILE12(35)	DF12	Event description record.

d. Logical Flow (Figure IV-15-B-7):

(1) Block L10. The flight leg coordinate points contained in the DSL order are passed to the model by routine DOSR. The coordinates are placed in OBJX, OBJY on the unit's status record. The first coordinate pair is in those locations when processing by this routine begins. A value of -1 in NTIME indicates that more coordinate pairs are contained in the order. Sequential calls to routine DOSR cause each succeeding coordinate pair to be passed through OBJX, OBJY. When the contents of NTIME are no longer negative, DOSR is not called. The coordinates are transferred to LEGX(4), LEGY(4) on the data file 12 array. If more than four coordinate pairs are encountered, an error message is printed and processing terminates. The content of NTIME is the desired time of arrival at the landing zone. A value of zero in NTIME indicates that the assault is to begin immediately.

(2) Block 1. Routine WETTHR is called to determine the weather/visibility index (0 to 3) which governs the aircraft flight speed.

(3) Block L43. The aircraft item codes contained in the AIRDAT array are converted to aircraft type indices (1 to 9) by searching the ACAVL table for corresponding codes on both escort and transport aircraft. The item codes had been entered into AIRDAT when the unit received an accept transport order.

(4) Block 2. The transport aircraft flight speed is taken from the VELTAB array for the weather/visibility condition determined in block 1 and transport aircraft type index determined in block L43. The transport aircraft fuel consumption rate is taken from the CONSMP table for the flight speed which was determined above. Altitude of 50 feet is assumed.

(5) Block 3. If no escort aircraft are present, block L47 is omitted.

(6) Block L47. Same as block 2 excepting for escort aircraft instead of transport aircraft.

(7) Block L49. The flight speed of the combined unit is set to the minimum of the transport and escort speeds.

(8) Block L50. The total flight time from pickup to landing zone is calculated using the speed determined in block L49 and the flight legs determined in block L10. (Aircraft landing time is added to the flight time but the landing times are not currently available.)

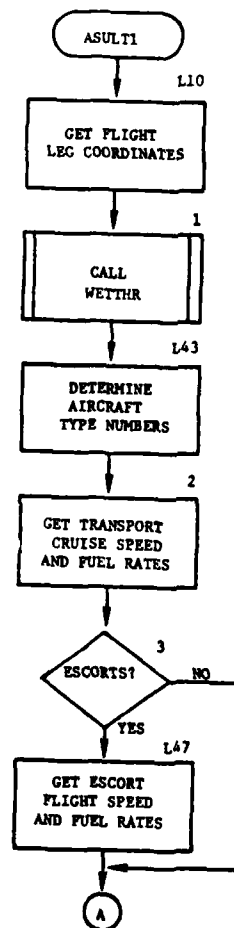


Figure IV-15-B-7. Routine ASULT1 (Continued on Next Page)

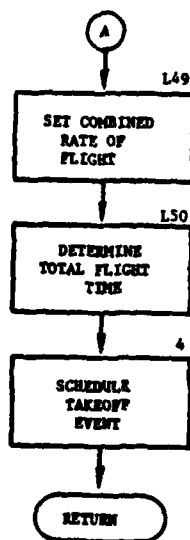


Figure IV-51-B-7. Routine ASULT1 (Concluded)

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(9) Block 4. Data assembled are saved in the data file 12 array. The takeoff time is calculated using the flight time and the requested arrival time. The takeoff event is scheduled by calling routine EVTSET which enters the event in the event table and puts the data file 12 array onto data file 12. The takeoff event will be processed by routine ASULT2.

9. ROUTINE ASULT2:

a. Purpose. ASULT2 is called by routine ASULT at the scheduled takeoff time. The functions of this routine are to load the shuttle unit with the correct quantities of personnel and equipment and to schedule the initiation of the first flight leg. It is also called to load subsequent trips. A holding mission unit is created when it is necessary to leave some equipment or personnel at the pickup zone for subsequent trip(s).

b. Input Variables:

(1) Standard Common Block Area. UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FILE12(35)	TWO	Event description record.
TRANWV(3,50)	DF11	Transport weight and volume capacities.
EQPWV(11,233)	DF11	Equipment weight and volume.
EXCL(50)	DF7	Secondary priority equipment indicators. Four indicators per word.
EEQPT (100)	EQUIPT	Equipment type codes. Four codes per word.
MIXTAB(12)	DF7	Airmobile equipment mix table.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
FILE12(35)	DF12	Event description record.

d. Logical Flow (Figure IV-15-B-8):

(1) Blocks 1, 1A, 1B. The transport capacity table (TRANWV) is taken from data file 11 and searched to find the capacity of the transport aircraft presently assigned to the unit being moved. If the transport type is not contained on the table, an error message is printed and the job is terminated. If found, the total weight and volume capacities of the transports available to the unit are calculated. If no transport aircraft are present, the event is rescheduled to 1 minute later.



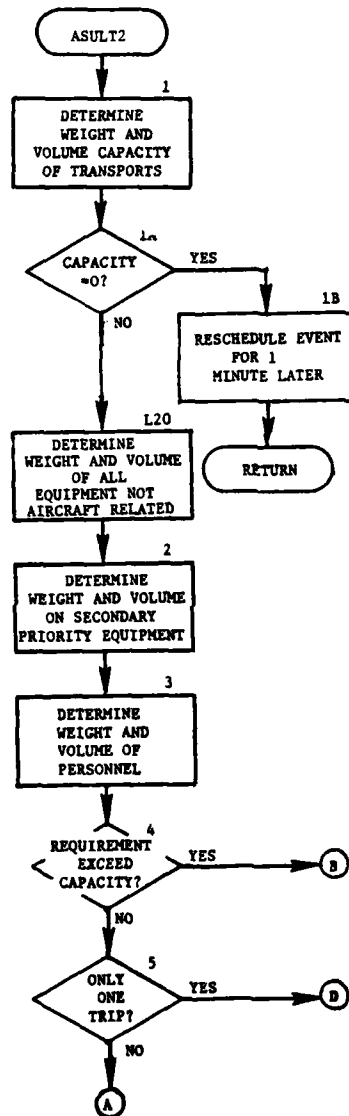


Figure IV-15-B-8. Routine ASULT2 (Continued on Next Page)

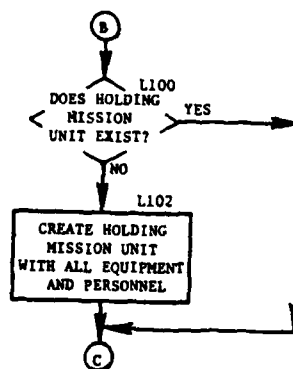
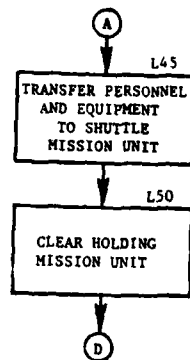


Figure IV-15-B-8. Routine ASULT2 (Continued)

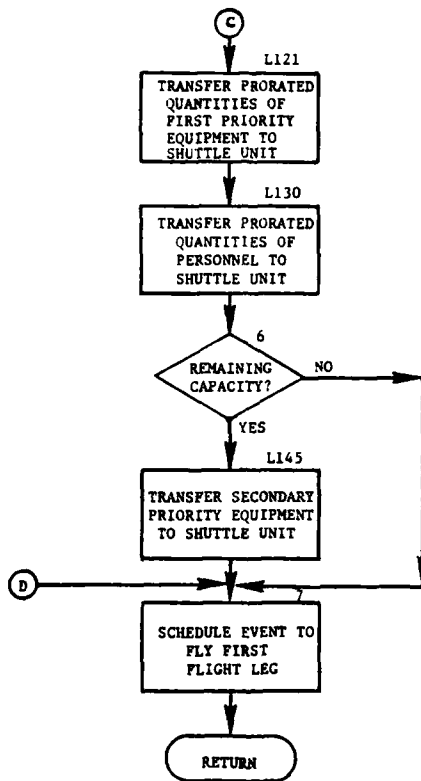


Figure IV-15-B-8. Routine ASULT2 (Concluded)

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(2) Block L20. The equipment weight and volume table (EQPWV) is taken from data file 11 and the equipment type codes (EOHC) are taken from COMMON EQUIPT. The EOHC entries for each aircraft type, aircraft munitions, and class IIIA fuel are set to M. The total weight and volume of all equipment currently at the pickup zone not coded with an M are determined.

(3) Block 2. The total weight and volume of all secondary priority equipment at the pickup zone not coded with an M are also calculated.

(4) Block 3. The weight and volume of all personnel at the pickup zone, excluding the aircraft crews, are calculated.

(5) Block 4. If the entire load cannot be moved during this trip, control branches to block L100; otherwise, control goes to block 5.

(6) Block 5. If this is the only trip to be made, control goes to block 7; otherwise, control goes to block L45.

(7) Block L45. If this is not the only trip, the unit at the pickup zone is a holding mission unit. All personnel and equipment in the holding mission unit are transferred to the shuttle mission unit.

(8) Block L50. The status record of the holding mission unit, no longer required, is cleared and the unit becomes available for other events.

(9) Block L100. If this is not the first trip, a holding mission unit exists. Block L102 is omitted.

(10) Block L102. A holding mission unit is created and equipment not coded M is transferred from the moving unit to the holding mission unit.

(11) Block L121. The fraction of the personnel and the first priority equipment which can be moved during this trip is calculated. It is the minimum of the fractional volume and fractional weight capabilities. The amount of each first priority equipment type in the holding mission unit is prorated by the fraction and transferred to the shuttle unit. (On the first trip, the shuttle unit is the unit ordered to perform the assault. On following trips, it is a mission unit.)

(12) Block L130. The number of personnel in the holding mission unit is also prorated by the same fraction and transferred to the shuttle unit.

(13) Block 6. If there is no remaining lift capacity, block L145 is omitted.

(14) Block L145. The procedure explained in block L121 (paragraph d(11) above) is repeated for that quantity of secondary priority equipment which can also be lifted on this trip.

(15) Block 7. The event to initiate the first flight leg is described in the data file 12 array and scheduled to occur immediately by setting IFNT (56,1) to a value of one.

10. ROUTINE ASULT3:

a. Purpose. ASULT3 regulates the movement of the shuttle unit between the pickup and landing zones. It schedules in-flight attrition events for each flight leg, ASULT2 and ASULT4 events upon arrival at the pickup and landing zones respectively, and refuel/rearm events when appropriate.

b. Input Variables:

(1) Standard Common Block Area. UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FILE12(35)	DF12	Event description record.
MIXTAB(12)	DF07	Airmobile mix table.

c. Output Variables:

(1) Standard Common Block Areas. UMAIN, UNTLOC.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
FILE12(35)	DF12	Event description record.

d. Logical Flow (Figure IV-15-B-9):

(1) Block 1. If the shuttle unit is leaving the landing zone on a return flight and the landing zone is in friendly territory, control goes to block L250 to determine if the unit needs refueling and rearming. A jump flag is set to return control if the unit does not need refueling and rearming.

(2) Block 2. If the unit is in the process of leaving the landing or pickup zone, blocks 3 and 4 are omitted, and the leg pointer has a value of 0 or -1.

(3) Block 3. The time of flight of the preceding leg is determined from the distance flown and the airspeed. The rate of fuel consumption for escort aircraft and transport aircraft is calculated and subtracted from the quantity of fuel on board.

(4) Block 4. The location of the shuttle unit is updated on the unit status record and the location table in common.

(5) Block L101. If the flight is toward the landing zone, the leg pointer is incremented. If it is toward the pickup zone, the leg pointer is decremented. This pointer identifies the flight leg to be flown.

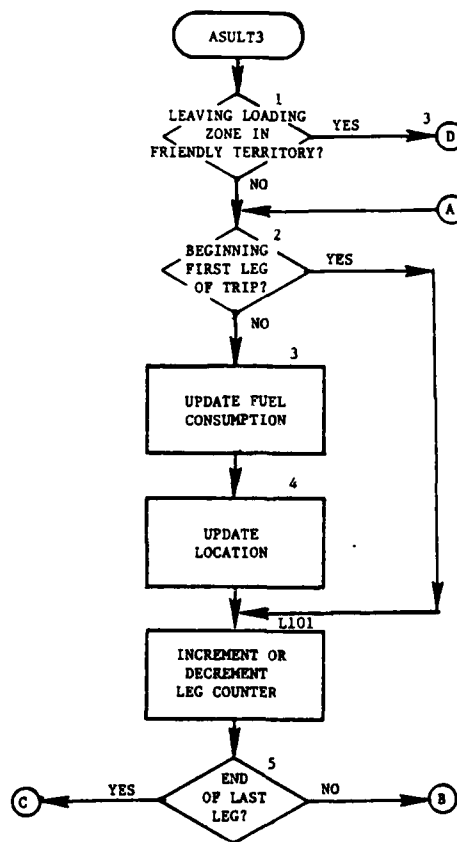


Figure IV-15-B-9. Routine ASULT3 (Continued on Next Page)

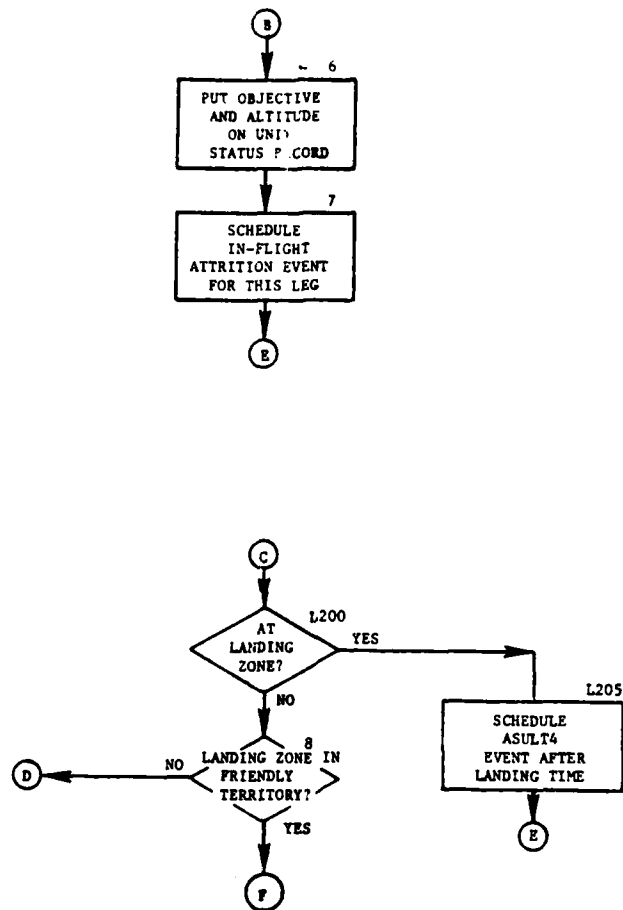


Figure IV-15-B-9. Routine ASULT3 (Continued)

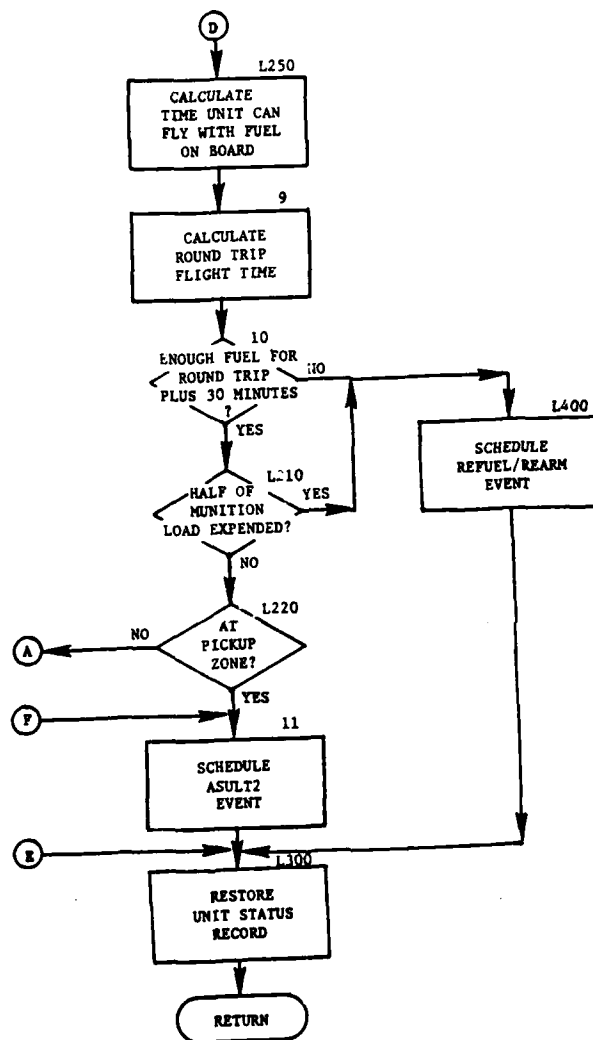


Figure IV-15-B-9. Routine ASULT3 (Concluded)



(6) Block 5. If the leg pointer has a value of zero or if it exceeds the number of legs in the assault, the unit has arrived at the landing or pickup zone and control goes to block L200.

(7) Block 6. The altitude is fixed at 50 feet and the value of MEVTX and MEVTY on the unit status record are set to the coordinate of the end point of the flight leg to be flown.

(8) Block 7. The in-flight attrition operation code is set and IFNT(56,1) is set to one to initiate that event immediately. Control transfers to block L300.

(9) Block L200. If the shuttle unit has arrived at the landing zone, control goes to block L205. If it has arrived at the pickup zone, control continues to block 8.

(10) Block 8. If the unit has arrived at the pickup zone and the landing zone is in enemy territory, a refuel/rearm check is made, with the jump flag set to cause control to go to block 11 and control goes to block L250. Otherwise, control goes directly to block 11.

(11) Block L250. The length of time that the unit can fly with the fuel presently on board is calculated from the consumption rates.

(12) Block 9. The time required to fly all flight legs is added to the landing time.

(13) Block 10. If the unit cannot fly a complete round trip with 30 minutes reserve, control goes to block L400 to schedule a refuel/rearm event.

(14) Block L210. The mix table is read from data file 7 and the full load of munitions for the current number of escort aircraft is calculated. If the unit has less than half of the full load, control goes to block L400.

(15) Block L400. The return location on the data file 12 array is set to the current location of the unit. The refuel/rearm operation code is set and the return operation code is set. The content of IFNT(56,1) is set to one to cause the event to be initiated immediately.

(16) Block L220. If the refuel/rearm check was made for a unit leaving the landing zone (jump flag equals 0) control goes to block 2.

(17) Block 11. The unit has returned to the pickup zone for another load and trip. The ASULT2 operation code is set and IFNT(56,1) is set to one to cause the event to be initiated immediately.

(18) Block L300. The unit status record of the shuttle unit is returned to data file 1.

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11. ROUTINE ASULT4:

a. Purpose. ASULT4 controls the unloading of personnel and equipment at the landing zone and the consolidation of the unit. It also initiates the event sequence to return the aircraft to the pickup zone for any additional required trip loads.

b. Input Variables:

(1) Standard Common Block Areas. UMAIN, UCOOP, TCLOCK.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FILE12(35)	DF12	Event description record.
MIXTAB(12)	DF07	Airmobile mix table.
FEBXIN	ZONDAT	FEBA intercept with X axis.
IANGL	DF16	Force orientation angle.

c. Output Variables:

(1) Standard Common Block Areas. UMAIN, UCOOP, UNTLOC.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
FILE12(35)	DF12	Event description record.

d. Logical Flow (Figure IV-15-B-10):

(1) Block 1. If there is a nonzero value in IUIDML, part of the unit has arrived on a previous trip. Control then goes to block L500; otherwise, control goes to block 2.

(2) Block 2. The unit being moved is given a stay event for zero time. This causes the unit to resume its ordered event cycle.

(3) Block 3. The X axis intercept of a line passing along the forward edge of the unit and parallel to the FEBA is calculated. The X intercept of that line is compared with FEBXIN to determine if the unit is across the FEBA from the remainder of its force.

(4) Block 4. If the unit is across the FEBA, AMBLFG is set to one; otherwise, it is set to zero. If some of the unit is still at the pickup zone (IUIDMP contains a nonzero value), AMBLFG is decremented by two.

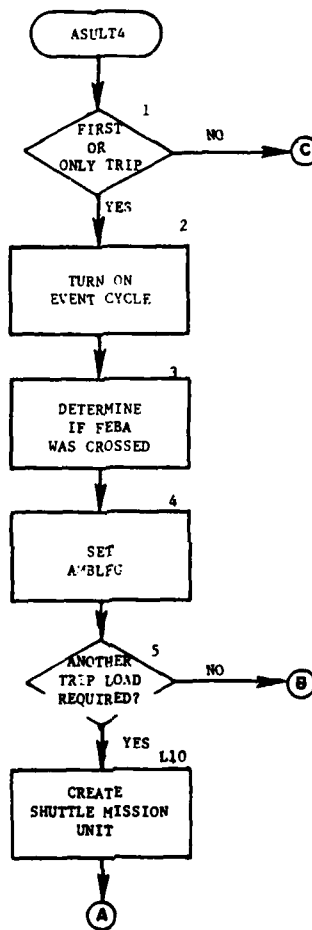


Figure IV-15-B-10. Routine ASULT4 (Continued on Next Page)

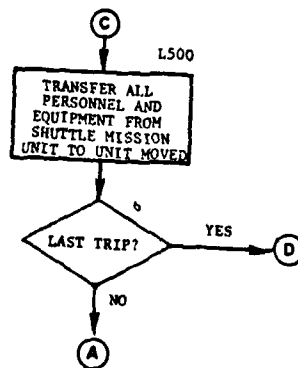
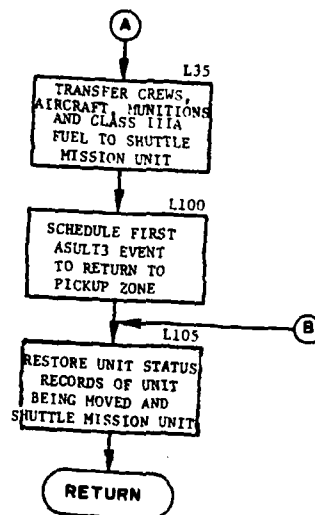


Figure IV-15-B-10. Routine ASULT4 (Continued)

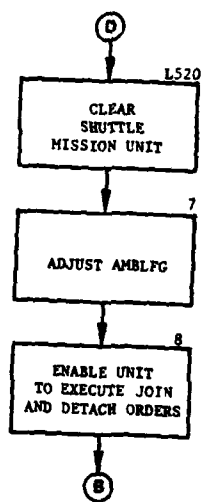


Figure IV-15-B-10. Routine ASULT4 (Concluded)

(5) Block 5. If none of the unit is still at the pickup zone, control goes to block L105; otherwise, control goes to block L10.

(6) Block L10. The unit being moved will remain at the landing zone. A shuttle mission unit is created to simulate subsequent trips between the pickup and landing zones.

(7) Block L35. All aircraft, munitions, and class IIIA fuel are transferred from the unit at the landing zone to the shuttle mission unit. The required number of personnel for the aircraft crews is also transferred. The number and types of equipment are obtained from the mix table.

(8) Block L100. The operation code is set to 24 for the ASULT3 event. The leg pointer is initialized to zero and IFNT(56,1) is set to one to cause the event to be initiated immediately.

(9) Block L105. The applicable unit status records are restored onto data file 1.

(10) Block L500. This is a subsequent trip. The status records of the shuttle mission unit and the unit at the landing zone are read into common and all personnel and equipment in the shuttle unit are transferred to the unit at the landing zone.

(11) Block 6. If additional trips are to be made, control goes to block L35.

(12) Block L520. The status record of the shuttle mission unit is cleared and the unit is available for use by another event sequence.

(13) Block 7. The value of AMBLFG on the unit being moved is incremented by two to indicate that it is no longer en route.

(14) Block 8. If the unit has a join or detach order pending, the unit is given a stay event to enable it to resume its ordered event cycle.

## 12. COMMON BLOCK FRRA:

a. Purpose. Common block FRRA contains variables which are used in the forward refuel/rearm segment of the Airmobile Model. Most FRRA variables are equivalenced to IDUM; however, some variables are equivalenced to UMAIN. The working portion of FRRA (work) is stored in data file 24.

### b. Variables:

<u>Name</u>	<u>Equivalenced to</u>	<u>Description</u>
IUIDMU(20)	WORK(1)	IUID of mission unit.
TIF(20)	WORK(21)	Total number of inlets to be refueled.

<u>Name</u>	<u>Equivalenced to</u>	<u>Description</u>
TACRA(20)	WORK(41)	Total number of aircraft to be rearmed.
READY(20)	WORK(61)	Number of aircraft ready to be rearmed.
TAC(20)	WORK(81)	Time required to rearm one aircraft of this flight.
RFTPI(20)	WORK(101)	Refuel time per inlet.
RACAT(100)	WORK(121)	Rearm capacity availability times.
RACAA(100)	WORK(221)	Amount of rearm capacity available at time RACAT.
RFC	WORK(321)	FRRA refuel capacity.
RAC	WORK(322)	FRRA rearm capacity.
QI	WORK(323)	Queue index.
RFP	WORK(324)	Refuel index.
RAP	WORK(325)	Rearm index.
TLTFC	WORK(326)	Total amount of fuel committed to units. Long-term fuel, incremented as units are assigned to FRRA.
TSTFC	WORK(327)	Short-term fuel committed to units, incremented as units begin refueling.
MTRF	WORK(328)	Maneuver time for refueling.
MTRA	WORK(329)	Maneuver time for rearming.
WORK(330)		Pointer to the last record used on data file 24 (stored in record 1).
IOPR	KDUM(1)	Numeric operator code; indicates unit's refuel/rearm status.
MUID	KDUM(2)	IUID of mission unit.
TRL	KDUM(3)	Rearm time pointer (RACAT, RACAA).
IUIDA	KDUM(4)	IUID of mission unit (same as MUID).
LTFL	KDUM(5)	Long-term fuel committed to unit.
STFC	KDUM(6)	Short-term fuel committed to unit.

<u>Name</u>	<u>Equivalenced to</u>	<u>Description</u>
IUIDF	KDUM(7)	IUID of FRRA.
ACBP	KDUM(31)	Number of aircraft being processed.
IRETX	KDUM(33)	Return X coordinate.
IRETY	KDUM(34)	Return Y coordinate.
IOPRET	KDUM(35)	Next IOPR of mission unit.
CONSUM	IDUM(21)	Aircraft fuel consumption rates from data file 14.
MIXTAB	IDUM(29)	Airmobile mix table from data file 7.
KDUM	IDUM(94)	Automatic event order table.
WORK	IDUM(151)	FRRA working array described above.
DMU	NOR	Mission unit index.
FCOMP	OBJX	Number of fuel inlets remaining to be refueled.
ACOMP	OBJY	Number of aircraft for a particular mission unit which remain to be rearmed.
PRSRFP	DGZX	Number of refuel points currently available.
PRSRAP	DGZY	Number of rearm points currently available.
NAUTRA	MUNTPY	Number of authorized rearm points.
MIX	AIRDAT(8)	Pointer to the mix table associated with this unit.
CPRSRF	CDGZX	Number of refuel points currently available.
CPRSRA	CDGZY	Number of rearm points currently available.
CNAURA	CMUNTP	Number of authorized rearm points.

13. ROUTINE RREXEC:

a. Purpose. This routine is the executive routine of the refuel/rearm part of the Airmobile Model. Routines RRFRRA, RRQUE, RRTURN, and RRFLD are all called by this routine. RRFLD calls REFUEL and RATIM.

b. Input Variables. Standard common block, FRRA.



c. Output Variables. None

d. Logical Flow (Figure IV-15-B-11):

(1) IOPR = 40. When this event occurs, the aircraft mission unit could find no forward refueling/rearming areas (FRRA) available on its last attempt. Either the FRRA was moving to a new location or it was under enemy attack. The unit has waited 5 minutes and is trying again.

(2) IOPR = 41. When this event occurs, the aircraft mission unit is making its first search for FRRAs. It first tries to find FRRA which is in direct support to the mission unit. The second choice is FRRA in general support. The last choice is a FRRA in direct support to other units. The time when the flight will arrive at the selected FRRA is also calculated.

(3) IOPR = 42. This event occurs as the flight arrives at the FRRA. The flight is either put into a holding area or is put in a refueling queue. If the flight is put in a holding area, an IOPR = 45 event is scheduled to occur in 5 minutes.

(4) IOPR = 43. Part of a flight has just completed refueling. Those aircraft that have been refueled are put into a rearming queue or into a holding area if no rearming is required. If additional aircraft in this flight need fuel, the refueling is scheduled; otherwise, the next flight in the refuel queue is examined.

(5) IOPR = 44. Part of a flight has just completed rearming. Those aircraft that have been rearmed are put into a holding area. If all aircraft have completed refueling and rearming, an IOPR = 49 event is scheduled. If additional aircraft need rearming, the rearming is scheduled.

(6) IOPR = 45. When the flight first arrived at the FRRA, the refueling queue was full. The flight was diverted to a holding area. After a 5-minute delay, the flight is trying again.

(7) IOPR = 46. The flight is in queue and requesting refueling. The refuel capacity of the FRRA has been saturated until the present time.

(8) IOPR = 47. The flight is in rearming queue and requesting rearming.

(9) IOPR = 48. Not used.

(10) IOPR = 49. Flight has completed refueling and rearming. It has now flown from the FRRA to its next objective.

#### 14. ROUTINE RRFRA:

a. Purpose. When a unit requests refueling and rearming services, this routine selects a forward refueling and rearming area (FRRA) and sends the unit to the FRRA. A unit's initial request enters RRFRA with IOPR equals

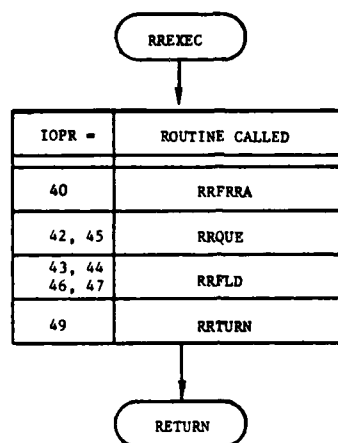


Figure IV-15-B-11. Routine RREXEC

41. Subsequent requests by the same unit enter with IOPR equals 40. The routine attempts to locate FRRA for the requesting mission unit in the following sequence:

- . in direct support of the mission unit or its superior unit.
- . in general support
- . in direct support of another unit.

If these three attempts fail, a 5-minute delay is scheduled after which another attempt is made.

b. Input Variables:

- (1) Standard Common Areas. UMAIN, UCOOP, FRRA, UTDTBL, UNTLOC.
- (2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IRRUTD	DF7	UTDs of FRRA units.
CONSUM	DF14	Fuel consumption rates of aircraft.
IF7	DF7	Refuel maneuver time in minutes [IF7(241)].
IF7		Rearm maneuver time in minutes [IF7(242)].
NN	DF7	Number of nozzles on each refuel device.
IC	DF7	Equipment item code of refuel device.

c. Output Variables.

- (1) Standard common block variable: DELT
- (2) FRRA common block variables: RAC, RFC, IOPR.

d. Logical Flow (Figure IV-15-B-12):

(1) Block 1. A unit entering RRFRRRA with IOPR equals 41 is making an initial request for refueling and rearming services. A unit entering RRFRRRA with IOPR equals 40 requested refueling and rearming services previously, but no FRRAs were available, and the unit is making another request. The list of possible FRRA UTDs is read from data file 7.

(2) Block 2. When an aircraft mission unit requires fuel or ammunition, it is determined whether the aircraft unit has an FRRA unit in direct support. The mission unit's status record is read from data file 1.

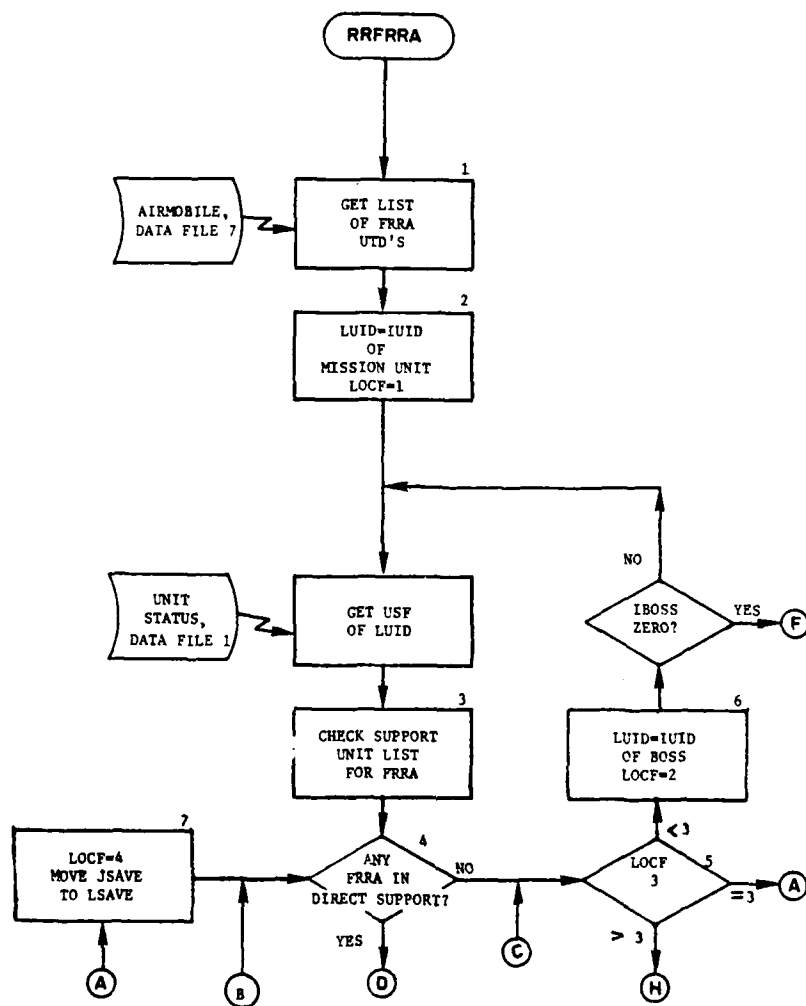


Figure IV-15-B-12. Routine RRFERRA (Continued on Next Page)

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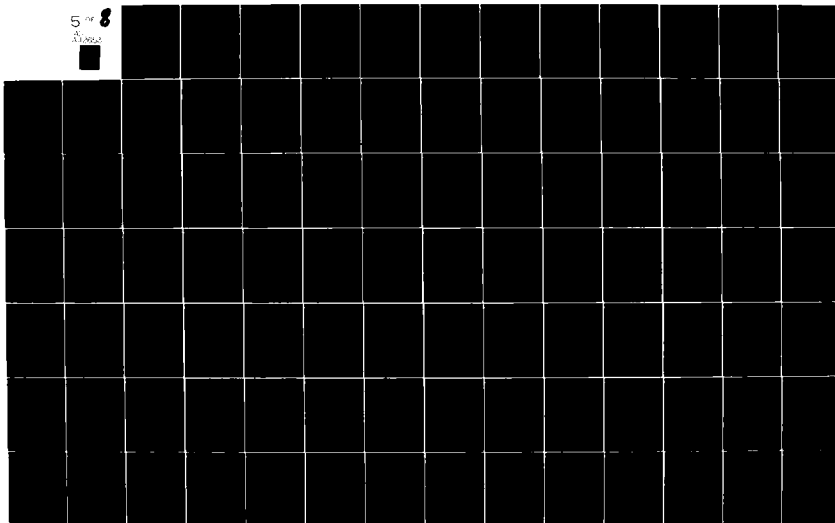
ARMY COMBINED ARMS COMBAT DEVELOPMENTS ACTIVITY FORT--ETC F/G 15/7  
DIVWAS MODEL DOCUMENTATION. VOLUME II. PROGRAMMER/ANALYST MANUA--ETC(U)  
JUL 76

UNCLASSIFIED

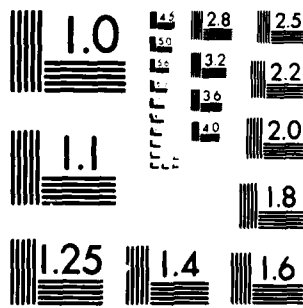
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12653



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS 1963 A

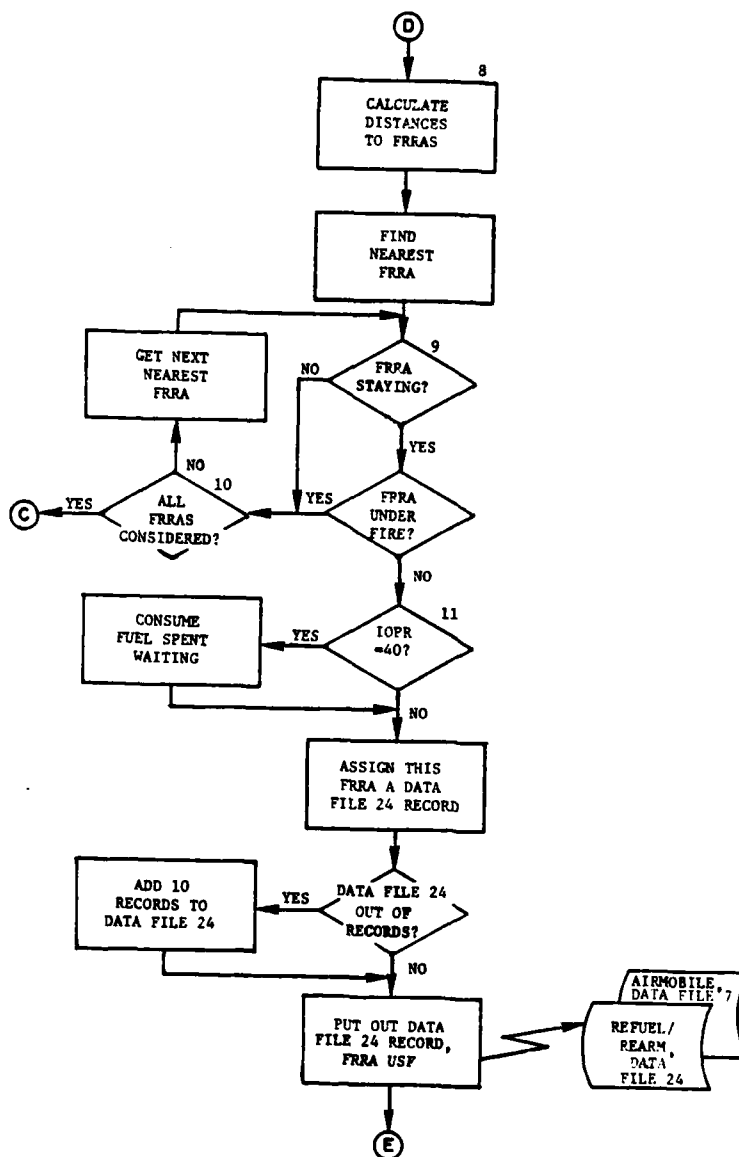


Figure IV-15-B-12. Routine RRFRRRA (Continued)

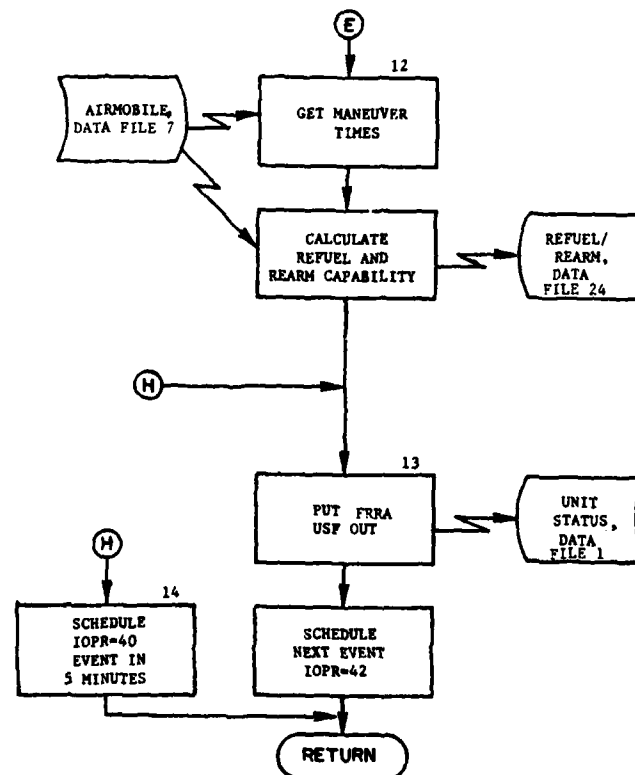


Figure IV-15-B-12. Routine RRFRA (Continued)



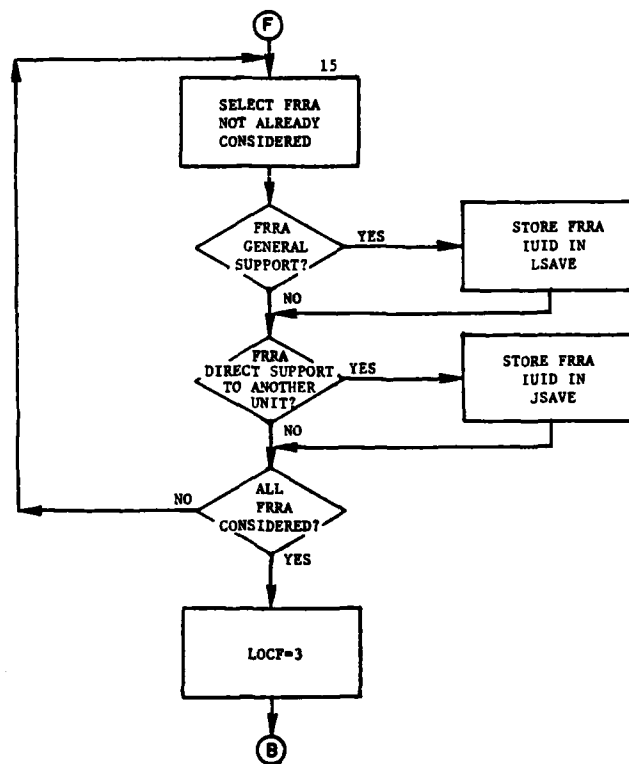


Figure IV-15-B-12. Routine RRFRRR (Concluded)

(3) Block 3. A check is then made to determine if any of the units in direct support is an FRRA.

(4) Block 4. If at least one direct support unit is an FRRA, control passes to block 8. If none are, control goes to block 5.

(5) Block 5. In this block a check is made to determine if both the mission unit and its superior have been examined for FRRA direct support units. If not, control flows to block 6. If FRRA units in general support have not been examined, control flows to block 7. If all FRRA units have been examined except those in direct support of other units, control passes to block 14.

(6) Block 6. If only the mission unit has been examined and no FRRA unit in direct support was found, the superior of the mission unit is considered. If the IUID of the superior unit is zero, control goes to block 15; otherwise, the unit status record is read and control passes to block 3.

(7) Block 7. If all FRRA units in direct support to either the mission unit or its superior and all FRRA units in general support have been examined, FRRA units in direct support to other units are examined. Control goes to block 4.

(8) Block 8. At least one FRRA candidate has been found. The distances from the FRRA units to the release point from the Airmobile Model are calculated. For those available, the FRRA unit nearest to the release point is selected.

(9) Block 9. After an FRRA unit is selected, the unit is examined to determine if it is in a resupply mode; i.e., stay order. If it is not, control passes to block 10. If it is, a check is made to determine if the unit is under fire. If the unit has been assessed casualties in the last 5 minutes it is under fire. If it is not under fire, control goes to block 11; otherwise, block 10 is executed.

(10) Block 10. Since this FRRA unit is no longer a possible candidate, a check is made to determine if other FRRA units are available. If all FRRA units in this group have been considered, control returns to block 5; otherwise, the next closest FRRA unit in this group is selected and control returns to block 9.

(11) Block 11. An FRRA unit has been found. If IOPR equal 40, the fuel that this mission unit consumed while waiting is extracted from its unit status record. A data file 24 record is assigned the FRRA unit. This record is used to store the FRRA's refuel and rearm queue information. If data file 24 is too small, it is expanded by 10 records. The FRRA unit's status record and data file 24 record are put out and control goes to block 12.

(12) Block 12. The FRRA unit's rearm and refuel maneuver times are read from data file 7 and stored in the work area. The number of rearm points authorized to the FRRA is read from data file 7 and reduced by the

ratio of current personnel strength of the FRRA unit to the authorized personnel strength. The number of refuel nozzles available at the FRRA is also calculated. This information is put on data file 24.

(13) Block 13. The status record of the FRRA unit is put back on the unit status file. Finally, the arrival of the mission unit at the FRRA is scheduled and control returns to the calling routine.

(14) Block 14. No FRRA units are currently available. A 5-minute delay is scheduled with IOPR equal 40. After the delay has elapsed, another attempt will be made to find an FRRA. The control returns to the calling routine.

(15) Block 15. FRRA units in direct support to either the mission unit or its superior have been examined and rejected as possible candidates. Remaining FRRA units are now examined. Those FRRA units in general support are stored in array LSAVE and those in direct support to other units are stored in JSAVE. After all FRRAs have been considered, LOCF is set equal to three and control returns to block 4.

#### 15. ROUTINE RRQUE:

a. Purpose. This routine is called when the aircraft mission unit that requires refueling/rearming arrives at the FRRA. RRQUE sets the parameters that place the unit in the refuel queue. If the queue is full, the aircraft is scheduled to wait in a holding area for 30 minutes to enter the refuel queue again.

#### b. Input Variables:

(1) Standard Common Areas. UMAIN, UCOOP, FRRA.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
MIXTAB(1)	DF7	Equipment item code of escort aircraft.
MIXTAB(3)		Maximum amount of fuel on each escort aircraft.
MIXTAB(4,6,8)		Equipment item codes of munitions loaded on escorts.
MIXTAB(5,7,9)		Amounts of munitions loaded on escorts corresponding to munitions equipment item codes.
MIXTAB(10)		Equipment item code of transport aircraft.
MIXTAB(12)		Maximum amount of fuel on each transport aircraft.
MIXTAB(13)		Rearm time per escort aircraft.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
MIXTAB(14)		Number of escort refuel inlets.
MIXTAB(15)		Number of transport refuel inlets.

c. Output Variables:

(1) FRRA Common Block Variables. FCOMP, ACOMP, and ACP.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
TAV	Call	Time increment added to TCLOCK, time when flight fragment will be refueled.
IDT	Call	Same as TAV.
NFUEL	Call	Flag indicating whether refueling can occur at this time.

d. Logical Flow (Figure IV-15-B-13):

(1) Block 1. Entry can be initiated by either of two events. Either a mission unit is attempting to enter the refuel queue at the FRRA for the first time (IOPR = 42) or the queue was full the first time and the unit is trying after a 30-minute delay (IOPR = 45). In both cases, the mission unit's status record is read into UMAIN, the FRRA unit's status record is read into UCOOP, and the data file 24 work area for the FRRA is brought into common. The coordinates of the FRRA unit are assigned to the mission unit.

(2) Block 2. The fuel consumed during this flight as the aircraft flew from the release point to the FRRA or as it waited to enter the refuel queue is calculated and subtracted from the fuel on board the aircraft.

(3) Block 3. Before the aircraft unit can be placed in the refuel queue, a check determines if the queue is full. Capacity has been set at 20. If the queue is full, the flight is diverted to a holding area for 30 minutes. At the end of this time, another attempt will be made by this aircraft unit to enter the refuel queue.

(4) Block 4. If the queue is not full, the IUID of the mission unit is entered in the IUIDMU array. The data file 12 information is stored in the data file 24 work area.

(5) Block 5. Since the mission unit does not transfer its aircraft to the FRRA unit's status record, the mission unit is assigned a width and depth for assessment of damage from artillery fire. Aircraft are considered to be uniformly distributed in the first (or front) band of the rectangle used to represent the unit.

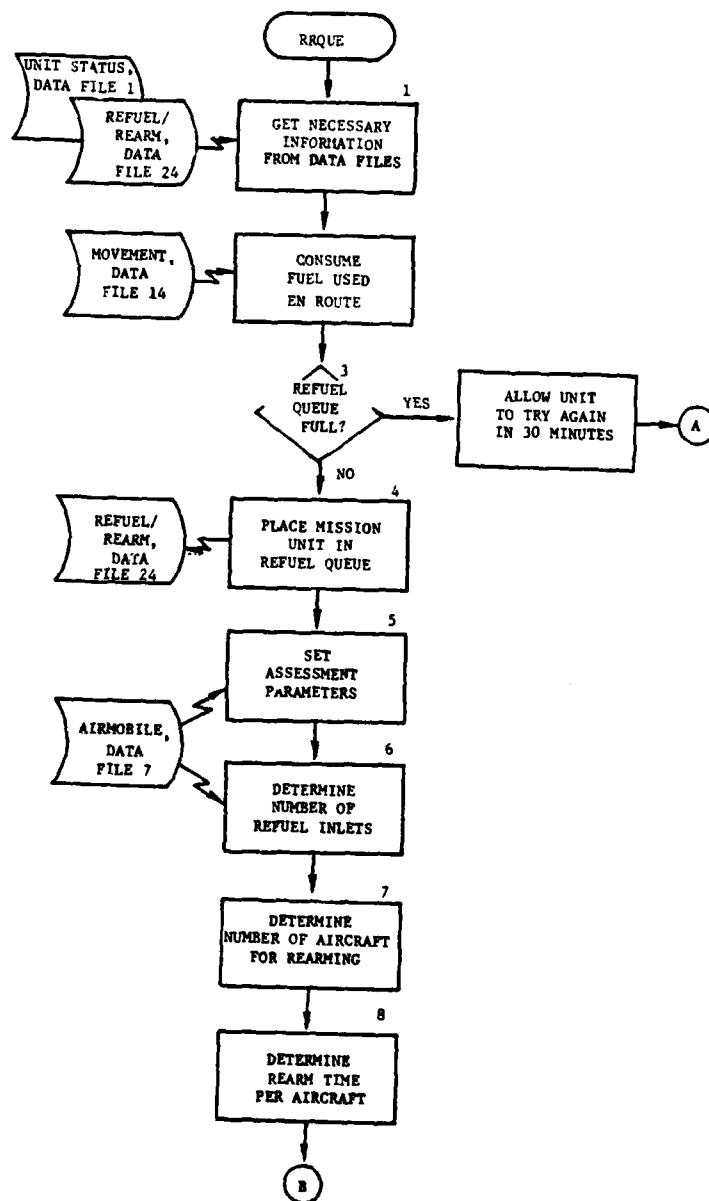


Figure IV-15-B-13. Routine RRQUE (Continued on Next Page)

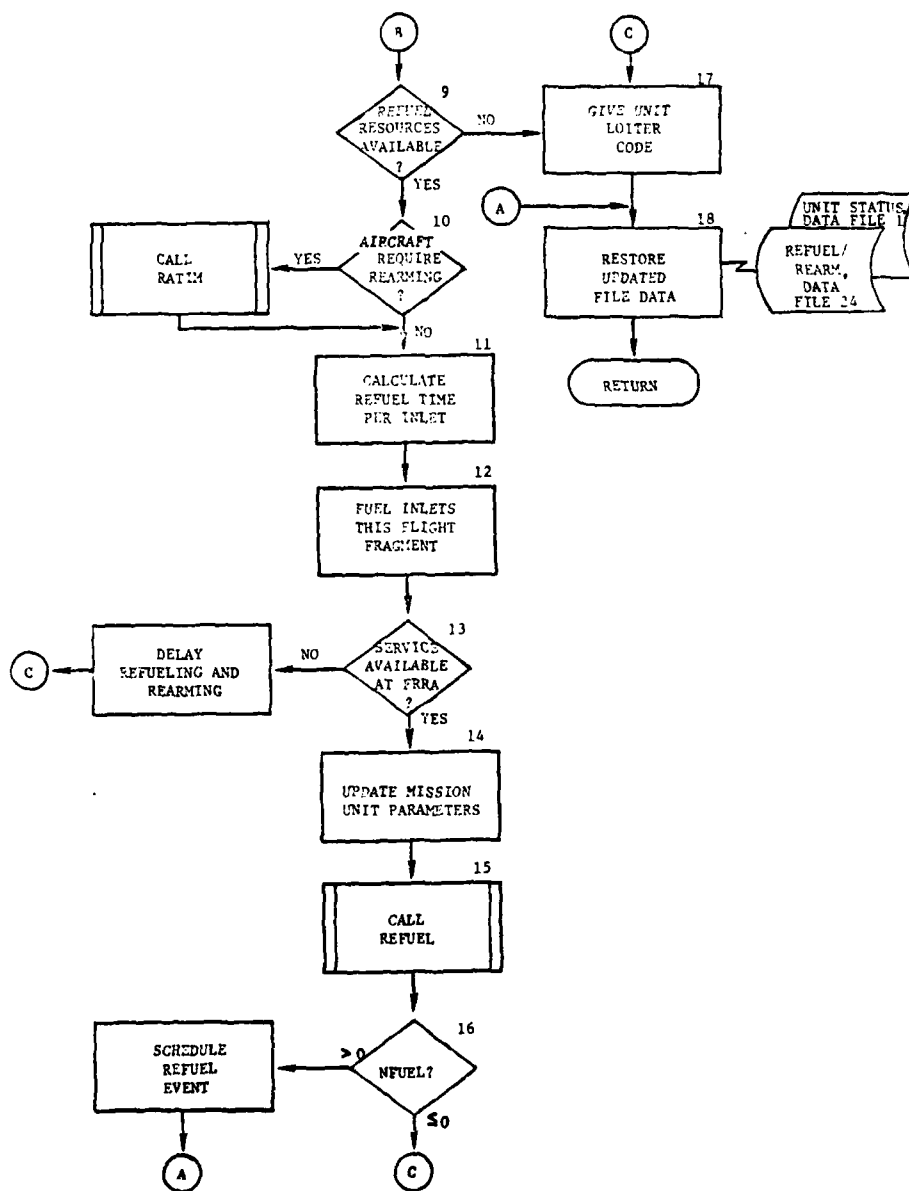


Figure IV-15-B-13. Routine RRQUE (Concluded)

(6) Block 6. The number of inlets to be refueled on these aircraft are calculated. Number of inlets rather than number of aircraft are used since some aircraft may have more than one fuel inlet. An aircraft with two inlets will be refueled faster than the same aircraft with only one inlet. Number of inlets per aircraft is obtained from data file 7.

(7) Block 7. The number of aircraft to be rearmed is based on the number of escort aircraft available. Transport aircraft are not rearmed. Those escort aircraft that have expended at least 1 percent of their ammunition load are rearmed.

(8) Block 8. The rearming time for each aircraft in the flight unit is equal to the rearming time per aircraft from the MIXTAB array on data file 7 plus a maneuver rearming time from data file 7. This new rearming time is stored in the data file 24 work array in TAC(21). The refuel and rearm counters are set and stored in the mission unit's status record.

(9) Block 9. A check determines if there are available refuel nozzles at the FRRA. If there are none, control goes to block 17.

(10) Block 10. If refuel nozzles are available, another check determines if rearming is required by this flight unit. If it is, routine RATIM is called to determine when the rearm capability will be available.

(11) Block 11. Refuel time (in centiminutes) per inlet is calculated by dividing the number of gallons of fuel required per inlet by the intake rate of the fuel tanks. A constant intake rate of 50 gallons per minute is assumed. A refueling maneuver time is added to arrive at the refueling time per inlet, RFTPI(21).

(12) Block 12. The number of inlets to be fueled during this flight segment will be the lesser of the available refuel nozzles and the number of inlets that require refueling. The amount of fuel required to fill these inlets is calculated. The refueling time per inlet is subtracted from the earliest rearming time calculated in RATIM to determine when refueling of this segment can commence. If this time is in the future, the mission unit will not begin refueling until that time is reached.

(13) Block 13. If sufficient fuel is not available to refuel the flight segment, a 15-minute delay is scheduled (IOPR = 46) at which time another attempt will be made to refuel the aircraft. If the earliest refueling time calculated in block 12 has not been reached, a delay is scheduled (IOPR = 46) until that time. In both these cases control passes to block 17.

(14) Block 14. If refuel facilities are available, the mission unit's altitude is set equal to zero, and NORD equal to one.

(15) Block 15. An attempt is made to refuel this flight segment by setting NFUEL equal to one and calling routine REFUEL.

(16) Block 16. If refueling can occur, the refueling event is scheduled with IOPR equal 43. Control goes to block 18; otherwise, control passes to block 17.

(17) Block 17. If refueling cannot begin immediately, NORD is set equal to 32 and NTIME is set equal to TCLOCK.

(18) Block 18. The updated file data are restored to the files. If the refuel queue was full, only the mission unit's status record is put out; otherwise, both the mission unit's status record and its associated data file 24 work area are put out.

#### 16. ROUTINE RRFLD:

a. Purpose. This routine simulates the actual refueling and/or rearming of the flight segments. In addition it schedules additional refueling/rearming of flight segments as nozzles and rearming points become available. This routine is entered when the value of IOPR is equal to 43, 44, 46, or 47.

##### b. Input Variables:

(1) Standard Common Area: UMAIN, UCOOP, FRRA.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
MIXTAB	DF7	Information on escort and transport aircraft in mission unit.
IC	DF7	Equipment item codes and number of refueling equipment.

c. Output Variables. FRRA common block variables, FCOMP, ACOMP and ACBP.

##### d. Logical Flow (Figure IV-15-B-14):

(1) Block 1. This block checks the value of IOPR (43, 44, 46, or 47) and control is transferred appropriately.

(2) Block 1A. A unit entered at this point (IOPR = 43) has completed all or partial refueling. The mission unit's status record is brought from data file 1 and stored in UMAIN, the FRRA unit's status record is brought in and stored in UCOOP, and the data file 24 work area and the airmobile data are brought in from data file 24 and data file 7 respectively.

(3) Block 2. The number of nozzles currently available to refuel is recalculated to account for attrition and resupply.

(4) Block 3. The number of inlets for this unit that have not been refueled are reduced by the number of inlets that have completed refueling. The resulting number is placed in FCOMP and stored on the mission unit's status record.

(5) Block 4. The number of nozzles that are available to refuel is increased by the number of inlets that have completed refueling.



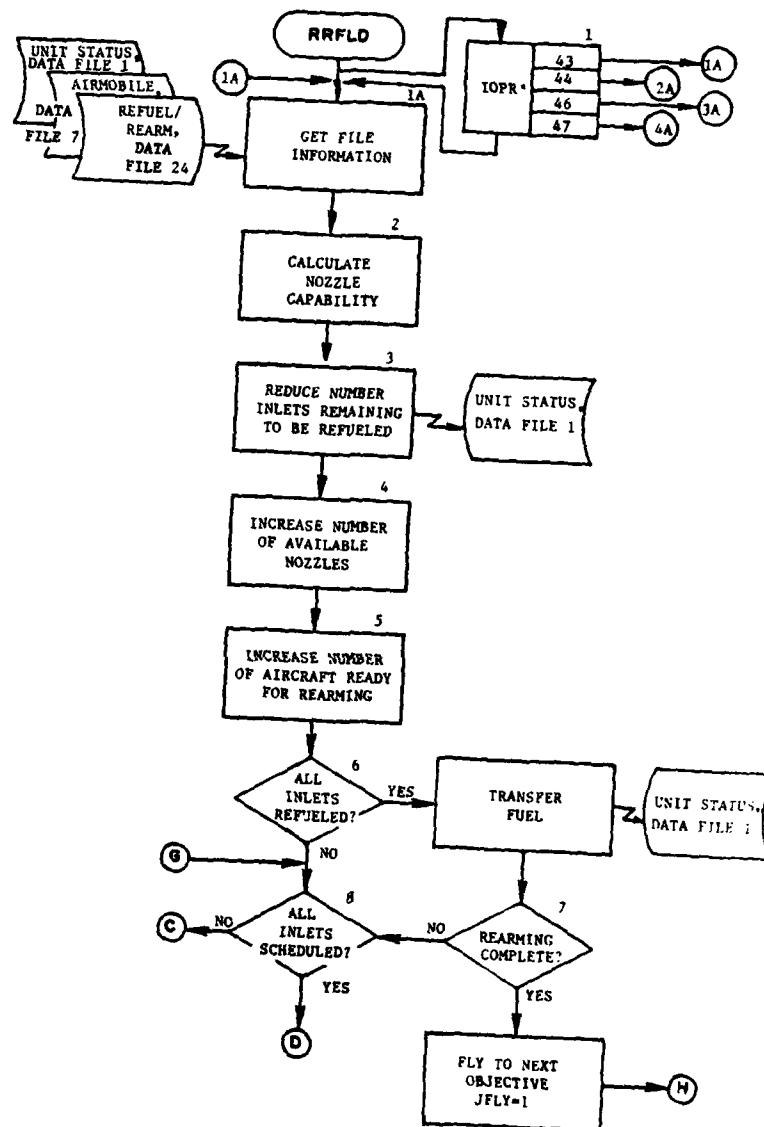


Figure IV-15-B-14. Routine RRFLD (Continued on Next Page)

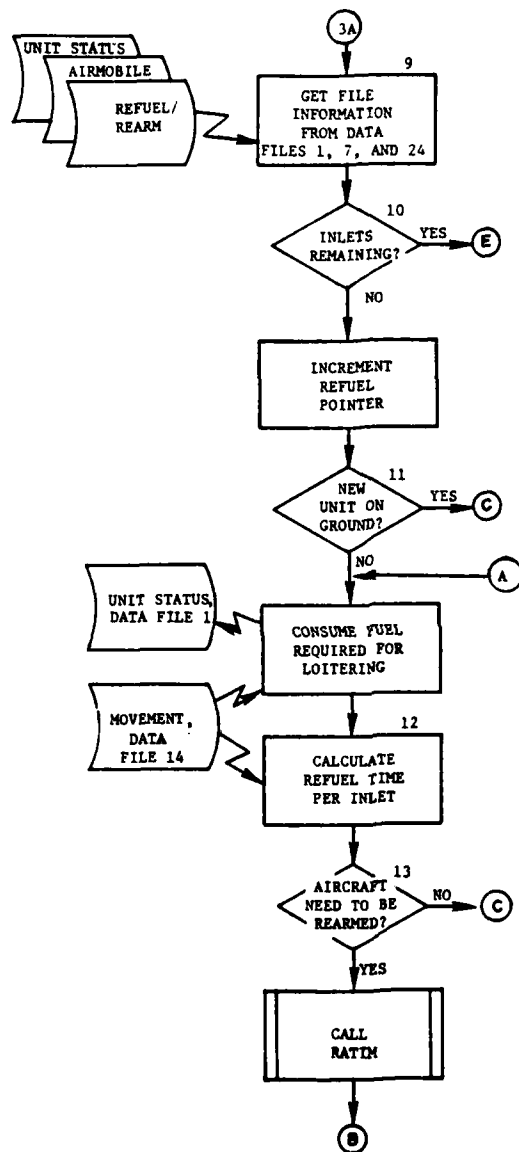


Figure IV-15-B-14. Routine RRFLD (Continued)

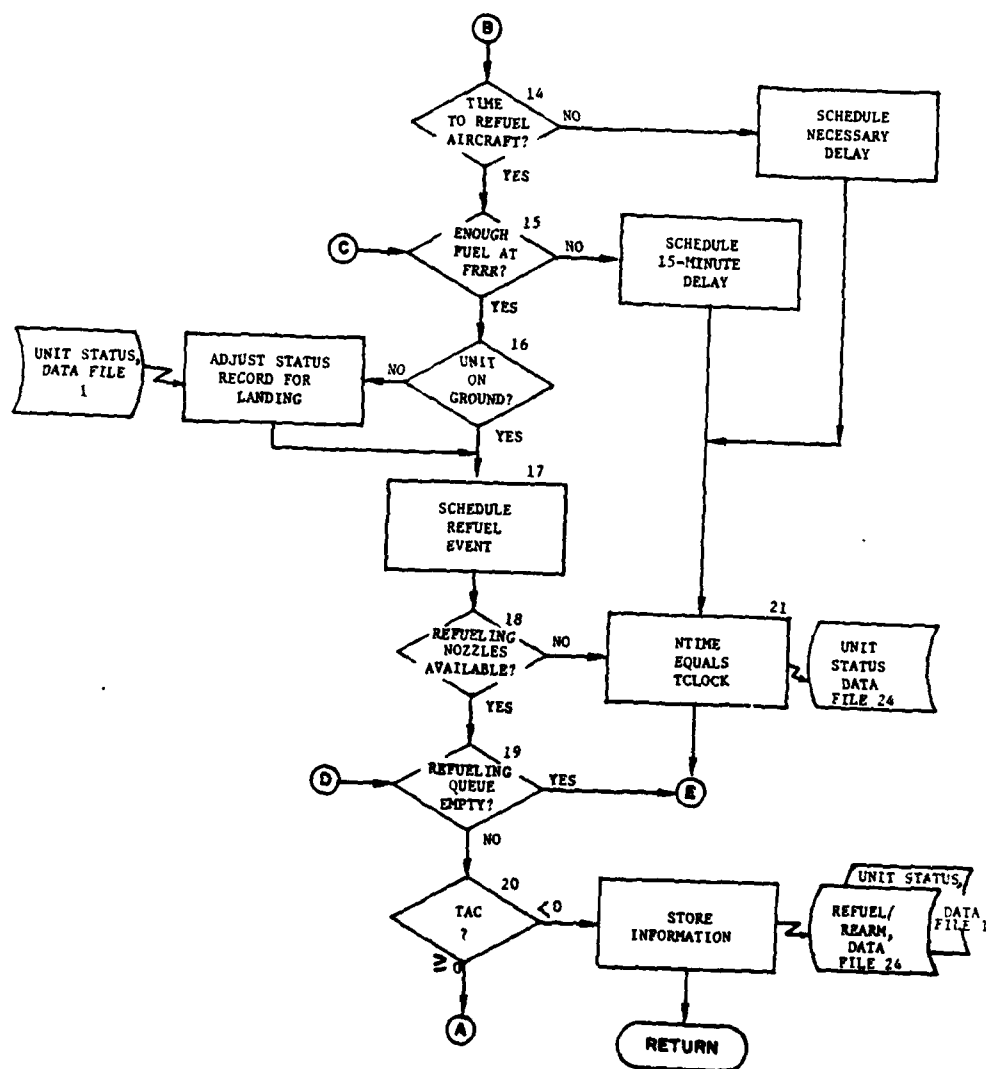


Figure IV-15-B-14. Routine RRFLD (Continued)

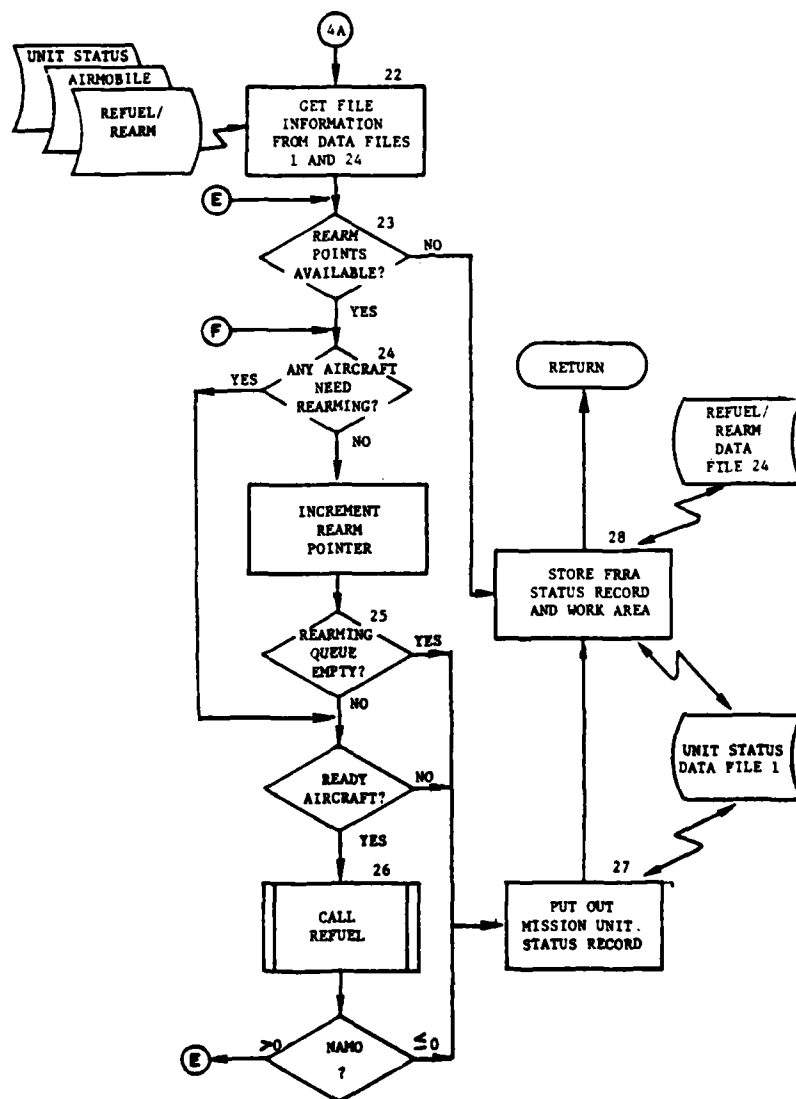


Figure IV-15-B-14. Routine RRFLD (Continued)

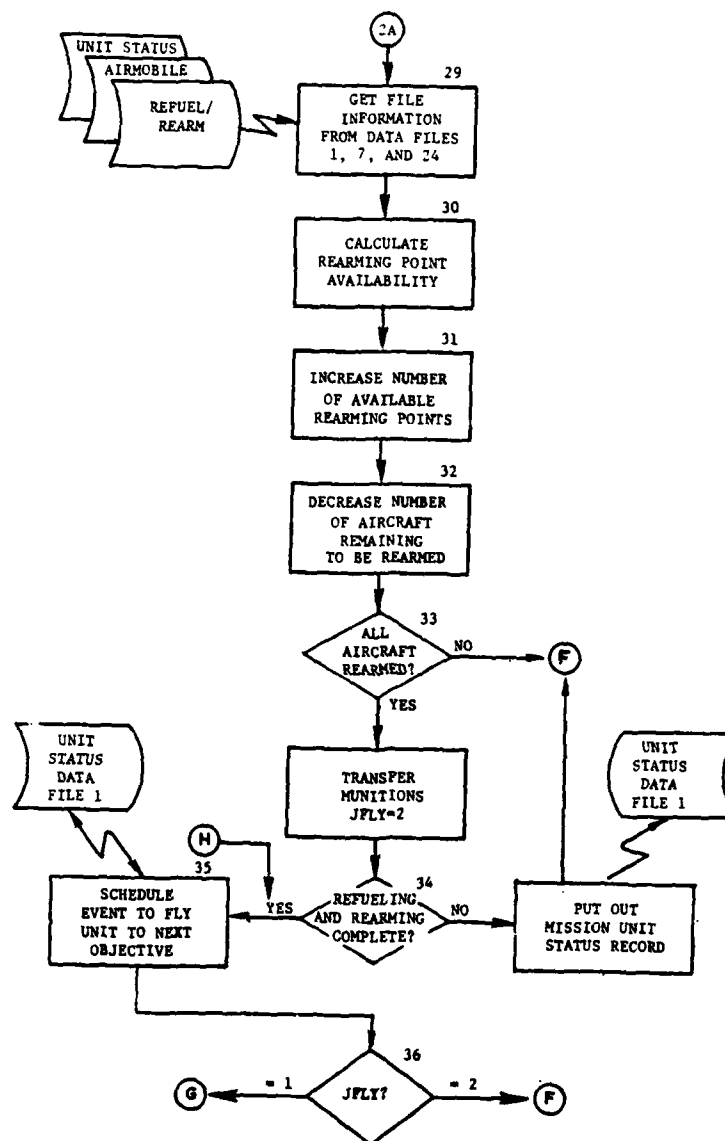


Figure IV-15-B-14. Routine RRFLD (Concluded)

(6) Block 5. The number of aircraft ready for rearming is increased by the number that have completed refueling. If the result is greater than the number requiring rearming, the value is set equal to the required number. Escort aircraft are assumed to have refueled prior to transport aircraft.

(7) Block 6. If all aircraft in the flight unit have not completed refueling, control goes to block 8; otherwise, the fuel required to fill the aircraft is transferred from the FRRA unit's status record to the mission unit's status record. The mission unit's status record is put back on data file 1. Control goes to block 7.

(8) Block 7. If all aircraft in the unit have not completed rearming, control goes to block 8; otherwise, the unit has completed refueling and needs no rearming. It will be flown to its next objective. Control goes to block 35.

(9) Block 8. If scheduling has not been completed for all inlets in this unit, control goes block 15; otherwise, control goes to block 19.

(10) Block 9. A mission unit enters at this point (IOPR = 46) because facilities were not previously available. As in block 1A, the file information is read from the data files.

(11) Block 10. A check determines if all fuel inlets have been scheduled for refueling for this unit. If not, control goes to block 23; otherwise, the refuel pointer is incremented, control goes to block 11, and a new mission unit is considered.

(12) Block 11. If the new unit has landed at the FRRA, control goes to block 15. If the unit has not landed, the fuel consumed while it loitered is calculated and subtracted from the mission unit's status record. Control goes to block 12.

(13) Block 12. Refueling time per inlet is calculated for this unit. A constant 50-gallons-per-minute intake rate is assumed for all aircraft inlets. A maneuver time is also included.

(14) Block 13. A check determines if the new unit requires rearming. If it does not, control passes to block 15. If it does, routine RATIM is called to determine the earliest time a rearming capability will be available. If a rearming capability will be unavailable when this segment finishes refueling, control goes to block 14.

(15) Block 14. If refueling of the aircraft is delayed until a previous unit releases a rearming capability, the necessary delay is scheduled with IOPR equal 46 and control goes to block 21.

(16) Block 15. If refueling can be scheduled immediately, a check is made to ensure that there is sufficient fuel at the FRRA to refuel this flight segment. If sufficient fuel is unavailable, a 15-minute delay is scheduled with IOPR = 46. The 15-minute delay allows the FRRA unit to be resupplied with fuel. If, at the end of the 15-minute delay, fuel is still

unavailable, another 15-minute delay will be scheduled. Delays will be scheduled until fuel becomes available at the FRRA. Routine REFUEL determines if fuel is available at the FRRA. If fuel is unavailable, control goes to block 21 after the delay is scheduled.

(17) Block 16. If sufficient fuel is available for this flight segment, a check determines whether the unit has landed. If it has not, the appropriate parameters are adjusted on its unit status record to simulate landing.

(18) Block 17. The refueling event is scheduled.

(19) Block 18. If there are refueling nozzles available for use, a search is made for another unit to refuel. If all refuel nozzles were in use, control passes to block 21.

(20) Block 19. If nozzles are available, a check is made to determine if there are units in the refuel queue. If so, control passes to block 23; otherwise, control goes to block 20.

(21) Block 20. If the current mission unit has been loitering, control goes to block 11; otherwise, the data file information is stored and control returns to the calling routine.

(22) Block 21. NTIME is set equal to TCLOCK and control goes to block 23.

(23) Block 22. A mission unit entering at this point (IOPR = 47) has made previous attempts to rearm, facilities were not available, and is again attempting to rearm. As in blocks 1 and 9, the necessary information is read from the data files.

(24) Block 23. If no rearming points are available control goes to block 28.

(25) Block 24. If rearm points are available and there are aircraft that need rearming control goes to block 25. If no aircraft require rearming, a search is initiated for another unit to rearm by incrementing the rearm pointer by one.

(26) Block 25. If the rearming queue is empty, control goes to block 27; otherwise, a check is made to determine if the new unit has aircraft to rearm. If not, control goes to block 27.

(27) Block 26. If the current unit has aircraft that require rearming, routine REFUEL is called. If rearming is complete, control goes to block 27; otherwise, control goes to block 23.

(28) Block 27. The mission unit's status record is put on data file 1.

(29) Block 28. The FRRA unit's status record is put on data file 1 and the work area is put on data file 24. Control returns to the calling routine.

(30) Block 29. A mission unit entering at this point (IOPR = 44) has partially completed rearming. The data file information is read as in blocks 1, 9, and 22.

(31) Block 30. The number of rearming points available is recalculated to allow for losses from attrition or increases through resupply.

(32) Block 31. The number of rearming points not in use is increased by the number of aircraft that have completed rearming. Rearming points are also modified to consider changes calculated in block 30.

(33) Block 32. The number of remaining aircraft to be rearmed is reduced by the number of aircraft that have completed rearming.

(34) Block 33. If all aircraft in this unit have not completed rearming, control goes back to block 24. If all aircraft have rearmed, the munitions are transferred from the FRRA unit's status record to the mission unit's status record. JFLY is set equal to two.

(35) Block 34. If both refueling and rearming events are incomplete for this flight unit, the mission unit's status record is put on data file 1, and control goes to block 24.

(36) Block 35. If both refueling and rearming events of this flight unit are complete, the event to fly the unit to its next objective is scheduled.

(37) Block 36. If JFLY equal 2, control goes to block 24. If JFLY equal 1, control goes to block 8.

#### 17. ROUTINE REFUEL:

a. Purpose. This routine, called by RRFLD, adjusts the supply point queue parameters necessary for refueling and rearming.

##### b. Input Variables:

(1) Standard Common Block Area. FRRA.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
NFUEL	Call	Refueling capability:

NFUEL = 0, aircraft cannot be refueled at this time.

NFUEL = 1, aircraft will be refueled.



c. Output Variables:

(1) Standard common block variables.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IDT	Call	Time increment that will be added to the current time to determine when the event being scheduled will occur.
ACBP	Call	Number of aircraft in this segment.

d. Logical Flow (Figure IV-15-B-15):

(1) Block 1. This block checks the value of the time increment (IDT) and control is transferred to block 1A (refueling) if it is less than zero; otherwise, control is transferred to block 9 (rearming).

(2) Block 1A. The supply point queue parameters necessary for refueling are adjusted. If NFUEL = 1 sufficient fuel is available; otherwise, control flows to block 2.

(3) Block 2. The fuel needed by this flight segment is calculated as the product of the number of inlets being fueled in this segment times the number of gallons required by each inlet.

(4) Block 3. If the supply point has sufficient fuel available to refuel this flight segment, control flows to block 5; otherwise, block 4 is executed.

(5) Block 4. When fuel at the supply point is insufficient, the flight is put in a holding area for 15 minutes. NFUEL is set equal to 0, IOPR is set equal to 46, and IDT is set equal to 1500. Control returns to RREXEC. After 15 minutes another attempt will be made to refuel this flight segment. If resupply of fuel by the Combat Service Support Model has occurred, the refueling will be accomplished on the next attempt.

(6) Block 5 and 6. If sufficient fuel is available to refuel the flight segment, a check is made to determine if refuel nozzles are available. If they are not, NFUEL is set equal to zero and control returns to RREXEC; otherwise, control flows to block 7.

(7) Block 7. Refueling of the flight segment is possible. Refueling capacity is reduced by the number of inlets being refueled; the number of inlets to be refueled is reduced by the number of inlets being refueled. ACBP is set equal to the number of inlets being refueled.

(8) Block 8. The time that the refueling of this flight segment will be completed is put in IDT, IOPR is set equal to 43, and NFUEL is set to 1. Control returns to RREXEC.

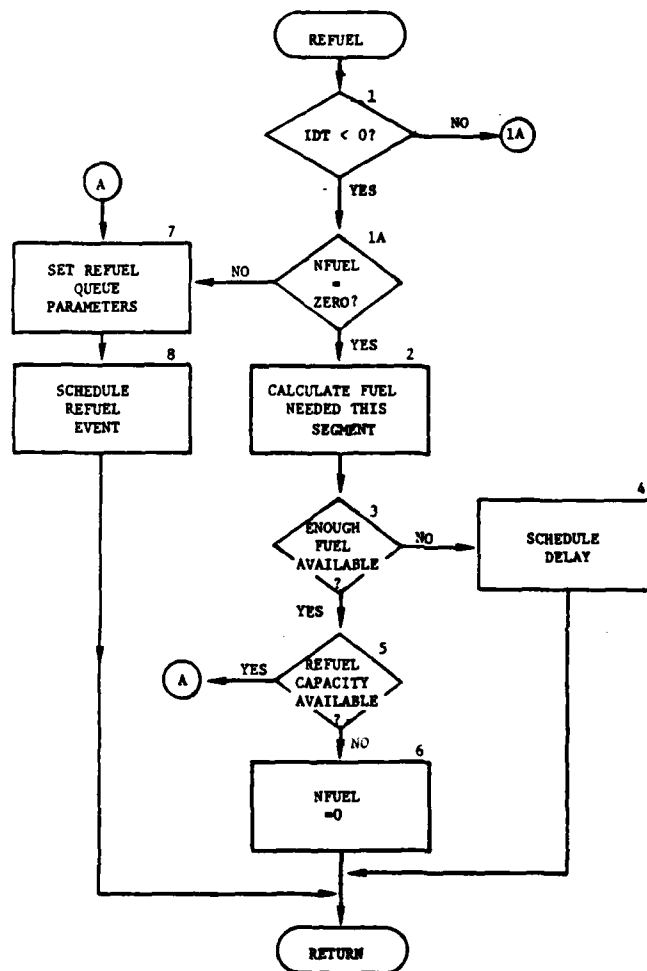


Figure IV-15-B-15. Routine REFUEL (Continued on Next Page)

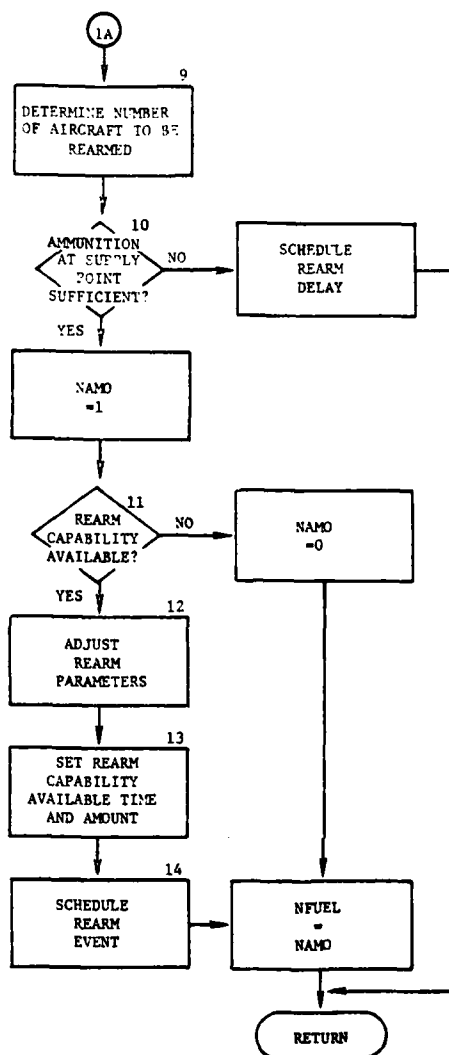


Figure IV-15-B-15. Routine REFUEL (Concluded)

(9) Block 9. The supply point queue parameters necessary for rearming are adjusted and the number of aircraft to be rearmed is calculated as the minimum of the available rearming capability and the number of aircraft that are ready to be rearmed.

(10) Block 10. If the amount of ammunition, at the supply point is insufficient to rearm this aircraft flight segment, a 15-minute delay in rearming is scheduled by scheduling an airmobile event with an operation code of 47. The flight segment is held in the queue until it is time to attempt rearming again. NAMO is set equal to zero.

(11) Block 11. If the amount of ammunition at the FRRA meets the needs for this flight segment, NAMO is set equal to one. A test is made to determine if the rearming point has a rearming capability available. If it does not, NAMO and NFUEL are set equal to zero and control returns to routine RRFLD.

(12) Block 12. If a rearming capability is available at the FRRA, rearming will be performed. The number of aircraft that will be rearmed in this flight segment (ACBP) is the lesser of the number of rearming points available for rearming (RAC) and the number of aircraft that are ready for rearming (READY). The parameter with the minimum value is set equal to zero. ACBP is subtracted from the larger quantity and from the number of aircraft that require rearming.

(13) Block 13. The time that this flight segment will complete rearming is calculated as the rearming time to rearm one aircraft plus a rearming maneuver time plus the current game time. This completion time and the number of aircraft in the flight fragment are stored for use in routine RATIM.

(14) Block 14. The rearming event is scheduled with an IOPR code for 44.

#### 18. ROUTINE RATIM:

a. Purpose. The refueling/rearming portion of the Airmobile Model is designed so that an aircraft will not land at an FRRA if a rearming capability will not be available at the time the unit's first flight segment completes refueling. Instead, the flight is diverted to a holding area until rearming capability is available at the FRRA. This routine, called by RRFLD, calculates the time rearming capability will become available to this unit.

#### b. Input Variables:

(1) Common Block Areas. FRRA, LGTPER.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
RRAP	Call	An index equal to RAP that points to the mission unit in the work array that is requesting rearming.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IPT	Call	An index which points to the previous mission unit.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
KTMA	Call	Earliest time this unit can start refueling (this time is added to TCLOCK).

d. Logical Flow (Figure IV-15-B-16):

(1) Block 1. When this routine is entered, the number of rearming points that are available is reduced by the number of points that have been attrited.

(2) Block 2. The number of rearming points required by the flight unit under consideration is determined.

(3) Block 3. The RACAT array is examined to determine if any flight segments are being rearmed. If not, control passes to block 7.

(4) Block 4. If the RACAT array contains flight segments, the segment that will be rearmed next is examined.

(5) Block 5. The number of rearming points that will be released after this segment is rearmed is added to the available rearming capability.

(6) Block 6. A new time is calculated for the completion of rearming for the next flight segment of the previous unit. If the previous flight unit has all rearming scheduled, control goes to block 7; otherwise, control returns to block 3.

(7) Block 7. The time counter, KTMA, will contain the time rearming capability will be available.

19. ROUTINE RRTURN:

a. Purpose. This routine updates parameters and returns control of the mission unit to the model requesting that it be resupplied.

b. Input Variables:

(1) Standard Common Areas. UMAIN, UCOOP, and FRRA.

(2) Other Variable:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
MUID	TWO	IUID of FRRA unit for mission unit.

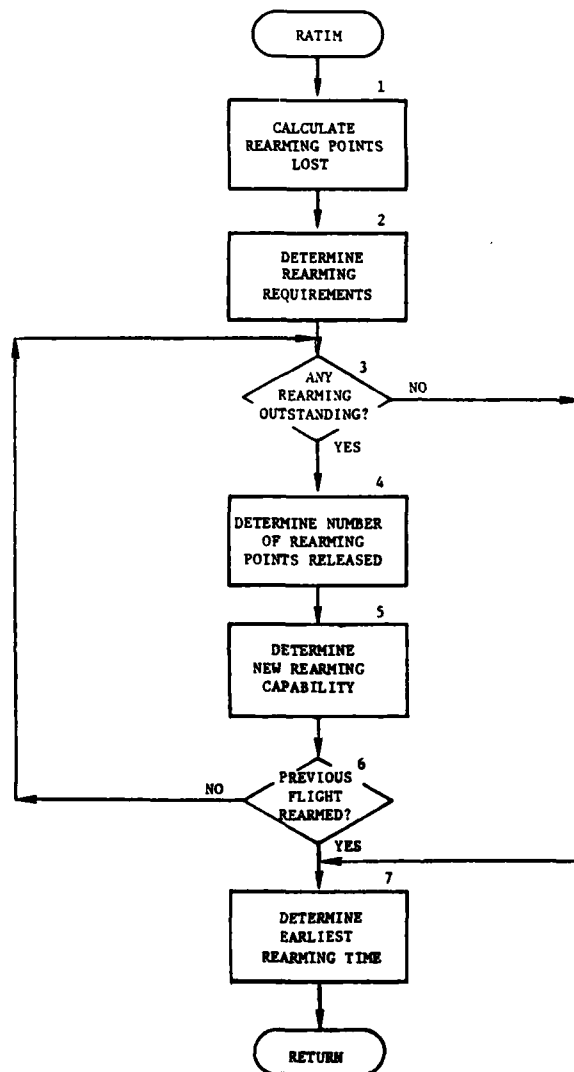


Figure IV-15-B-16. Routine RATIM

c. Output Variables:

(1) FRRA Common Block Variable. IOPR.

(2) Other Variable:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IFNT(56,1)	ONE	Cycle flag indicating whether another airmobile event is to follow immediately.

d. Logical Flow (Figure IV-15-B-17):

(1) Block 1. When this routine is called, the status record of the mission unit which completed refueling/rearming operations is read into UMAIN.

(2) Block 2. The mission unit has reached its new objective and is ready for the next airmobile event. The unit assumes the coordinates of its new location.

(3) Block 3. Fuel consumed by the mission unit in flying from the FRRA to the new objective is calculated and subtracted from the mission unit's status record.

(4) Block 4. The mission unit's status record is put back on data file 1 and the FRRA unit's status record is read. The record number on data file 24 that gives data file 12 information for this unit is taken from the FRRA unit's status record.

(5) Block 5. The FRRA work area array is obtained from data file 24.

(6) Block 6. The next Airmobile IOPR is obtained from word 35 of data file 12 array, IFNT (56,1) is set equal to one, and control returns to the calling routine that processes the next airmobile event.

20. ROUTINE RLEAS:

a. Purpose. Routine RLEAS is the executive driver for the group of routines associated with the release of escort and transport aircraft terminating an airmobile lift. Routine RLEAS is activated by a DSL release transport order.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IOPER	TWO	Program operation code, IDUM (94).

c. Output Variables. None.

d. Logical Flow (Figure IV-15-B-18):

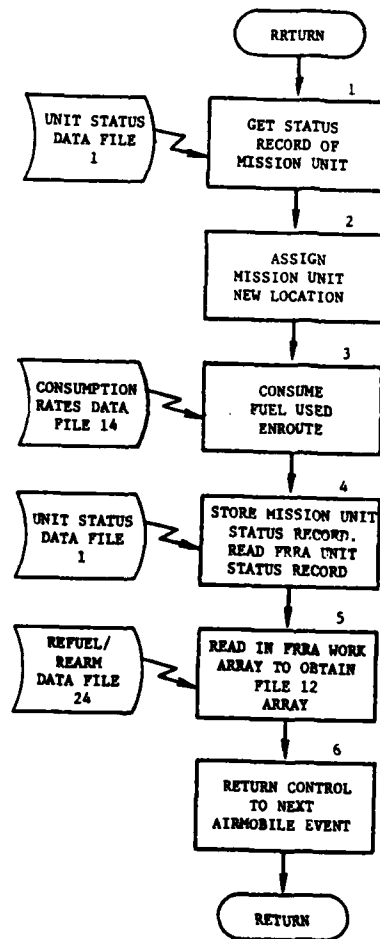


Figure IV-15 -B-17. Routine RRTURN



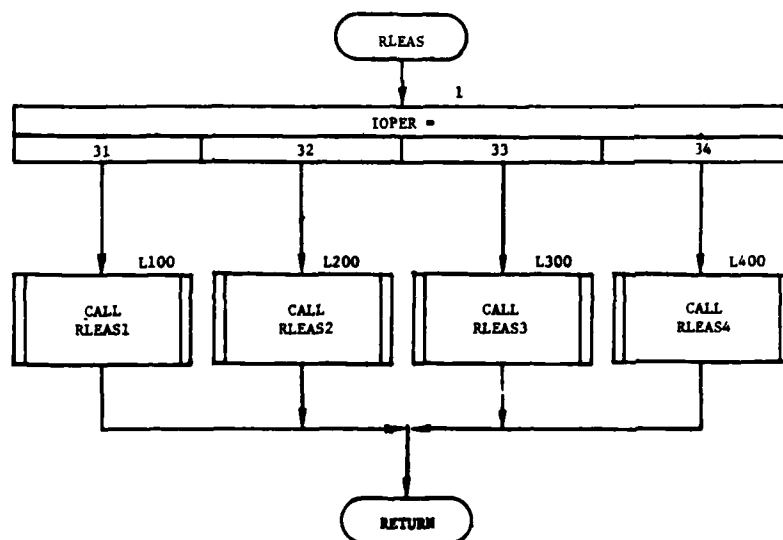


Figure IV-15-B-18. Routine RLEAS

(1) Block 1. Determine the operation code from IOPER to direct RLEAS to call the proper routine.

(2) Blocks L100, L200, L300, and L400. Routines within the RLEAS segment are called.

21. ROUTINE RLEAS1:

a. Purpose. Routine RLEAS1 first determines if any part of the return flight, to the airbase, is over enemy airspace. If so, an air mission unit is created. Both escort and transport aircraft with related resources are transferred from the unit at the landing zone to the mission unit. An event is scheduled for in-flight attrition. If penetration of enemy airspace is not required, the aircraft are flown back to their respective airbases.

b. Input Variables:

(1) Standard Common Block Variables.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IUIDTP	TWO	Unit that was transported.
IDMSTR	TWO	Newly created mission unit.
MIXTAB	DF7	Mission resource data.
ACAVL(72)	DF26	Aircraft item code data.
FLTSPD(36)	DF26	Aircraft flight speeds.
CONSMP(10)	DF14	Aircraft fuel consumption rates.

c. Output Variables:

(1) Standard Common Block Variables.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IFLG	TWO	Penetration flag; 0 = no, 1 = yes.
FUEL	TWO	Aircraft fuel to be consumed during next flight segment.
TRATE	TWO	Transport fuel consumption rate.
ERATE	TWO	Escort fuel consumption rate.

d. Logical Flow (Figure IV-15-B-19):

(1) Block 1. The unit status record of the unit that was transported is obtained from data file 1.

(2) Block 2. The flight speeds of the transport and escort aircraft are determined.

(3) Block 3. The fuel consumption rates for transport and escort aircraft are determined.

(4) Blocks 4 and 5. Routine PENRAT determines if the next flight segment will fly over enemy airspace.

(5) Block 6. If escort aircraft accompanied the airlift, control goes to block L100.

(6) Blocks 7, 8, and L100. If escort and transport aircraft originate at the same airbase, control transfers to Block L100. Only one mission unit is created and the aircraft fly as a single unit. If they originated at separate airbases, two separate mission units must be created, and aircraft fly to separate airbases.

(7) Block L175. Create an air mission unit.

(8) Block 9. If escort aircraft did not accompany the airlift, control transfers to block L340.

(9) Block 10. If an escort mission unit has been created and loaded, control transfers to block L340.

(10) Block 11. Transfer the escort aircraft and related resources and equipment from the transported unit to the mission unit.

(11) Block 12. If another air mission unit is needed, control goes to block L175.

(12) Block L340. Transfer the transport aircraft and related resources and equipment from the transported unit to the mission unit.

(13) Block 13. Set the coordinates of the mission unit to those of the transported unit at the landing zone.

(14) Blocks 14, 15, and 16. Determine if penetration will occur. If so, set the objective coordinates of the mission unit to those of the safe point, and set an event to schedule the in-flight attrition segment.

(15) Block 17. Determine if one or two mission units were created.

(16) Block 18. Set the objective coordinates of the mission unit(s) to those of the airbase(s).

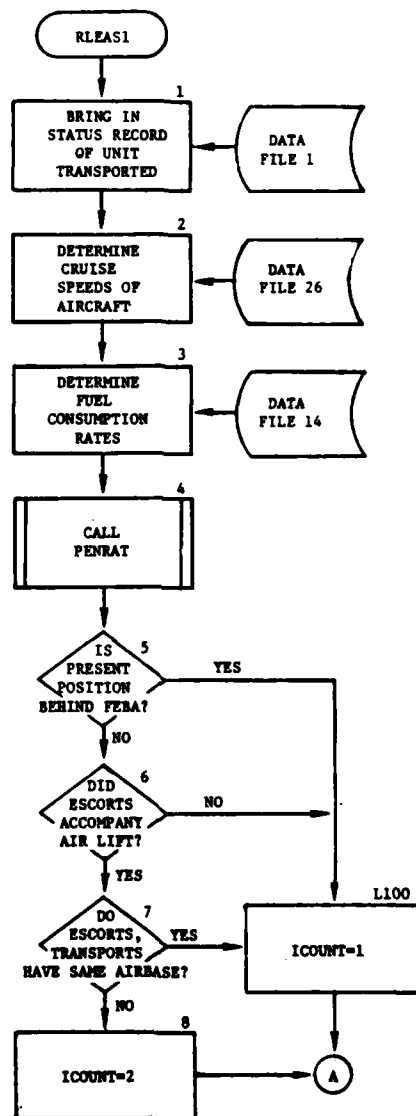


Figure IV-15-B-19. Routine RLEAS1

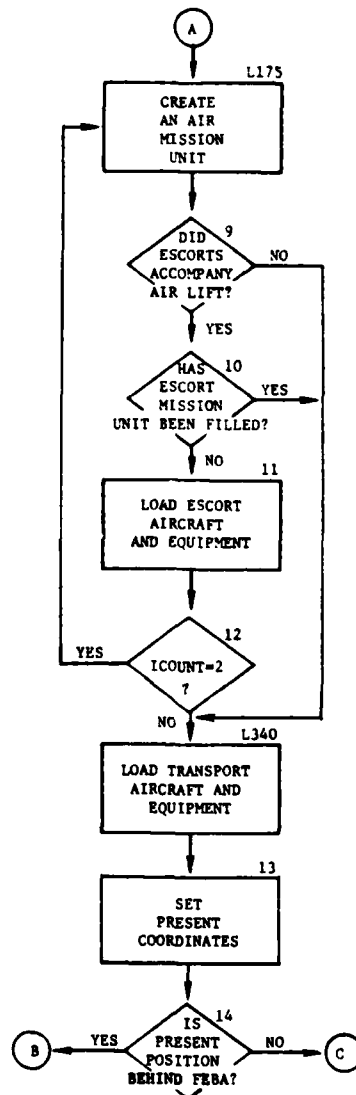


Figure IV-15-B-19. Routine RLEAS1 (Continued)

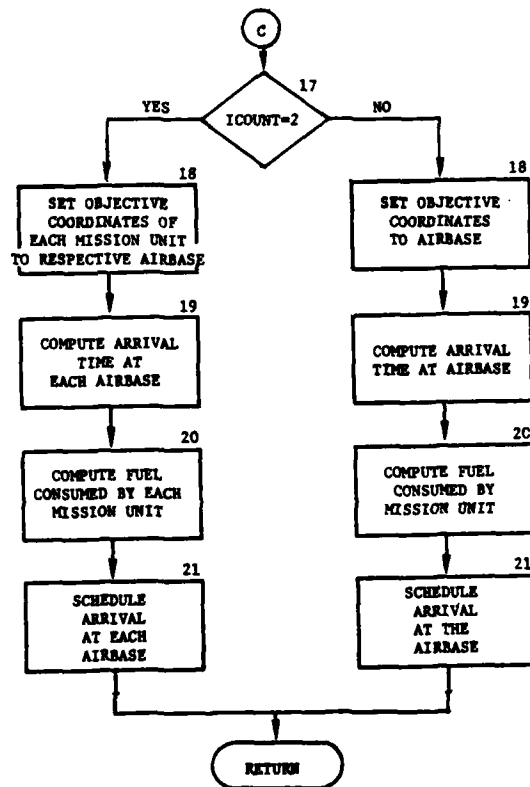
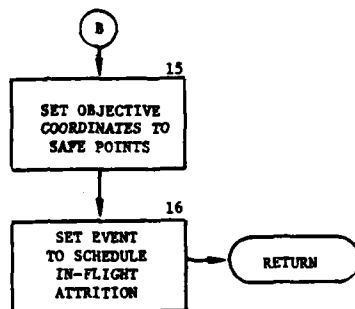


Figure IV-15-B-19. Routine RLEAS1 (Concluded)

(17) Block 19. Compute the arrival time at the airbase(s).

(18) Block 20. Compute the fuel consumed by the mission unit(s) on the return flight segment.

(19) Block 21. Schedule the arrival of the aircraft at the airbase(s).

22. ROUTINE RLEAS2:

a. Purpose. Routine RLEAS2 is called by routine RLEAS following an in-flight attrition assessment of the mission unit on its return flight to the airbase. Routine RLEAS2 determines the airbase(s) from which the aircraft originated and schedules their return.

b. Input Variables:

(1) Standard Common Block Variables.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
MSNUNT	TWO	Escort mission unit.
FUEL	TWO	Fuel consumed on last flight segment.
TRATE	TWO	Transport fuel consumption rate.
ERATE	TWO	Escort fuel consumption rate.
MIXTAB(12)	DF7	Mission resource data.

c. Output Variables:

(1) Standard Common Block.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FUEL	TWO	Fuel to be consumed on the next flight segment.
IDTRAN	TWO	Transport mission unit.

d. Logical Flow (Figure IV-15-B-20):

(1) Block 1. Get the unit status record of the air mission unit from data file 1.

(2) Block 2. Compute the time required for the transports to return to the airbase.

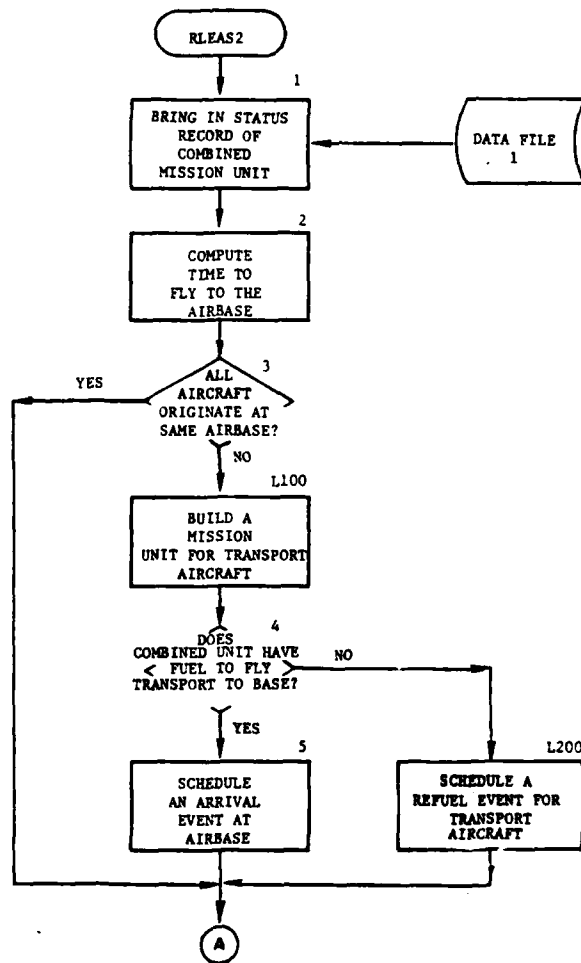


Figure IV-15-B-20. Routine RLEAS2 (Continued on Next Page)



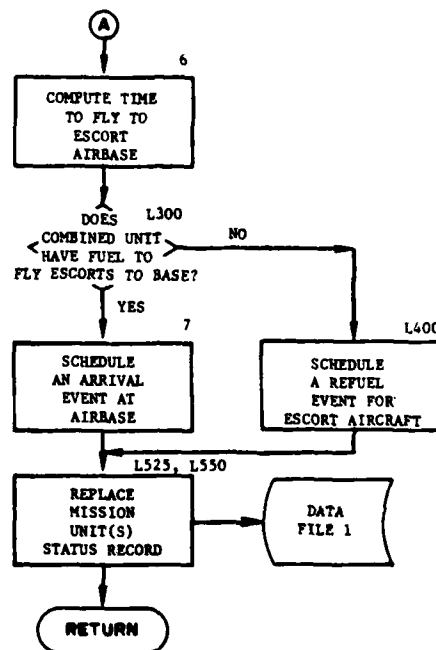


Figure IV-15-B-20. Routine RLEAS2 (Concluded)

(3) Block 3. Determine if both transport and escort aircraft originate at the same airbase.

(4) Block L100. Build an air mission unit for the return of the transport aircraft.

(5) Block 4. Determine if there is sufficient fuel for the transport aircraft's return flight.

(6) Block 5. Schedule an event for the arrival of the transport aircraft at the airbase.

(7) Block L200. Schedule an event for the transport mission unit to refuel at the nearest refueling facility.

(8) Block 6. Compute the time required for the escorts to return to the airbase.

(9) Blocks L300 and 7. If there is sufficient fuel for the escort aircraft's return flight, an event is scheduled for the arrival of the escort aircraft at the airbase. If not, control goes to block L400.

(10) Block L400. An event is scheduled for the escort mission unit to refuel at the nearest refueling facility.

(11) Blocks L525 and L550. Replace the unit status record(s) of the mission unit(s) on data file 1.

### 23. ROUTINE RLEAS3:

a. Purpose. Routine RLEAS3 is called by routine RLEAS when the aircraft have arrived at the airbase to determine landing times and maintenance availability times associated with aircraft damage and to schedule an event for the restoration of the aircraft into the airbase.

#### b. Input Variables:

(1) Standard Common Block Variables.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
PENFLG	TWO	Penetration flag; 0 = no, 1 = yes.
IUIDAB	TWO	Airbase unit.
MSNUNT	TWO	Air mission unit.
FUEL	TWO	Fuel consumed on the last flight segment.
ACAVL(72)	DF26	Aircraft item code data.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
LANDTM(36)	DF26	Aircraft landing times.
AVLTM1(36)	DF26	Escort availability times.
AVLTM2(36)	DF26	Transport availability times.

c. Output Variables:

(1) Standard Common Block.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
AMOUNT	TWO	Amount of aircraft to be restored.

d. Logical Flow (Figure IV-15-B-21):

(1) Block 1. Bring in the unit status record of the air mission unit from data file 1.

(2) Block 2. Bring in the unit status record of the airbase unit from data file 1.

(3) Block 3. Determine if the aircraft in the mission unit are escort or transport.

(4) Block 4. Transfer the aircraft fuel and personnel from the air mission unit to the airbase unit.

(5) Blocks 5, 6, and L310. Determine whether the aircraft are escorts or transports.

(6) Block L40. Transfer escort aircraft munitions from the air mission unit to the airbase unit.

(7) Blocks 7 and 8. Determine the landing time for appropriate escort or transport aircraft as a function of speed and prevailing weather conditions.

(8) Block 9. Obtain the availability times of damaged aircraft in repair from data file 26.

(9) Block L325. Determine if the return flight segment penetrated enemy airspace. If so, control passes to block 12.

(10) Blocks 10 and 11. If any aircraft sustained a B-kill, an event is scheduled, as a function of the availability time for a B-kill, to restore the aircraft at the airbase. Increment the activity counter to report aircraft unavailable.

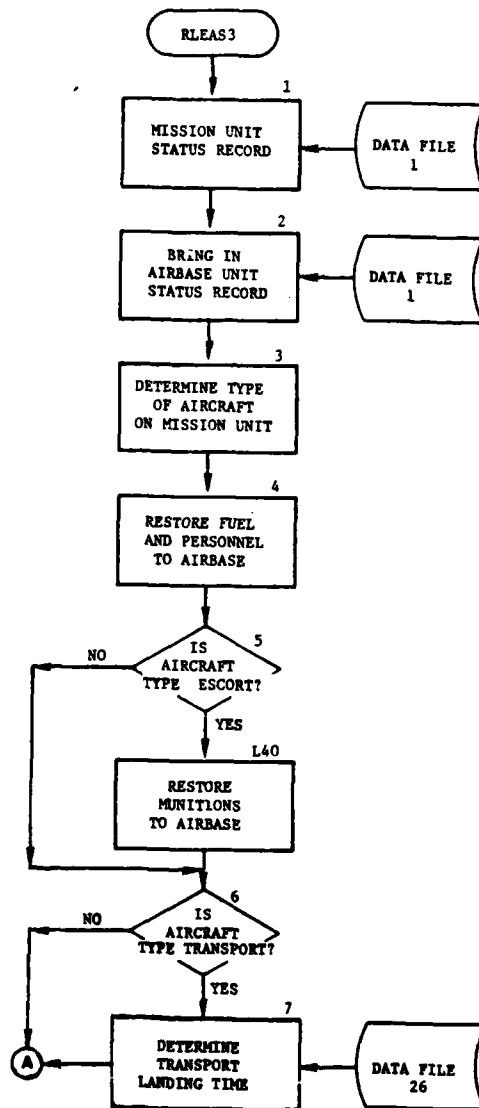


Figure IV-15-B-21. Routine RLEAS3 (Continued on Next Page)

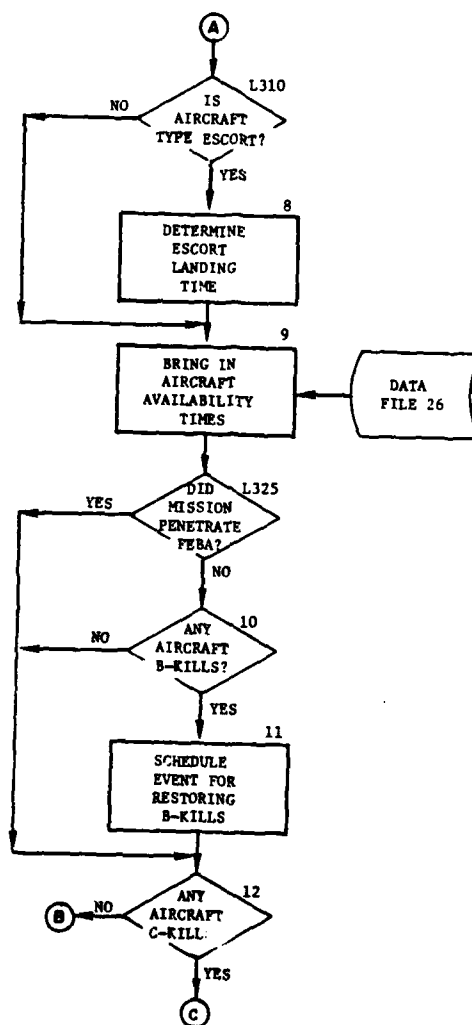


Figure IV-15-B-21. Routine RLEAS3 (Continued)

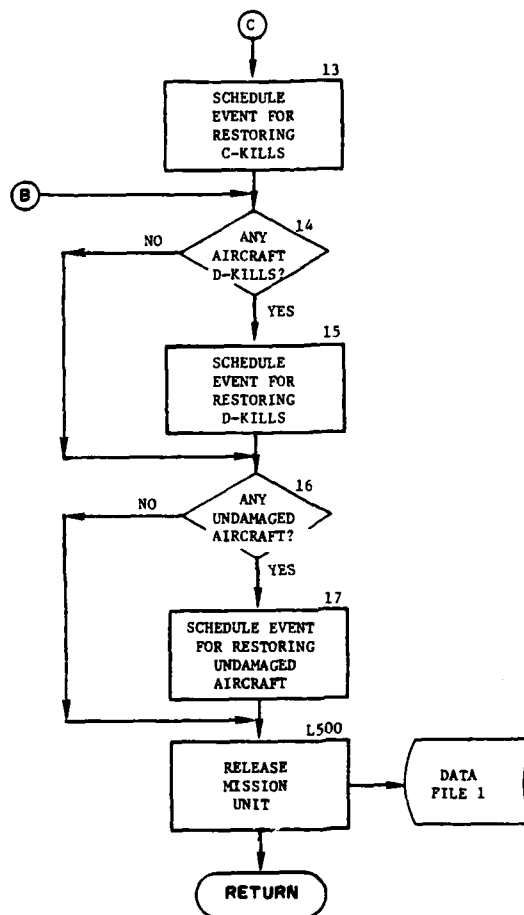


Figure IV-15-B-21. Routine RLEAS3 (Concluded)

(11) Block 12. Determine if any aircraft sustained a C-kill. If not, control passes to block 14.

(12) Block 13. If so, an event is scheduled, as a function of the availability time for a C-kill, to restore the aircraft at the airbase. Increment the activity counter to report aircraft unavailable.

(13) Blocks 14 and 15. If any aircraft sustained a D-kill, schedule an event, as a function of the availability time for a D-kill, to restore the aircraft at the airbase. Increment the activity counter to report aircraft unavailable. If not, control goes to block 16.

(14) Blocks 16 and 17. If there are undamaged aircraft, schedule an event, as a function of landing time, to restore the aircraft at the airbase. Increment the activity counter to report aircraft unavailable.

(15) Block L500. Clear the status record of the mission unit and return it to data file 1.

#### 24. ROUTINE RLEAS4:

a. Purpose. Routine RLEAS4, called by routine RLEAS, restores damaged and undamaged aircraft to the airbase at the completion of the delay imposed by landing and damage repair times.

##### b. Input Variables:

(1) Standard Common Block Variables.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IUIDAB	TWO	Airbase identification.
IACEOH	TWO	Aircraft item code.
AMOUNT	TWO	Number of aircraft damaged.

c. Output Variables. Standard Common Block Variables.

d. Logical Flow (Figure IV-15-B-22):

(1) Block 1. Bring in the status record of the airbase unit from data file 1.

(2) Block 2. Restore the aircraft to availability status at the airbase.

(3) Block 3. Decrement the activity counter by the number of aircraft being restored into the airbase.

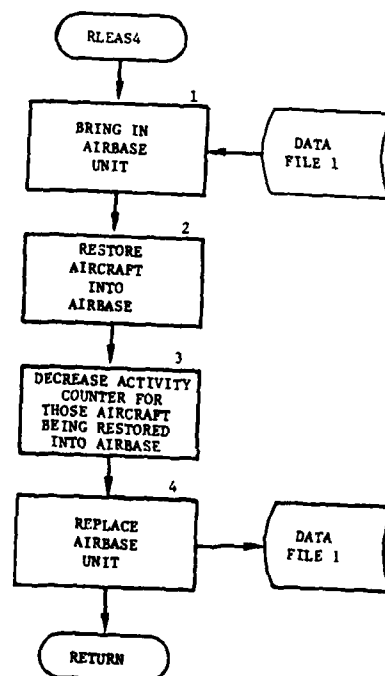


Figure IV-15-B-22. Routine RLEAS4



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(4) Block 4. Replace the airbase unit status record on data file 1.

25. ROUTINE PENRAT.

a. Purpose. This routine establishes X and Y coordinates at the location the flight path enters hostile airspace. If a given point on the flight path is within hostile airspace, a flag is set to indicate that penetration of hostile airspace will occur. By considering aircraft type and weather visibility, the time to fly from the pickup point to a safe point is calculated. PENRAT is called by ACCPT1, ACCPT2, and RLEAS1.

b. Input Variables:

(1) Standard Common Block Variables.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IUIDTP	TWO	IUID of unit being transported by air.
FUNIT	ZONDAT	IUIDs of enemy front-line battalions.
IDEP	DF1	Depth of forwardmost enemy unit.
FLTSPD	DF26	Flight airspeed.
SLOPE	ONE	Slope of the battlefield (for line joining centers of mass of Red and Blue units).

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IFLG	Call	Penetration flag: 0 = pickup point is not inside hostile airspace; 1 = pickup point is inside hostile airspace.
AXFEBA	Call	X coordinate of safe point.
AYFEBA	Call	Y coordinate of safe point.
ITIME	Call	Time to fly from pickup point to safe point.

d. Logical Flow (Figure IV-15-B-23):

(1) Block 1. The front-line enemy maneuver battalions are identified by the array FUNIT in common ZONDAT. The X intercept of each unit is calculated.

(2) Block L75. The forwardmost enemy unit is determined by ranking X intercepts according to force.

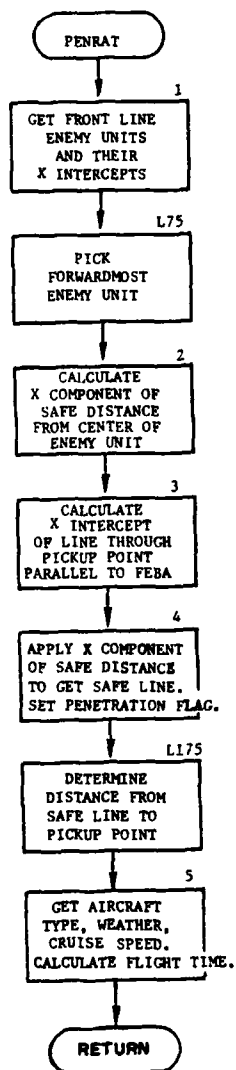


Figure IV-15-B-23. Routine PENRAT

(3) Block 2. The safe distance, composed of one half the depth of the forwardmost unit plus a local constant (currently 6000 meters), is translated into its X component.

(4) Block 3. The X intercept (PINCEP) is calculated for a line parallel to the FEBA and passing through the designated point on the flight path (pickup point).

(5) Block 4. Depending on whether the flight is Red force or Blue force, the X component of the safe distance is applied to establish the X intercept of the safe line. Accordingly, if the designated point on the flight path (pickup point) is within hostile airspace, the penetration flag remains set to one; otherwise, it is set to zero.

(6) Block L175. The distance from the designated pickup point perpendicular to the safe line is calculated from the X component of this distance and the angle represented by the slope of the battlefield.

(7) Block 5. Cruise speed and flight time are developed. Depending on the calling routine, flight speed is obtained from either the unit status file or from data file 26 based on weather and aircraft type.

#### 26. ROUTINE SETTYP:

a. Purpose. This routine sets a designated element within a character array to a designated character value. The character array is composed of a series of integer words, each containing four characters (left justified).

##### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IEOH	Call	Number of the character element to be set. (Normally an equipment item code).
LETR	Call	A word containing the character to be set into EOHTYP. The character is left justified.

##### c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
EOHTYP(50)	Call	Array containing four characters per word, left justified.

##### d. Logical Flow (Figure IV-15-B-24):

(1) Block 1. The word within EOHTYP that contains the character to be set is calculated by:

$$IWRD = (IEOH - 1) / 4 + 1 \quad (IV-15-B-1)$$

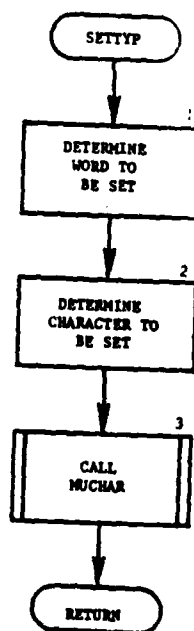


Figure IV-15-B-24. Routine SETTYP

(2) Block 2. The character within that word is calculated by:

IEOH - (IWRD - 1) \* 4 (IV-15-B-2)

(3) Block 3. Routine MVCHAR is called to move the first character of LETR into the appropriate character of EOHTYP.

27. ROUTINE MISUNT:

a. Purpose. This routine identifies an available mission unit to be used for an airmobile operation. If no such unit is available, a new mission unit is created.

b. Input Variables:

(1) Standard Common Area. UNTLOC.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IFORCE	Call	Flag indicating the force requiring a mission unit: 1 = Blue, 2 = Red

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IUID	Call	Unit identification number of the mission unit.
UID(2)	Call	Alphanumeric identification of the mission unit.

d. Logical Flow (Figure IV-15-B-25):

(1) Block 1. The content of UID is set to an initial value of BBBB0001 (Blue) or RRRR0001 (Red).

(2) Block L10. Function IUIDF is called to return the IUID of the unit identified by UID. If the unit has not previously been defined, a value of zero is returned.

(3) Block 2. If the unit has not been defined, control goes to block L100; otherwise, control goes to block 3.

(4) Block 3. If the unit's location is not zero, it is being used and control goes to block L50 to select another unit.

(5) Block L50. The counter in the lower four characters of UID is incremented and control loops to block L10.

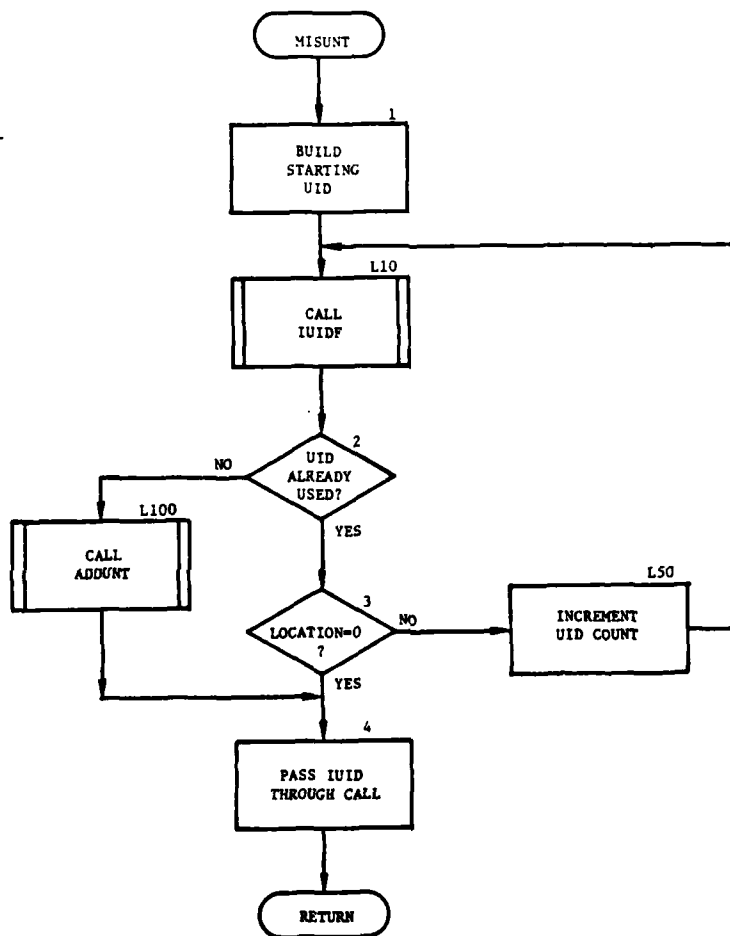


Figure IV-15-B-25. Routine MISUNT

(6) Block L100. If no previously defined mission unit is currently available, routine ADDUNT is called to add another unit and assign it the UID constructed in blocks L10 and L50.

(7) Block 4. The IUID is returned from either IUIDF or ADDUNT. Control returns to the calling routine.

28. ROUTINE MORS:

a. Purpose. This routine is the driver program for overlay 17, segment 5. It calls routine MES or routine SIS.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FILE12(1)	TWO	Operation code.

c. Output Variables. None.

d. Logical Flow. This routine extracts the rightmost digit of FILE12(1) as the operation code and calls routine SIS if this operation code value is equal to two; otherwise, routine MES is called.

29. ROUTINE CIRCLE:

a. Purpose. This routine returns the central angle subtended by that portion of the circumference of a given circle (lying in the X,Y plane) that is contained within the radius of a given sphere. The elevations of circle and sphere centers are specified and can differ.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	X coordinate of center of circle.
Y1	Call	Y coordinate of center of circle.
Z1	Call	Z coordinate of center of circle.
R1	Call	Radius of circle.
X2	Call	X coordinate of center of sphere.
Y2	Call	Y coordinate of center of sphere.
Z2	Call	Z coordinate of center of sphere.
R2	Call	Radius of sphere.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
CIRCLE	Call	Central angle subtended in circle by that portion of its circumference contained in sphere.

d. Logical Flow (Figure IV-15-B-26):

(1) Block 1. The slant and horizontal distance between centers of circle and sphere, and the radius of the sphere as intersected by the plane of the circle, are calculated from the coordinates.

(2) Blocks 2 and 3. If the horizontal distance between centers of circle and sphere equals or exceeds the sum of the radius of the circle plus the radius of the sphere as intersected by the plane of the circle, no overlap of the circle by the sphere is possible, and the desired output angle is set to zero.

(3) Blocks 4 and 5. If the horizontal distance between centers of circle and sphere is less than or equal to the radius of the sphere as intersected by the plane of the circle less the radius of the circle, the circle must be totally contained by the sphere, and the desired output angle is set to  $2\pi$ .

(4) Block 6. The central angle subtended by that portion of the circumference of the circle which is within the sphere is computed by the half-angle formula.

30. ROUTINE GASRCH:

a. Purpose. This routine generates a list of enemy units that are located within the specified radius of a given point. Only air defense capable units (ADCU) are placed in the list. If the unit is moving, it is not included in the list. The total number of units in the list is also returned.

b. Input Variables:

(1) Standard Common Block Areas. BPOINT, RPOINT, INTERR, and IEVENT.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
UID	Call	Identification of the unit requesting the search.
X	Call	X coordinate of the center of the area to be searched.



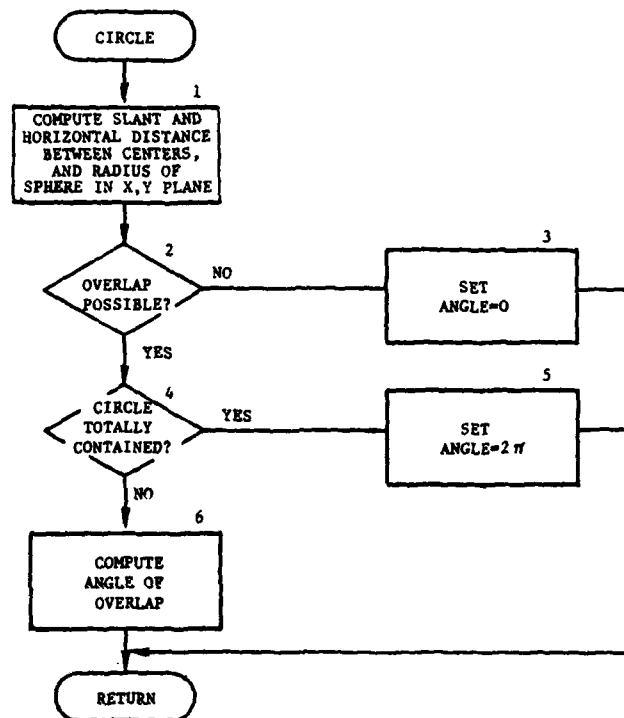


Figure IV-15-B-26. Routine CIRCLE

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<u>Name</u>	<u>Source</u>	<u>Contents</u>
Y	Call	Y coordinate of the center of the area to be searched.
S	Call	Radius of search area.
JMAX	Call	Maximum number of enemy units to be listed.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
UNTLST	Call	List of IUIDs of enemy units found.
J	Call	Total number of IUIDs in UNTLST.

d. Logical Flow (Figure IV-15-B-27):

(1) Block 1. Square the radius of the search area (S) to determine size of search area.

(2) Block 2. Determine whether the requesting unit is Red or Blue force, and initialize the starting and ending values of the loop utilizing BPOINT or RPOINT.

(3) Block 3. Determine if unit is a resolution unit.

(4) Blocks 4, 5, and L5. If the third character of the unit type designator is M, or the fourth character of the unit type designator is D, GET EVT is called to return the event code.

(5) Block 6. If the event code is equal to two, the unit is moving and control transfers to block 11.

(6) Block 7. Calculate the distance from the search center.

(7) Block 8. If the unit is not in the search area, control transfers to block 11.

(8) Block 9. Compare the number of units in the list with JMAX to determine if the unit list is full. If so, control returns to the calling routine; otherwise, control goes to block 10.

(9) Block 10. Add the unit to the list and increment the unit counter by one.

(10) Block 11. If this unit was the last enemy unit, control returns to the calling routine; otherwise, control transfers to block 3.

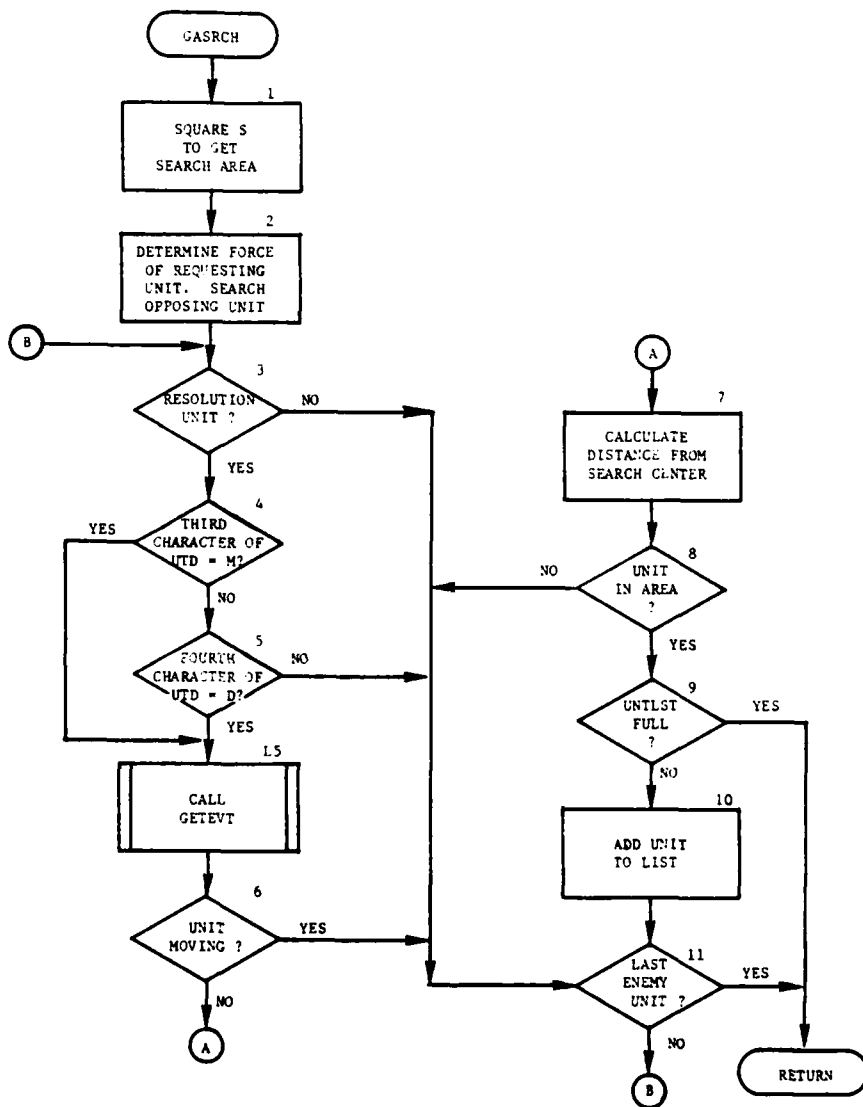


Figure IV-15-B-27. Routine GASRCH

31. ROUTINE ATTDVR:

a. Purpose. This routine is the driving routine for in-flight attrition. It initializes the event record, updates the unit's status record, and calls the appropriate overlay.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FILE12(35)	TWO	Automatic event description record.
		FILE12(1). Operation code for this unit.
		FILE12(4) or FILE12(5). IUID of the mission unit.
		FILE12(31). Record used in data file 7.
		FILE12(32). Flight leg indicator: 2 = last flight leg; 0 = another flight segment.
		FILE12(35). Operation code for the next operation.

c. Output Variables:

(1) Standard Common Block Variable: UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
FILE12(35)	TWO	Automatic event description record.
		FILE12(32). Flight leg indicator: 2 = last flight leg; 0 = otherwise.
		FILE12(31). Record used on data file 7.
		FILE12(1). Operation code.

d. Logical Flow (Figure IV-15-B-28):

(1) Blocks 1 and 2. Get the IUID of the mission unit from FILE12. The IUID is in word four of FILE12 if the event code (IEC) is equal to 13 and the next operation code (IPROG) is between 20 and 30; otherwise, the IUID is in word five. Get the unit's status record from data file 1.

(2) Blocks 3 and 4. Determine if any transport equipment is on hand and transfer control to block 8 if the equipment is present. If escort equipment is on hand, transfer control to block 8.

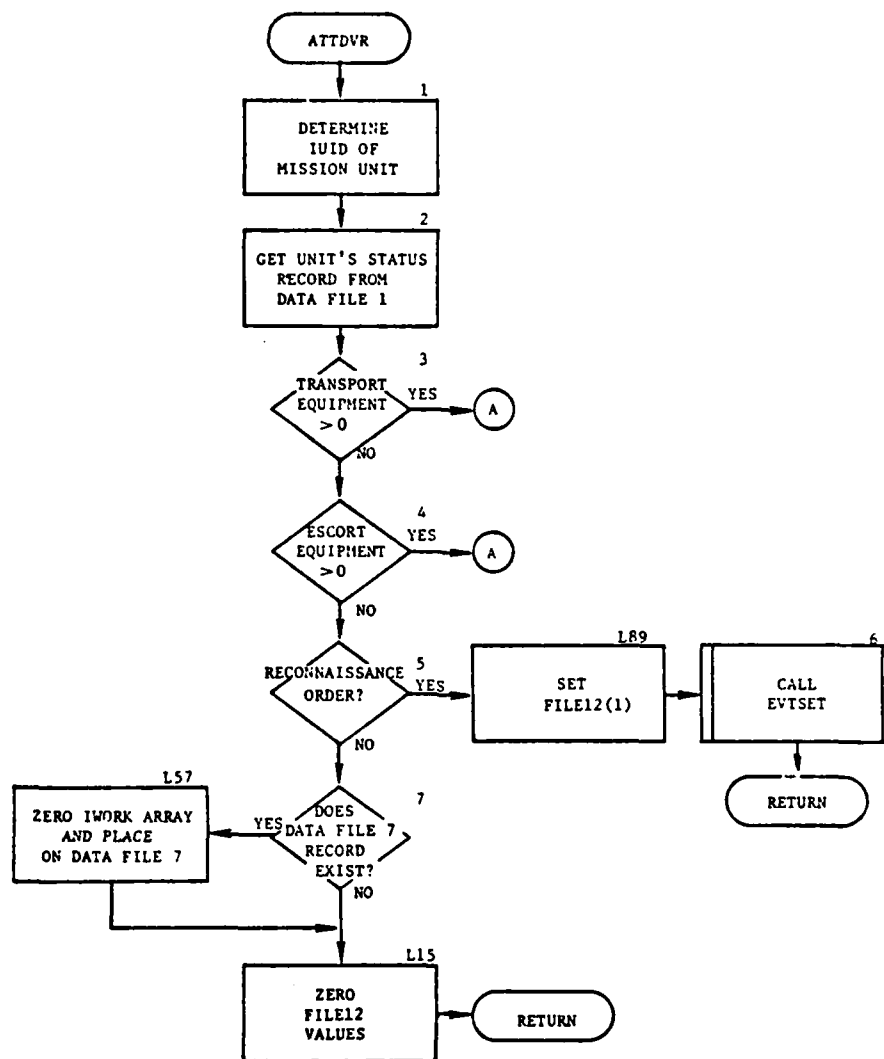


Figure IV-15-B-28. Routine ATTDVR (Continued on Next Page)

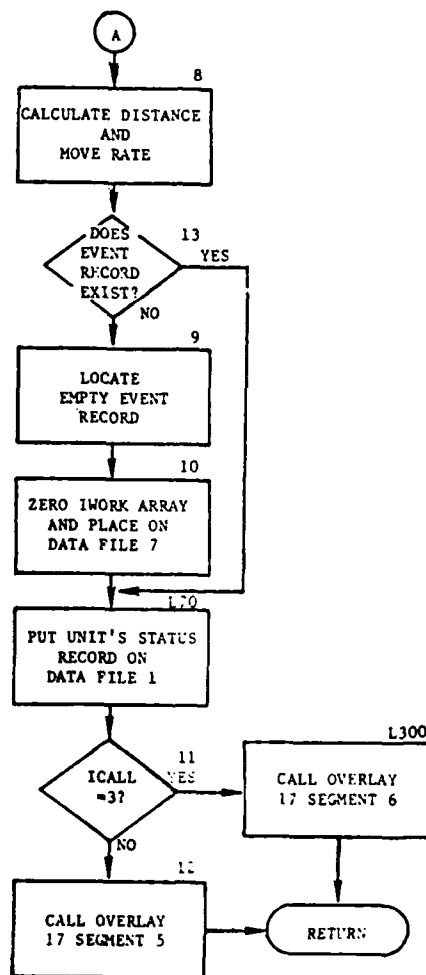


Figure IV-15-B-28. Routine ATTDVR (Concluded)

(3) Blocks 5, L89, and 6. Check to determine if this is a reconnaissance mission. If it is, set FILE12(1) to the next operation code (IPROG) and call EVTSET to schedule the next event.

(4) Blocks 7 and L57. If a data file 7 record does not exist, one is assigned. Initialize the IWORK array and put it on data file 7.

(5) Block L15. Set appropriate FILE12 values to zero.

(6) Block 8. Calculate the distance and move rate.

(7) Block 13. Check to determine if an event record was assigned.

(8) Blocks 9 and 10. Locate an empty event record, initialize the IWORK array, and put it on data file 7.

(9) Block L70. Put the unit's status record on data file 1.

(10) Blocks 11, L300, and 12. Determine which overlay segment to call. Call the appropriate overlay, and return control to the calling routine.

#### 32. ROUTINE MES:

a. Purpose. This routine identifies major engagement segments (MES) of a flight leg where attrition can occur. If the aircraft reaches the end of the flight leg with no possible engagement segments found, the coordinates of the air unit are updated to the end of the flight leg and an event is set for the time the air unit reaches the end of the flight leg. A major engagement segment (MES) is determined when there is a change in the total number of units capable of firing or the total number of weapons firing.

##### b. Input Variables:

(1) Standard Common Block Variable. UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
JPASS	TWO	Flight leg indicator: 0 = initial flight leg 1 = intermediate flight leg 2 = last flight leg 9 = Airmobile event call.
IOPER	TWO	Unit's operation code.
NEXTOP	TWO	Next operation code.
MSNUNT	TWO	IUID of mission unit.
IRANGE	DF7	Range of a particular weapon.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
NITCAP	DF7	Night capability of an air defense weapon.
NWECAP	DF7	Weather capability of an air defense weapon.
MAXALT	DF7	Maximum altitude of an air defense weapon.
MINALT	DF7	Minimum altitude of an air defense weapon.
MAXSPD	DF7	Maximum speed of an air defense weapon.
MINSPP	DF7	Minimum speed of an air defense weapon.

c. Output Variables:

(1) Standard Common Block Variables. UMAIN

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IXB	DF7	X coordinate of major engagement segment beginning.
IYB	DF7	Y coordinate of a major engagement segment beginning.
IXE	DF7	X coordinate of a major engagement segment end.
IYE	DF7	Y coordinate of a major engagement segment end.
MESST	DF7	Major engagement segment start time.
LOSST	DF7	Line-of-sight starting time.
IDELT	DF7	Elapsed time of major engagement segment.
JPASS	DF12	Flight leg indicator: 0 = initial flight leg 1 = intermediate flight leg 2 = last flight leg 9 = Airmobile event call.

d. Logical Flow (Figure IV-15-B-29):

(1) Block 1. Write FILE12.

(2) Block 2. Bring in the GTAA related variables and put them in array IWORK.



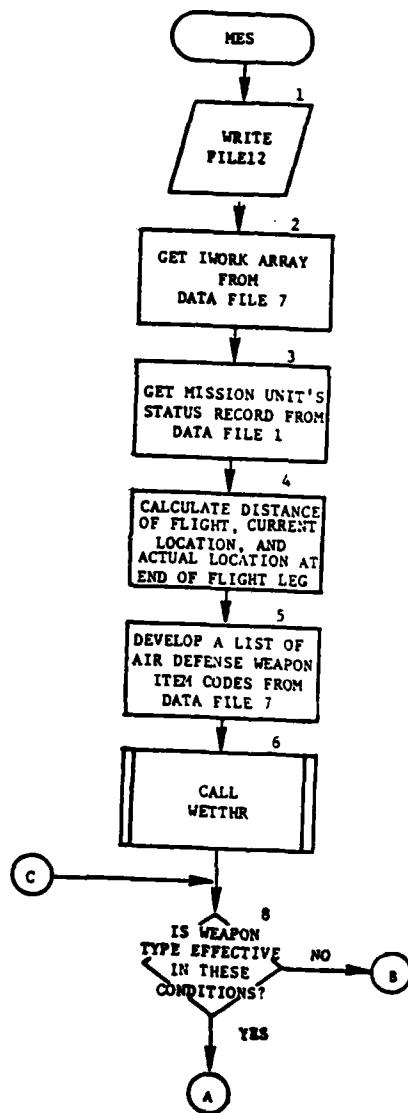


Figure IV-15-B-29. Routine MES (Continued on Next Page)

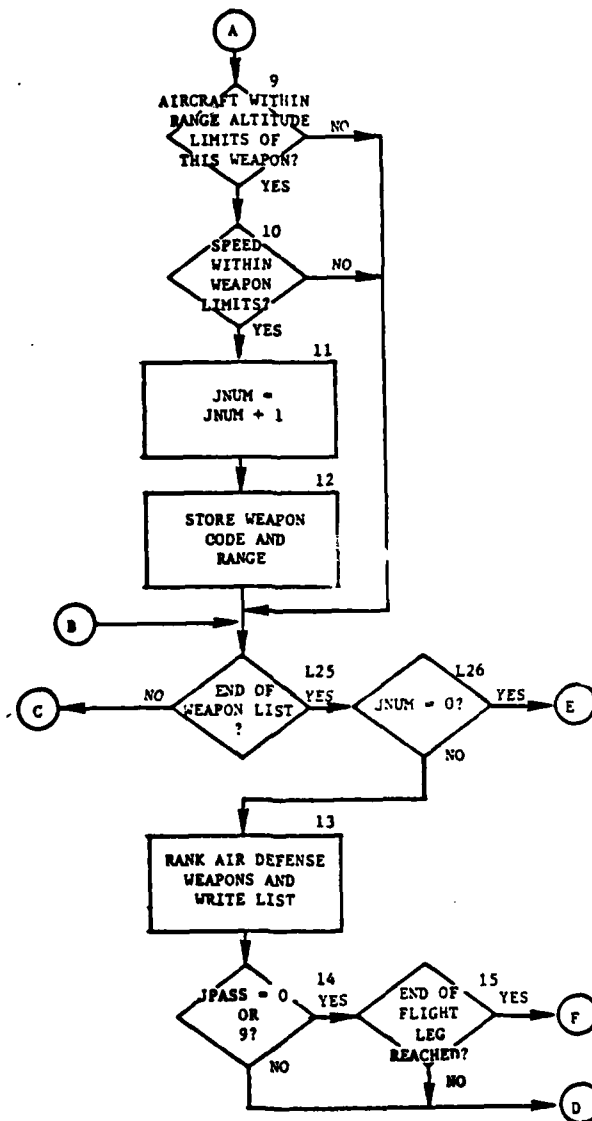


Figure IV-15-B-29. Routine MES (Continued)

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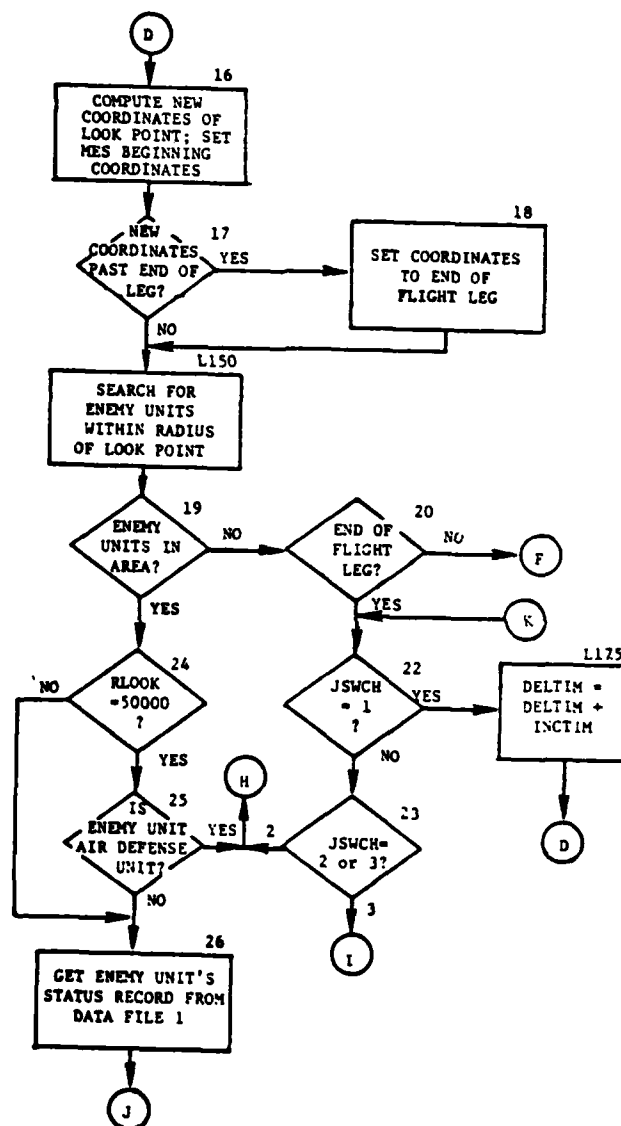


Figure IV-15-B-29. Routine MES (Continued)

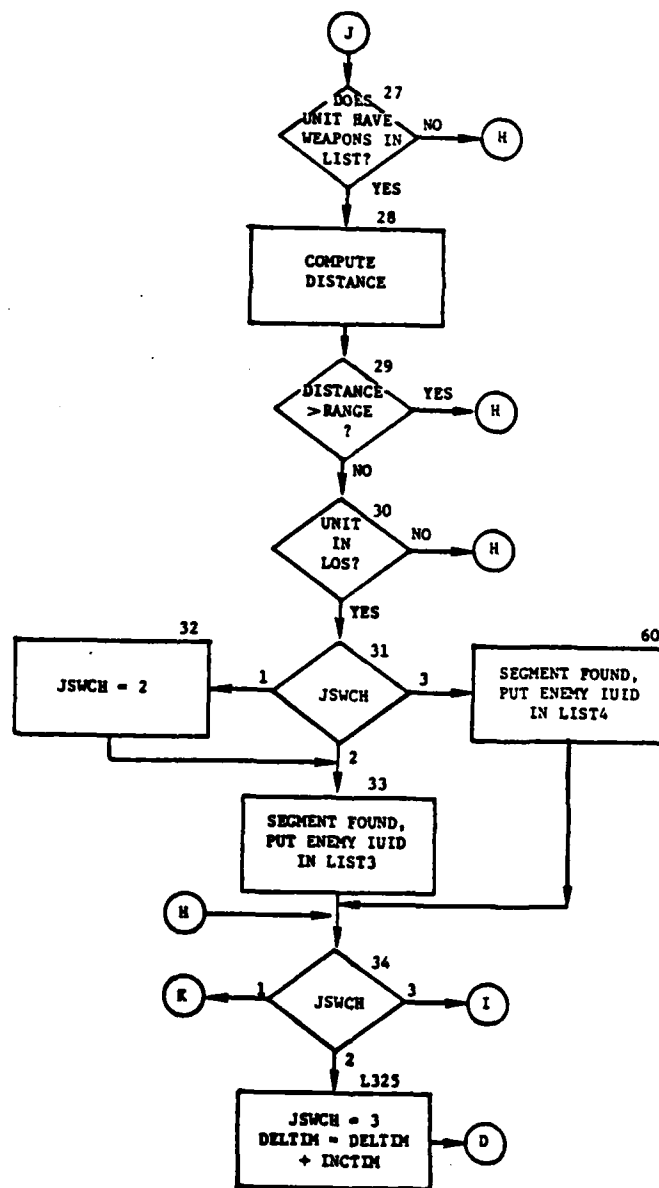


Figure IV-15-B-29. Routine MES (Continued)

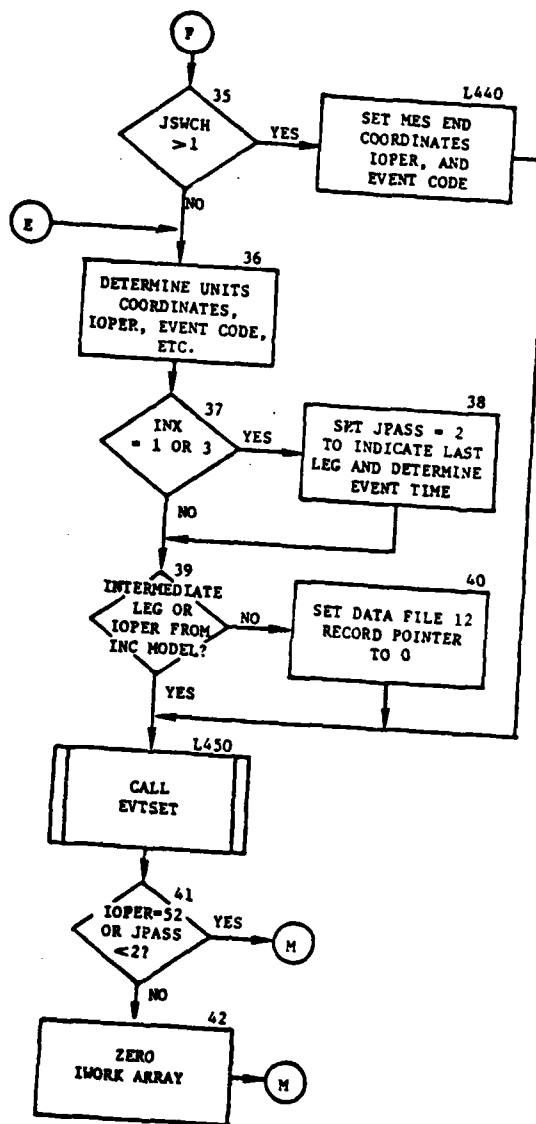


Figure IV-15-B-29. Routine MES (Continued)

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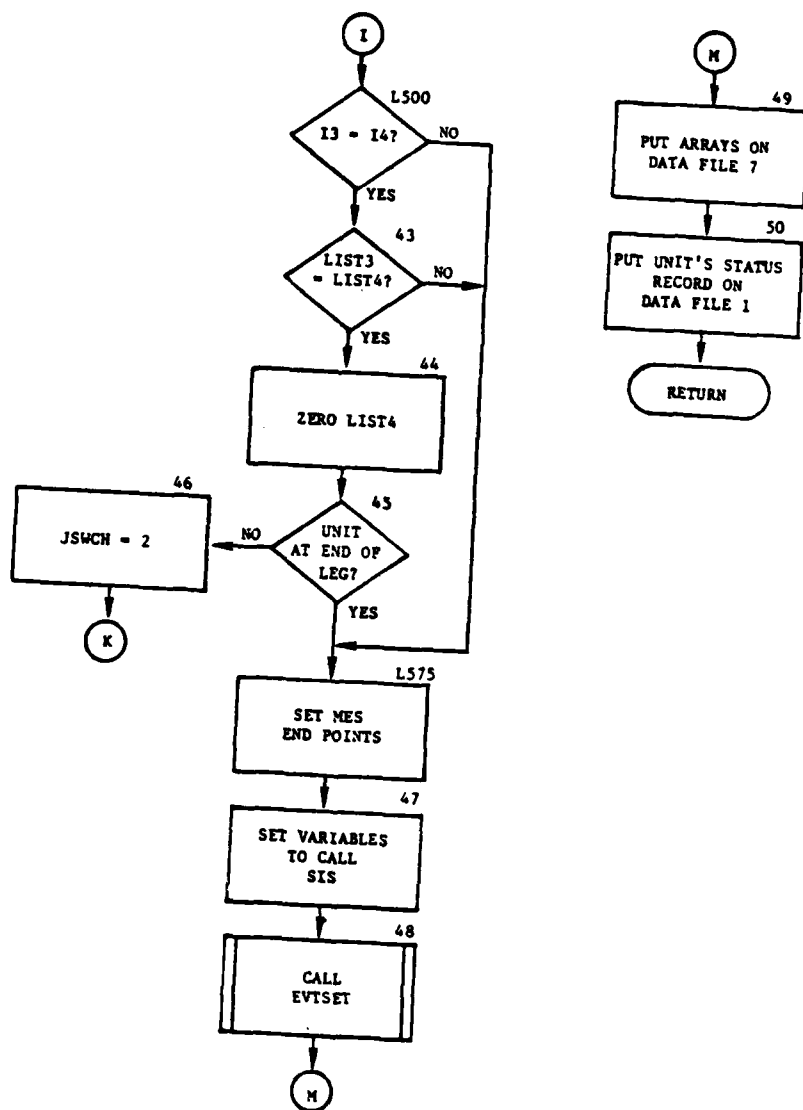


Figure IV-15-B-29. Routine MES (Concluded)

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(3) Block 3. Get the unit status record information from data file 1 and put it in UMAIN.

(4) Block 4. Calculate the distance of the flight leg, the current location and the location at the end of the flight leg.

(5) Block 5. Develop a list of air defense weapon item codes from the data on data file 7.

(6) Block 6. Call WETTHR to get the weather index.

(7) Block 8. Determine if a certain type of weapon is effective in the present weather and light conditions.

(8) Block 9. Check to determine if the aircraft is within the limits of this weapon type.

(9) Block 10. Determine if the aircraft speed is within the capability limits of this weapon type.

(10) Blocks 11 and 12. Increment the number of satisfactory weapon types (JNUM) by one and store this weapon code and its range.

(11) Block L25. Determine if this is the end of the weapons list.

(12) Block L26. Determine if the number of air defense weapons is greater than zero.

(13) Block 13. Call RANKA to rank the air defense weapons with ranges in descending order.

(14) Block 14. Determine if JPASS is equal to zero or nine.

(15) Block 15. Determine whether the end of the flight leg has been reached by comparing XACT and YACT with MEVTX and MEVTY.

(16) Block 16. Compute the new coordinates of a look point and set MES beginning coordinates. The radius of the search area (RLOOK) is also determined.

(17) Blocks 17 and 18. If the new coordinates are past the end of the flight leg, reset the coordinates to the end of the flight segment.

(18) Block L150. Call GASRCH to search within a specified radius, RLOOK, for enemy units. The enemy units are returned in LIST1 and the number of units in 11.

(19) Block 19. Check 11 to determine if the number of enemy units in the area is greater than zero.

(20) Block 20. Determine whether or not the end of the flight leg has been reached by the look point.

(21) Blocks 22 and L175. If JSWCH is equal to one, control transfers to block L175, where the time increment (INCTIM) is added. JSWCH equal to one indicates a major engagement segment start has not been found.

(22) Block 23. Transfer control to an appropriate block depending on the value of JSWCH. If JSWCH is greater than one, a major engagement segment start has been found.

(23) Blocks 24 and 25. Test the value of RLOOK; if the altitude of the aircraft is greater than 15,000 feet, only air defense capable units (ADCU) are checked.

(24) Block 26. Get the unit status record of the enemy unit from data file 1 and put it in UCOOP.

(25) Block 27. Determine whether the enemy unit possesses any weapons in the list.

(26) Block 28. Compute the distance from the enemy unit to the aircraft.

(27) Blocks 29 and 30. If the aircraft is within range of the weapon type and the aircraft is in line of sight of the enemy, a major engagement segment has been found.

(28) Blocks 31 and 32. Transfer control to an appropriate block depending on the value of JSWCH and set JSWCH equal to two if its previous value was one.

(29) Blocks 33 and 60. Put the IUID of the enemy unit in LIST3. If JSWCH is equal to three, put succeeding enemy units in LIST4. This enables the routine to detect a new major engagement segment when I3 does not equal I4 or LIST3 does not equal LIST4.

(30) Block 34. Transfer control to the appropriate block depending on the value of JSWCH.

(31) Block L325. Set JSWCH equal to three and increment the time.

(32) Blocks 35 and L440. If JSWCH is greater than one, set the major engagement segment end point coordinates, IOPER, and the event code.

(33) Block 36. Set the coordinates of the unit to the end of the flight leg and schedule the event to return to the calling routine when the air unit reaches the end of the flight leg. The unit is moved up at that time.

(34) Blocks 37 and 38. A value of INX equal to one or three, indicates a reconnaissance event, and when the end of the flight leg is reached, the data file 7 record is zeroed.



(35) Blocks 39 and 40. If this is not an intermediate leg (JPASS greater than two) or this call was from reconnaissance, the data file 12 record pointer is set to zero.

(36) Block L450. Call EVTSET to schedule an event that will return control to the calling routine when the end of the flight leg is reached.

(37) Blocks 41 and 42. If routine SIS is not to be called next (IOPER not equal to 52), or this is the last flight leg (JPASS less than two), zero the IWORK array.

(38) Blocks L500 and 43. If I3 is not equal to I4 or LIST3 is not equal to LIST4, a major engagement segment ending has been found. These conditions indicate a change in the constant weapon-unit combinations.

(39) Block 44. Zero LIST4.

(40) Blocks 45 and 46. If the unit is not at the end of the flight leg, set JSWCH equal to two.

(41) Blocks L575, 47, and 48. Set the end points for the major engagement segment and set the variables required in the call to SIS. Call EVTSET.

(42) Blocks 49 and 50. Put the major engagement segment data on data file 7 and put the unit's status record on data file 1.

### 33. ROUTINE SIS:

a. Purpose. Routine SIS is called in response to the events initiated in MES. SIS updates the position of the air unit to the location of the start of this segment of the flight leg. The primary task of SIS is to examine the current status and air defense capability of each air defense weapon system expected by MES to be capable of participating in this segment of the flight leg. This examination reveals subsegments called constant fire segments (FS) or intercept segments (IS) in which weapons are capable of delivering projectiles that will intercept the air unit during this segment of the flight leg.

#### b. Input Variables:

(1) Standard Common Block Variables. UMAIN and UCOOP.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
FILE12(35)	TWO	Event description record.
IOPER		FILE12(1). Unit operation code.
MISNUNT		FILE12(34). IUID of the mission unit.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
JPASS		FILE12(32). Flight leg indicator: 0 = initial flight leg 1 = intermediate flight leg 2 = last flight leg 9 = Airmobile event call.
NEXTOP		FILE12(35). Next operation code.
I3	DF7	Number of air defense capable units in this segment.
LIST3	DF7	List of air defense capable units in this segment.
IXB	DF7	Beginning X coordinate of major engagement segment.
IYB	DF7	Beginning Y coordinate of major engagement segment.
IXE	DF7	Ending X coordinate of major engagement segment.
IYE	DF7	Ending Y coordinate of major engagement segment.
MESST	DF7	Major engagement segment starting time.
LOSST	DF7	Line-of-sight starting time.
IDELT	DF7	Elapsed time of major engagement segment.
LASTET	DF7	Time of last constant fire sent to GTAA.
IDELYT	DF7	Delay time until weapon can start firing.
WEPRNG	DF7	Weapon range.
MUZVEL	DF7	Muzzle velocity.
DRAGF	DF7	Drag coefficient of weapon.
IRESPR	DF7	Radius of area of responsibility.
MJNITN	DF7	Munition type.
IBOUND(1)	DF7	Lock-on boundary.

c. Output Variables:

(1) Standard Common Block Variables. UMAIN and UCOOP.

(2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
ISREC	DF7	Constant fire data from SIS: Word 1 = beginning fire time Word 2 = ending fire time Word 3 = IUID of air defense capable unit Word 4 = weapon type.
FILE12(35)	DF12	Event description record.
IOPER		FILE12(1). Unit's operation code.
JREC		FILE12(31). Pointer to record on data file 7 of ISREC values, packed into two rightmost digits of FILE12(31).
LASTET	DF7	Time of last constant fire sent to GTAA.

d. Logical Flow (Figure IV-15-B-30):

- (1) Block 1. A message starting the SIS mission unit is written.
- (2) Block 2. Bring in the air defense capable unit and weapon data from data file 7.
- (3) Block 3. The length of the major engagement segment is calculated by calling routine RANGEF and passing it the coordinates of the beginning and ending major engagement segments.
- (4) Block 4. The unit status record for the mission unit is brought in from data file 1 and stored in UCOOP.
- (5) Block 5. The major engagement segment end time (MESEND) is calculated by adding IDELT to MESST.
- (6) Block 6. The air unit is moved to the major engagement segment beginning coordinates.
- (7) Block 7. If JPASS is greater than zero and JPASS is not equal to nine, this is an intermediate leg.
- (8) Blocks 8 and 9. If this is an Airmobile event, JPASS is set to two to indicate the data file 7 record should be zeroed at the end of the flight leg.
- (9) Blocks 10 and 12. If this is not the last flight leg, set the last event time to the major engagement segment start time. Also, since this

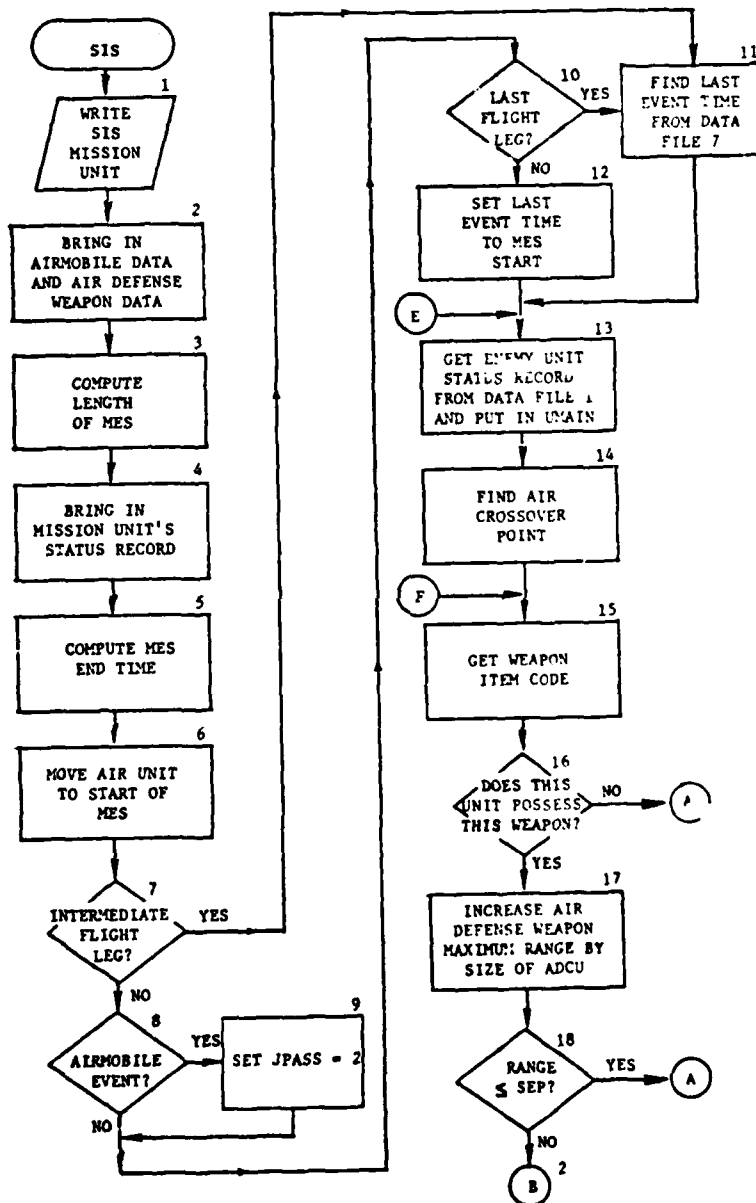


Figure IV-15-B-30. Routine SIS (Continued on Next Page)

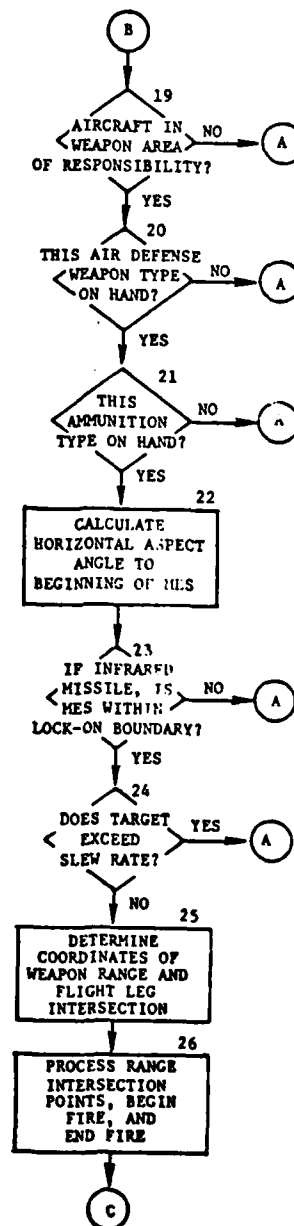


Figure IV-15-B-30. Routine SIS (Continued)

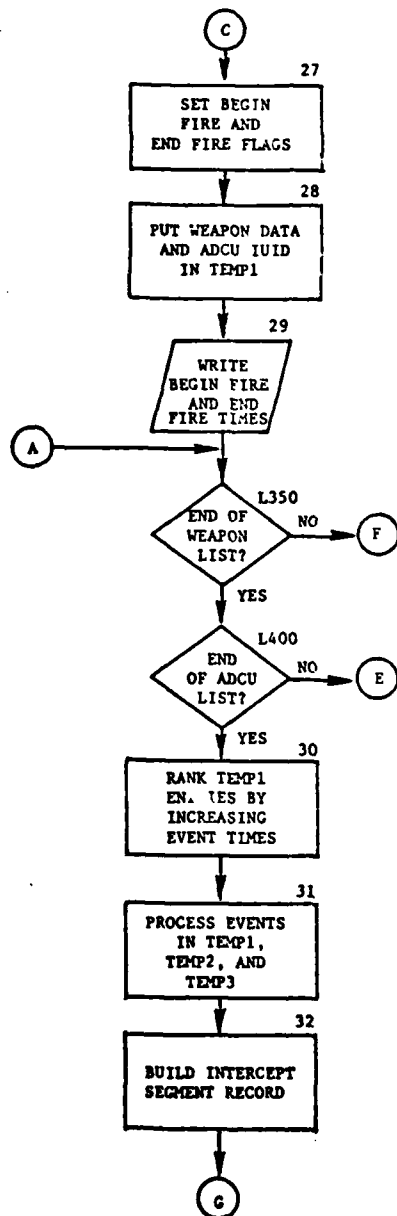


Figure IV-15-B-30. Routine SIS (Continued)

IV-15-B-117

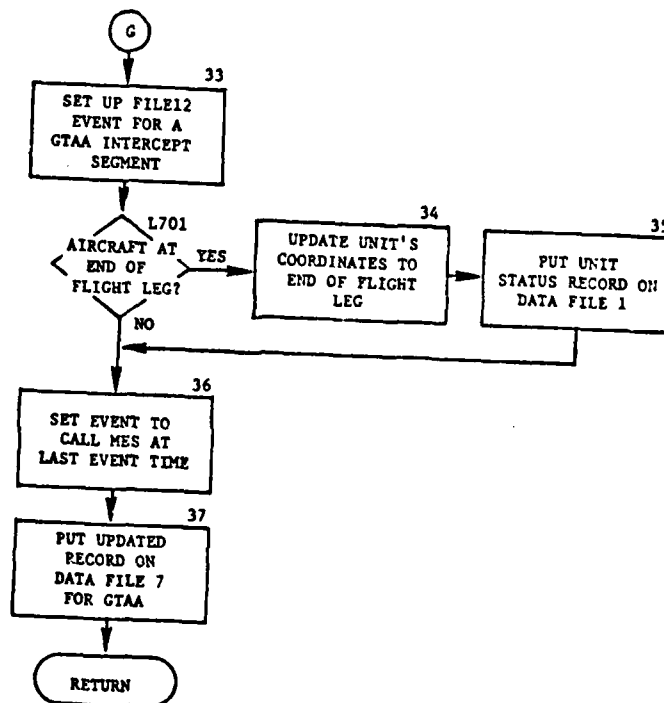


Figure IV-15-B-30. Routine SIS (Concluded)

IV-15-B-118

is the initial flight leg, the work arrays--TEMP1, TEMP2, and TEMP 3--that are used to set up constant fire events for GTAA are zeroed.

(10) Block 11. Because this is an intermediate flight leg, the last event time is obtained from data file 7.

(11) Block 13. Obtain the unit status record of an enemy unit from data file 1 and put it in UMAIN.

(12) Block 14. Call PONTLN to get the crossover point.

(13) Block 15. Obtain a weapon item code from array IWEPN.

(14) Block 16. If the enemy unit does not possess this weapon, control is transferred to the end of the weapon loop.

(15) Block 17. This block adds half of the width or the depth--whichever is less--to the maximum range of the weapon.

(16) Block 18. If the weapon's maximum range is less than the distance between the air unit and the enemy unit (SEP), control is transferred to the end of the weapon loop.

(17) Block 19. Control is transferred to the end of the weapon loop if the aircraft is not in the area of responsibility of the enemy unit (IRESPR).

(18) Block 20. Transfer control to the end of the weapon loop if the quantity of this weapon is less than 0.5.

(19) Block 21. Determine if the enemy unit possesses the munition type required by this weapon.

(20) Block 22. Calculate the horizontal aspect angle to the beginning of the major engagement segment.

(21) Block 23. If the weapon is an infrared missile, determine if the major engagement segment is within the maximum lock-on boundary (IBOUND(1)).

(22) Block 24. If the aircraft speed exceeds the slew rate of the weapon, control is transferred to the end of the weapon loop.

(23) Block 25. Call CHORD to determine the coordinates of the weapon range and flight leg intersection.

(24) Block 26. Process the points where the weapon can begin firing and end firing. Determine these points utilizing the enemy unit's location and the range and characteristics of the weapon.

(25) Block 27. Set the value of IFLAG to one for a beginning fire time and two for an ending fire time.



(26) Block 28. Put the air defense capable unit IUID, weapon type, beginning fire time, and beginning flag code in array TEMP1. This is also done for the ending fire time.

(27) Block 29. The beginning and ending fire times are written.

(28) Block L350. This block is the end of the weapon loop. If the list is not exhausted, control is returned to the beginning of the loop.

(29) Block L400. The block is the end of the ADCU loop. If the list is not exhausted, control is returned to the beginning of the loop.

(30) Block 30. Routine RANKA is called to rank the TEMP1 entries by increasing event times.

(31) Block 31. Using the arrays TEMP1, TEMP2, and TEMP3, process the events into the ranked order and format.

(32) Block 32. Put the data from the above arrays in array ISREC. Each entry of ISREC contains four words. Also, the value of JREC is established. A total of ISNUM of these records will be created.

(33) Block 33. Schedule an automatic (FILE12) event for GTAA.

(34) Blocks L701 and 34. If the aircraft is at the end of the flight leg, update the unit's coordinates to the end of the flight leg.

(35) Block 35. Put the mission unit's status record on data file 1.

(36) Block 36. Set an automatic (FILE12) event to call MES at the last event time.

(37) Block 37. The updated record to be used in GTAA, including array ISREC, is put on data file 7.

#### 34. ROUTINE GTAA:

a. Purpose. GTAA is called in response to the attrition event scheduled in SIS. Based on the data derived from the constant fire segment (CFS) generated in SIS, status adjustments are made and weapon capabilities are elaborated to approximate average capability over the constant fire segment. Suppressive fire and effects on air defense weapons are accounted for.

#### b. Input Variables:

(1) Standard Common Block Variables. UMAIN and UCOOP.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IXB	DF7	Beginning X coordinate of a major engagement segment.
IYB	DF7	Beginning Y coordinate of a major engagement segment.
MESST	DF7	Time of a major engagement segment start.
IXE	DF7	Ending X coordinate of a major engagement segment.
IYE	DF7	Ending Y coordinate of a major engagement segment.
IDELT	DF7	Elapsed time of a major engagement segment.
LASTET	DF7	Last event time.
IOPER	TWO	Unit's operation code.
MSNUNT	TWO	FILE12(1), FILE12(31), and FILE12(34). IUID of the mission unit.
KREC	TWO	Pointer to this unit's record on data file 7.
DIVERT	DF7	Distance that escorts are allowed to divert from a path.
ACDATA	DF7	Aircraft data.
MISTM	DF7	Suppression mission duration time.
ESCDT	DF7	Escort delay time.
ISLANT	DF7	Maximum slant range for the weapon system.
MUZVEL	DF7	Muzzle velocity of a weapon.
DRAGF	DF7	Drag coefficient.
IBOUND(1)	DF7	Lock-on boundary of a missile.
BRSTRN	DF7	Number of rounds per burst.
BRSTRT	DF7	Burst rate, in rounds per minute.
DRSTD L	DF7	Interburst delay time.
MAGCAP	DF7	Magazine capability in rounds.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
RELDEL	DF7	Reload delay time.
RELYF	DF7	Reliability factor.
VISDEG	DF7	Weather visibility degradation.
ECMF	DF7	Electromagnetic countermeasure fraction.
ISLEWV	DF7	Vertical slew rate.
ISLEWH	DF7	Horizontal slew rate.
MUNITN	DF7	Munition type.
IFLAG	DF7	Weapon flag.
AVMIL	DF7	Average miss distance for a missile, in artillery mils.
MPKDAT	DF7	Missile probability of kill data segment.
ENDXIS	DF7	X coordinate of end of an intercept segment.
ENDYIS	DF7	Y coordinate of end of an intercept segment.

c. Output Variables:

- (1) Standard Common Block Variables. UMAIN and UCOOP.
- (2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
PSPROD	TWO	Survival probability product of aircraft.
PKM	TWO	Kill probability for a missile.
FILE12	TWO	Automatic event table.
NADCU	TWO	Number of air defense capable units.
ENDXIS	TWO	End X coordinate of an intercept segment.
ENDYIS	TWO	End Y coordinate of an intercept segment.

d. Logical Flow (Figure IV-15-B-31):

- (1) Block 1. GTAA is written.
- (2) Block 2. Zero two probability arrays, PKM and PSPROD. PKM is the probability of a kill for a missile and PSPROD is the probability of survival for an aircraft.

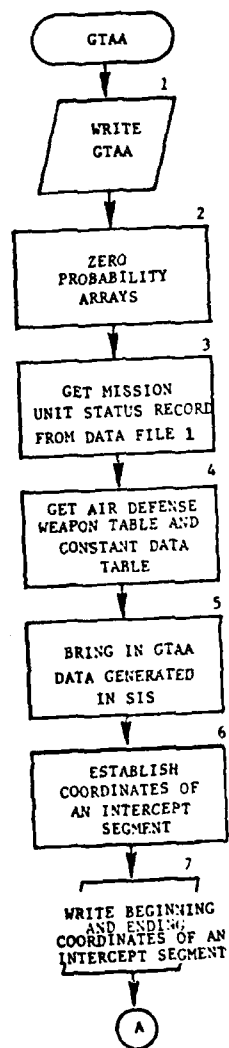


Figure IV-15-B-31. Routine GTAA (Continued on Next Page)

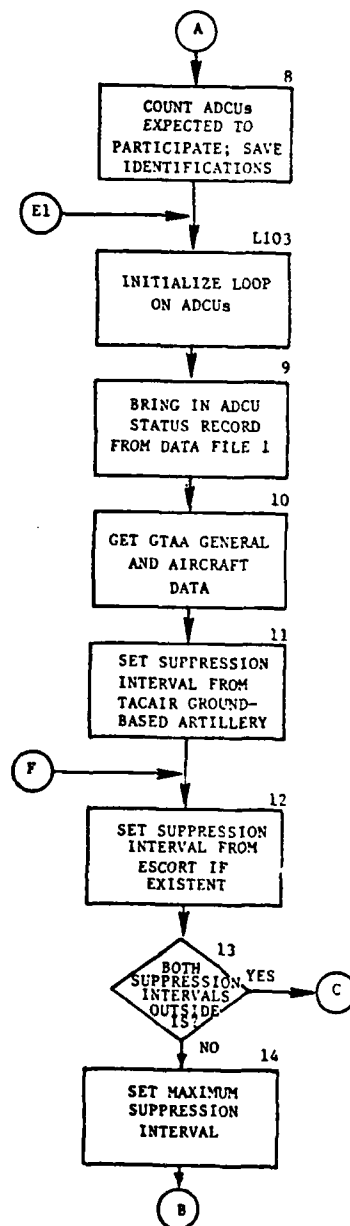


Figure IV-15-B-31. Routine GTAA (Continued)

IV-15-B-124

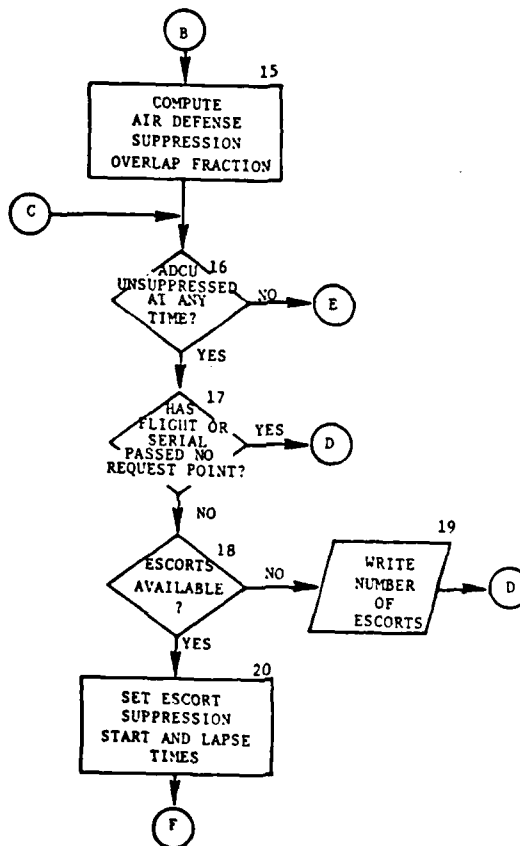


Figure IV-15-B-31. Routine GTAA (Continued)

IV-15-B-125

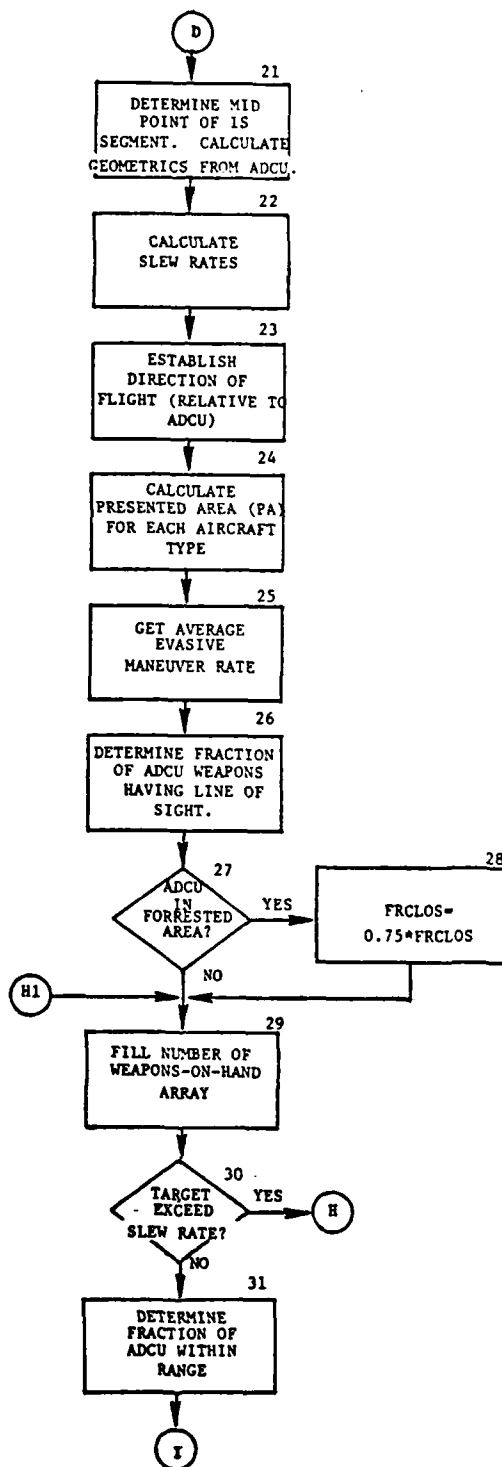


Figure IV-15-B-31. Routine GTAA (Continued)

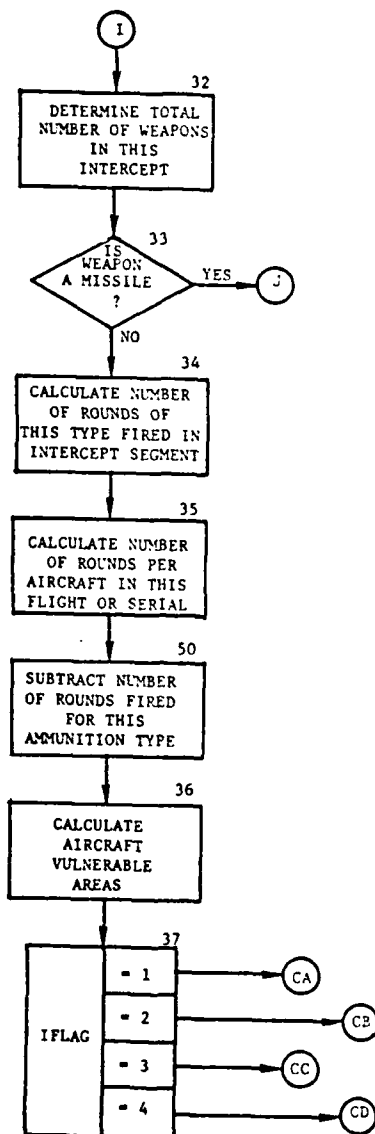


Figure IV-15-B-31. Routine GTAA (Continued)



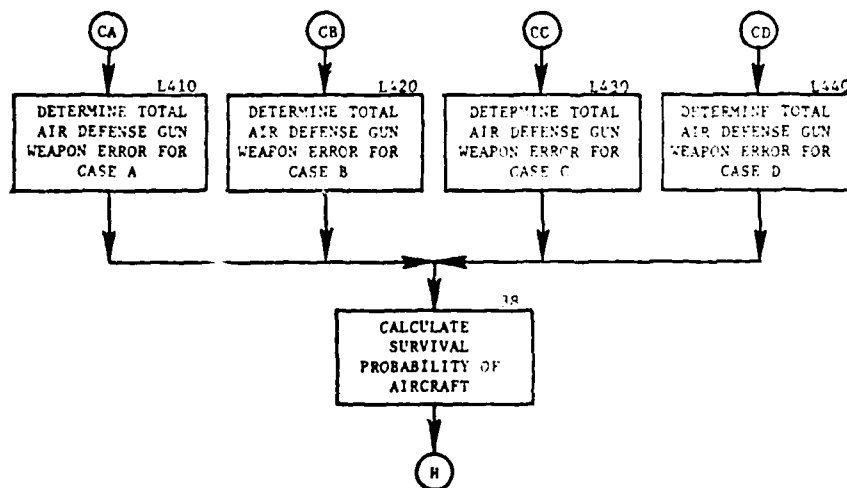


Figure IV-15-B-31. Routine GTAA (Continued)



- (3) Block 3. Get the mission unit's status record from data file 1 and put it in UMAIN.
- (4) Block 4. Bring in the air defense weapon table (IWEPN).
- (5) Block 5. The data generated in SIS is put in the array IWORK from data file 7.
- (6) Block 6. Calculate the beginning and ending coordinates of an intercept segment.
- (7) Block 7. Write the beginning and ending coordinates of the intercept segment.
- (8) Block 8. Count air defense capable units expected to participate in the intercept segment and save their identifications on the array ID.
- (9) Block L103. Initialize a loop on the air defense capable units. The air defense capable units are examined one-at-a-time.
- (10) Block 9. Bring in the air defense capable unit status record from data file 1 and put it in UCOOP.
- (11) Blocks 10 and 11. Get the suppression duration time and the GTAA general and aircraft data from data file 7. Set the suppression interval for the TACAIR ground-based artillery.
- (12) Block 12. Calculate the suppression intervals of the air defense capable unit caused by the escorts.
- (13) Block 13. Determine whether the suppression intervals are outside of the intercept segment.
- (14) Block 14. The maximum suppression interval is calculated.
- (15) Block 15. The total suppression overlap fraction is calculated.
- (16) Block 16. If the air defense capable unit suppression lasts to the end of the intercept segment, control is transferred to the end of the air defense capable unit loop.
- (17) Block 17. If the flight or serial has already passed the point where it can call for escorts (no request point), control is transferred to block 21.
- (18) Blocks 18 and 19. If two escorts are not available, write the total number of escorts on hand and transfer control to block 21.
- (19) Block 20. Set the escort suppression start and lapse times; then, transfer control to block 12 to recalculate the total suppression fraction.

(20) Block 21. Determine the mid point of the intercept segment and calculate other geometrics from the air defense capable unit to be used later.

(21) Block 22. Using the geometrics calculated in block 21, calculate the weapons slew rates in radians per centiminute.

(22) Block 23. Establish the direction of the flight. IDIREC is set to one if the flight is toward the air defense capable unit or IDREC is set to two if the flight is away from the air defense capable unit.

(23) Block 24. Given the angles from the air defense capable unit to the aircraft, the presented area (PA) is calculated for each aircraft type.

(24) Block 25. Calculate an average maneuver rate for a given aircraft using the aircraft data from data file 7.

(25) Blocks 26, 27, and 28. Determine the fraction of air defense capable unit weapons having a line of sight to the aircraft. If the ADCU is in a fore ted area, multiply the fraction of the line of sight (FRCLOS) by 0.75.

(26) Block 29. Fill the number of weapons on hand array. This block is the beginning of the weapons loop.

(27) Block 30. If the aircraft exceeds the weapon's slew rates, control is transferred to the end of the weapons loop.

(28) Block 31. Determine the fraction of the air defense capable unit within range.

(29) Block 32. Determine the total number of weapons capable of firing in this intercept given the existing conditions.

(30). Block 33. If the weapon is a missile, transfer control to block 39.

(31) Block 34. Since the weapon is not a missile, calculate the total amount of this munition type to be fired during this intercept segment given the existing conditions.

(32) Block 35. Calculate the number of rounds fired per aircraft during this flight or serial.

(33) Block 50. Subtract the number of rounds fired for this ammunition type from the equipment on hand.

(34) Block 36. Calculate the vulnerable areas for each type of aircraft.

(35) Block 37. Depending on the value of IFLAG, control is transferred to one of the four equation sets of weapon errors for guns.

(36) Blocks L410, L420, L430, and L440. Calculate the weapon errors. Four sets of equations are used to approximate the weapon error associated with four types of gun systems:

- . Visually sighted 12.7mm or 0.50 caliber machinegun
- . Optically directed 14.5mm, 23mm, and 57mm systems
- . Range only radar systems
- . Full solution radar systems.

(37) Block 38. Calculate the probability of an aircraft surviving and store this probability in array PSPROD which is used by LOSSES.

(38) Block 39. Initialize the missile calculations. Calculate a one-sigma error based on the missile's average miss distance.

(39) Block 40. Determine which aircraft has the largest presented area.

(40) Block 41. Given the presented area, sigma, and a random number, calculate the missile miss distance.

(41) Block 42. Interpolate the probability of a kill (PK) array at the calculated miss distance.

(42) Block 43. Fill the probability of a missile kill (PKM) array with data from the PK array and total number of weapons for the later call to LOSSES.

(43) Block 44. Subtract the number of rounds fired from the equipment on hand.

(44) Block 45. Write the number of rounds fired and the probability of a missile kill (PKM) array.

(45) Blocks L698 and L699. These blocks are the end of the weapon and air defense capable unit loops.

(46) Block 46. Zero the array ISLIST containing the air defense capable units, their weapon types, and starting and ending firing times.

(47) Block 47. Call routine LOSSES.

### 35. ROUTINE LOSSES:

a. Purpose. The routine LOSSES determines attrition to personnel and equipment based on the sum of all probabilities of kill for both missiles and guns, places the lost personnel and equipment into an array for passage to the score board routine, updates the coordinates of the mission unit for the aircraft, and puts the score board pointer and updated equipment array back on the unit status file.

b. Input Variables:

- (1) Standard Common Block Area. UMAIN.
- (2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
PKM	TWO	Probability of kill for missile type.
PSPROD	TWO	Probability of survival product for guns.
ENDXIS	TWO	X coordinate of unit at end of this major engagement segment.
ENDYIS	TWO	Y coordinate of unit at end of this major engagement segment.
NADCU	TWO	Number of air defense capable units encountered.

c. Output Variables:

- (1) Standard Common Block Variable. IOUT.
- (2) Other Variables. None.

d. Logical Flow (Figure IV-15-B-32):

(1) Block L96. Initialize necessary variables including array to be used for scoring losses and set total number of personnel to present strength plus suppressed strength plus fraction of personnel.

(2) Blocks 1, 2A, and 2B. Escort and transport aircraft losses are processed separately with transport aircraft processed first. The item code of each type of aircraft is contained in the AIRDAT array kept on the unit status record for this mission unit, with AIRDAT(2) containing the transport item code and AIRDAT(4) containing the escort item code.

(3) Blocks L705, 3, 4, 5, 6, and 7. Initialize loop through the probability of kill array for each of four possible types associated with each of 15 permissible mission types. The aggregate total represents the total amount of aircraft losses for this major engagement segment. The ratio of aircraft lost to aircraft remaining is computed with a maximum boundary of 1.0. If no aircraft were lost, control transfers to block L706. The total number of aircraft lost is subtracted from the total aircraft on hand to obtain the new amount, and personnel lost are subtracted from unit's total personnel to obtain unit's present strength.

(4) Blocks 8, 9, 10, 11, L720, and L730. Because the reconnaissance overlay makes the decision whether a unit is shot down, thereby losing both aircraft and equipment, no attrition other than loss of aircraft is calculated

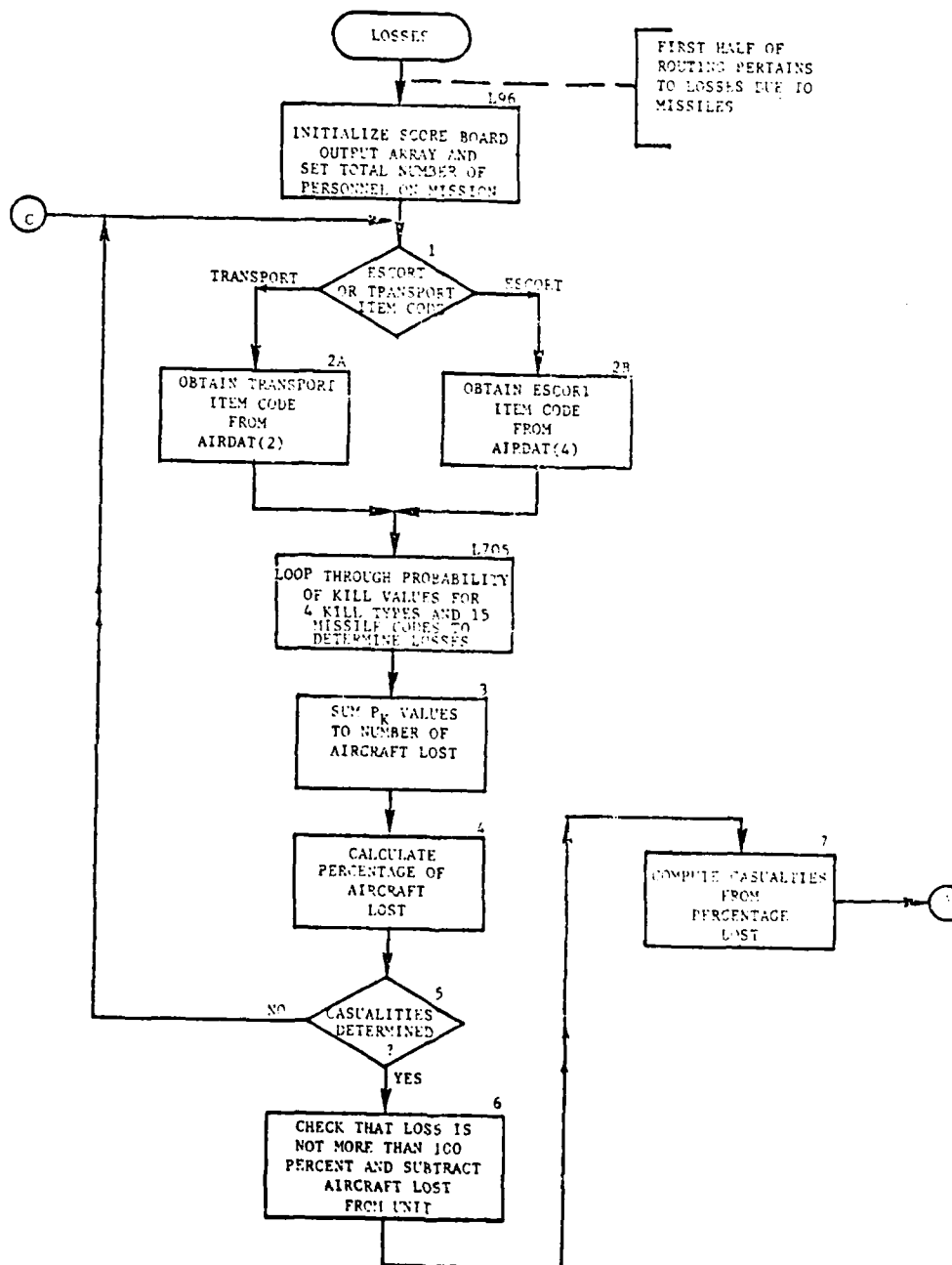


Figure IV-15-B-32. Routine LOSSES (Continued on Next Page)

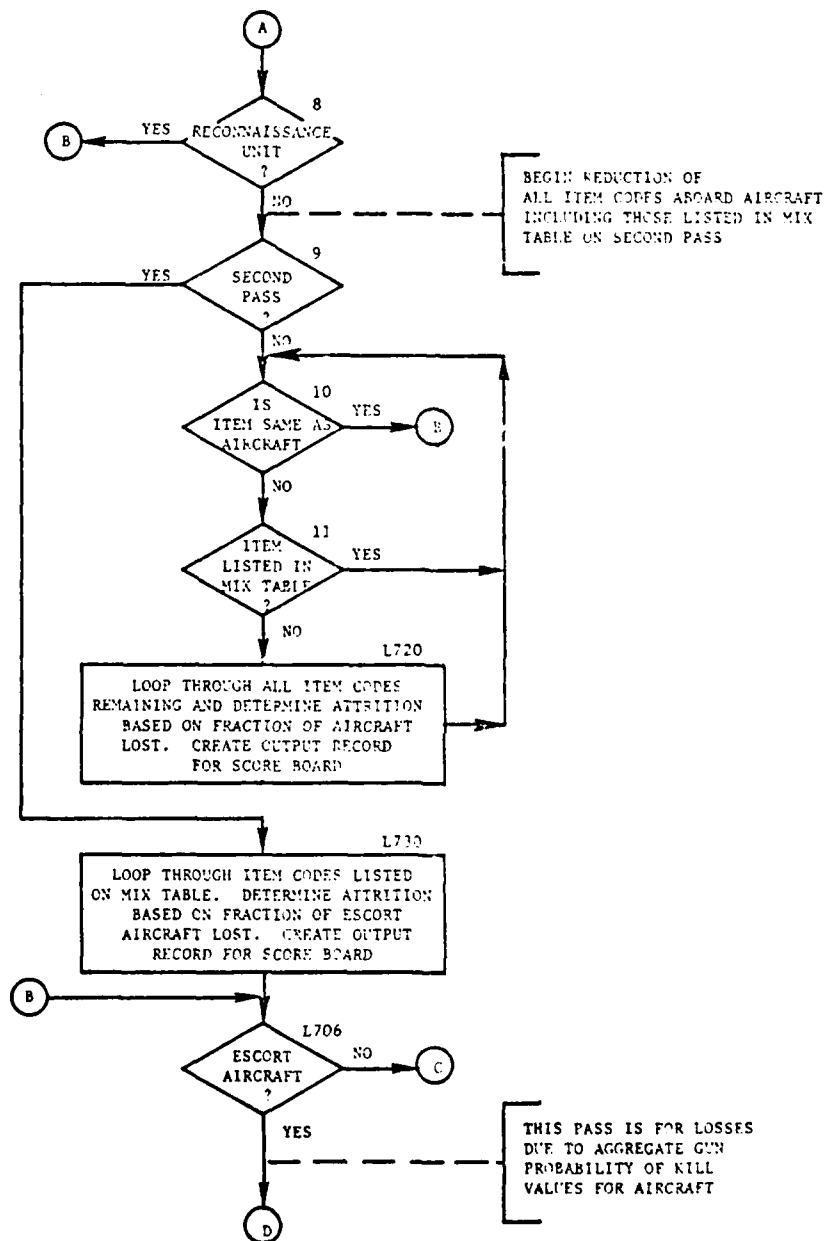


Figure IV-15-B-32. Routine LOSSES (Continued)

IV-15-B-135



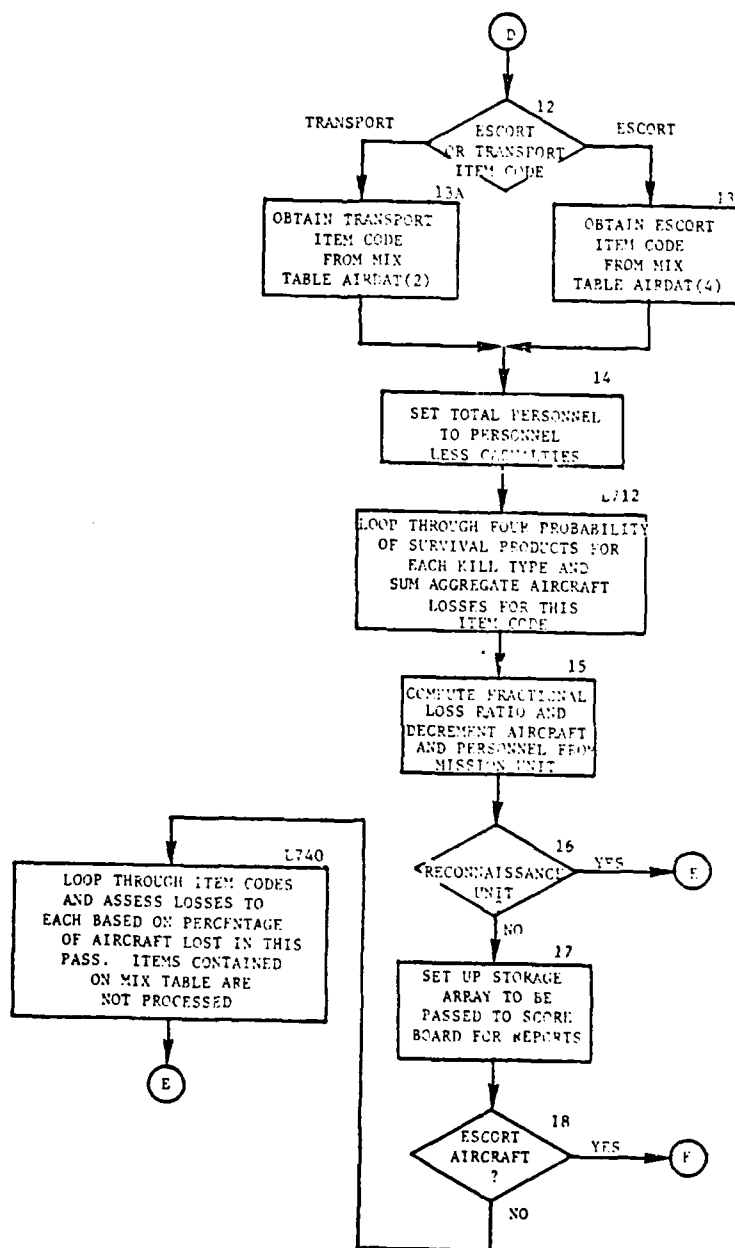


Figure IV-15-B-32. Routine LOSSES (Continued)

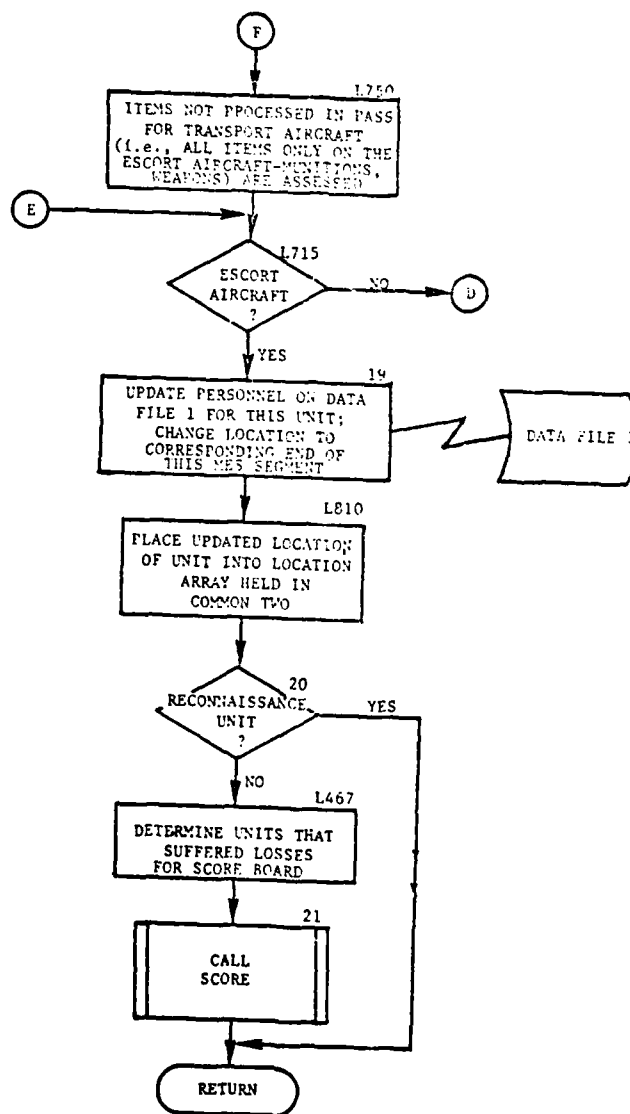


Figure IV-15-B-32. Routine LOSSES (Concluded)

by LOSSES. Branch to block L706 if this is a mission unit created by the reconnaissance overlay. Because escort aircraft have items that are not carried on transport aircraft, separate loops assess losses for items on the transport aircraft and items particular only on the escort craft, both based on the ratio previously calculated. The MIX table is used to distinguish escort item codes. Losses assessed in both loops are placed in a score board array to be summed for additional losses, rearranged, and passed to routine SCORE.

(5) Block L706. If this is the pass for transport aircraft, control returns to block 1.

(6) Blocks 12, 13A, 13B, 14, L712, and 15. Repeat the same type of logic described in the previous paragraph, accumulating and assessing losses due to guns. Determine whether to assess transport or escort aircraft. Initialize loop through the four probability of survival products for guns and sum the aggregate aircraft losses. Compute the loss ratio of aircraft lost to aircraft on hand, and subtract the aircraft and personnel losses from the current amounts.

(7) Blocks 16, 17, 18, L740, L750, and L715. Bypass the assessment of equipment if this is a reconnaissance unit with control branching to block L715. Separate loops process the attrition of equipment on the transport and escort aircraft sequentially. If processing losses for the transport aircraft, control branches to block 12 to assess escort aircraft for guns.

(8) Blocks 19, L810, and 20. After replacing the current strength of personnel and amounts of equipment (including number of aircraft) back onto the unit status file, update the unit's coordinates to its location at the end of this segment, placing the coordinates onto both the unit status file and into the location array stored in common. If this is a reconnaissance mission unit, that will be assessed and scored by the reconnaissance overlay, control returns to the calling routine.

(9) Blocks L467 and 21. The mission unit's origin, rather than its superior unit, is considered when determining which unit should be assessed the calculated losses as follows:

(a) If the unit being assessed is not a model-generated mission unit, losses are assessed directly to the unit.

(b) If the unit being assessed is a model-generated mission unit and the unit has escorts and transports from the same airbase, losses are assessed to the airbase.

(c) If the unit being assessed is a model-generated mission unit and the unit has escorts from one airbase and transports from a second airbase, losses for escorts are assessed to the airbase providing escorts, and transport losses assessed to the airbase providing transports. Once the appropriate unit for scoring has been selected, and the lost equipment array rearranged, routine SCORE updates the score board for this unit, and returns control to the calling routine.

## APPENDIX C

### AIRMOBILE MODEL OUTPUT DESCRIPTIONS

1. INTRODUCTION. This appendix contains samples and detailed descriptions of printed output from routines within the Airmobile Model of the Period Processor. The output of each routine, depicted by a figure, is explained in the following paragraphs.

#### 2. ROUTINE ACCPT1.

a. A sample of the printed output from routine ACCPT1 is presented in Figure IV-15-C-1. Each print group is identified by an alphabetic descriptor and explained below. Unless otherwise stated, the listed print statements are keyed to print switch 2.

<u>Output Descriptor</u>	<u>Explanation</u>
A	The airmobile mix table is printed. The entries of this table are defined in paragraph 4 of Appendix B to this chapter.
B	The numerical weather code for the existing weather conditions (0-3). This value is printed by routine WETTHR and is not keyed to a print switch.
C	The list of all eligible airbases in the force is printed with the unit identification numbers and coordinates.
D	The speed (knots) and fuel consumption rates (gallons per hour) for the transport aircraft.
E	The identification number of each candidate airbase is printed as it is considered in order of preference.
F	The total fuel required for all transport aircraft.
G	Selection type code (1 = source of escort aircraft, 2 = source of transport aircraft, 3 = source of all aircraft).
H	This group of print is produced by routine PENRAT and lists: <ul style="list-style-type: none"><li>. The identification number of the forwardmost enemy battalion</li><li>. Distance from the safe point to the pickup point in meters</li><li>. Intercept of line parallel to the FEBA trace and passing through the safe point with the X axis</li></ul>



- . Intercept of line parallel to the FEBA trace and passing through the pickup point with the X axis
- . The difference between the two preceding values
- . Projection of the safe distance onto the X axis

This group of print is not keyed to a print switch.

- I The game time delay until the mission unit is to arrive at the pickup point in centiminutes, the time required to fly to the safe point or pickup point in centiminutes, and the gallons of fuel consumed en route.
- J The automatic event description (FILE12 array) contains the following information:

<u>Word</u>	<u>Content</u>
1	Operation code
2	Unit accepting transport
3	Airmobile mix number
4	Number of transport aircraft
5	Mission unit identification
6	Number of escort aircraft
7	Pickup time
8	Escort mission unit identification
9	Transport mission unit identification
10	Combined mission unit identification
11	Force (1 = Blue, 2 = Red)
12	Transport aircraft item code
13	Fuel consumed
15	Transport aircraft fuel consumption rate
35	In-flight attrition return operator

b. Additional printed output not present in the example are described below.

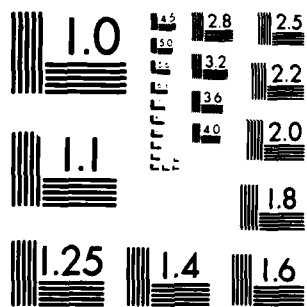
AD-A112 653 ARMY COMBINED ARMS COMBAT DEVELOPMENTS ACTIVITY FORT--ETC F/6 15/7  
DIVWAS MODEL DOCUMENTATION. VOLUME II. PROGRAMMER/ANALYST MANUA--ETC(U)  
JUL 76  
UNCLASSIFIED CACDA-TR-8-76-VOL-2-PY-4 NL

6 8

5

1

# 12653



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



(1) If the number of trips has been specified, the weight and volume of the unit, weight and volume capacity of each transport aircraft, and required number of transport aircraft are printed between descriptors A and B.

(2) If the escort and transport aircraft are selected from different airbases, the time required for the escort aircraft to fly to the transport airbase is printed before descriptor J.

3. ROUTINE ACCPT2. A sample of the printed output from routine ACCPT2 is presented in Figure IV-15-C-2. All output has been described in the preceding paragraph.

4. ROUTINE ACCPT3. The only output from routine ACCPT3 is the automatic event descriptor (FILE12 array) defined above.

5. ROUTINE ASULT1. A sample of the printed output from routine ASULT1 is presented in Figure IV-15-C-3. Each print group is identified by an alphabetic descriptor and explained below. All output is keyed to print switch 2.

<u>Output Descriptor</u>	<u>Explanation</u>
A	The alphanumeric identification of the unit performing the assault.
B	The automatic event description (FILE12 array) defined in paragraph 7 of Appendix B to this chapter.
C	The velocity of the escort and transport aircraft respectively, in knots, followed by the limiting velocity in meters per centimute.

6. ROUTINE ASULT2. A sample of the printed output from routine ASULT2 is presented in Figure IV-15-C-4. Each print group is identified by an alphabetic descriptor as explained below. All output is keyed to print switch 2.

<u>Output Descriptor</u>	<u>Explanation</u>
A	The automatic event description (FILE12 array) defined in paragraph 7 of Appendix B to this chapter.
B	Airmobile mix table defined in paragraph 4 of Appendix B to this chapter.
C	200-character array. The locations of "M" entries in the list identifying item codes of equipment exempt from the weight and volume limitation.
D	The first column of this table contains weights and the second column contains volumes.

Figure IV-15-C-2. Printed Output Sample from Routine ACCPT2





Output  
Descriptor

Explanation

If entire unit can be lifted:

Row 1 - unused  
Row 2 - lift capacity  
Row 3 - unit requirement

If the entire unit cannot be lifted:

Row 1 - unit requirement  
Row 2 - unused lift capacity  
Row 3 - load remaining

7. ROUTINE ASULT3. A sample of the printed output from routine ASULT3 is presented in Figure IV-15-C-5. Each print group is identified by an alphabetic descriptor and explained below. All output is keyed to print switch 2.

Output  
Descriptor

Explanation

- A        The automatic event descriptor (FILE12 array) defined in paragraph 7 of Appendix B to this chapter.
- B        The first entry is the distance flown on previous flight leg. The second entry is the time required for previous flight leg. If a refuel decision was made, the second entry is the time the unit can fly with the fuel currently on board and the third entry is the length of time required to fly one complete round trip.

8. ROUTINE ASULT4. The output from routine ASULT4 is only the automatic event description (FILE12 array) described in paragraph 7 of Appendix B to this chapter.

9. ROUTINE RLEAS1. A sample of the printed output from routine RLEAS1 is presented in Figure IV-15-C-6. Each print group is identified by an alphabetic descriptor and explained below. Descriptor B and D are keyed to print switch 2.

Output  
Descriptor

Explanation

- A        The weather condition code (0-3). This value is printed by routine WETTHR.
- B        The transport and escort fuel consumption rates in gallons per hour from data file 14.
- C        Output from routine PENRAT, described previously.
- D        Automatic event description (FILE12 array). The array contains the information which follows.



Ⓢ

IV-15-C-10

<u>Word</u>	<u>Content</u>
1	Operation code.
2	Unit releasing aircraft
3, 4, and 5	Mission unit identifications
6	Penetration flag (0 = no, 1 = yes)
7	Fuel consumed during next flight leg
11	Force (1 = Blue, 2 = Red)
12	Transport aircraft item code
35	In-flight attrition return code

10. ROUTINE RLEAS2. A sample of the printed output from routine RLEAS2 is presented in Figure IV-15-C-7. Each print group is identified by an alphabetic descriptor and explained below. All output is keyed to print switch 2.

<u>Output Descriptor</u>	<u>Explanation</u>
A	The time required to fly from the safe point to each airbase in centiminutes.
B	Automatic event description (FILE12 array) defined in preceding paragraph.

11. ROUTINE RLEAS3. A sample of the printed output from routine RLEAS3 is presented in Figure IV-15-C-8. Each print group is identified by an alphabetic descriptor and explained below. Descriptors A and D are keyed to print switch 2.

<u>Output Descriptor</u>	<u>Explanation</u>
A	The number of B-, C-, and D- kills suffered by transport and escort aircraft.
B	Aircraft landing times from data file 26 in centiminutes for transport and escort aircraft.
C	Time to restore undamaged transport and escort aircraft to service in centiminutes.
D	Automatic event description (FILE12 array), described previously.
Not shown	Times to restore damaged aircraft may appear between descriptors B and C.





**ⓓ**



12. ROUTINE RLEAS4. A sample of the printed output from routine RLEAS4 is shown below. This print identifies the airbase, the item code of the aircraft being restored, and the number of aircraft. It is keyed to print switch 2.

```

***      RLEAS4
IUIDAB = 196
IACECH = 86
AMOUNT = 5.00000

```

13. REARM/REFUEL SUBMODEL. The printout shown in Figure IV-15-C-9 is output from the Rearm/Refuel submodel of the Airmobile Model. This submodel simulates the rearming and refueling of aircraft flights using the restraints of time and resources input to it.

<u>Output Descriptor</u>	<u>Explanation</u>
A	TCLOCK = Current game time in centiminutes. FRRA IOPR = Numerical code indicating rearm/refuel status of flight and which routine is to be called to further process the flight. MUID = IUID of the mission unit. MUID4 = IUID of the assault unit.
B	DMX = Distance from mission unit to resupply point.
C	IUIDMU = IUID of mission unit. COCUID = IUID of forward rearm/refuel area (FRRA). IRRUTD = List of UTDs of possible FRRAs.
D	INDX = Index indicating the UTD of the FRRA selected. IREC24 = Number of the record on data file 24 assigned to this unit IOPR = See FRRA IOPR description, descriptor A.
E	PRSRAP = Present number of rearm points (=RAC * present strength/ authorized strength) PRSRFP = Present number of refuel points (Σ number of refuel points per vehicle * number of vehicles on hand) RAC = Rearm capacity of FRRA if it has 100 percent personnel strength. RFC = Refuel capacity of FRRA if it has 100 percent vehicles authorized. DELT = Time required for the mission unit to reach the FRRA chosen.
F	IUIDMU = List of the IUIDs of mission units being processed or to be processed at this FRRA. TIF = List of the total number of inlets to be refueled in each mission unit. TACRA = List of the total number of aircraft to be rearmed in each mission unit.

(A) TCLOCK= xxxx, FRRA IOPR= xxx MUID= xxx MUID4= xxxx  
 (B) DMX= xxx  
 (C) IUIDMU= xxx COCUID= xxx  
 IRRUTD= AAAA AAAA ...  
 (D) INDX= xxx IREC24= xxx IOPR= xxx  
 (E) PRSRAP = xxx PRSRFP = xxx RAC = xxx RFC = xxx DELT = xxx

(F) IUIDMU= xxx xxx xxx ...  
 xxx xxx xxx ...  
 TIF= xxx xxx xxx ...  
 xxx xxx xxx ...  
 TACRA= xxx xxx xxx ...  
 xxx xxx xxx ...  
 READY= xxx xxx xxx ...  
 xxx xxx xxx ...  
 TAC= xxx xxx xxx ...  
 xxx xxx xxx ...  
 RFTPI= xxx xxx xxx ...  
 xxx xxx xxx ...  
 RADAT= xxx ...  
 xxx ...  
 xxx ...  
 xxx ...  
 RACAA= xxx ...  
 xxx ...  
 xxx ...  
 RFC = xxx RAC = xxx QI = xxx RFP = xxx RAP = xxx

(G) IA = xxx IS = xxx ICR = xxx DELT = xxx CLASS3A= xxx  
 (H) IRB = xxx IWD = xxx MIXTAB = xxx xxx xxx ...  
 (I) K = xxx TIF = xxx EOH = xxx  
 (J) RAP = xxx QI = xxx TAV = xxx RFC = xxx  
 (K) IDT = xxx ACBP = xxx  
 (L) IOPR = xxx ALT = xxx AIRSPD = xxx K = xxx EOH = xxx CONSUM = xxx  
 (M) IOPR = xxx IUIDMU = xxx RA TIME POINTER = xxx NABP = xxx RETX = xxx  
 RETY = xxx RET IOPR = xxx  
 (N) FCOMP = xxx ACOPM = xxx

Figure IV-15-C-9. Sample Printed Output from Rearm/Refuel (Continued On Next Page)

(O) — RRQUE - xxx xxx xxx xxx xxx xxx xxx xxx  
 (P) — RRQUE - xx. xx. xx. xx. xx. xx.  
 (Q) — MUID = xxx CUID = xxx QI = xxx RFC = xxx RAC = xxx RFP = xxx RAP = xxx  
 (R) — 
 NN = xxx xxx xxx ....  
 IC = xxx xxx xxx ...  
 TOTRFP = xxx RFC = xxx ACBP = xxx COPRSRFP= xxx
   
 (S) — IOPR = xxx IDT = xxx

Figure IV-15-C-9. Sample Printed Output from Rearm/Refuel (Concluded)

Output  
Descriptor

Explanation

F      READY = List of the number of aircraft which have been refueled  
         and are ready to be rearmed in each mission unit.  
         TAC = List of the times required to arm one aircraft in each  
         mission unit.  
         RFTPI = List of the times required to refuel one fuel inlet in  
         each mission unit.  
         RACAT = List of times rearm capacity will become available.  
         RACAA = List of the amounts of rearm capacity that will become  
         available at the times listed under RACAT above.  
         RFC = See descriptor E.  
         RAC = See descriptor E.  
         QI = Pointer to the last position being used in the 20-position  
         queue of the FRRA.  
         RFP = Pointer to the position in the queue of the mission unit  
         currently being refueled.  
         RAP = Pointer to the position in the queue of the mission unit  
         currently being rearmed.

G      IA = Altitude cut-off indicator.  
         IS = Air speed cut-off indicator.  
         ICR = Pointer to consumption rate selected.  
         DELT = Time required by mission unit to fly to FRRA.  
         CLASS3A = Amount of fuel consumed en route to FRRA.

H      IRB = Force indicator (1 = Blue, 2 = Red).  
         IWD = Pointer to the first word of the mix table selected.  
         MIXTAB = Mix table describing the composition of the mission  
         unit. A description of each word follows.

<u>Word</u>	<u>Content</u>
1	Escort aircraft item code
2	Escort aircraft personnel
3	Escort aircraft fuel capacity
4	Escort aircraft munition type 1 item code
5	Escort aircraft munition type 1 amount
6	Escort aircraft munition type 2 item code
7	Escort aircraft munition type 2 amount
8	Escort aircraft munition type 3 item code
9	Escort aircraft munition type 3 amount
10	Transport aircraft item code

<u>Word</u>	<u>Content</u>
11	Transport aircraft personnel
12	Transport aircraft fuel capacity
13	Escort aircraft rearm time
14	Escort aircraft fuel inlets
15	Transport aircraft fuel inlets

<u>Output Descriptor</u>	<u>Explanation</u>
I	K = Aircraft item code. TIF = Number of inlets to be refueled in this mission unit. EOH = Number of aircraft in this mission unit.
J	RAP = See descriptor F. QI = See descriptor F. TAV = Time next rearm capacity will be available. RFC = See descriptor E.
K	IDT = Time required to refuel these aircraft. ACBP = Number of aircraft inlets being refueled.
L	IOPR = See FRRA IOPR, descriptor A. ALT = See UMAIN description, Chapter 2 to Section VII. AIRSPD = See UMAIN description, Chapter 2 to Section VII. K = Item code of aircraft. EOH = Number of aircraft. CONSUM = Fuel consumed by mission unit en route to FRRA.
M	IOPR = See FRRA IOPR descriptor A. IUIDMU = IUID of mission unit. RA Time Pointer = Pointer to entry in RADAT and RACAA arrays for this unit. NABP = Number of aircraft being processed at this time. RETX, RETY = Coordinates of location that mission unit is to return to when rearming and returning are complete. RET IOPR = Numerical code indicating the operation that the unit is to engage in when rearming and refueling are complete.
N	FCOMP = Number of inlets remaining to be refueled in the mission unit. ACOMP = Number of aircraft remaining to be rearmed in the mission unit.
O	RRQUE = QI = See descriptor F. RFP = See descriptor F.

Output  
Descriptor

Explanation

RAP = See descriptor F.  
IOPR = See descriptor A, FRRA IOPR.  
TCLOCK = Current game time.  
NTIME = Time mission unit begins waiting in FRRA queue.  
TAV = Time mission unit can begin refueling.  
DELT = Time unit must wait to enter queue.

P

RRQUE =  
RFC = See descriptor E.  
RAC = See descriptor E.  
FRQ = Fuel required by unit.  
CLAS3A = Amount of fuel on hand in unit.  
TIF(QI) = Total inlets to be refueled in this unit.  
RFTPI(QI) = Time required to refuel one inlet in this unit.

Q

MUID = UID of mission unit.  
CUID = UID of FRRA.  
QI = See descriptor F.  
RFC = See descriptor E.  
RAC = See descriptor E.  
RFP = See descriptor F.  
RAP = See descriptor F.

R

NN = List of number of nozzles per refuel device in FRRA.  
IC = List of item codes of refuel devices in FRRA.  
TOTRFP = Total refuel points in FRRA at this time.  
RFC = See descriptor E.  
ACBP = Number of aircraft being processed.  
COPRSRFP = Present refuel capacity of FRRA.

S

IOPR = See descriptor A, FRRA IOPR.  
IDT = Time which will elapse before the next rearm/refuel event for this unit.

14. ROUTINE SIS. A sample of the printed output from routine SIS is presented in Figure IV-15-C-10. Each print group is identified by an alphabetic descriptor and explained below.

Output  
Descriptor

Explanation

A

SIS MSUNT is the IUID of the aircraft. DISTBE is the total distance of the MES and MESEND is the end time of the MES.

B

IADCU is the unit identification index of an air defense-capable unit (ADCU) and ITEM is the item code of the ADCU weapon. QUANT is the amount of this weapon on hand. ADDIST is the distance of this weapon from the aircraft and WEP RNG is the range of this particular weapon.



(A)	SIS MSMT	295			
	DISTBE	2037.20			
	MESEMO	697			
	IADCU	835			
	ITFM	22			
(B)	QUANT	15.000			
	ADDTST	5011.99			
	WEP RMC	2400.00			
	IADCU	835			
	ITFM	70			
	QUANT	2.000			
	ADDTST	5011.99			
	WEP RMC	5500.00			
(C)	6901	4011	4500		
	6902	2.00000			
	6903	2.00000			
	6907	3300			
	6908	.00500	.73200		
	6110	113000.0000			
	91000.0000				
	116500.0000				
	92200.0000				
	110790.5530				
	00070.3640				
	3350.3025				
	1.6490				
	114104.3517				
	91963.9725				
	0.0000				
	.7496				
(D)					
(E)	6130	631	600		
	6150	2			
	8350	631	600		
(F)	TEMP1				
	035	70	631	1	0
	035	70	600	2	0
	0	0	0	0	0
	0	0	0	0	0

Figure IV-15-C-10. Sample Printed Output from Routine SIS  
(Continued on Next Page)

[TEMP]									
(A)	434	74	694	1	0				
	434	74	704	2	0				
	0	0	0	0	0				
	0	0	0	0	0				
(B)	6425	1							
	6430								
	6440								
	6450								
(C)	6460	74	0	0	0	0			
	6470								
	6480								
	6490								
(D)	6500	1	634	704	836	74			
	6510								
	6520								
	6530								
(E)	6540	1	0	0	295	0	0	0	0
	6550				0	0	0	0	0
	6560				0	0	0	0	0
	6570				0	0	0	0	0
(F)	6580	1	0	0	295	0	0	0	0
	6590				0	0	0	0	0
	6600				0	0	0	0	0
	6610				0	0	0	0	0

Figure IV-15-C-10. Sample Printed Output from Routine SIS (Concluded)

Output  
Descriptor

Explanation

- C Following indicator 6901 is the distance of the aircraft from the front of the ADCU unit and the range of this weapon. After indicators 6902 and 6903 the amount of this weapon on hand is printed. Indicator 6907 lists the maximum lock-on boundary of a missile. After indicator 6908 the effective slew rate required to fire at the aircraft and the slew rate of the particular weapon is printed.
- D Format indicator 6110 contains the beginning X and Y coordinates of a MES, the ending X and Y coordinates of a MES, the effective X and Y beginning intercept, the corresponding SEP and THAD values from PONTLN, the effective ending X and Y intercept, and the corresponding SEP and THAD values from PONTLN.
- E Format indicator 6122 shows whether or not the weapon intercept points are beyond the beginning and ending major engagement segment (MES) points. If both values are 1 or both values are 2, the intercepts are both off of the same end of the MES and both coordinates are dropped; however, if the values are not the same, the points straddle the MES and they are retained. The beginning and ending firing times follow format indicator 6123. If the value following format indicator 6150 is greater than zero, the delays are skipped. The effective beginning and ending firing times follow indicator 6350.
- F Array TEMP1 contains the IUID of an ADCU in the first position, the weapon item code in the second, the firing time in the third, and a flag indicating beginning (1) or ending (2) firing time in the fourth position.
- G TEMP1 contains the same values as explained for descriptor F except that the array has been ranked by the firing times.
- H The value following indicator 6625 is a counter in a loop on array TEMP2. Format indicator 6630 is written to show that there were not any values greater than zero in the first position of array TEMP2.
- I Following IREC is the value of the record pointer and the values of array ISREC. Indicator 6460 contains the first two entries in array TEMP2 and the value of ICOUNT. Indicator 6501 is written to show this is a later time event and a check is being made to find the counterpart. The value of K (loop counter), the record pointer, and the array ISREC follow indicator 6640.
- J The values contained in array FILE12 are listed.

Output  
Descriptor

Explanation

K	Indicator 6470 contains the value of a loop counter which compares the contents of array TEMP1 and TEMP2. Indicator 6490 contains the values of TEMP2.
L	The values contained in array FILE12 are listed.
Not Shown	The first intercept time is before the MES start if indicator 6130 is written. The beginning intercept is set to the MES start time. Statement 6130 contains the MES start and end times. Indicator 6140 is the same as 6130 except that the end time was greater than the MES end time. The delay time follows indicator 6151 if it exists. Indicator 6700 contains the MES end time if no intercept segment was found.

15. ROUTINE GTAA:

a. A sample of the printed output from routine GTAA is presented in Figure IV-15-C-11. Each print group is identified by an alphabetical descriptor and explained below.

Output  
Descriptor

Explanation

A	GTAA indicates routine GTAA has been entered.
B	The list following GTAA 8000 contains the X and Y values of the beginning coordinates of a major engagement segment (MES), X and Y ending coordinates of a MES, IOPER, IUID of the mission unit, time of last assessment, record pointer, pointer to weapon array on data file 7, intercept segment start and end time, MES distance, MES elapsed time, beginning X and Y intercept coordinates, ending X and Y intercept coordinates, fraction of time of MES between MES start and intercept start, and the fraction of time of MES between MES start and intercept end.
C	Format indicator 8099 lists the IUIDs of the ADCUs detected.
D	Indicator 8105 contains the fraction of suppression time (FRACSU) and the suppression flag. Following indicator 8150 are the values of the X, Y, and Z coordinates of the mid point of the intercept segment, the distance of the aircraft from the mid point of the intercept segment, distance of the base, the sine of the horizontal angle, the altitude of the ADCU, the slant range, the sine of the vertical angle, the cosine of the horizontal angle, the horizontal slew rate, the vertical slew rate, the distance of the ADCU, the direction of the flight, and the cosine of the vertical angle.



0615	.99000
0615	.98000
0615	.85000
0615	.80000
0615	.60000
0615	.50000
0615	.40000
0615	.30000
0615	.20000
0615	.15000
0615	.10000
0620	10.00000
0650	

72254

(A)

(B)

Figure IV-15-C-11. Sample Printed Output from Routine GTAA (Concluded)

Output  
Descriptor

Explanation

- E Following statement indicator 2234 is an aircraft equipment item code and a listing of array ACDATA.
- F Indicator 8160 contains the loop counter, the ACDATA subscript, amount of aircraft type 1, amount of aircraft type 2, bottom presented area, side presented area, front and rear presented area, presented area for type J, average evasive maneuver turn rate, aircraft type (rotary or fixed wing), and the equipment item code. Indicator 8180 is followed by the roughness and vegetation index, the forestation factor, the target of the vertical angle, the vertical angle, and the fraction of line of sight. 8185 contains the resultant fraction of line of sight.
- G The list following 8200 contains the record pointer, the weapon item code, and the amount of weapons on hand. Following 8220 are the values of the air defense weapon type, the aircraft type, the record pointer, the horizontal slew rate of the weapon, and the vertical slew rate of the weapon. 8230 is followed by the visibility index, the index value, the visibility degradation, the eight variables passed to routine CIRCLE, and the fraction of the ADCU weapons within range.
- H 8240 is followed by the fraction of the unit's fatalities, the fraction of the unit suppressed, the reliability factor, and the array ECMF. 8250 contains the loop counter, weapon flag, and number of weapons on hand at last inventory for this ADCU.
- I The values following format indicator 8601 are the slant range, average miss distance for a missile in mils, equipment item code, amount of equipment type 1, amount of equipment type 2, amount of equipment on hand for this type of aircraft, average miss distance, one sigma error, presented area (1), presented area (2), several intermediate calculations used to find the miss distance, and the miss distance. 8612 contains a record pointer, weapon flag, number of words for a GETWRD, and the maximum miss distance.
- J Format indicator 8615 gives a list of probabilities at equal intervals.
- K The first value following indicator 8620 is the magnitude of the steps in the preceding probability and the second value is the resultant probability. Indicator 8650 contains the amount of the weapon fired and the probability of a kill for a missile array.

b. Additional printed output not present in the example are described below.

(1) Indicator 8103 contains the IUID of the ADCU, the intercept segment start time, the intercept segment end time, start time for the TACAIR/ground-based artillery suppression, and the end time for the same suppression. Indicator 8104 contains the suppression flag followed by the intercept segment start and end times, and the effective artillery suppression times. Indicator 8110 contains intermediate calculations used to determine whether the aircraft is past the no request point. 8111 is followed by the start and end times for an escort suppression and the aircraft type.

(2) Indicator 8125 is followed by the amount of escort aircraft on hand. Indicator 8300 contains the average fire rate without reloading, time to exhaust the magazine capacity, reload delay time, number of reloads, effective firing time, and the number of rounds fired. 8351 lists the amount of ammunition on hand, the number of rounds fired, and the number of rounds fired per aircraft. 8360 lists the slant range, the drag coefficient, the muzzle velocity, the time of flight for the projectile, the directional factor, the striking velocity, and the vulnerable area array.

(3) Format indicator 8400 is followed by the aircraft speed in meters, the target angular rate from the ADCU, the slant range adjusted for use with mils, the average aircraft turn acceleration in meters per second, and the ballistic, aiming, and target maneuver error. 8410 is followed by intermediate calculations used to calculate the total ballistic, aiming, and target maneuver errors for case A (standard deviation in meters squared). Indicators 8420 and 8421 contain the same information for case B. 8430 is for case C and 8440 is for case D. 8500 is followed by the number of weapons on hand for this type, two loop counters, and the amount of aircraft on hand for escorts and for transports. 8501 contains the probability of a hit by one round, the number of weapons on hand, two loop counters, two index values, the vulnerable area, the presented area, the probability of a kill for one round, the number of rounds, the probability of a kill for n rounds, and the probability of the aircraft's survival.

(4) Indicators 9045, 9046, 9047, and 9048 contain the joint suppression interval.

16. ROUTINE LOSSES. A sample of the printed output from this routine is presented in Figure IV-15-C-12. Each print group is identified by an alphabetical descriptor and explained as follows.

<u>Output Descriptor</u>	<u>Explanation</u>
A	Following the format indicator 8701 is the value of the amount of aircraft on hand.
B	The value following format indicator 8703 is the amount of aircraft remaining. Indicator 8706 contains the aircraft item code and the amount of aircraft now on hand.
C	Format indicator 8708 is written for each type of kill (A, B, C, and D). The values written are the loss to missiles, the loss to guns, casualties, aircraft type indicator, and the type of kill.



(A)	[ 6701	1.00000				
(B)	[ 6703	0.00000				
	[ 6706					
	65	0.00000				
(C)	[ 6708	1.00000	0.00000	2.00000	1	1
	[ 6708	1.00000	0.00000	2.00000	1	2
	[ 6708	1.00000	0.00000	2.00000	1	3
	[ 6708	1.00000	0.00000	2.00000	1	4
(D)	END OF GTAA. XACT, YACT= 114920.00 90361.00					

Figure IV-15-C-12. Sample Printed Output from Routine LOSSES

Output  
Descriptor

Explanation

D            XACT and YACT are the unit's location when the unit leaves GTAA on this flight leg.

17. ROUTINE MES. The printed output of routine MES is shown in the example of Figure IV-15-C-13. An alphabetical descriptor identifies each print group which is explained below.

Output  
Descriptor

Explanation

A            The values of array FILE12 as they are passed to routine MES are listed.

B            The first three values are the unit's present location (XACT, YACT, and ZACT). The second three values are the coordinates where the unit is being moved (MEVTX, METVY, MEVTZ).

C            A list of the air defense weapon item codes is given.

D            The values following the statement indicator 6904 are the weapon's night capability code (NITCAP), the weapon's weather capability code (NWECAP), and the weather code for this location. Following statement indicator 6905 are the weapon's maximum and minimum altitude and the altitude of the aircraft. Following statement indicator 6906 are the maximum and minimum speed of the weapon and the airspeed of the aircraft.

E            This is a list of the air defense weapon item codes that are capable of intercepting the aircraft. Following is a list of the ranges of the corresponding air defense weapons.

F            DELF is the accumulated distance flown. RLOOK is the radius of the search area at this look point. Following NEW COORDS is the unit's actual location for this look point (XA, YA, and ZA).

G            Following UNIT is the IUID of the air defense capability unit (ADCU). DIST1 is the distance of the ADCU from the aircraft and JSWCH is the status of the flight leg.

H            I3 is the number of units in LIST3 and I4 is the number of units in LIST4. LIST3 and LIST4 contain IUIDs of ADCUs.

I            IOPER is the event code of the automatic event created in MES.



APPENDIX D

SOURCE LISTINGS FOR PERIOD PROCESSOR AIRMOBILE MODEL

(AVAILABLE UNDER SEPARATE COVER)

IV-15-D-1

## APPENDIX E

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CHAPTER 16

COMBAT SERVICE SUPPORT MODEL

1. MILITARY ACTIONS REPRESENTED:

a. General. Personnel, major end items, and combat essential material must be replaced within a military unit when required. If the unit does not have a ready source of personnel and materiel, the capability of the unit to accomplish its mission is severely limited. The DIWAG Combat Service Support (CSS) Model simulates personnel replacement, resupply of critical consumables and expendables, and resupply of major end items. The model does not simulate resupply of repair parts. The resupply or replacement process is treated in three essential areas; requesting, distributing, and receiving supplies. These aspects of resupply are simulated differently for critical consumables and expendables (classes III and V) and for personnel, class I, and major end items.

b. Resupply of Critical Consumables and Expendables:

(1) Requesting. The process of requesting or ordering supplies requires the determination of the quantity to request, when to request, and the priority of the request.

(a) The quantity to request is based on a critical level check. If the amount authorized of an item is less than this critical quantity, resupply request is initiated.

(b) The priority of a request is dictated by the mission of the using unit. Within the model, highest priority is assigned to resupply of the front-line maneuver units. Second highest priority is assigned to all other maneuver units and all artillery units. Third priority is to resupply points used for (1) and (2). The lowest priority is assigned to other units not included in the first three priorities.

(2) Distribution of Supplies. In treating supply distribution, the distribution method or policy, routing, and treatment of materiel upon receipt must be considered.

(a) Method of Distribution. The Army supply system utilizes two methods of distribution; unit distribution and supply point distribution. Unit distribution refers to the delivery of supplies from the supplying activity to the consuming unit, and supply point distribution requires the consuming unit to pick up

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supplies from the supplying activity using its own personnel and vehicles. Both methods of distribution are treated in the Combat Service Support Model. If one method of distribution is impossible because of lack of sufficient transportation means, the model automatically attempts to effect the supply action using the other method of distribution.

1. In unit distribution all supplies requested are transported to the requesting unit on vehicles provided by the supplying unit. If there are not enough available supplies, the unfilled portion of the order remains due until they become available. The order and shipping times for unit distribution include the times required to place and fill the order, load the vehicles, transport the supplies, and unload them and make the supplies available to the using unit.

2. In supply point distribution the unit needing supplies must provide its vehicles and send them to the supply point. Order and shipping times in supply point distribution include the times required to move the vehicles to the supply point, load the supplies, and return to the unit.

3. The model attempts to airlift supplies if sufficient ground transportation is not available and aircraft are available at the supply unit.

4. If a unit is involved in an airmobile operation, it is not resupplied until the airlift has been completed. If the unit is airlifted into hostile territory, resupply is effected only through airlift operations; otherwise, resupply is handled in the same manner as described above.

(b) Routing. Materiel can pass through a number of intermediate holding or handling points as it progresses from an original source of supply to the ultimate user. Within the model intermediate and initial supply points are treated. Intermediate supply points function similarly to the ultimate using unit insofar as the process of obtaining supplies is concerned; an intermediate supply point has a point of supply identified from which it can obtain the required items by unit or supply point distribution, based on its critical supply level for the item. An intermediate supply point may temporarily run out of supplies if the demand exceeds its on-hand stocks and resupply capability. Initial supply points are treated within the model as being unlimited sources of supply. The routing of supplies to a using unit through intermediate supply points or directly from an initial supply point is established as part of the force's task organization through gamer input.



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(c) Treatment Upon Receipt. Upon receipt of supplies, the using unit generally holds the supplies in bulk until such time as it is necessary or convenient to distribute them to the ultimate user. For example, bulk ammunition can be held in the combat trains of a maneuver unit for some period of time until its distribution among the weapons systems that fire the ammunition can be effected. Within the model, every unit which receives supplies is treated as having a holding point for bulk supplies, nominally the unit combat trains. Supplies are delivered to the trains and transferred from trains to the unit's using entities on a periodic basis. As currently programmed this process is accomplished once every 2 hours. Artillery and air units may receive quantities in bulk whenever needed on an emergency resupply basis; such resupply is handled within the Area Fire and Air Ground Models.

(d) Materiel Flow. Figure IV-16-1 illustrates the basic flow of materiel from an initial supplier, to the nominal trains of an intermediate supplier, to the intermediate supplier's using (in this case shipping) entities in the using unit. Zero, one, or more than one intermediate suppliers may be involved. The figure also illustrates the basic flow of personnel, major end items, and class I consumables in which all nominal trains are bypassed.

c. Resupply of Personnel, Major End Items, and Class I:

(1) Resupply of Major End Items:

(a) To accomplish the resupply of major end items, the pregame data load specifies by item code which items active in the game are treated as major end items, the amount of each item available for replacement during each 24-hour increment, and if separate transport is required, the equipment item to transport each item to be replaced.

(b) To establish the quantity of items available for resupply, a multiple class supply point which controls receipt and issue of major items is established within the model. This point contains all items available for resupply where the amount available on a given day is the accumulation of amounts specified by input for that and all previous days, less the amount that has actually been sent to using units. The basic assumption is that limited stocks are available in division maintenance floats and rear service areas. Initial stocks and daily replenishment quantities can be specified in the constant data input.

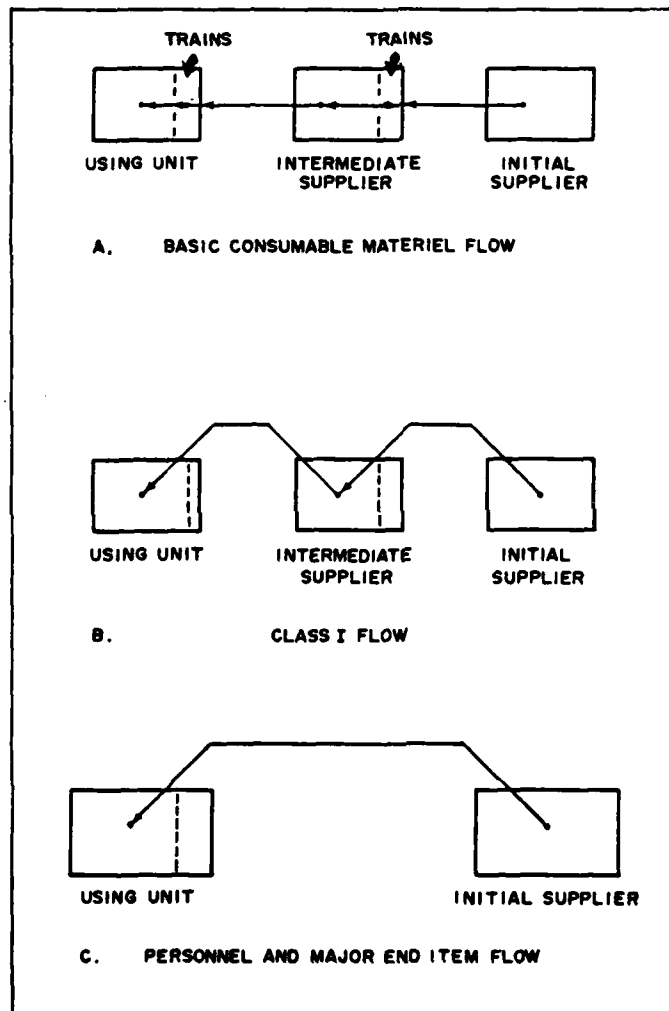


Figure IV-16-1. Flow of Resupply Actions in Combat Service Support Model

(c) To determine units receiving major items, a type of daily loss report which serves as a requisition is developed for each unit active in the game. Units are resupplied within three groups with first priority to front-line maneuver units, second priority to other maneuver units and artillery units, and third priority to all other units. If insufficient items are available to meet all requirements within a priority group, available items are prorated according to needs. For example, if unit A requires 10 items and unit B requires 20 items and only 15 are available, unit A will receive 5 items and unit B will receive 10 items. An item will move from the supply point to the receiving unit at the road movement rate of the item, if self-transportable, or of the transporter, if not self-transportable.

(2) Resupply of Class I:

(a) Class I supplies are items consumed at a uniform and predictable rate, irrespective of combat or terrain conditions, and require no adaptation to individual requirements (FM 17-1, Reference 1). Within the model class I supplies consist of rations. In the division, a formal requisition for class I supplies is not required. The division supply and transport battalion requests rations for the division, based on estimated strength figures provided by the adjutant general, 72 hours before the time rations are to be delivered. Upon receipt, rations are broken down into battalion and separate unit lots based on personnel daily summaries submitted by each unit. In rapidly changing situations, it may be necessary for units to submit daily informal requisitions for the number of rations required. These requisitions compensate for cross attachments and casualties.

(b) In the model class I is resupplied daily. It is assumed that units submit daily informal requests for number of rations required. Requisitions compensate for cross attachments and casualties. The resupply level of a unit is based on the number of personnel attached to the unit at the time resupply is to occur. This time is fixed within the model. Once the number of personnel in a unit is determined, the resupply quantity is calculated on a pounds-per-man-per-day basis. The class I consumables are delivered directly to the using units.

(c) The main purpose for modeling class I resupply is to constrain the transportation available to resupply other commodities, primarily ammunition and fuel. It is assumed that battalions and separate units use organic transportation to pick up rations at the division class I distribution point in the brigade trains area. If all food ordered cannot be delivered at the first attempt, the unfilled orders remain, due to be filled. At each succeeding update attempts are again made to fill the remaining class I orders. No new class I orders are generated for 24 hours, but the unfilled orders are retained until filled. Unlike class I, all other consumables that cannot be delivered as scheduled have new backorders created at each update.

(3) Personnel Replacement:

(a) All requested personnel replacements received by the division are processed by the replacement detachment, which is under the control and supervision of the adjutant general. The normal capacity of the detachment is 300 replacements at one time and can be increased if additional control personnel and equipment are provided.

(b) Replacements are assigned to the division on the basis of daily replacement status reports submitted to higher headquarters by the division adjutant general. These reports are based upon TOE position vacancies as shown in unit morning reports. Replacements are provided from personnel arriving from the zone of interior, hospital returnees, personnel being rotated from other areas, and casualties being returned to duty from various sources. Replacements, even in combat, are obtained through formal requisitioning procedures. Replacement personnel are requisitioned to replace actual losses in TOE positions only. Replacements cannot be requisitioned for a unit in advance of its needs.

(c) Personnel requisitions are modeled as follows:

1. Company commanders do not requisition personnel replacements; however, they do submit morning reports or feeder morning reports, showing company personnel losses, through battalion to division. The company commanders receive, orient, and assign personnel replacements upon arrival at the company.

2. The battalion S1 does not requisition personnel replacements. He monitors the morning reports or feeder morning reports of the subordinate units to ascertain that the units have included known losses on the reports.

3. Upon notification that personnel replacements are available, the battalion S1 coordinates directly with the S3 and appropriate special Staff Officers to determine battalion priorities and then informs the division AG of the priority of assignment to the companies. The AG publishes division special orders assigning the individual to his company directly from the division replacement company.

(d) Within the model personnel replacement occurs once each day at a predetermined hour. Time of replacement is fixed in the model. The number of personnel replaced is based on two factors, type of unit and current strength of a unit. Data are input to specify number of replacement personnel available during each 24 hours of game play. If sufficient personnel are not available to bring all units up to their authorized levels, the priority of replacement is front-line maneuver units, artillery and other maneuver units, and all other units. Within priority groups, available replacements are evenly prorated according to a unit's losses. Personnel are resupplied directly to the using unit. Within the model, no attempt is made to replace personnel by grade or military occupation specialty.

(e) Replacement of personnel follows the logic developed for resupply of principal items. Personnel are only requested once per day based on combat losses.

## 2. MODEL DESIGN:

a. Model Logic. The basic logical flow of the Combat Service Support Model is shown in Figure IV-16-2. The sequence of processing groups of units shown in the figure imposes a priority on the units to be serviced. In resupplying critical consumables and expendables, transportation resources available to both the supplying and receiving units are used in allocating transport. Thus, by the time the second and third groups of units are processed, transportation organic to the supply point may have already been allocated to service higher priority units. In the case of personnel and major end items only a limited number of replacements is available. Resources are allocated with first priority to front-line maneuver units, second priority to other maneuver units and artillery units, and third priority to all remaining units. The dynamic data files and the significant model steps used in the model logic are identified below and discussed in detail in paragraph 3.

b. Dynamic Data Files. The Combat Service Support Model uses four dynamic data files: the unit status file, the supply action file, the supply status file, and the backorder file.

(1) The unit status file contains information on the current status of each unit involved in the game, updated as a result of any simulated activity involving the unit. It contains the quantities of equipment currently on hand in each unit and points to the unit's records on the supply status file.

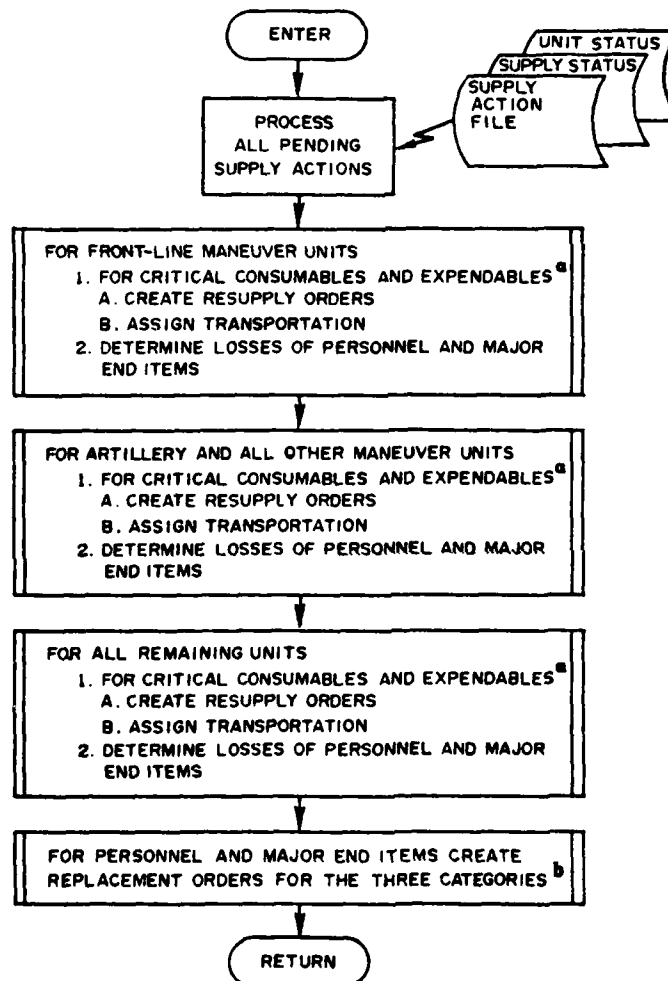
(2) The supply status file contains information pertaining to the current supply status of a unit. For every resolution unit in the game, one record is maintained on this file for each equipment item that may be supplied to the unit. (See Chapter 3 of this section for a discussion of resolution units.)

(3) The supply action file contains a record for every supply action currently in process. A supply action is the movement of an equipment item order quantity with its associated transportation resources from the supply point to the unit or the movement of the transportation resources alone from the unit to the supply point. These records are updated as the order quantity and transporting vehicles progress between supply points and receiving units.

(4) The backorder file maintains a record of each supply requirement for which a supply action must be initiated.

c. Model Steps. As shown in Figure IV-16-2, the major Combat Service Support Model steps are: (1) updating supply action file entries, (2) creating resupply orders and assigning transportation to fill the resupply orders for

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a. See Figure IV-16-3

Figure IV-16-2. Combat Service Support Model

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critical consumables and expendables, (3) determining losses of personnel and major end items, and (4) creating replacement orders for personnel and major end items. The model is generally entered on a periodic basis (currently once every 2 hours in the DIVWAG system), and all pending supply actions are processed. Next, for each force steps 2 and 3 are accomplished sequentially for each of three groups of units; front-line maneuver units, other maneuver units and all artillery units, and all other units. This sequence of unit groups imposes a first priority level on the assignment of transportation. Finally, after steps 2 and 3 are completed for all units, personnel and major end items replacement orders are created sequentially for the three unit groups.

### 3. SUBMODEL SPECIFICATIONS:

#### a. Processing of Critical Consumables and Expendables:

##### (1) General:

(a) Figure IV-16-3 shows the processing logic which occurs within a group of units to resupply critical consumables and expendables. Since major end items and personnel are resupplied only once a day, a check has been incorporated to determine on which processing cycle their resupply is to be initiated. At the appropriate time, losses of major end items and personnel are accumulated for each unit. The actual requisitioning of major end items and personnel does not occur during the first pass through the units (see paragraph b below).

(b) Since class I (food) is to be ordered only once a day, a check has been entered to determine when that time occurs. Only at the specified time is class I ordered. The quantity ordered is based on the personnel strength of the unit at the time the order is initiated.

(c) The flow of logic illustrated in Figure IV-16-3 may be broken into three logical processes: the determination of supply requirements, the allocation of available transportation means to meet supply requirements, and the supply actions involved in actually fulfilling supply requirements utilizing the allocated transportation. Details of these processes are contained in the following subparagraphs.

(2) Determination of Supply Requirements. The method used within DIVWAG is to check if the items have fallen below a "critical" level (currently set at 50% of the authorized amount).

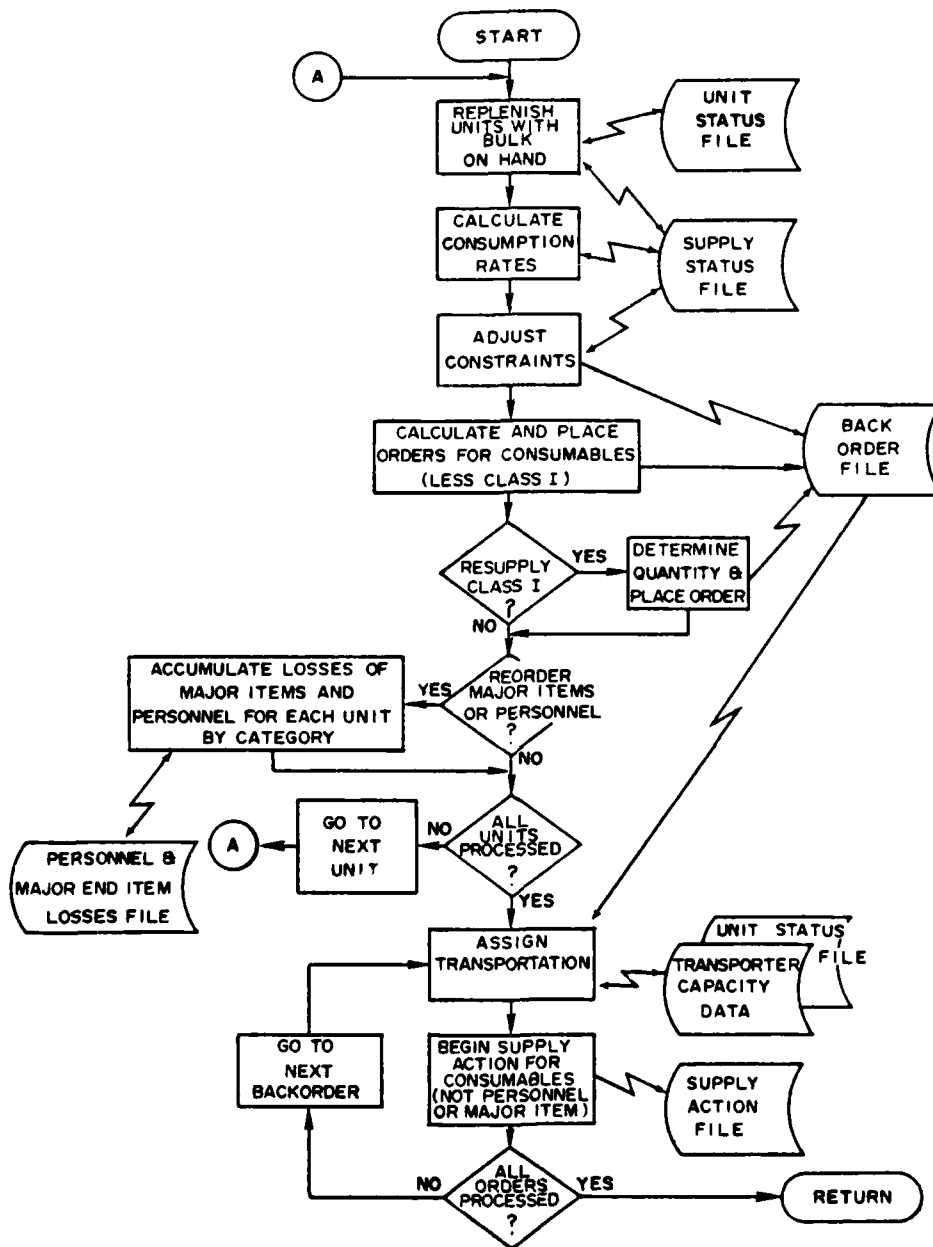


Figure IV-16-3. Processing of Critical Consumables and Expendables



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IV-16-11

review period, the projected usage rate,  $\bar{r}$ , and the mean average deviation,  $s$ , of that usage rate are calculated based on the exponential averaging technique of FM 38-22 (Reference 2). These values are combined to develop an accelerated usage rate,  $r_q$ , which should not be exceeded in nine cases out of ten, under the assumption that the usage rate of the items involved follows a normal distribution. In the figure,  $\bar{r}$ , for a given review cycle, is the negative slope of the current supply level line, and  $r_q$  is the negative slope of the projected supply level line. Next, the delivery lead time (DLT), or the amount of time in which this unit could expect delivery of supplies, is found; and the projected supply level at current time plus DLT is calculated using the accelerated usage rate and compensating for any supplies already on order. If this projected level is negative, a supply order is placed. The amount ordered is the difference between authorized and projected levels (where this projected level uses the nonaccelerated projection rate), compensating again for items already ordered. During this process, stocks are transferred, within the unit, from a bulk loaded status to a readily usable status; and a constraint factor, reflecting the emergency of the order, is calculated for later use in assigning a priority to the order.

(b) Calculation of Usage Rates:

1. In calculating usage rates, the model uses the amount of the item currently in a readily usable status,  $e_r$ , currently on hand but bulk loaded,  $e_t$ , and the amounts authorized in these categories,  $a_r$  and  $a_t$ . The projected usage rate is calculated:

$$\bar{r}_1 = A \cdot \bar{r}_{1-1} + B \cdot r \quad (\text{IV-16-1})$$

where:

- $\bar{r}_1$  = projected usage rate for this review period
- $\bar{r}_{1-1}$  = projected usage rate for the previous period
- $A = 0.75 [1 - \exp - (h/12)]$
- $B = 1 - A$
- $r = [(a_r - e_r) + TR] / t_r$
- $h$  = number of hours into the game
- $t_r$  = review period (120 minutes)
- $TR$  = amount shifted from  $e_t$  to  $e_r$  during the review cycle in response to emergency requests.

This is a variation of the basic exponential smoothing equation, in which A and B are constants. As originally designed, the values of A and B were 0.75 and 0.25, respectively. These are arbitrarily chosen smoothing constants intended to give a fairly gradual transition from past to current history. They are subject to adjustment. The correction factor to A is used to dampen the effects of the start of game situation in which no prior usage rate is available. The value of r is used to represent the usage rate since the last review cycle. After r has been computed, the amount of items available for use,  $e_r$ , is brought up to its authorized level,  $a_r$ , or as close thereto as stocks in bulk,  $e_t$ , permit. The equations used are:

$$e_r' = e_r + \min [(a_r - e_r), e_t] \quad (\text{IV-16-2a})$$

$$e_t' = e_t - \min [(a_r - e_r), e_t] \quad (\text{IV-16-2b})$$

where the prime (') denotes the value after adjustment. It should be noted that r is the true usage rate only if  $e_r$  was at its authorized level at the beginning of the review cycle. In other cases, it indicates a serious deficit which will tend to increase over time, thus inflating  $\bar{r}$  and driving the model to a more immediate supply order action.

2. The mean average deviation of the projected usage rate is calculated using the same exponential smoothing weights:

$$s_1 = A s_{1-1} + B \cdot |r - \bar{r}_{1-1}| \quad (\text{IV-16-3})$$

where:

$$s_1 = \text{mean average deviation of } \bar{r}_1$$

$$s_{1-1} = \text{mean average deviation of } \bar{r}_{1-1}$$

and other variables are previously defined.

3. The accelerated usage rate,  $r_q$ , is calculated as:

$$r_q = \bar{r}_1 + (1.3 \cdot 1.25 \cdot s_1) \quad (\text{IV-16-4})$$

where the constant 1.3 is used to give the approximate ninetieth percentile of a normal distribution, and 1.25 is the conversion factor from the mean average deviation to the standard deviation as provided in FM 38-22, Reference 2.

(c) Projected Outage. The projected outage situation, using the accelerated usage rate, is determined:

$$Q = e_r + e_t + e_o - r_q \cdot d \quad (\text{IV-16-5})$$

where:

$Q$  = outage indicator

$e_o$  = amount of the item currently on order and in the process of being delivered

$d$  = delivery lead time

$e_r, e_t, r_q$  = previously defined.

The amount currently in the process of being shipped is determined by a review of all pending supply action file records for which the unit involved is the recipient. This file is described in more detail in subparagraph (4) below. The delivery delay time,  $d$ , is determined by:

$$d = h_d (t_{\text{tran}} + t_{\text{OH}}) \quad (\text{IV-16-6})$$

where:

$d$  = delivery lead time

$h_d$  = 1 if the unit receives unit distribution of the item

$h_d$  = 2 if the unit receives the item by supply point distribution

$t_{\text{tran}}$  = nominal transport time

$t_{\text{OH}}$  = overhead time.

Nominal transport time for this item is determined considering the distance between the unit and its supplier and the preferred transport vehicle. The supplier is identified as part of the original game task organization input. The preferred transport vehicle for this item and this distribution method is part of the Combat Service Support Model data base, required as input prior to game initiation. The model obtains (within Movement Model constant data) the limiting road speeds of the preferred vehicle, under current weather and light conditions; averages the speeds, which are given for two terrain

conditions; and applies this average speed to the distance between supplier and supplier to develop a nominal transport time. Overhead time, also part of the game data base, is intended to represent normal lumped overhead for filling an order, loading and offloading vehicles, and any other actions, exclusive of travel time, associated with a request for this item. If the value of  $Q$  in Equation 9-5 is negative; i.e., projected usage within delivery lead time exceeds stocks on hand and on order, a new order is generated. If an outage is projected, the amount ordered is calculated by Equation 9-7:

$$a_o = a_r + a_t - [e_r + e_t + e_o - \bar{r}_i d] \quad (10-16-9-7)$$

where  $a_o$  = amount of order, and the other variables are previously defined. The quantity in brackets in Equation 9-7 is identical to the calculation of  $Q$  in Equation 9-5, with the projected usage rate substituted for the accelerated rate. In both cases, this is the projected level of supply of the unit just prior to receipt of supplies if ordered at this time under the appropriate use rates. The difference between these levels is the variable safety level of the logistic model, a function of the mean average deviation of the projected usage level and the delivery lead time:

$$SL = d(r_q - \bar{r}_i) = d \cdot 1.625 s_i \quad (10-16-9-8)$$

SL = safety level.

(d) Constraint Factor. Once a supply order is generated, it must compete with other orders for available transportation means. To allow assignment of priorities among supply orders, a constraint factor is computed for each item at each review period:

$$c_i = c_{i-1} \cdot \exp(1 - \bar{r}_i/m) \quad (10-16-9-9)$$

where:

$c_i$  = constraint factor for current review cycle

$c_{i-1}$  = constraint factor of last review cycle

$\bar{r}_i$  = current projected usage rate of Equation 9-1

$m$  = minimum rate (Equation 9-10).

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The constraint factor is set at 0.2 for first line units, 0.3 for artillery and other maneuver units, 0.4 for intermediate supply points, and 0.6 for all other units.

(3) Assignment of Transportation. Once the supply status of all units within a group of units has been reviewed and any necessary supply orders generated, transportation is assigned to meet the supply requirements. Each supply order generated by the group of units is processed based on the priority of the order; i.e., the order with the lowest constraint factor, then the order with the next lowest constraint factor, and so on. As currently designed, no attempt is made to allocate transportation from the total force resources. Rather, for each supply order, only transportation organic to the requesting unit and the designated point of supply is considered.

(a) Logical Flow. The logical flow of the transportation assignment algorithm is shown in Figure IV-16-5. For each unit type and each item to be resupplied, a standing operating procedure (SOP) distribution method is defined in the data base (unit or supply point distribution). Each item also has an associated supply class. Three preferred vehicles are designated for each distribution method as well as for air transport. Upon entry to the algorithm, the SOP distribution method is first attempted. The preferred vehicles are taken in order and assigned to transport the quantity ordered (fractional vehicles are used). If sufficient numbers of the first choice vehicle are available in the requesting (supply point distribution) or supplying (unit distribution) unit, processing is completed. If sufficient vehicles are not available, all available vehicles are assigned and the process is repeated for the remaining order quantity using the second choice vehicle. If the order is still unfilled, available third choice vehicles are assigned. Once all available vehicles under the preferred distribution method have been assigned, the same process may be repeated for the preferred vehicles available in the other unit, under the remaining distribution method, always working on the unfilled portion of the order. If the order remains unfilled under both ground distribution methods, a third cycle may be tried, attempting to use air transport. The decision to attempt the alternative ground transportation method and air transportation is based on the constraint factor,  $c_1$  (priority), of the item.

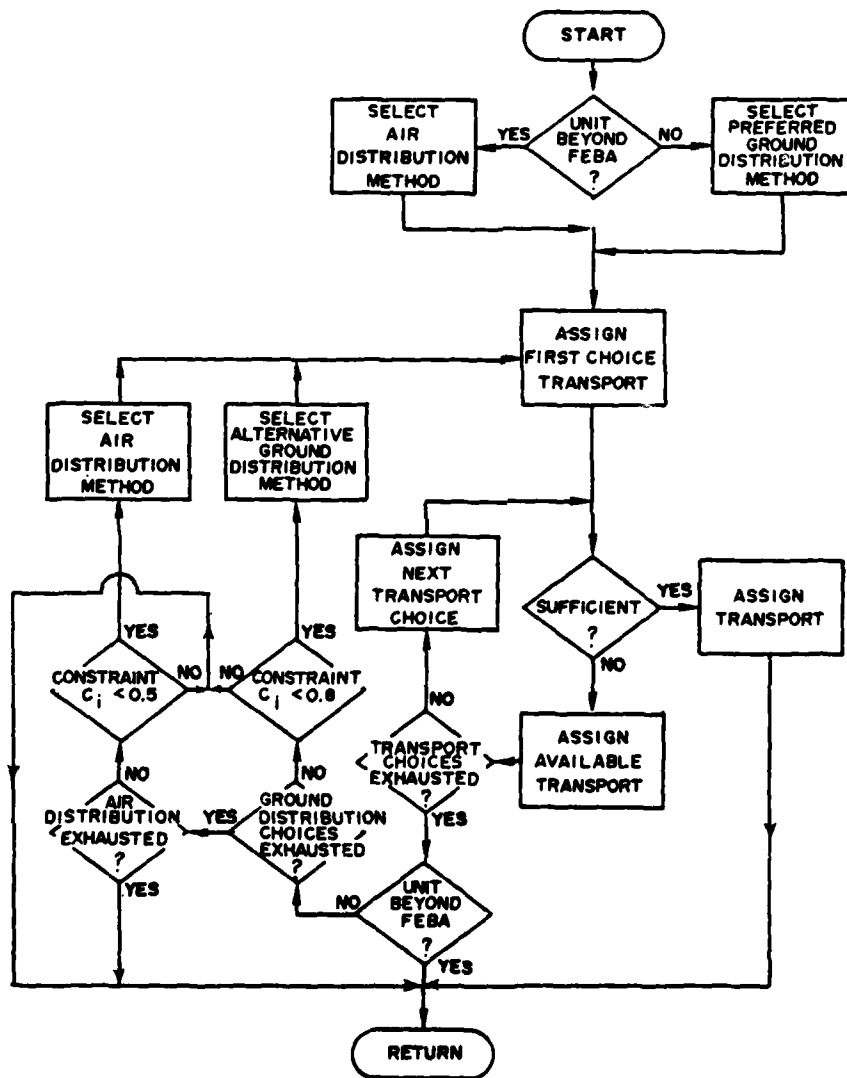


Figure IV-16-5. Transport Assignment Algorithm

As currently programmed, the second ground distribution method is attempted if  $c_1$  is less than 0.8, and air transport is attempted if  $c_1$  is less than 0.5. These values are judgmentally set.

(b) Essential Calculations:

1. General. The transportation algorithm is essentially a logical check and decision process with minimal calculation involved. The necessary calculations are those used to determine the extent to which available transportation can move the requested amount of supplies. This is accomplished by comparing the weight and volume of the order to weight and volume capacities of the available transport vehicles and either assigning as much of the available capacity as is required to carry the full order or assigning the total available transport capacity to carry as much of the order as is possible. Within the process, a check is also made to verify that the supply point under unit distribution has sufficient stocks to fill the order. If not, all available stocks are used.

2. Weights and Volumes. The weight and volume of the order quantity are calculated by multiplying the order quantity by unit bulk weights and volumes contained in the constant data base. Similarly, weight and volume transport capacities are calculated by multiplying the number of currently available (within the requesting unit for supply point distribution or at the supply point for unit distribution) vehicles by the bulk weight and volume capacities per vehicle, also in the constant data base. If the weight and volume capacities of available transport equal or exceed the weight and volume of the order, the order can be transported, and a percentage of the available transport vehicles is assigned:

$$v_t = v_a \cdot p_t = v_a \cdot \max(p_{wt}, p_{vt}) \quad (\text{IV-16-11})$$

where:

$v_t$  = number of vehicles assigned to the order

$v_a$  = number of vehicles available in the unit

$p_t$  =  $\max(p_{wt}, p_{vt})$ , the percentage of transport capacity assigned for the order

$p_{wt}$  = ratio of weight of the order to weight transport capacity

$p_{vt}$  = ratio of volume of the order to volume of the transport capacity.



If the weight or volume transport capacity is exceeded by the weight or volume of the order, all available vehicles are assigned, and a percentage of the order is filled as calculated by:

$$c_f = c_o \cdot p_c = c_o \cdot \min(p_{wc}, p_{vc}) \quad (\text{IV-16-12})$$

where:

- $c_f$  = amount of the ordered item to be transported by the assigned vehicles
- $c_o$  = amount of the order outstanding up to this assignment of vehicles
- $p_c$  =  $\min(p_{wc}, p_{vc})$ , the percent of the order to be filled
- $p_{wc}$  = ratio of available transport weight capacity to weight of outstanding amount of order
- $p_{vc}$  = ratio of available transport volume capacity to volume of outstanding amount of order.

As an order, or part of an order is filled, records on the supply action file (discussed in subparagraph (4) below) are generated, and the assigned vehicles are removed from the unit status file of the unit providing them, thus becoming unavailable for assignment until the supply action is completed. If unit distribution is involved, the amount of materiel shipped is removed from the status file of the supply point. If this should exceed stocks on hand at the supply point, only the amount on hand is shipped; and the amount of transport involved is adjusted accordingly.

(4) Supply Actions. The supply action file is used to keep track of the status of all supply actions. As transport capacity is assigned to an order, two entries (records) are initialized on this file; one to keep track of the vehicles and one to keep track of the materiel (or personnel) being transported. Each record on the supply action file contains six essential values:

- $t_e$ , game time that the record is due to be updated
- $u_1$ , identification of the unit generating the order
- $u_2$ , identification of the unit filling the order
- $i$ , equipment item code, identifying the item involved in the action (vehicle or consumable)

- .  $n_i$ , quantity of item  $i$  involved in the action
- .  $s$ , status flag for the supply action.

At the beginning of each Combat Service Support Model review cycle, all existing records on the file are updated. The actions taken in initiating and updating these records depend upon whether unit distribution or supply point distribution is involved and are explained below.

(a) Unit Distribution Supply Actions:

1. Initiation. To initiate a unit distribution supply action record, the unit identifications  $u_1$  and  $u_2$ ; equipment item code,  $i$ ; and quantity of item,  $n_i$ ; are set. The quantity involved is that established by the transportation assignment algorithm discussed in subparagraph (3) above. As discussed in subparagraph (3) above, these quantities are subtracted from the unit status file of the providing unit. (For an initial supply point, the quantity of materiel or personnel is actually added to the supply point unit status file. Thus, no limits on flow of supplies into the force are simulated, and this unit maintains a count of materiel and personnel entered into the force simulated from external sources.) The time that the record is due to be updated,  $t_e$ , is calculated by adding transit time for the vehicle involved to the current game time. Transit time is calculated based on the distance between units and the mobility characteristics of the vehicle as described in subparagraph (2) above. Briefly, it assumes the average (over terrain types) limiting vehicle speed under prevailing light and weather conditions and a straight line route between units. The action status flag is set to 1, indicating the update action to be taken at time,  $t_e$ , is that for arrival of unit distribution at the receiving unit.

2. Arrival at Receiving Unit. When a time,  $t_e$ , less than or equal to current game time is sensed during the update cycle and an action status flag of 1 is found, the arrival at the receiving unit is treated. The action file record containing materiel is closed after the item quantity,  $n_i$ , is added to the unit's amount of the item on hand in bulk. The action file record containing vehicles is updated by adding transit time and bulk overhead time for unit distribution to  $t_e$  and setting the action status flag to 3, indicating the time at which vehicles will be returned to the supply point after offloading and the return trip.

3. Return to Supply Point. When scheduled action time,  $t_e$ , is exceeded by current review time, and an action status flag of 3 is found, the vehicles are returned to the status file of the supply point, becoming available for reassignment; and the supply action record is removed.

(b) Supply Point Distribution Actions:

1. Initiation. Supply point distribution action records are initiated similarly to unit distribution records. For each action, two records are initiated; one for the vehicles and one for the materiel (or personnel). The appropriate unit identifications, equipment item code, equipment quantity, and times are set. In this case, no check is made of the amount of materiel available at the supply point. The number of vehicles is subtracted from the unit status file of the providing unit, in this case the unit initiating the requirement. The action status flag is set to 2, indicating the arrival at the supply point as the next event.

2. Arrival at Supply Point. When  $t_e$  is exceeded by review time and an action flag of 2 is found, actions upon arrival at the supply point are treated by updating the supply action record. The transit time and bulk overhead time for loading are added to  $t_e$  to obtain the new event time. Both records are turned around by inserting the new event time and an action flag of 4. Additionally, the quantity of materiel to be returned to the requesting unit is subtracted from the unit status file of the supply point. If the supply point has insufficient stocks, all available stocks are taken, and the quantity on the materiel action record is reduced accordingly. (As discussed in subparagraph (a) above, there is no limit on initial supply points, and quantities are added to unit status files.)

3. Return to Requesting Unit. When  $t_e$  is exceeded by game time, and the action status flag is 4, the return trip to the requesting unit is complete. Quantities of vehicles are returned to the unit status file becoming available for reassignment; quantities of materiel received are added to the units' on hand bulk quantities; and the supply action records are removed.

b. Processing of Personnel and Major End Items:

(1) The processing which occurs in determining the quantities of major end items and personnel to be supplied to the various units is displayed in Figure IV-16-6. The flow can be broken into two logical processes: determination of replacement quantities and creation of supply actions.

(2) As losses of personnel and major end items are calculated for each unit, they are accumulated for each unit group. The available resources are first compared with the requirements of the front-line maneuver units. If available resources are sufficient to meet their requirements, then the front-line units are allotted enough replacements to satisfy their needs. All artillery units and any other maneuver units are then examined. If their requirements can also be met, then all remaining units are examined.

(a) When sufficient quantities of a major end item or personnel are not available to satisfy the total requirements of a unit group, the quantity available is prorated to the units based on the units' losses. As

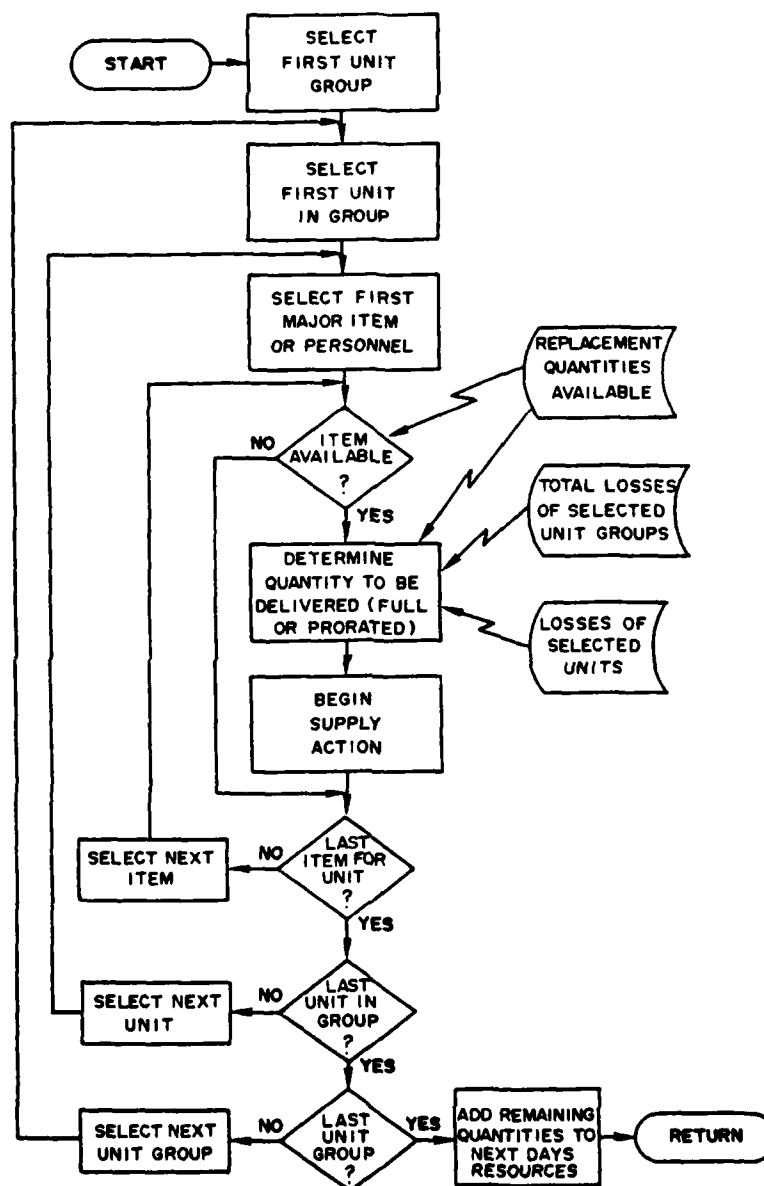


Figure IV-16-6. Processing of Major End Items and Personnel

an example, if 10 tanks are available for resupply but a need exists for 20 (6 to one unit and 14 to a second unit), then the first unit would receive three and the second unit would receive seven. If after the front line maneuver units' requirements are met, no resources are available, the remaining unit groups are not allocated replenishment or replacements. Similarly, if the second unit group's requirements cannot be met, then the third unit does not receive replenishment or replacements.

(b) The number of personnel and quantity of major end items of equipment that will be available to the division for resupply on each day of combat are specified pregame for each major end item. Items not used on a given day are added to the next day's available quantity.

(3) Supply Actions. The supply action file is used to maintain the status of all supply actions. As personnel and major end items are allocated, an entry (record) is initialized on this file. Six essential values are contained on the supply action file record. These values were delineated in subparagraph a(4) above. The status flag for this action is set equal to 5. The time that the record is due to be updated is set equal to current time plus the time required for the item or its transporter to travel from the division rear services area to the receiving unit. The rate of movement is the road movement rate of the major end item if it is self-propelled; otherwise, the rate is that of the transporter. When the replacements reach the receiving unit, they are immediately added to the unit's status file.

4. HISTORY TAPE OUTPUT. The Combat Service Support Model writes the following event records onto the period history tape.

<u>Record Type</u>	<u>Title</u>	<u>Frequency</u>
511	Backorder Event	One record for each backorder processed.
521	Supply Action Event	One record for each supply action processed.

The detailed description of the record formats is presented in paragraph 2c of Appendix A to Chapter 1 of Section VI.

## APPENDIX A

### COMBAT SERVICE SUPPORT MODEL INPUT REQUIREMENTS

1. INTRODUCTION. The Combat Service Support Model simulates all resupply and replacement functions except the rearming and refueling of Blue army aircraft performing airmobile operations. The Airmobile Model simulates these aspects of combat service support. Subsistence, fuel, barrier materials, ammunitions, and major end items are the major classes of supply (I, III, IV, V, and VII, respectively) of which replacement is simulated by the DIVWAG system. Data loaded for TOE load, movement, task organization, terrain, weather, and other operations are also used by Combat Service Support; thus, there is a relationship between the Combat Service Support Model and the constant data inputs of the other models. This appendix provides the instructions needed for completing data entries for constant data input to the Combat Service Support Model. Subsequent paragraphs detail the information necessary to complete the forms used to enter data in the desired format.

a. Supply. The Combat Service Support Model uses the supply organization specified for each force by pregame input as described in Chapter 3 of this section, which also describes how consumable supplies are loaded for each unit. Those instructions cover both supplies carried by the individual men, weapons, and vehicles of the unit and bulk quantities of supplies carried by vehicles of the unit's trains. The Combat Service Support Model monitors the level of supplies within units and replaces supplies as consumption and combat losses occur.

b. Data Requirements. The Combat Service Support Model simulates the replacement of personnel, replenishment of expendable and consumable supplies, and resupply of major end items of equipment. The data requirements are those associated with the transport needed to move the supplies; the physical dimensions of the consumable and major equipment items; the preferred means of transport; and, if there are alternatives, the ranking of the transport alternatives. All the data requirements for this model are not satisfied by the CSS load program. Data must be obtained from the unit status file to determine how many vehicles are available to move supplies. If some were lost, it requires a longer period of time to transport the same load since many more round trips are required. If other supply-consuming equipments were also destroyed, and hostile forces reduced the combat effectiveness of several units, there would be a lesser demand for supplies. These considerations, plus other logistical support factors, are included in the model.

c. Data Base. The constant data input for the Combat Service Support Model is loaded into data file 11 and is accessed by the model as needed dynamically during the course of the war game. Figure IV-16-A-1, Combat Service Support Data Base, illustrates the configuration of the data base. Four different card formats are used for entering data into data file 11, which is directly concerned with the Combat Service Support Model's constant data inputs. Each card is identified with the card identification number that is always entered

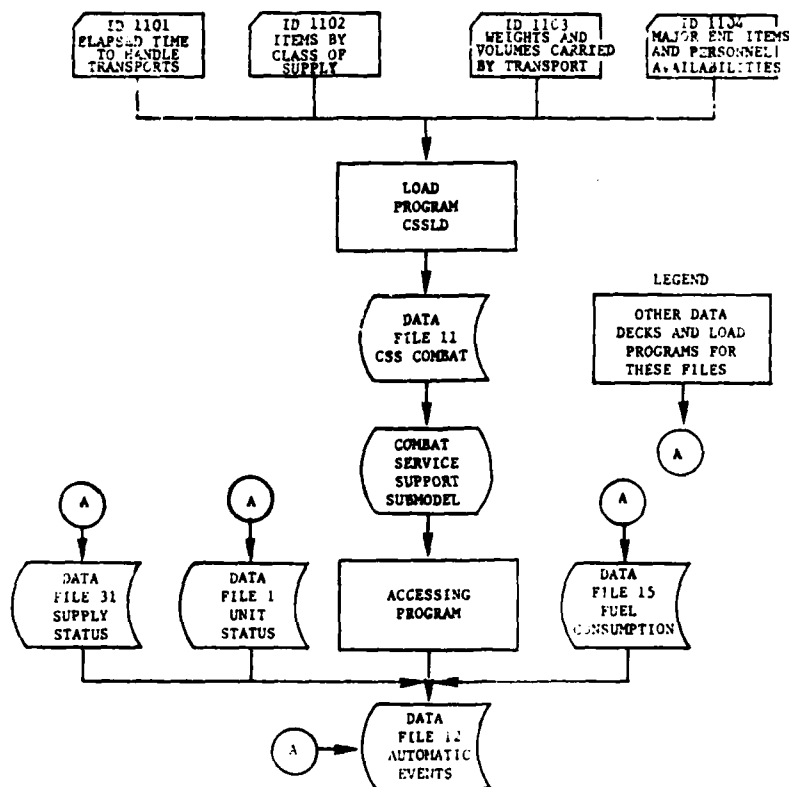


Figure IV-16-A-1. Combat Service Support Data Base

in card columns 73-76. The details of entering data in these card formats are explained in the following paragraphs of this chapter. A brief explanation of each follows:

(1) Elapsed Time in Handling Transports. This format is card identification 1101, which indicates that the card is the first of the 1100 series and the data are to be loaded into data file 11. This card format contains delay time data on truck loading, unloading, start-up, forming convoys, and the like.

(2) Items by Class of Supply. In Figure IV-16-A-1 this card is identified as 1102, indicating that it is the second series of card formats to be entered in data file 11. The categorization of each item, identified by equipment item code, to the class of supply to which it may be assigned is the type of data to be recorded in this card format. Data to be entered are concerned with the rated weights and volume (cube) of each item used. The cube and weight are on a per-unit basis. These data are compared with the hauling capability of the transport selected to make certain that there is a match or that items are not transported about the battlefield unless such a match exists. Additionally, this card is designed to record the data that rank the transports in terms of type of hauling to be done and the adaptability of the vehicle for the load to be carried.

(3) Weights and Volumes Carried by Transports. The capability of a transport to carry the supplied item is contained in the data to be entered in this card format. The identification of 1103 has been assigned to this card format, the third in the series being loaded into data file 11.

(4) Class VII and Personnel Available for Resupply by Day. This card, 1104, specifies the number of personnel and major end items of equipment that are available for resupply by day.

2. ELAPSED TIME TO HANDLE TRANSPORTS AND CLASS I CONSUMPTION RATES. The data to be included in this card format (ID 1101, Figure IV-16-A-2) are elapsed time to start, load, and unload trucks, and to load and unload aircraft. In addition, the rate of consumption of class I, subsistence, in pounds per man per day is indicated. One card is prepared for each force.

a. Card Type (Column 1). Card column 1 has the number 1 preprinted, and no changes are to be made. In card column 2 enter "R" for the Red force or "B" for the Blue force.

b. Minutes Elapsed Time to Load Trucks, Unit Distribution (Columns 6-9). Regardless of the type of truck and the capacity in weight or cube, enter the time in minutes that will elapse from the start to finish of loading a truck when used in unit distribution. This entry is an average and does not necessarily represent the times for a specific transport or specific consumable.

c. Minutes Elapsed Time to Start Trucks (Columns 12-15). Enter in minutes the elapsed time to start trucks and organize convoys.





d. Minutes Elapsed Time to Unload Unit Distribution Trucks at Destination (Columns 18-21). This time is the minutes needed to unload unit distribution trucks at their destination. Use an average figure for the different types of transports used in the game as the time period required to unload any one truck. The time entered is for an individual truck with its full complement of personnel.

e. Minutes Elapsed Time to Load Trucks at the Supply Point (Columns 24-27). Enter the time to load trucks at the supply point. The time represents an average for all type trucks.

f. Class I Pounds/Man/Day (Columns 33-35). Enter the subsistence consumption rate on a per-man-per-day basis. No decimals or fractions are to be entered; only whole numbers are permitted. Fractions or decimals will be rounded to the nearest whole number. Packaged weights are used.

g. Minutes to Load Aircraft (Columns 38-41). Enter the average time required to load aircraft. The entry represents an average for all type loads for all type aircraft used by the force to transport personnel, supplies, and equipment.

h. Minutes to Unload Aircraft (Columns 44-47). Enter the average time required to unload aircraft. The entry represents an average for all type loads for all type aircraft used by the force to transport personnel, supplies, and equipment.

3. ITEMS BY SUPPLY CLASS. Each item is identified by the class of supply to which it is assigned (card ID 1102, Figure IV-16-A-5). This entry is used to establish the relationship between the consuming unit and the unit which provides its logistics support. For example, a quartermaster company may be given the mission of supplying subsistence to designated units. This mission would be specified as described in Chapter 3. Equipment item codes that represent food, class I, are assigned an equipment item code of 1 (both forces use this code). When replenishment of consumable 1 is needed for a specific unit the Combat Service Support Model searches the supply organizations and determines the unit that issues class I supplies to the specific unit. The model then performs the necessary activities needed in replenishment, such as determining the location of the class I issue unit, time and distance factors to the unit that is to draw rations, quantity of rations required, and transport needed with fuel consumption.

a. Card Format. One card is required for each item code to be played during the game.

b. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in card column 1. In card column 2 enter "R" for Red forces or "B" for Blue forces.

c. Equipment Item Code (Columns 5-7). Enter the equipment item code in card columns 5 to 7 (right justified). A card for personnel replacement should also be prepared for each force with the characters PER in columns 5-7.



d. Class of Supply (Columns 9-10). Enter, in Arabic numerals, the class of supply to which the item listed in card columns 5-7 is assigned. For personnel, enter the number 10 in columns 9-10.

e. Pounds of Weight (Columns 12-19). In these columns enter the weight of each item code on a per-unit basis. There is an understood decimal between columns 17 and 18. If the item weighs less than 1 pound, enter its weight as a decimal fraction.

f. Volume in Cubic Feet (Columns 21-28). In these columns enter the cubic feet of volume for the item. If a consumable is shipped to the using unit with appropriate crating, preservatives, and the like, then these items should be included in the cube dimension. If the item will be transported as part of an airmobile movement during the game, but not necessarily resupplied, the volume must be specified here. There is an understood decimal between columns 26 and 27. If the item's cube is less than 1 cubic foot, enter its cube as a decimal fraction.

g. Transport Preference (Columns 30-64). In these series of card columns are entered the preferences for use of transports to haul the item listed in card columns 5-7. There are three conditions under which transport types are to be nominated in order of preference. The first is unit distribution, the second is supply point distribution, and the third is airlift of the item. In simulating the resupply of consumables to a given unit, the Combat Service Support Model first attempts to use the distribution method indicated on card ID 5201, type 2. If game conditions make this method impossible, the model tries alternative methods. For example, if supply point distribution was specified for class V, and the unit had lost its trucks, the model attempts resupply using the unit distribution method. As a last resort, and when the need is sufficiently critical, the model resorts to airlift to accomplish resupply of the unit.

(1) Unit Distribution (Columns 30-40). Unit distribution entries need not exclude entries in the supply point distribution transport preference except for class VII, which will be supplied only through unit distribution.

(a) First Preference (Columns 30-32). Enter the equipment item code for the transport considered the first preference for hauling the item listed in columns 5-7. If the item is class VII (major end items) and capable of transporting itself, the item code of the item to be resupplied should be entered here.

(b) Second Preference (Columns 34-36). Enter the equipment item code for the transport considered the second preference for hauling the item stated in columns 5-7.

(c) Third Preference (Columns 50-52). Enter the equipment item code for the transport considered the third preference for hauling this consumable stated in columns 5-7.

(2) Supply Point Distribution (Columns 42-52). Supply point distribution channel entries need not exclude entries in unit distribution for the specific item in columns 5-7, except for class VII items.

(a) First Preference (Columns 42-44). Enter the equipment item code for the transport considered the first preference for hauling the item stated in columns 5-7.

(b) Second Preference (Columns 46-48). Enter the equipment item code for the transport considered the second preference for hauling the item stated in columns 5-7.

(c) Third Preference (Columns 50-52). Enter the equipment item code for the transport considered the third preference for hauling this consumable stated in columns 5-7.

(3) Airlift (Columns 54-64). Regardless of the stated preference for either supply or unit distribution, if this item were to be airlifted the preference for type of aircraft is stated here. Since not all items are airlifted, an entry in this field is not always appropriate; however, there are no model limitations that would preclude any item from being airlifted.

(a) First Preference (Columns 54-56). Enter the equipment item code of the aircraft of first preference for airlifting the item in columns 5-7.

(b) Second Preference (Columns 58-60). Enter the equipment item code of the aircraft of second preference for airlifting the item in columns 5-7.

(c) Third Preference (Columns 62-64). Enter the equipment item code of the aircraft of third preference for airlifting the item in columns 5-7.

4. WEIGHTS AND VOLUMES CARRIED BY VARIOUS TRANSPORTS. As part of the Combat Service Support Model's simulation of resupply operations, the capacity of transport equipment is measured against the weight and volume of the materiel to be resupplied. For this reason, the performance factors for each transport are entered on this form (card ID 1103, Figure IV-16-A-4).

a. Card Format. Each card has the capability of recording the carrying capacity of three transports. It is probable that more than three transports will be issued to each opposing force (the model accommodates up to 50 per force); therefore, each force may have two or more of these cards.

b. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in column 1, and no changes are to be made. In column 2 only an "R" for Red forces or "B" for Blue forces is to be entered.

c. Transport Equipment Item Code Number (Columns 5-7). Enter the equipment item code number for each transport.

WEIGHTS AND VOLUMES OF TRANSPORT CAPACITIES											
CARD TYPE	ITEM CODE	WEIGHT, POUNDS	VOLUME, CUBIC FEET	ITEM CODE	WEIGHT, POUNDS	VOLUME, CUBIC FEET	ITEM CODE	WEIGHT, POUNDS	VOLUME, CUBIC FEET	CARD ID	CARD SEQ. NR.
RED OR BLUE	1	100	1.0	1	100	1.0	1	100	1.0	1	1
	2	200	2.0	2	200	2.0	2	200	2.0	2	2
	3	300	3.0	3	300	3.0	3	300	3.0	3	3
	4	400	4.0	4	400	4.0	4	400	4.0	4	4
	5	500	5.0	5	500	5.0	5	500	5.0	5	5
	6	600	6.0	6	600	6.0	6	600	6.0	6	6
	7	700	7.0	7	700	7.0	7	700	7.0	7	7
	8	800	8.0	8	800	8.0	8	800	8.0	8	8
	9	900	9.0	9	900	9.0	9	900	9.0	9	9
	10	1000	10.0	10	1000	10.0	10	1000	10.0	10	10
	11	1100	11.0	11	1100	11.0	11	1100	11.0	11	11
	12	1200	12.0	12	1200	12.0	12	1200	12.0	12	12
	13	1300	13.0	13	1300	13.0	13	1300	13.0	13	13
	14	1400	14.0	14	1400	14.0	14	1400	14.0	14	14
	15	1500	15.0	15	1500	15.0	15	1500	15.0	15	15
	16	1600	16.0	16	1600	16.0	16	1600	16.0	16	16
	17	1700	17.0	17	1700	17.0	17	1700	17.0	17	17
	18	1800	18.0	18	1800	18.0	18	1800	18.0	18	18
	19	1900	19.0	19	1900	19.0	19	1900	19.0	19	19
	20	2000	20.0	20	2000	20.0	20	2000	20.0	20	20
	21	2100	21.0	21	2100	21.0	21	2100	21.0	21	21
	22	2200	22.0	22	2200	22.0	22	2200	22.0	22	22
	23	2300	23.0	23	2300	23.0	23	2300	23.0	23	23
	24	2400	24.0	24	2400	24.0	24	2400	24.0	24	24
	25	2500	25.0	25	2500	25.0	25	2500	25.0	25	25
	26	2600	26.0	26	2600	26.0	26	2600	26.0	26	26
	27	2700	27.0	27	2700	27.0	27	2700	27.0	27	27
	28	2800	28.0	28	2800	28.0	28	2800	28.0	28	28
	29	2900	29.0	29	2900	29.0	29	2900	29.0	29	29
	30	3000	30.0	30	3000	30.0	30	3000	30.0	30	30
	31	3100	31.0	31	3100	31.0	31	3100	31.0	31	31
	32	3200	32.0	32	3200	32.0	32	3200	32.0	32	32
	33	3300	33.0	33	3300	33.0	33	3300	33.0	33	33
	34	3400	34.0	34	3400	34.0	34	3400	34.0	34	34
	35	3500	35.0	35	3500	35.0	35	3500	35.0	35	35
	36	3600	36.0	36	3600	36.0	36	3600	36.0	36	36
	37	3700	37.0	37	3700	37.0	37	3700	37.0	37	37
	38	3800	38.0	38	3800	38.0	38	3800	38.0	38	38
	39	3900	39.0	39	3900	39.0	39	3900	39.0	39	39
	40	4000	40.0	40	4000	40.0	40	4000	40.0	40	40
	41	4100	41.0	41	4100	41.0	41	4100	41.0	41	41
	42	4200	42.0	42	4200	42.0	42	4200	42.0	42	42
	43	4300	43.0	43	4300	43.0	43	4300	43.0	43	43
	44	4400	44.0	44	4400	44.0	44	4400	44.0	44	44
	45	4500	45.0	45	4500	45.0	45	4500	45.0	45	45
	46	4600	46.0	46	4600	46.0	46	4600	46.0	46	46
	47	4700	47.0	47	4700	47.0	47	4700	47.0	47	47
	48	4800	48.0	48	4800	48.0	48	4800	48.0	48	48
	49	4900	49.0	49	4900	49.0	49	4900	49.0	49	49
	50	5000	50.0	50	5000	50.0	50	5000	50.0	50	50
	51	5100	51.0	51	5100	51.0	51	5100	51.0	51	51
	52	5200	52.0	52	5200	52.0	52	5200	52.0	52	52
	53	5300	53.0	53	5300	53.0	53	5300	53.0	53	53
	54	5400	54.0	54	5400	54.0	54	5400	54.0	54	54
	55	5500	55.0	55	5500	55.0	55	5500	55.0	55	55
	56	5600	56.0	56	5600	56.0	56	5600	56.0	56	56
	57	5700	57.0	57	5700	57.0	57	5700	57.0	57	57
	58	5800	58.0	58	5800	58.0	58	5800	58.0	58	58
	59	5900	59.0	59	5900	59.0	59	5900	59.0	59	59
	60	6000	60.0	60	6000	60.0	60	6000	60.0	60	60
	61	6100	61.0	61	6100	61.0	61	6100	61.0	61	61
	62	6200	62.0	62	6200	62.0	62	6200	62.0	62	62
	63	6300	63.0	63	6300	63.0	63	6300	63.0	63	63
	64	6400	64.0	64	6400	64.0	64	6400	64.0	64	64
	65	6500	65.0	65	6500	65.0	65	6500	65.0	65	65
	66	6600	66.0	66	6600	66.0	66	6600	66.0	66	66
	67	6700	67.0	67	6700	67.0	67	6700	67.0	67	67
	68	6800	68.0	68	6800	68.0	68	6800	68.0	68	68
	69	6900	69.0	69	6900	69.0	69	6900	69.0	69	69
	70	7000	70.0	70	7000	70.0	70	7000	70.0	70	70
	71	7100	71.0	71	7100	71.0	71	7100	71.0	71	71
	72	7200	72.0	72	7200	72.0	72	7200	72.0	72	72
	73	7300	73.0	73	7300	73.0	73	7300	73.0	73	73
	74	7400	74.0	74	7400	74.0	74	7400	74.0	74	74
	75	7500	75.0	75	7500	75.0	75	7500	75.0	75	75
	76	7600	76.0	76	7600	76.0	76	7600	76.0	76	76
	77	7700	77.0	77	7700	77.0	77	7700	77.0	77	77
	78	7800	78.0	78	7800	78.0	78	7800	78.0	78	78
	79	7900	79.0	79	7900	79.0	79	7900	79.0	79	79
	80	8000	80.0	80	8000	80.0	80	8000	80.0	80	80
	81	8100	81.0	81	8100	81.0	81	8100	81.0	81	81
	82	8200	82.0	82	8200	82.0	82	8200	82.0	82	82
	83	8300	83.0	83	8300	83.0	83	8300	83.0	83	83
	84	8400	84.0	84	8400	84.0	84	8400	84.0	84	84
	85	8500	85.0	85	8500	85.0	85	8500	85.0	85	85
	86	8600	86.0	86	8600	86.0	86	8600	86.0	86	86
	87	8700	87.0	87	8700	87.0	87	8700	87.0	87	87
	88	8800	88.0	88	8800	88.0	88	8800	88.0	88	88
	89	8900	89.0	89	8900	89.0	89	8900	89.0	89	89
	90	9000	90.0	90	9000	90.0	90	9000	90.0	90	90
	91	9100	91.0	91	9100	91.0	91	9100	91.0	91	91
	92	9200	92.0	92	9200	92.0	92	9200	92.0	92	92
	93	9300	93.0	93	9300	93.0	93	9300	93.0	93	93
	94	9400	94.0	94	9400	94.0	94	9400	94.0	94	94
	95	9500	95.0	95	9500	95.0	95	9500	95.0	95	95
	96	9600	96.0	96	9600	96.0	96	9600	96.0	96	96
	97	9700	97.0	97	9700	97.0	97	9700	97.0	97	97
	98	9800	98.0	98	9800	98.0	98	9800	98.0	98	98
	99	9900	99.0	99	9900	99.0	99	9900	99.0	99	99
	100	10000	100.0	100	10000	100.0	100	10000	100.0	100	100

Figure IV-16-A-4. Weights and Volumes of Transport Capacities Card Format

d. Pounds of Weight the Transport is Capable of Carrying (Columns 8-15). The weight in pounds that this transport is capable of hauling is entered here. This value is its rated load carrying capability. There is an understood decimal between columns 13 and 14.

e. Volume in Cubic Feet (Columns 16-23). The volume of the payload for this specific transport is the entry made in these columns. Because the sling load capabilities of some helicopters make this constraint inappropriate, a series of eight nines (99999999) is entered in this field when applicable. There is an understood decimal between columns 21 and 22.

f. Other Transports and Their Physical Carrying Capacities (Columns 26-65). As mentioned earlier there are provisions in these card columns for the entry of two additional transports, making three total for the entire card. In all probability each of the opposing forces will have more than three different type transports for movement of consumables about the battlefield and in support of its troops. The data to be entered for these additional transports will be prepared in the same manner as explained in the preceding subparagraphs.

g. Additional Cards. The process of preparing the load-carrying capacities of the various transports for each of the opposing forces may require more than one card. Each additional card that is prepared will have the following as standard entries in addition to the explanation of entries given in the foregoing subparagraphs.

- (1) The number 1 will always be entered in card column 1.
- (2) "R" or "B" will be entered in card column 2.
- (3) In card columns 73-76 the numbers 1103 will be written.

5. RESUPPLY OF CLASS VII AND PERSONNEL. The number of personnel and quantity of major end items of equipment (class VII) that are available for resupply by day (card ID 1104, Figure IV-16-A-5) must be specified. The Combat Service Support Model performs the necessary activities needed to resupply the personnel and class VII items based on the quantity available for resupply; however, the quantity available on one or more days which is not resupplied will be added to the next day on which resupply is requested. In other words, if the item is not resupplied, the quantity available for resupply is cumulative through the current day. In those cases where replacement of personnel casualties and losses of major end items of equipment for either the Red or the Blue force is not desired, make no entries for that force. In such cases, the model does not resupply. Similarly, when resupply for one or more days is not desired, the absence of entries for those days results in no resupply on those days.

a. Card Format. One card is required for each item code that may be resupplied during the play of the game.





b. Card Type and Force Designator (Columns 1-2). The number 1 has been preprinted in card column 1. In card column 2 enter "R" for Red forces or "B" for Blue forces.

c. Equipment Item Code (Columns 5-7). Enter the equipment item code in card columns 5-7 (right justified). A card for personnel replacement should also be prepared for each force, with the characters PER in columns 5-7.

d. Day for Resupply (Columns 9-10). Enter the day on which resupply of this item can be effected. The day is right justified in column 10.

e. Amount Available for Resupply (Columns 12-16). Enter the amount of the item available for resupply on the day listed in card columns 9-10.

f. Day for Resupply (Columns 18-19). Enter the day on which resupply of this item can be effected. The day is right justified in column 19.

g. Amount Available for Resupply (Columns 21-25). Enter the amount of the item available for resupply on the day listed in card columns 18-19.

h. Day for Resupply (Columns 27-28). Enter the day on which resupply of this item can be effected. The day is right justified in column 28.

i. Amount Available for Resupply (Columns 30-34). Enter the amount of the item available for resupply on the day listed in card columns 27-28.

j. Day for Resupply (Columns 36-37). Enter the day on which resupply of this item can be effected. The day is right justified in column 37.

k. Amount Available for Resupply (Columns 39-43). Enter the amount of the item available for resupply on the day listed in card columns 36-37.

l. Day for Resupply (Columns 45-46). Enter the day on which resupply of this item can be effected. The day is right justified in column 46.

m. Amount Available for Resupply (Columns 48-52). Enter the amount of the item available for resupply on the day listed in card columns 45-46.

n. Day for Resupply (Columns 54-55). Enter the day on which resupply of this item can be effected. The day is right justified in column 55.

o. Amount Available for Resupply (Columns 57-61). Enter the amount of the item available for resupply on the day listed in card columns 54-55.

p. Day for Resupply (Columns 63-64). Enter the day on which resupply of this item can be effected. The day is right justified in column 64.

q. Amount Available for Resupply (Columns 66-70). Enter the amount of the item available for resupply on the day listed in card columns 63-64.

r. Additional Cards. The process of specifying the days available for resupplying each item of equipment or personnel may require more than one card. Each additional card is prepared in the same format as described in the preceding subparagraphs. The maximum number of daily increments for resupply is 14.

6. COMBAT SERVICE SUPPORT CONSTANT DATA DECK STRUCTURE. This paragraph describes the data deck structure for constant data input used in the Combat Service Support Model; i.e., the cards making up the deck and the order in which they must be read into the DIVWAG system.

a. Combat Service Support Constant Data Input Cards. The different card formats used to enter constant data inputs for the Combat Service Support Model are listed in Figure IV-16-A-6. In the figure the numbers 1101 indicate that the card is to load data in data file 11 and is the first card format of that series. At the far right is the program name for loading the data in each of the files. These card formats are used to create and update the constant data input files for the Combat Service Support Model.

Card Type	Card Title	Card ID	Load Program Name
1	Elapsed Time to Handle Vehicles and Class I Consumption Rate	1101	CSSL D
1	Items of Supply by Class	1102	CSSL D
1	Weight and Volume Capacity of Transports	1103	CSSL D
1	Class VII and Personnel Available for Resupply by Day	1104	CSSL D

Figure IV-16-A-6. Combat Service Support Card Format Listings

b. Creating Constant Data Files for Combat Service Support. The Combat Service Support constant data input files are created by reading in the data decks structured as illustrated in Figure IV-16-A-7. At the right of the figure are displayed two subdecks, one for Blue forces and the other for Red forces. A breakout of each subdeck is shown in the left side of the figure. The card groupings are segregated by card ID with a group header card, which is blank except for the card ID, preceding each group.

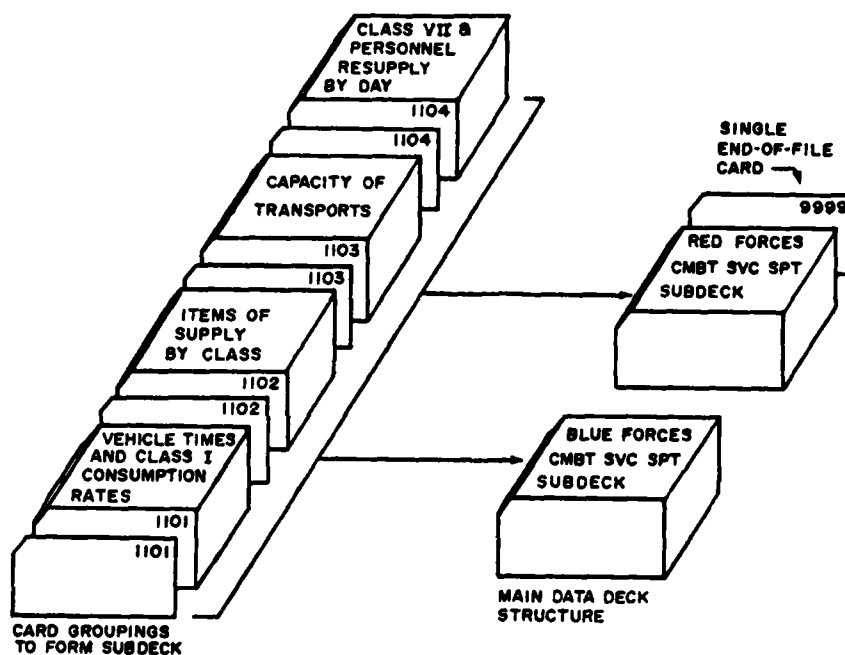


Figure IV-16-A-7. Combat Service Support Data Deck Structure

(1) Elapsed Time to Handle Vehicles and Class I Consumption Rate. At the forefront on the left is card type 1, ID 1101. The ID 1101 card should be placed first in each of the subdecks for Blue and Red forces. It is also allowable to put the blue ID 1101 card and the Red ID 1101 card into a common ID 1101 group. The ID 1101 cards must be preceded by an 1101 header card.

(2) Items of Supply by Class. The next group is that for defining items of supply, card type 1, ID 1102. The card group for ID 1102 is preceded by an 1102 header card and follows the ID 1101 card group.

(3) Weight and Volume Capacity of Transports. The third group of cards is card type 1, ID 1103, which defines capacities of transport vehicles. The ID 1103 card group, including an 1103 header card, is placed immediately behind the ID 1102 card group.

(4) Class VII and Personnel Resupply by Day. The last card group is card type 1, ID 1104. This group is placed immediately following the card group for ID 1103. The ID 1104 card group must have an 1104 header card.

c. Updating Combat Service Support Constant Data Files. Changes to the data deck read into the constant data files for Combat Service Support can be readily accomplished through the use of the retained data deck. The updating consists of correction of an error in a data element, deletion of information, or addition of new data. The procedures outlined below govern these processes.

(1) Correcting an Error. The card with the error is located and a new card produced with the changed data punched in. The old card is then removed from the deck and the newly produced card is inserted in its location. The entire data deck for both the Red and the Blue forces is then submitted for another run on the computer system. The recreation of the constant data files through reading in the deck with the changed data on cards constitutes the correction of an error or change of a data element.

(2) Deletion of Information. The deletion process consists of eliminating the entire file, deleting one data element, or zeroing out a record. For eliminating a complete disk storage, the control cards for the system are used. To delete a data element, select the cards that have unwanted data, remove them from the data deck, and resubmit the deck to the computer system. The omission of those cards and the recreation of the data files for constant data inputs for the Combat Service Support Model causes that data to be erased from the files.

(3) Addition of Data. This procedure also uses the retained complete data deck. First, the data to be added are prepared in punch card form and integrated into the data decks. When each set of newly produced cards has been added, the deck is assembled and resubmitted to the computer system for reread. Each time data are entered in the constant data files for Combat Service Support, a printout report series is generated which displays the information appearing in the files.

## APPENDIX B

### COMBAT SERVICE SUPPORT MODEL PROGRAM DESCRIPTIONS

1. INTRODUCTION. The Combat Service Support Model comprises eight routines. SERSUP, the major routine, performs necessary resupply calculations. It is supported by specialized utility routines TRNTIM, EVTFIL, SUPFIL, BOFILE, FETCH, MISOUT, RESLVE, and CSSANL. The macro flow of the Combat Service Support Model is shown in Figures IV-16-2, IV-16-3, IV-16-5, and IV-16-6.

#### 2. ROUTINE SERSUP:

a. Purpose. SERSUP is the controlling routine and performs the bulk of calculations required for the Combat Service Support Model. The routine has three major loops. The first loop processes all pending supply actions. The second major loop creates new backorders for critical consumables and expendables and processes these backorders by assigning available transport. The third loop allocates replacements of personnel and major end items. Both the second and third major loops are executed three times. First, they are executed for front-line maneuver units; secondly, for artillery units and other maneuver units; and, finally, for all other units.

#### b. Input Variables:

##### (1) Standard Common Block Areas:

. UMAIN	. IRFOOD	. DAY	. EENT
. UCOOP	. SWITCH	. HOUR	. UTDTAB
. WEATHR	. BPOINT	. MINUTE	. UNTLOC
. IBFOOD	. RPOINT	. BMNT	. LETTER

##### (2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
EVTAB (7)	DF11	Area holding a seven-word pending supply action entry.
SUPREC (10)	DF31	Area holding a ten-word supply status record.
BO (3)	DF11	Area holding a three-word backorder record.
IARRAY (412)	DF11	Transport load and unload times equipment item code/supply class cross references.
NOEVNT	DF11	Number of pending supply action entries for this update cycle.
NEMPTY	DF11	Pointer to start of supply action file on DF11.

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<u>Name</u>	<u>Source</u>	<u>Contents</u>
NSIZE	DF11	Pointer to end of supply action file on DF11.
CROSS (11)	DF11	List of transports eligible to haul a particular equipment item plus weight and volume of equipment items.
TRANWV (3,50)	DF11	Equipment item code, weight capacity, and volume capacity for 50 types of transport vehicles.
AVAIL (201)	DF11	Number of each equipment item available for resupply for each day.
FUNIT	ZONDAT	IUID for maximum of 20 front-line units.
MCLASB (200)	DF9	Mobility classes of Blue force equipment.
MCLASR (200)	DF9	Mobility classes of Red force equipment.
IRAT1B (20)	DF14	Vehicle movement rates, terrain type 1, Blue force.
IRAT2B (20)	DF14	Vehicle movement rates, terrain type 2, Blue force.
IRATE1 (20)	DF14	Vehicle movement rates, terrain type 1, Red force.
IRATE2 (20)	DF14	Vehicle movement rates, terrain type 2, Red force.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
EVTAB (7)	DF11	Area holding a seven-word pending supply action entry.
SUPREC (10)	DF31	Area holding a ten-word supply status record.
BO (3)	DF11	Area holding a three-word backorder record.
NOEVNT	DF11	Number of pending supply action entries to be considered on next update cycle.
NEMPTY	DF11	Pointer to start of supply action file on DF11.
NSIZE	DF11	Pointer to end of supply action file on DF11.
BOCHG	TWO	Variable used in subroutine BOFILE.

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
BOCORE	TWO	Variable used in subroutine BOFILE.
SUPCHG	TWO	Variable used in subroutine SUPFILE.
SUPCRE	TWO	Variable used in subroutine SUPFILE.
EVTCHG	TWO	Variable used in subroutine EVTFILE.
EVTCLM	TWO	Variable used in subroutine EVTFILE.
IOUT (256)	ONE	Period history tape records.

d. Working Arrays. The event table (EVTBLE) and unit identification table (UIDTAB) are temporarily stored on data file 36 permitting 6000 words of Common TWO to be used for working arrays. Each working array is described below.

(1) Backorder Constraints, BOC2(1700). This array contains the constraint factors associated with unfilled backorders contained on data file 11. The first constraint factor is associated with the first backorder on data file 11; the second constraint factor is associated with the second backorder on data file 11, and so forth. Between update cycles, those constraint factors associated with unfilled Class I orders are stored on data file 11.

(2) Accumulated Losses, AMT1C2(201). This array contains the accumulated losses for each major end item and personnel for all front-line maneuver units. The number on order of an end item and the current number on hand are subtracted from the authorized level of that item. This difference is the value accumulated by item over all frontline maneuver units.

(3) Accumulated Losses, AMT2C2(201). This array contains the accumulated losses for all artillery units and maneuver units which are not front line.

(4) Accumulated Losses, AMT3C2(201). This array contains the accumulated losses for all units which are neither maneuver nor artillery units.

(5) Consumption Array, CONSM2(2560). This array contains 11 entries for each of the 201 equipment items (including personnel) contained in each unit (2211 words are used). The CONSM2 array is stored on data file 11 between update cycles. The 11 entries for each item are:

(a) Words 1-9. Equipment item codes of transport vehicles for each of nine distribution/preference combinations in the following order.

- . Unit distribution, first preference
- . Unit distribution, second preference

- . Unit distribution, third preference
- . Supply point distribution, first preference
- . Supply point distribution, second preference
- . Supply point distribution, third preference
- . Airlift, first preference
- . Airlift, second preference
- . Airlift, third preference

(b) Word 10. Unit weight of consumable.

(c) Word 11. Unit volume of consumable.

(6) Backorder Flag Array, IFDBO2(425). This array contains flags to indicate which of 1700 backorders will be passed to the next Combat Service Support update cycle. It is handled in SERSUP as a 1700-character array. This array is stored on data file 11 between update cycles.

(7) Zero Block, ZERO(512). These locations are filled with zeros in SERSUP for filling various arrays used in the SERSUP routine with zero entries.

e. Logical Flow:

(1) Blocks 1 through 9 (Figure IV-16-B-1), Initialization. The first nine blocks initialize the SERSUP routine. Aircraft on missions are returned to their airbases for the update cycle, and they will be put back in the mission units after the update. A call to routine MISOUT performs these functions. The parameters which initialize the input/output routines, EVTFIL, SUPFIL, and BOFILE, are set, as are the switches specifying times of resupply for Class I, personnel, and major end items. The table giving the mobility classes of each equipment item is read from data file 9, and a test is made to determine if the Class I, personnel, and major end items should be resupplied during the current update cycle. If so, appropriate switches are set. Other necessary data are brought into core, including the parameter NOEVNT, which specifies the number of supply action events that are pending. The contents of EVTBLE and VIDTAB are saved on data file 36.

(2) Blocks 10 through 20 (Figure IV-16-B-2), Pending Supply Actions. These blocks describe the logic which occurs in processing supply action entries. There are five major supply actions processed:

- . Arrival of consumables and loaded trucks at the receiving unit under unit distribution (INDEX1 = 1)
- . Arrival of the empty trucks back at the supply point under unit distribution after delivery of supplies (INDEX1 = 3)



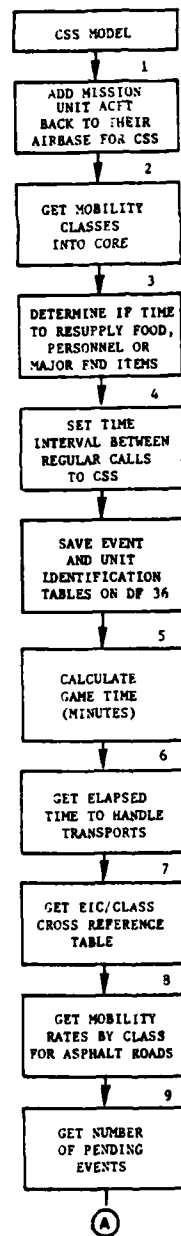


Figure IV-16-B-1. Combat Service Support Model Initialization

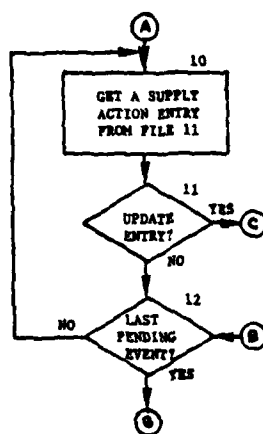


Figure IV-16-B-2. Pending Supply Actions (Continued on Next Page)

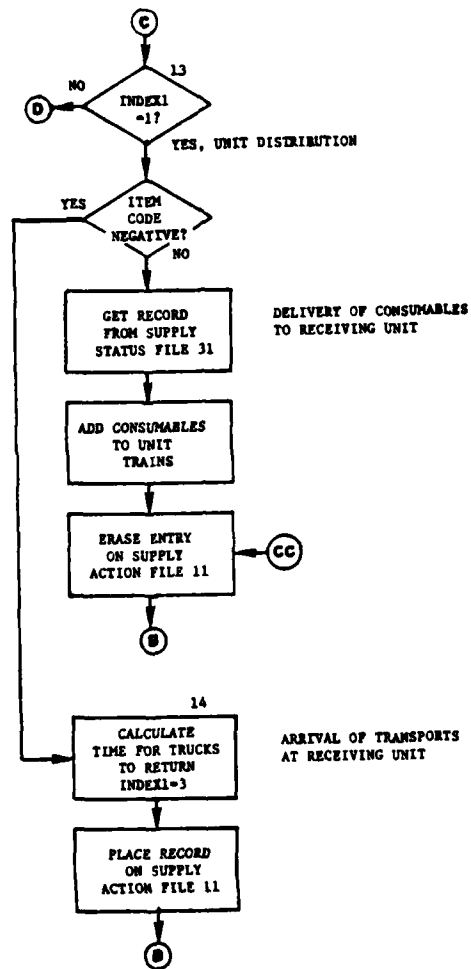


Figure IV-16-B-2. Pending Supply Actions (Continued)

IV-16-B-7

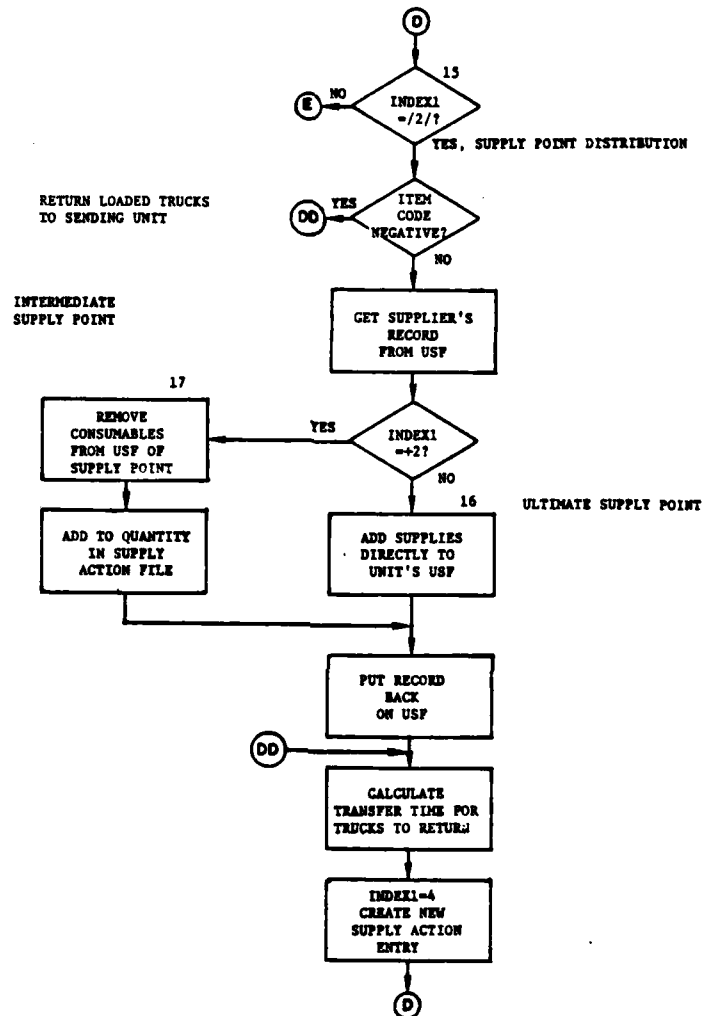


Figure IV-16-B-2. Pending Supply Actions (Continued)

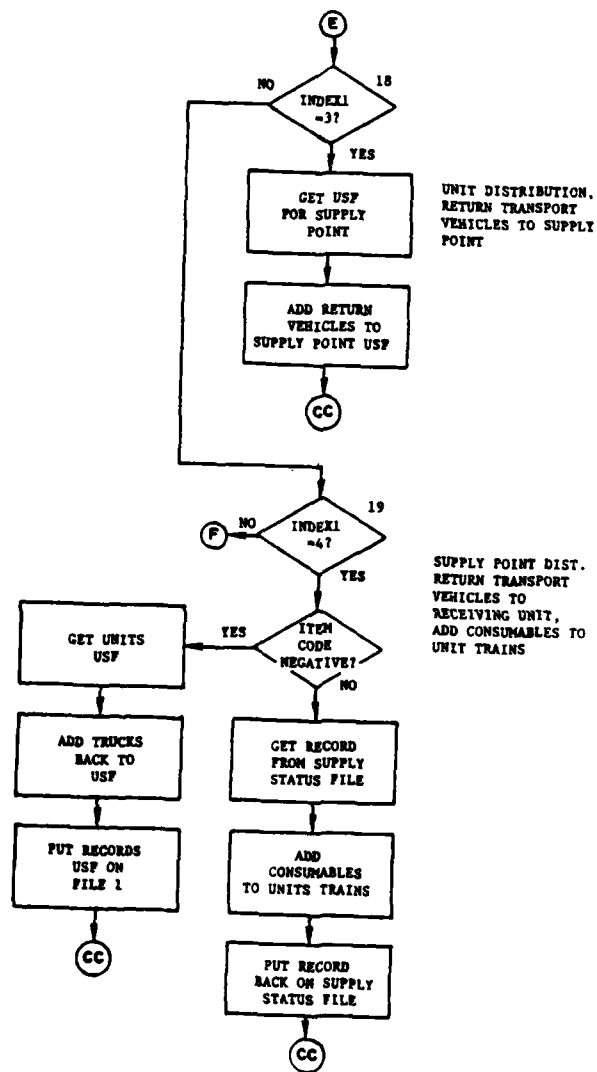


Figure IV-16-B-2. Pending Supply Actions (Continued)

IV-16-B-9

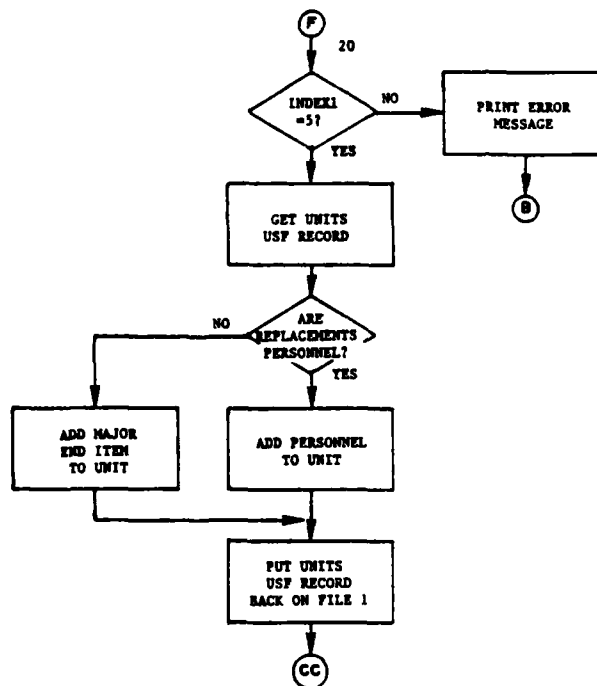


Figure IV-16-B-2. Pending Supply Actions (Concluded)

- . Arrival of supplies and the transporters at the receiving unit under supply point distribution (INDEX1 = 4)
- . Arrival of the empty trucks at the supply point to pick up the order under supply point distribution (INDEX1 = 2)
- . Arrival of personnel and major end items at their destinations (INDEX1 = 5).

(a) Blocks 10 through 12. A supply action entry is first examined to determine if current time exceeds the time the supply action was to occur. If it does, the action is processed; otherwise, it is held until the next Combat Service Support update cycle. After all pending supply actions are examined, resupply orders for critical consumables and expendables are created and available transportation assigned.

(b) Blocks 13 and 14. These blocks describe the logic when INDEX1 = 1, the action when trucks loaded with consumables arrive at the receiving unit under unit distribution. The consumables are added to the receiving unit's trains on data file 31. The empty trucks are given INDEX1 = 3, and the time of their return to the supply point is scheduled.

(c) Blocks 15 through 17. These blocks describe the logic when INDEX1 = + 2, the supply action which is the arrival of empty trucks from the receiving unit at the supply point with an order for supplies under supply point distribution. If INDEX1 = -2, the supply point is an ultimate supply point and the supplies are added to the ultimate supply point. If INDEX1 = +2, the supply point is an intermediate supply point and the required supplies are subtracted from the supply point. Supply actions are scheduled for the arrival of the supplies and for the trucks returning to the receiving unit. In both cases INDEX1 is set equal to 4.

(d) Block 18. This block describes the logic when INDEX1 = 3, the arrival of the empty trucks at the supply point after they have delivered supplies under unit distribution.

(e) Block 19. This block describes the logic when INDEX1 = 4, the arrival of loaded trucks at the receiving unit under supply point distribution. The trucks are added to the receiving unit's status record on data file 1; the consumables are added to the receiving unit's trains on data file 31.

(f) Block 20. This block describes the logic when INDEX1 = 5, the arrival of personnel replacements and major end item replenishments at their destinations. These items are added directly to the receiving unit's status record.

(3) Blocks 21 through 39 (Figure IV-16-B-3), Force Loop. Both second and third major loops of the Combat Service Support Model are executed first for the Blue force and then for the Red force. Blocks 21 through 26 initialize the second major loop. Weight and volume capacities of the transport vehicles are brought into core. If personnel and major end items are to be

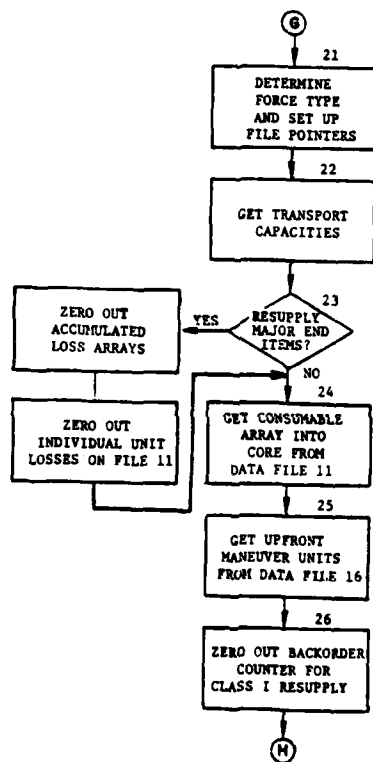


Figure IV-16-B-3. Force Loop (Continued on Next Page)



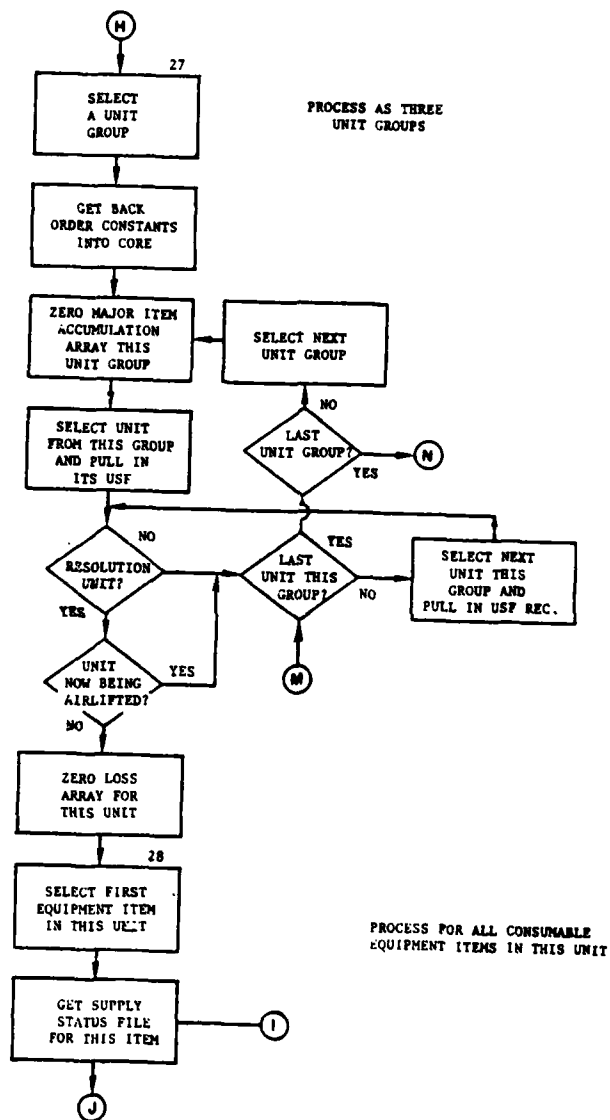


Figure IV-16-B-3. Force Loop (Continued)

IV-16-B-13

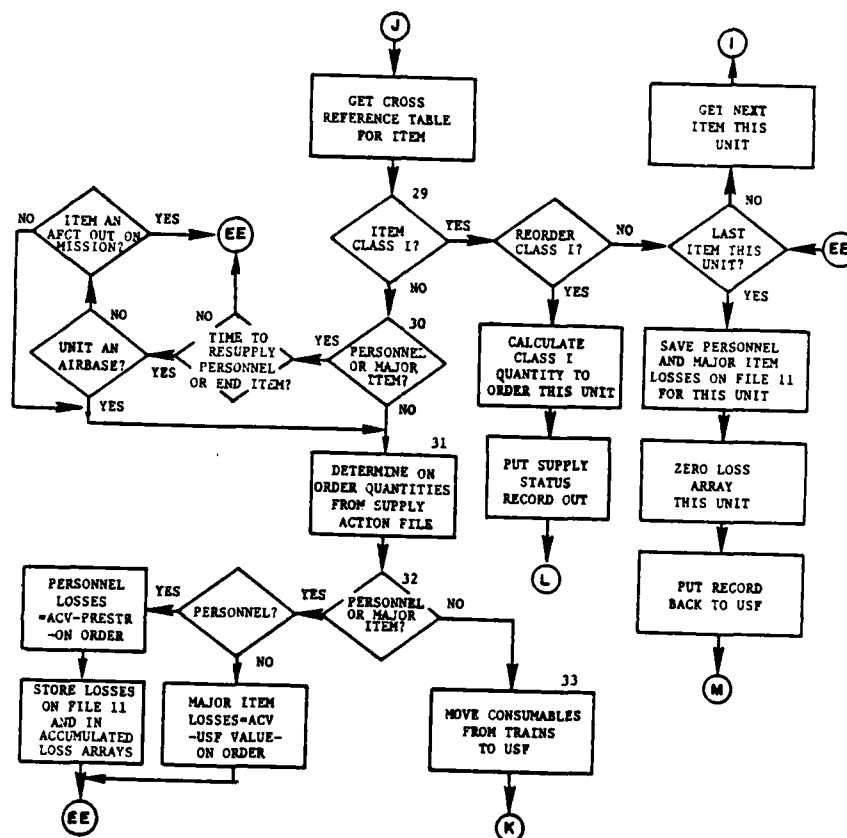


Figure IV-16-B-3. Force Loop (Continued)

IV-16-B-14

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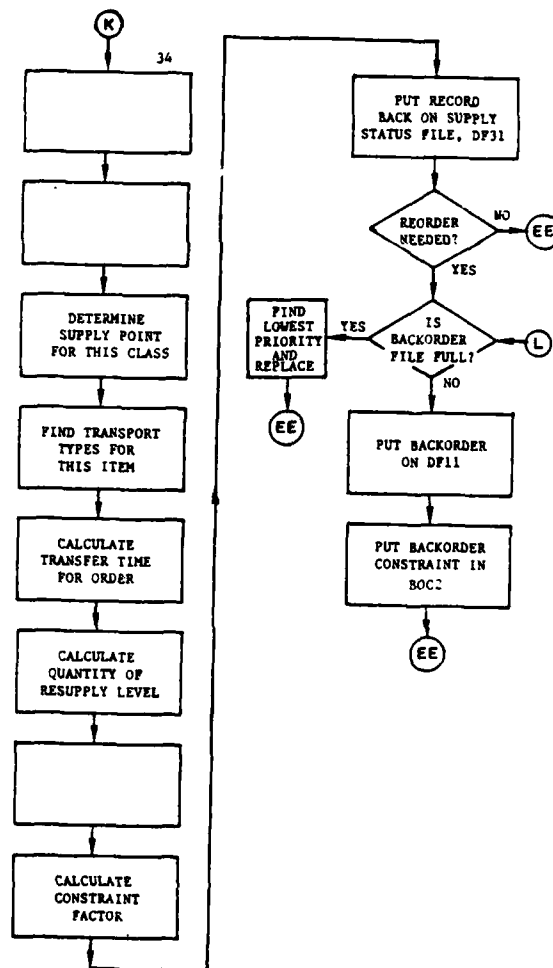


Figure IV-16-B-3. Force Loop (Continued)

IV-16-B-15

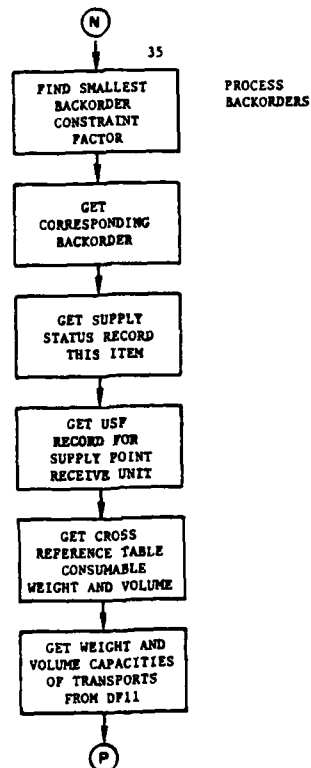


Figure IV-16-B-3. Force Loop (Continued)

IV-16-B-16

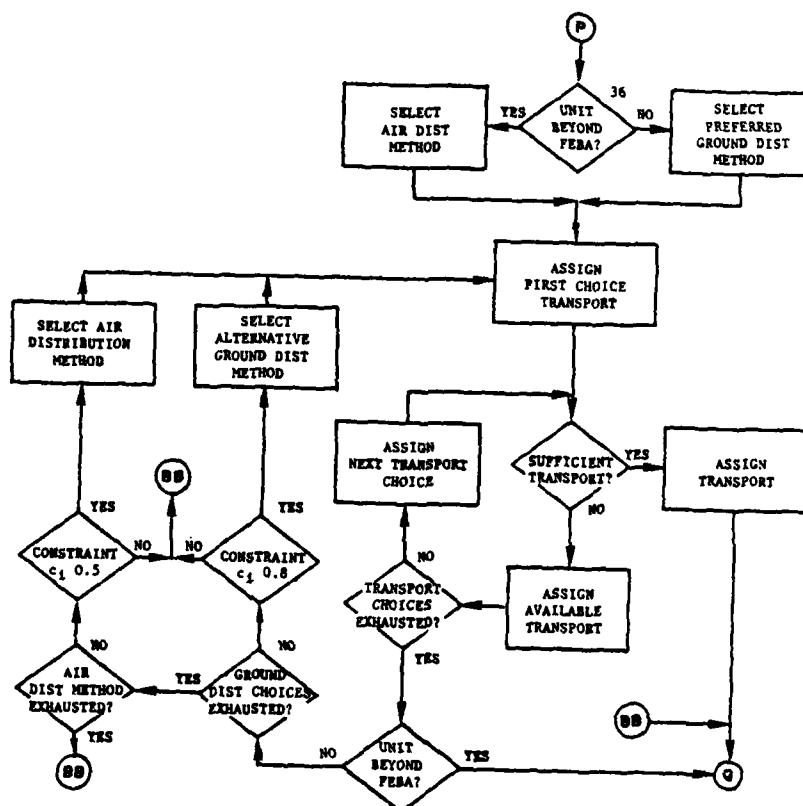


Figure IV-16-B-3. Force Loop (Continued)

IV-16-B-17

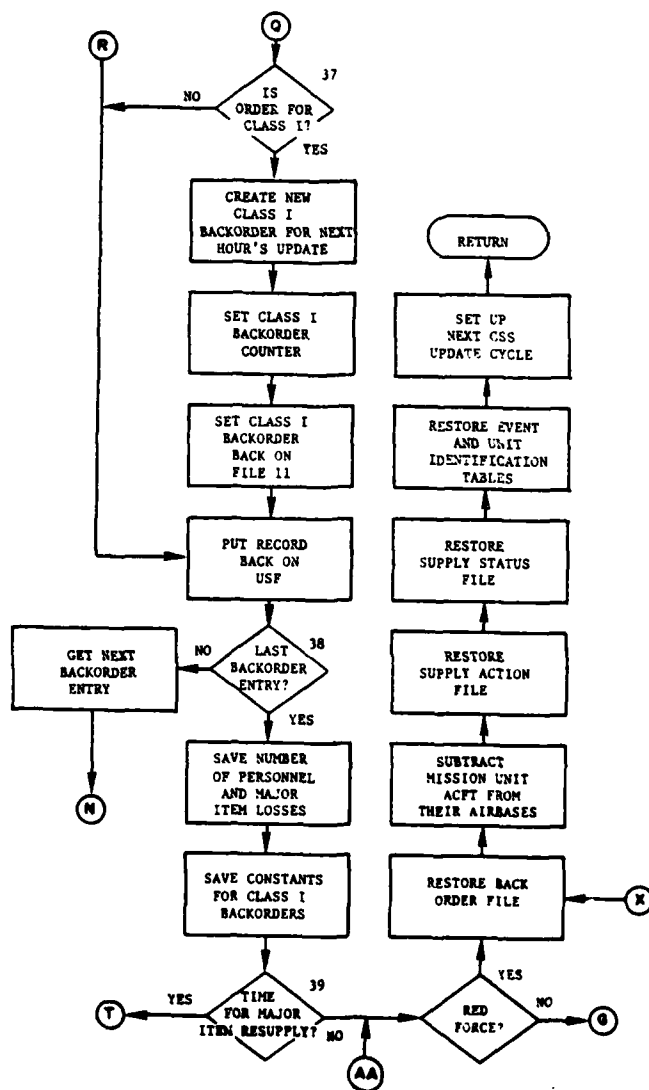


Figure IV-16-B-3. Force Loop (Concluded)

IV-16-B-18

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replaced during this update cycle, appropriate arrays are filled with zeros. The IUID's of maneuver units which are considered to be on the front line of the battlefield are read from data file 16. The backorder counter for Class I resupply is initialized to zero. Blocks 27 through 39 show the second major loop. Blocks 27 through 34 show the creation of backorders for critical consumables and expendables. Blocks 35 through 39 show the filling of these orders and the assignment of available transportation. This second major loop is processed first for front-line maneuver units, then for artillery and any other maneuver units, and finally for all other units.

(a) Block 27. This block depicts the logic of selecting a unit for processing. Each unit is checked to determine if it is resolution. If it is not, the next candidate unit is examined. A check is also made to ensure that the selected unit is not currently being airlifted. If it is, resupply is delayed until the airlift is completed.

(b) Block 28. After a particular unit has been selected, each equipment item in the unit is examined to determine if it need be resupplied.

(c) Block 29. If the item examined is Class I, a check is made to determine if it is time to reorder Class I. If it is not the next item of this unit is selected and examined. If it is reorder time, then a Class I backorder is generated. The next item is then selected.

(d) Block 30. If the item examined is personnel or a major end item, a check is made to determine if it is time to reorder. If it is not, the next item is selected. If it is reorder time, the unit is examined to see if it is an airbase. If it is not, and the equipment item is an aircraft which is out on a mission, no resupply of this item occurs. If the item should be reordered, the flow goes to block 31.

(e) Block 31. Before an order is issued for a consumable, a major end item, or personnel, a determination is made of the amount of the item that is currently on order. This on-order quantity is considered in calculating the amount of an item to reorder.

(f) Block 32. If the candidate item is personnel or a major end item, the reorder quantity which is needed is stored on data file 11 and the next equipment item is selected.

(g) Block 33. If the equipment item being examined is a consumable or expendable, the quantity on trains is moved to the equipment on hand array on the unit's status record to the extent that the unit is brought up to its authorized levels.

(h) Block 34. This section of logic creates the backorder for a single consumable or expendable. The quantity of the backorder is calculated. A maximum of 1700 backorders can be created. If this limit was not reached, the backorder is stored on file 11; otherwise, the backorder is lost and must be created on the next cycle.

(i) Block 35. The backorder with highest priority is selected and the corresponding supply status file, data file 31, entry is obtained. The supplier unit and supplied unit status records are brought into core from the data file 1. The weight and volume requirements of the consumable as well as the weight and volume capacities of available transport vehicles are brought into core.

(j) Block 36. At this point the backorder is filled if possible, and transportation is assigned. Three distribution methods are possible: unit distribution, supply point distribution, and airlift. Three transport vehicle types can be used under each distribution method. If the unit needing the order is in enemy territory, only airlift is attempted; otherwise, all three methods can be tried if the demand for a consumable is great enough. The constraint factor associated with the backorder must have a value less than 0.8 before the second ground distribution method will be attempted, and a value less than 0.5 before airlift will be used. The value of the constraint factor is inversely proportional to the demand for the consumable.

(k) Block 37. If the backorder was for Class I and only a partial order could be satisfied, a new backorder is created for the remaining quantity and stored on data file 11 until the next Combat Service Support update cycle.

(l) Block 38. A check is made to determine if there are other backorders to be processed. If there are, then blocks 35 through 38 are repeated. Otherwise, requirements of personnel replacements and replenishment of major end items are stored on data file 11. Backorder and constraint factors for Class I are also stored on data file 11.

(m) Block 39. At this point, a check is made to determine if major end items and personnel are to be updated during this cycle. If not, a check is made to determine if the Red force is being processed. If both tests are negative, control returns to block 21. If only the second test is negative (i.e., the Blue force is being processed), subroutine MISOUT is called to place aircraft back in their mission units. The buffer files are emptied, the event and unit identification table restored, and the next Combat Service Support update cycle is scheduled. If it is time for resupply of personnel and major end items, control goes to block 40.

(4) Blocks 40 through 47 (Figure IV-16-B-4), Personnel and Major End Item Resupply. These blocks show the third and final loop of the Combat Service Support Model. Supply action entries are created for personnel and major end items in this loop. This loop is executed three times. First, it is executed for all front-line maneuver units, then for all artillery units and other maneuver units, and finally for all other units.

(a) Block 40. This block is the beginning of the personnel and major end item resupply loop. Numbers of personnel and major end items available for resupply on the day being considered are brought into core from data file 11. Next, one of the three unit groups is selected.



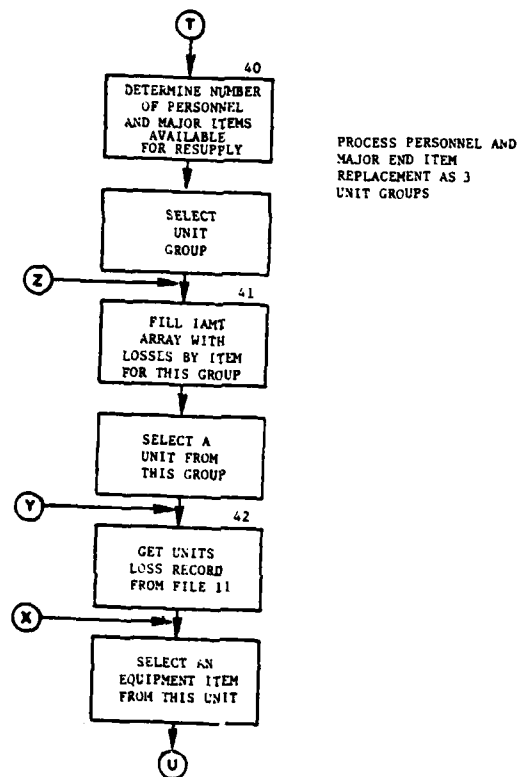


Figure IV-16-B-4. Personnel and Major End Items Resupply (Continued Next Page)

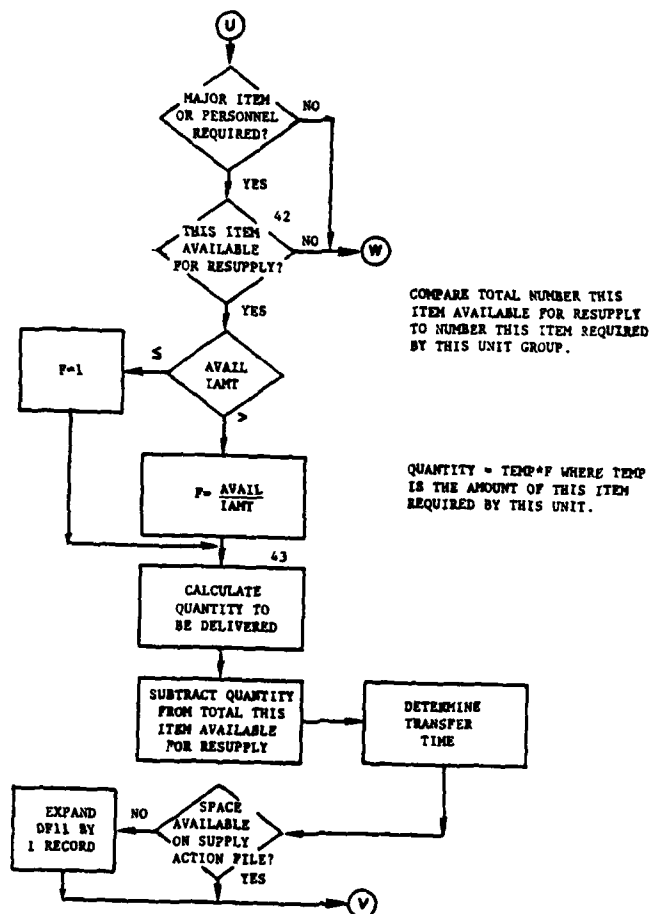


Figure IV-16-B-4. Personnel and Major End Items Resupply (Continued)

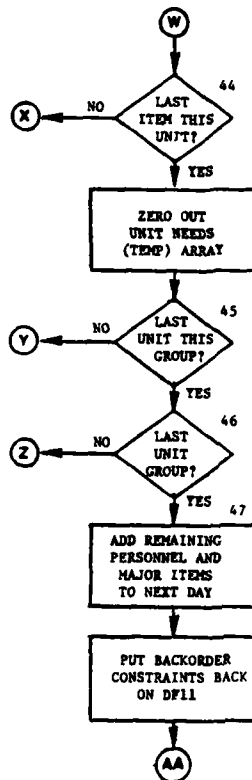


Figure IV-16-B-4. Personnel and Major End Items Resupply (Concluded)

(b) Block 41. The total losses by item for this unit group is obtained from the appropriate accumulated loss array. A unit is then selected from the given unit group.

(c) Block 42. The selected unit's loss record of personnel and major end items is obtained from data file 11. An item is selected from the unit; and, if it is a major end item or personnel, the following logic is used. If it is neither of the above, then the next item in the unit is examined.

(d) Block 43. If the item is available for resupply, the quantity to be delivered (full or prorated) is determined. The quantity ordered is subtracted from the total given in the AVAIL table. Transfer time for the vehicles to deliver major end items is determined.

(e) Block 44. If all items have been processed for the unit, the unit needs array is zeroed out. If not, the next item is selected.

(f) Block 45. If this is not the last unit in this group the next unit is selected and control goes to block 42.

(g) Block 46. If this is not the last unit group, the next unit group is selected and the flow returns to block 41.

(h) Block 47. Finally, the available personnel and major end items not used will be rolled into the next day's AVAIL table. The backorder constraints are stored on data file 11.

### 3. ROUTINE TRNTIM:

a. Purpose. This routine calculates the time in minutes required for a given vehicle to travel between two units.

#### b. Input Variables:

(1) Standard Common Block Areas. BPOINT and UNTLOC.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
MCLASB (200)	TWO	Mobility classes of Blue force equipment.
MCLASR (200)	TWO	Mobility classes of Red force equipment.
IRAT1B (20)	TWO	Vehicle movement rates versus mobility classes, Blue force, terrain type 1.
IRAT2B (20)	TWO	Vehicle movement rates versus mobility classes, Blue force, terrain type 2.
IRATE1 (20)	TWO	Vehicle movement rates versus mobility classes, Red force, terrain type 1.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IRATE2 (20)	TWO	Vehicle movement rates versus mobility classes, Red force, terrain type 2.
I1, I2	TWO	IUIDs of units between which vehicle is traveling.
LEOH	Call	Equipment item code of vehicle for which travel time is being calculated.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
ITIME	Call	Travel time (minutes).

d. Logical Flow (Figure IV-16-B-5):

(1) Block 1. Get the X and Y coordinates of the two units between which the vehicle is traveling from UNTLOC.

(2) Block 2. Calculate the distance in meters between the two units using the function RANGEF.

(3) Block 3. Get mobility class of the vehicle for the appropriate force.

(4) Block 4. If the mobility class is invalid, the travel time is set equal to zero and control is returned to the calling program.

(5) Block 5. Calculate the average velocity of the vehicle over the two terrain types for travel over an asphalt-surfaced road.

(6) Block 6. Calculate the travel time.

4. ROUTINE EVTFIL:

a. Purpose. This routine handles all input/output operations on supply action entries which are stored on data file 11 beginning in record 249. To increase the speed and efficiency of the Combat Service Support Model this routine uses a buffering scheme which allows 70 supply action entries to be accessed simultaneously. A maximum of 70 supply action entries are placed on a record of 512 words (i.e.,  $70 \times 7 = 490$  words). When a supply action entry is addressed, a block of 70 entries is brought into a buffer area called EVTVEC. After the particular event being considered is located, the seven-word entry is moved to a word area labeled EVTAB.

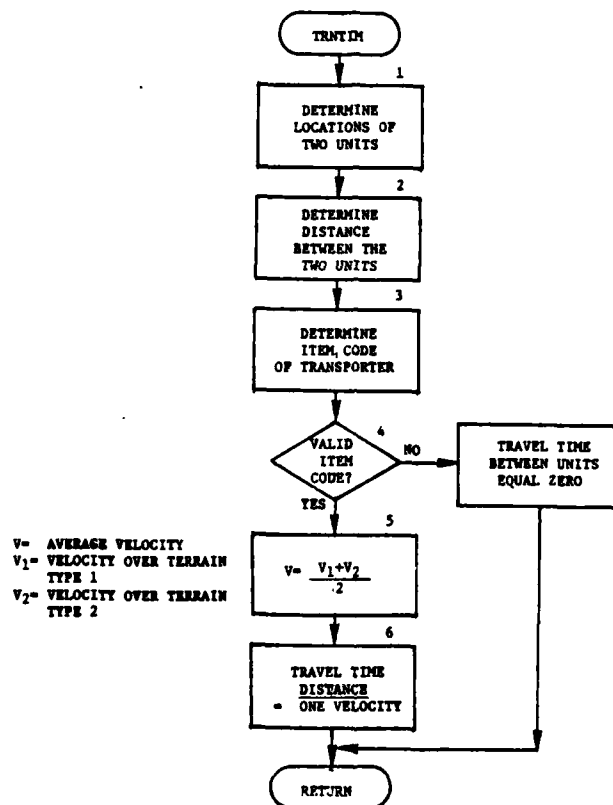


Figure IV-16-B-5. Routine TRNTIM

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IREC	Call	Relative location on data file 11 of the pending supply action being processed.
IO	Call	Type operation to be performed: IO = 1, input IO = 2, output IO = 3, final output, clear buffer
EVTCM	TWO	Switch indicating whether a new 490-word block needs to be buffered into or out of the buffer area.
EVTCHG	TWO	Switch indicating whether last operation was input or output: EVTCHG = 0, input EVTCHG = 1, output

c. Output Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
EVTVEC (490)	TWO	Buffer area containing 70 seven-word supply action events.
EVTAB (7)	TWO	Work area containing a single supply action entry.
EVTIM		EVTAB(1) Time entry is due to be updated, time = 0 denotes empty entry.
UNIT1		EVTAB(2) IUID of unit generating order.
RECNO		EVTAB(3) Record number on data file 31, supply status file.
KEOH		EVTAB(4) Equipment item code: if positive, item being ordered; if negative, transporting vehicle.
QUAN		EVTAB(5) Quantity being shipped.
UNIT2		EVTAB(6) IUID of supply point.
INDEX1		EVTAB(7) Index flag (1 through 4 or -2).

d. Logical Flow (Figure IV-16-B-6):

(1) Block 1. If this is a final output and the last operation was an input task, the buffer area is put back on data file 11.

(2) Block 2. If this is not a final output operation, the appropriate 490-word block on data file 11 is determined.

(3) Block 3. If the desired block is in the buffer area and an input operation is being performed, the supply action entry is moved from the buffer, EVTVEC, to the work area, EVTAB. If the desired 490-word block is in the buffer area and an output operation is being performed, EVTAB is moved to EVTVEC.

(4) Block 4. If the desired 490-word block is not in the buffer area, a check is made to determine if the last operation was an output. If not, the contents of the buffer area are placed on data file 11.

(5) Block 5. In any case, a new 490-word block is read into the buffer area and the appropriate switches set. The pending supply action entry is moved from the buffer area into EVTAB.

5. ROUTINE SUPFIL:

a. Purpose. This routine handles all maintenance input/output operations on the supply status file, data file 31. To increase the speed and efficiency of the Combat Service Support Model, this routine uses a buffer area which allows 50 supply status entries to be obtained with one disk access. A maximum of 50 supply status entries are placed on a record of 512 words (i.e.,  $50 \times 10 = 500$  words). When a supply status entry is addressed, a block of 50 entries is brought into a buffer area called SUPVEC (500). After the particular record being considered is found, the 10-word entry is moved to a work area labeled SUPREC.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IREC	Call	The relative location on data file 31 of the supply status record to be updated.
IO	Call	The operation type to be performed: IO = 1, input IO = 2, output IO = 3, final output, clear buffer
SUPCRE	TWO	A pointer to indicate if a new 500-word block (50 entries $\times$ 10 words per entry) need be buffered into or out of the buffer area SUPVEC (500).



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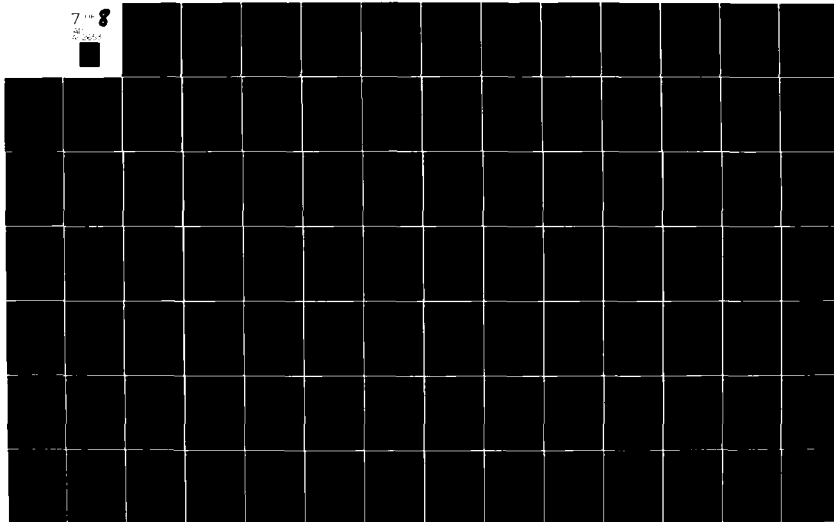
ARMY COMBINED ARMS COMBAT DEVELOPMENTS ACTIVITY FORT--ETC F/G 15/7  
DIVWAG MODEL DOCUMENTATION. VOLUME II. PROGRAMMER/ANALYST MANUA--ETC(U)  
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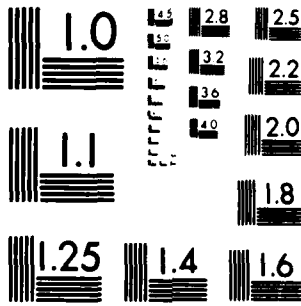
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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

IV-16-B-29

<u>Name</u>	<u>Source</u>	<u>Contents</u>
SUPCHG	TWO	A pointer to indicate if last operation was input or output: SUPCHG = 0, input SUPCHG = 1, output

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
SUPVEC (500)	TWO	Buffer area which holds 50 10-word supply status records.
SUPREC (10)	TWO	A work area which contains a single supply status record.
JEOH		SUPREC(1) Equipment item code (1-201)
ACV		SUPREC(2) Authorized on combat vehicles.
AOHT		SUPREC(3) Authorized on hand trains.
OHT		SUPREC(4) On hand trains.
RATUSE		SUPREC(5) Usage rate (biased by 1000).
SIGMA		SUPREC(6) Sigma (biased by 100).
INDEX2		SUPREC(7) Index flag: 1 = unit distribution 2 = supply point
ASR		SUPREC(8) Number of major end items or personnel replacements.
CONST		SUPREC(9) Backorder constraint factor (biased by 100).
SUPDEL		SUPREC(10) Not used.

d. Logical Flow (Figure IV-16-B-7):

(1) Block 1, Determine if this is a final output task. If it is, and the last operation was an input, the buffer area is put back on data file 31.

(2) Block 2. If this is not a final output task, the next 500-word block that is to be buffered in is determined.

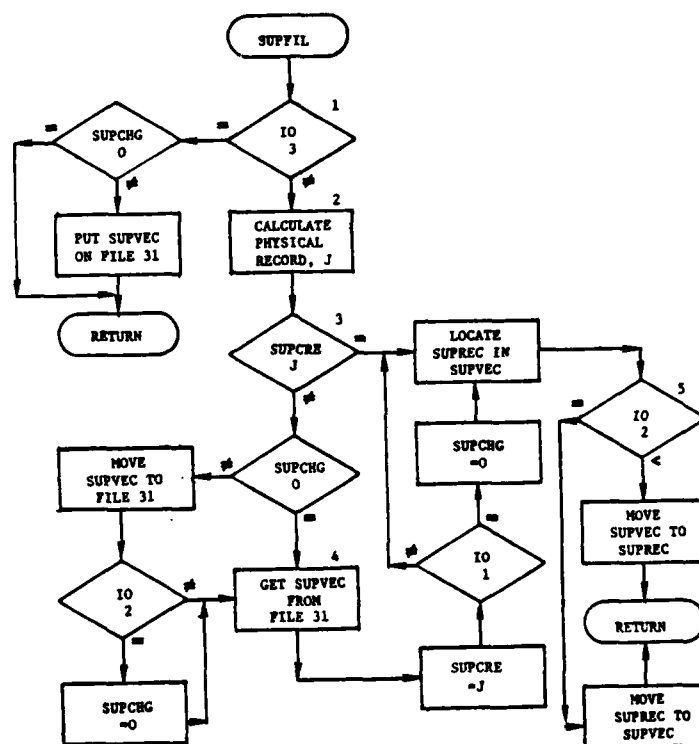


Figure IV-16-B-7. Routine SUPFIL

IV-16-B-31

(3) Block 3. If the desired block is in the buffer area and an input operation is being performed, the supply status record is moved from the buffer, SUPVEC, to the work area, SUPREC. If the desired 500-word block is in the buffer area and an output operation is being performed, SUPREC is moved to SUPVEC.

(4) Block 4. If a new 500-word block is required, it is read into SUPVEC. Before the record is read, a check is made against the file name table so that the read will not exceed the size of data file 31. This is required since new data file 31 records are sometimes created when units are joined or detached from one another.

(5) Block 5. When a 500-word block is put back on data file 31, a check is again made to ensure that the size of data file is not exceeded.

#### 6. ROUTINE BOFILE:

a. Purpose. This routine handles all input/output operations of the backorder files. For the Blue force, the backorder files are the first 10 records of data file 11. For the Red force, the backorder file is records 11 through 20. Each entry on the file consists of three words (see B0 array above). For each backorder entry, a corresponding constraint factor is stored in the BOC2 array. This routine uses a buffering scheme which allows 170 backorder entries to be obtained with one disk access. Up to 170 entries are placed on a record of 512 words (i.e.,  $170 \times 3 = 510$  words).

#### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IREC	Call	Specifies the relative location within the 1700 possible backorders on data file 11 of the desired 3-word backorder.
IO	Call	Indicates operation type: IO = 1, input IO = 2, output IO = 3, final output
BOCORE	TWO	Indicates whether a new 510-word block ( $170 \times 3$ ) need be buffered in or out of the buffer area.
BOCHG	TWO	Switch to determine if last operation input or output: BOCHG = 0, input BOCHG = 1, output

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
BOVEC(510)	TWO	Buffer area which holds 170 three-word backorder entries.
BO(3)	TWO	A work area which contains a single backorder entry, BO.
BOUNIT		BO(1) IUID of unit issuing order.
BOEOH		BO(2) Cross reference record on data file 31.
BOQUAN		BO(3) Quantity backordered.

d. Logical Flow (Figure IV-16-B-8). The logical flow is similar to that of EVIFIL and SUPFIL.

7. ROUTINE FETCH:

a. Purpose. This routine obtains a logical record from more than one physical record on data file 11.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IO	Call	Switch to indicate if operation is to be input or output: IO = 0, input IO = 1, output
LOGREC	Call	Relative location of logical record under consideration within the physical record.
LOCAV	Call	Location in core that information will be transferred into or from.
NREC	Call	Physical record where first logical record of the desired type will be found.
ILCON	Call	Number of words per logical record.
IPCON	Call	Number of words per physical record.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
LOCAV	Call	Array that information will be transferred into or from.

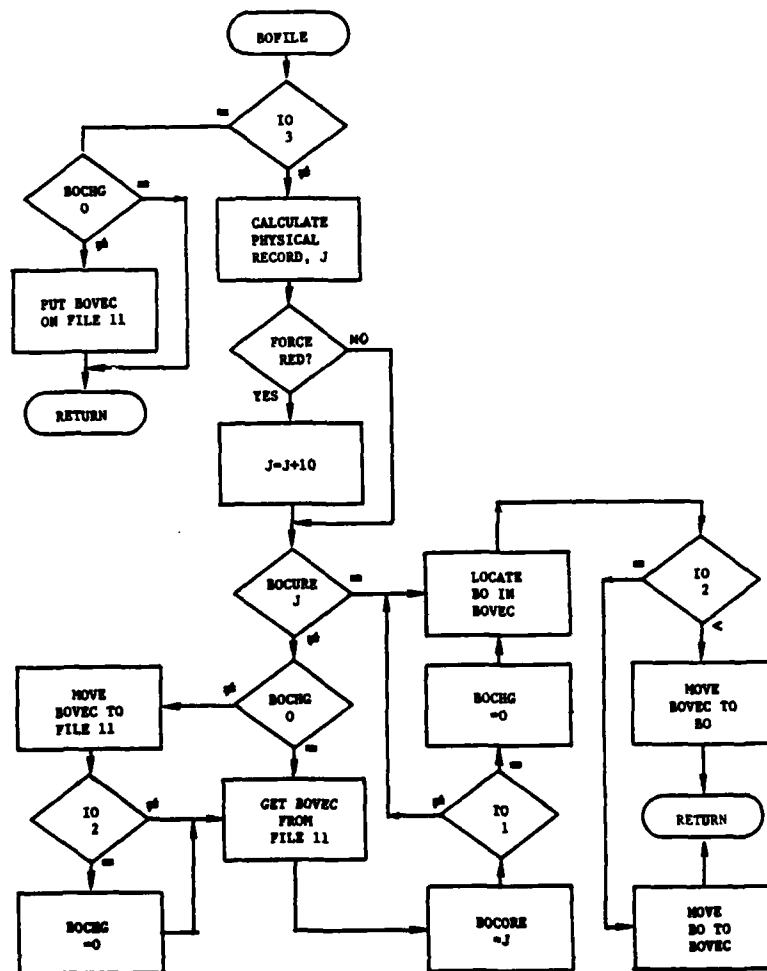


Figure IV-16-B-8. Routine BOFILE

IV-16-B-34



d. Description. When this program is entered, it is determined whether the desired logical record lies on more than one physical record. If it does, two calls are made to the appropriate input/output routine; otherwise, only one call is made. If the operation is input, subroutine GETWRD is called. If the operation is output, subroutine PUTWRD is called.

8. ROUTINE MISOUT:

a. Purpose. This routine prevents the Combat Service Support Model from resupplying aircraft to an airbase unit when the missing aircraft are on a mission during a resupply cycle. At the beginning of a resupply cycle, these aircraft are subtracted from the mission unit and added to the airbase unit. When the resupply cycle is complete, the aircraft are removed from the airbase unit and placed on the mission units.

b. Input Variables:

(1) Standard Common Block Areas. UMAIN, UCOOP, BPOINT, UNTLOC, and UTDTAB.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
F	Call	Switch indicating whether mission unit aircraft are added to or subtracted from their respective airbases: F = 1, add F = -1, subtract
ITRNAB	ONE	Airbase to which the transport aircraft belong.
ITEIC	ONE	Equipment item code of transport aircraft.
ICRTAB	ONE	Airbase to which the escort aircraft belong.
ICREIC	ONE	Equipment item code of escort aircraft.

c. Output Variable. None.

d. Logical Flow (Figure IV-16-B-9):

(1) Block 1. Find a resolution air-mission unit.

(2) Block 2. Determine if this air-mission unit has any escort aircraft.

(3) Block 3. If the air-mission unit has escort aircraft, add (or subtract) aircraft to (or from) appropriate airbase. A check is then made to determine if the mission unit has transport aircraft.

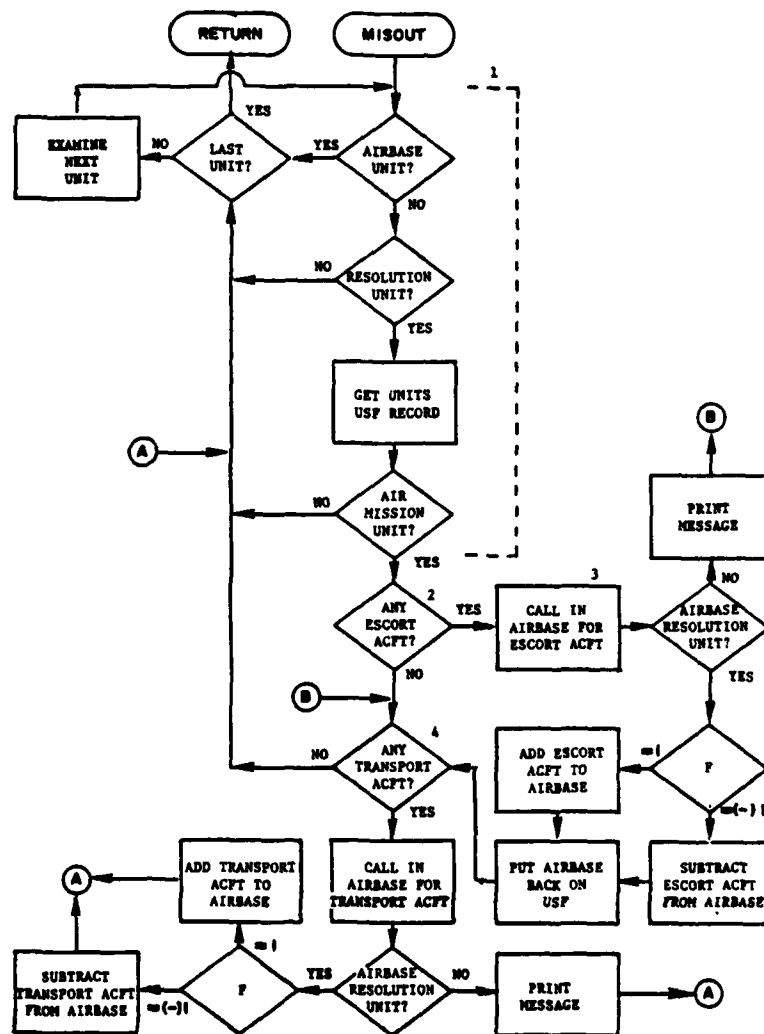


Figure IV-16-B-9. Routine MISOUT

IV-16-B-36

(4) Block 4. Does the air mission unit have transport aircraft? If it does, these aircraft are added to (subtracted from) the appropriate airbase unit.

(5) Block 5. If there are other air mission units, go to block 2 and examine the new unit.

9. ROUTINE RESOLVE:

a. Purpose. This routine determines if a given unit is resolution.

b. Input Variables:

(1) Standard Common Block Areas. UMAIN, UCOOP.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
I	Call	Indicator which specifies if unit status record is in UMAIN or UCOOP: I = 0, UMAIN I = 1, UCOOP

KUID	Call	KUID of unit which is under test.
------	------	-----------------------------------

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
J	Call	Indicator which specifies if unit was found to be resolution: J = 0, resolution J = 1, nonresolution

d. Logical Flow (Figure IV-16-B-10). After it is determined whether the unit status record is in UMAIN or UCOOP, the coordinates of the unit are checked to determine if they are non-zero. If either the X or Y coordinate is non-zero, the unit is resolution. A check is made to determine if this resolution unit has a supply status record on data file 31. If a supply status record exists, J returns to SERSUP with a value of zero. If no data file 31 record exists, J returns with a value of one. If the unit is non-resolution, a check is made to determine if the unit has a superior. If it does not, J returns with a value of one. If a superior unit is present, this unit is also checked for resolution.

10. ROUTINE CSSANL:

a. Purpose. This routine prepares the analysis output record for supply action events and calls PUTOUT to place the record on the period history tape.

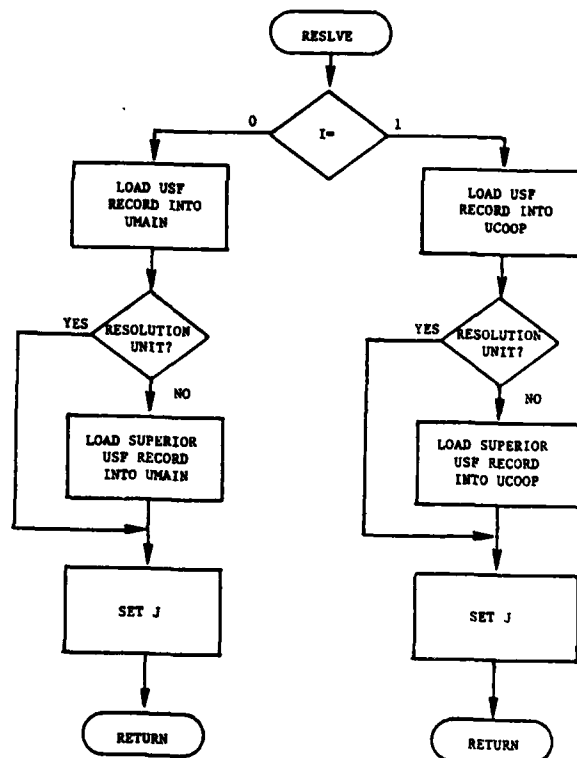


Figure IV-16-B-10. Routine RESOLVE

IV-16-B-38

b. Input Variables:

(1) Standard Common Block Areas: DAY, HOUR, MINUTE

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
EVTAB(7)	TWO	Refer to EVTFIL
I	Call	Action entry in or out flag: I = 1, supply action being processed I = 2, supply action being scheduled

c. Output Variable:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IOUT(256)	ONE	Analysis output record.

d. Logical Flow (Figure IV-16-B-11). The game time and record type code (521) are placed in the first two words of IOUT. The contents of EVTAB are moved to the appropriate words of IOUT. Routine PUTOUT is called to place the record on the period history tape.

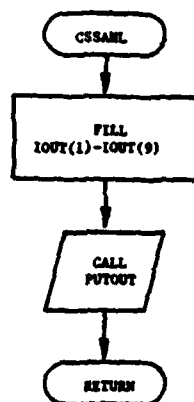


Figure IV-16-B-11. Routine CSSANL

IV-16-B-40

## APPENDIX C

### COMBAT SERVICE SUPPORT MODEL OUTPUT DESCRIPTIONS

This appendix contains a detailed description of printed output from routine SERSUP within the Combat Service Support Model of the Period Processor. Figure IV-16-C-1 depicts the format of the printout. In the figure, each line preceded by the number symbol (#) is not keyed to a sense switch; all other lines are keyed to sense switch 3. An alphabetical character (descriptor) designates an appropriate line, group of lines, or column in the figure that is explained as follows.

<u>Output Descriptor</u>	<u>Explanation</u>
A	This entry appears at the start of each Combat Service Support cycle and serves as an identification.
B	These entries give the game time and the status of the event file, data file 11.  GAMTIM: minutes since start of period NOEVNT: number of pending supply action events to be processed (stored on data file 11). NEMPTY: pointer to starting location in pending action event file of events to be processed. NSIZE: pointer to ending location of pending action event file.
C	This type entry appears for each unit that is to be resupplied. It is always identified by asterisks (*) in columns two through five. Three numbers are printed in this entry. The first is the unit identification record number of the unit being processed. The second and third are the start and end locations, respectively, on data file 31 of the supply status records for this unit.
D	This entry is printed for each consumable that a unit wants resupplied. If an entry does not appear for an item, that item will not be resupplied for the unit. This entry contains 10 fields and consists of the information stored on the supply status record, data file 31. The information is:  Field 1, JEOH: equipment item code (1-201)  Field 2, ACV: authorized on combat vehicles.  Field 3, AOHT: authorized on hand trains.





(J) MORBACK = 4  
 (M) CROSS 161 164  
 (L) WEIGHTS AND VOLUMES  
 4950800.0000 30360.0000 2346900.0000 11500.0000  
 PUT EVFILE 1 402 220 636 0 -161 1  
 PUT EVFILE 2 402 220 636 0 -161 1  
 CROSS 161 164  
 WEIGHTS AND VOLUMES  
 4912050.0000 37940.0000 2328907.1000 11382.0000  
 PUT EVFILE 3 473 227 659 0 -161 1  
 PUT EVFILE 4 473 227 659 0 -161 22

(N) COMBAT SERVICE SUPPORT  
 GANTEN = 476 MCEVMT = 516 NCMQTY = 491 MSIZE = 568  
 SUPPLY ACTION EVTAB 473 227 659 1 3843 287 1  
 PUT EVFILE 3 473 227 659 1 3843 287 1  
 SUPPLY ACTION EVTAB 473 227 659 1 3843 23 3  
 PUT EVFILE 4 550 227 659 1 3843 23 3  
 SUPPLY ACTION EVTAB 421 262 499 1 1246 282 1  
 PUT EVFILE 6 421 262 499 1 1246 282 1  
 SUPPLY ACTION EVTAB 421 262 499 1 1246 7 7  
 PUT EVFILE 10 454 262 499 1 1246 7 3

Figure IV-16-C-1. Routine SERSUP Sample Output (Continued)



Field 4, OHT: on hand trains.

Field 5, RATUSE: usage rate (biased by 1000).

Field 6, SIGMA: sigma (biased by 100).

Field 7, INDEX2: index flag; 1 = unit distribution, 2 = supply point.

Field 8, ASR: number of major end items or personnel replacements.

Field 9, CONST: backorder constraint factor (biased by 100).

Field 10, SUPDEL: not used.

E NOBO: This indicates which backorder is being generated.  
This number is incremented by one for each order within a group (i.e., front-line maneuver units).

F PUT BOFILE: This entry will appear each time the above entry appears. It contains three bits of information that are the unit identification record number of the requesting unit, the location of supply status file record for the requested item, and the requested number of units of this item.

G This entry is the same as D, except that D was for food and used different logic than other consumables. Entries H and I always follow G entries except for food, personnel, and major end items.

H RATE: usage rate for this item this Combat Service Support cycle.  
SIG: variance in usage rate this Combat Service Support cycle.  
R9: accelerated usage rate (see  $r_q$  in tech manual).  
DEL: difference between authorized and quantity on hand.  
OHT: on hand in trains.  
SUPDEL: not used.

I This entry will always follow G and H entries.  
Q: projected outage indicator, if Q is less than zero, order is generated.  
RR: restricted rate of usage.  
ASR: number of major end item or personnel replacements by type.  
CON: constraint factor,  $c_1$ .  
QT2: stock on hand and in bulk plus stock on order  
OHT: current amount of item on hand in trains.  
QT: delivery lead time.

- J After all items of each unit of a group, i.e., front-line maneuver units, have been processed and the consumable requests generated, available transportation is assigned. This entry will always appear as the first entry to the assignment logic.
- NOBACK: This number gives the total number of requests generated for this unit group. Entries K, L, and M are repeated for each request generated.
- K CROSS: This is an 11-word entry containing equipment item code of transports that will haul this consumable.
- Field 1, unit distribution first preference.  
Field 2, unit distribution second preference.  
Field 3, unit distribution third preference.  
Field 4, supply point distribution first preference.  
Field 5, supply point distribution second preference.  
Field 6, supply point distribution third preference.  
Field 7, airlift first preference.  
Field 8, airlift second preference.  
Field 9, airlift third preference.  
Field 10, weight of consumables.  
Field 11, volume of consumables.
- L WEIGHTS AND VOLUMES: This entry contains six fields as follows:
- Field 1, total weight capacity of transports.  
Field 2, total weight of consumables.  
Field 3, total volume capacity of transports.  
Field 4, total volume of consumables.  
Field 5, percent of available transport that will be used to deliver requested item.  
Field 6, percent of consumables that will be delivered.
- M PUT EVTFIELD: This entry contains eight fields. The first field specifies where this information will be stored on data file 11 starting with record 250. The last seven fields will be stored on data file 11 and contain information reflecting pending supply actions. These entries contain:
- EVTIM: time entry is due to be updated; Time=0 denotes empty entry.
- UNIT1, unit identification record number of unit that generated request.

RECNO, the supply status record number (data file 31) of the corresponding equipment item code for this unit (UNIT1).

KEOH, equipment item code of item being requested or of vehicle being used if equipment item code is negative.

QUAN, quantity of requested order being transported.

UNIT2, unit identification record number of supply point.

INDEX2, flag indicating type of supply action (1-4 or -2).

N      SUPPLY ACTION EVTAB: The seven numbers following this title are the same as the last seven that follow PUT EVTFIL (see output description M above). The SUPPLY ACTION EVTAB line denotes the pending supply action processed this Combat Service Support cycle. The PUT EVTFIL line denotes the pending supply action that will be stored on data file 11 and processed on the next Combat Service Support cycle. If EVTIM = 0, the supply action has been completed. The list of pending supply actions to be processed on the current Combat Service Support cycle always appears immediately after the COMBAT SERVICE SUPPORT heading.

O      ACV: authorized quantity of preceding item (i.e., item 39) in readily usable status, authorized in combat vehicles.

TEOH: quantity of preceding item (i.e., item 39) in readily usable status.

ONO: amount of item currently requested, possibly in transit.

P      In these instances the entry pertains to the resupply of a major end item or personnel. This particular entry pertains to a major end item, item code 88 (see description M, KEOH).

ACV: number of item requested for resupply.

TEOH: percent of requested quantity that will be issued.

ONO: actual amount to be resupplied. This number will be a rounded number. (see description M, QUAN).

APPENDIX D

SOURCE LISTINGS FOR PERIOD PROCESSOR COMBAT SERVICE SUPPORT MODEL

(AVAILABLE UNDER SEPARATE COVER)

APPENDIX E

REFERENCES

- 1. U.S. Department of the Army, Headquarters. FM 17-1, Armor Operations.  
14 October 1966.
- 2. U.S. Department of the Army, Headquarters. FM 38-22, Logistics Selective  
Management of Secondary Items. 9 December 1965.

## CHAPTER 17

### MAJOR SPECIAL PURPOSE PROGRAMS

1. INTRODUCTION. This chapter describes the major special purpose routines used by the Period Processor. These routines perform the initialization, termination, and restart functions required by the processor, and are contained in overlays 1 and 15. A macroflow diagram is presented in Figure IV-17-1.
2. INITIALIZATION. The initialization overlay is called once--and only once--at the beginning of each Period Processor run. This occurs at the beginning of each game period and may also occur if a period is restarted due to failure to complete the period in a single run because of time constraints or system malfunction. The primary purpose of the overlay is to initialize all necessary values in common ONE on the appropriate data files. The Period Processor control card is also read in this overlay. Routine INITIAL is the driver for all initialization processing.
3. TERMINATION. The termination overlay is executed at the completion of all Period Processor runs. This occurs when the period is completed, the run executes the specified running time, or the operator sets the termination sense switch. The purpose of this overlay is to store the contents of common onto data file 36, create a dump tape, and end file the history tape. At the end of each period, the event schedule is adjusted and all ongoing unit events are terminated. The driver for the termination processing is routine EXIT1.
4. RESTART. Periodic restart dumps are made during the Period Processor runs. The processing of a restart dump is identical to that of the termination with the exception that the history tapes are not endfiled.
5. COMMON TABLES. Upon completing the initialization and upon beginning the termination, the contents of common and the intelligence tables on data file 16 are printed in formatted tables by routine COMMDP. These tables permit rapid access to the status of key variables at the beginning and end of each run.
6. FOOD CONSUMPTION. Food consumption is calculated for all resolution units three times each day: 0800, 1200, and 1700 hours. Routine EAT is called at those times to update the quantities of food on hand contained on the unit status records. The amount of food subtracted each time is calculated in the following manner:

$$\text{Consumption} = \text{Strength} \cdot \text{Rate} \cdot 0.333 \quad (\text{IV-17-1})$$



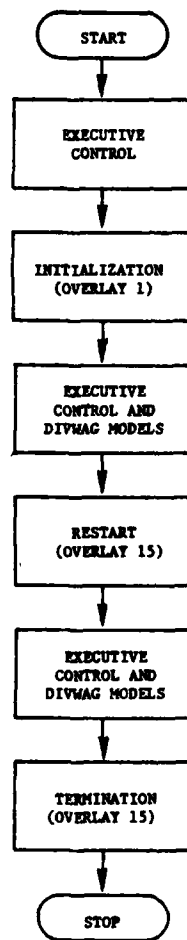


Figure IV-17-1. Special Purpose Routine Macroflow

## APPENDIX A

### INPUT REQUIREMENTS FOR THE MAJOR SPECIAL PURPOSE PROGRAMS

- The input to the major special purpose routine, INITIAL, is the single Period Processor control card. That card is described in Appendix A to Chapter 2 of this section, Input Requirements for Executive Control.
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APPENDIX B

MAJOR SPECIAL PURPOSE PROGRAM DESCRIPTIONS

1. INTRODUCTION. Each routine described in this appendix has a specialized purpose as follows:

- a. Initialization - INITIAL and COMMDP.
- b. Termination - XXIT, EXIT1, UTILDP, and SET41.
- c. Food Consumption - EAT.

The logic is more complex and these routines are not called with as relative frequency as the utility routines.

2. ROUTINE INITIAL:

a. Purpose. This routine initializes areas of common at the start of each period and certain dynamic data files at the start of each game.

b. Input Variables.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IRST	card	Characters REST for restart, blanks for start of period/game.
ECSFLG	card	1 - Extended Core Storage will be used for resolution units instead of data file 1.  0 - Use data file 1 instead of ECS.
IRONT	card	The wall-clock time, in minutes, that the job is to be allowed on the computer.
IRTME	card	The wall-clock time, in minutes, at which a restart tape will be dumped.
ISWCH(4)	card	Print control switches, 1=on, 0=off.
ITITLE	card	A desired title of up to 40 characters may be input to label the output of the run.
MSTOP	card	Game time in centiminutes that you desire this run to be terminated. If blank, run will continue to end of period.

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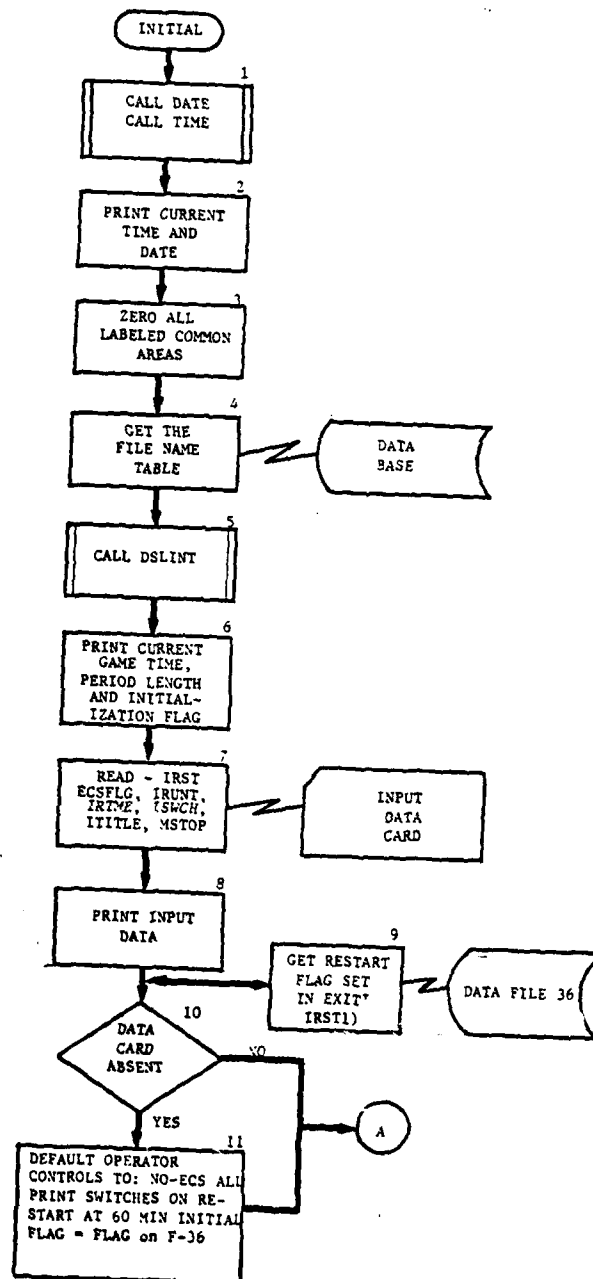


Figure IV-17-B-1. Routine INITIAL (continued on next page)

IV-17-B-2

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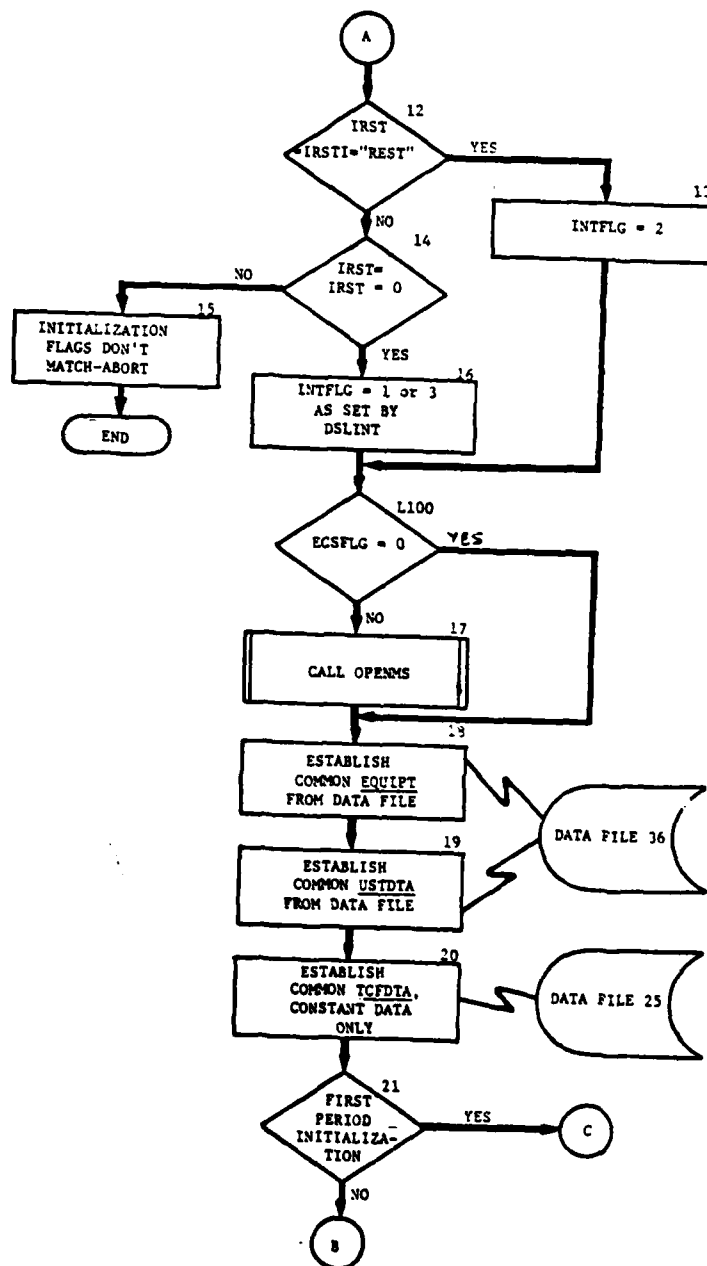


Figure IV-17-B-1. Routine INITIAL (continued)

IV-17-B-3

APR 15 1975

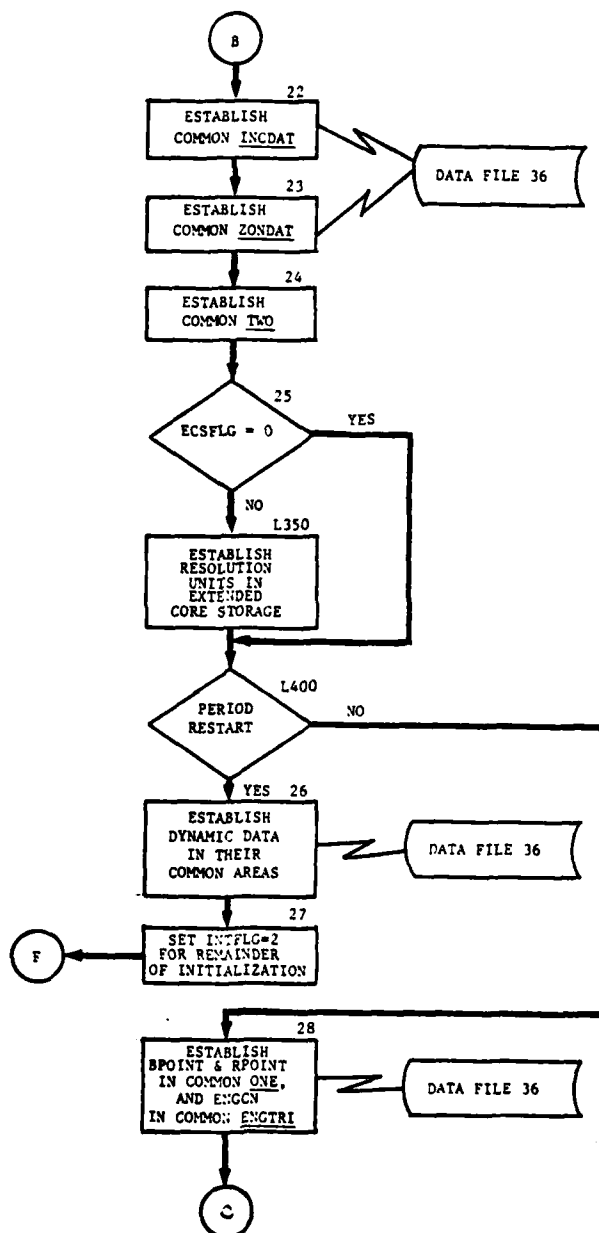


Figure IV-17-B-1. Routine INITIAL (continued)

IV-17-B-4

APR 15 1975

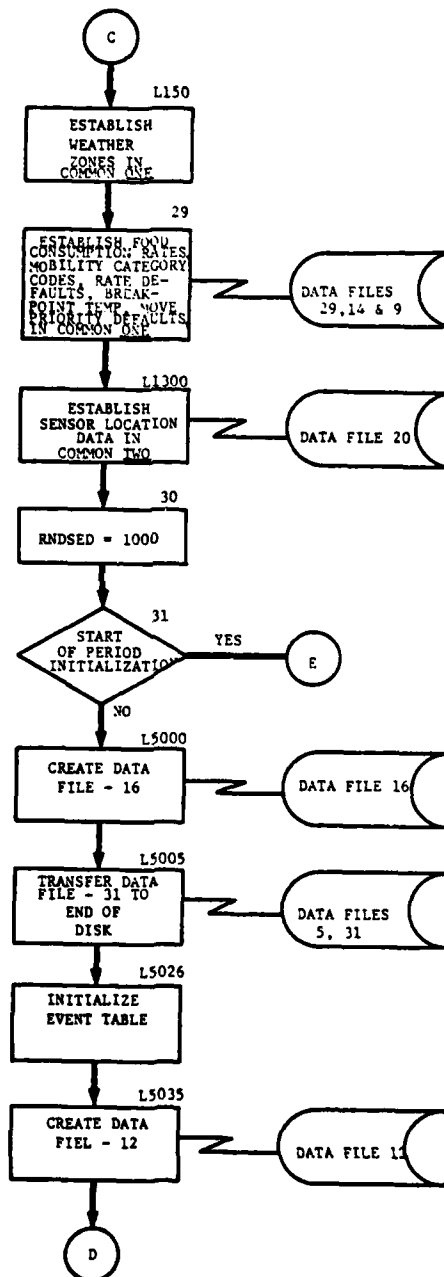


Figure IV-17-B-1. Routine INITIAL (continued)  
IV-17-B-5

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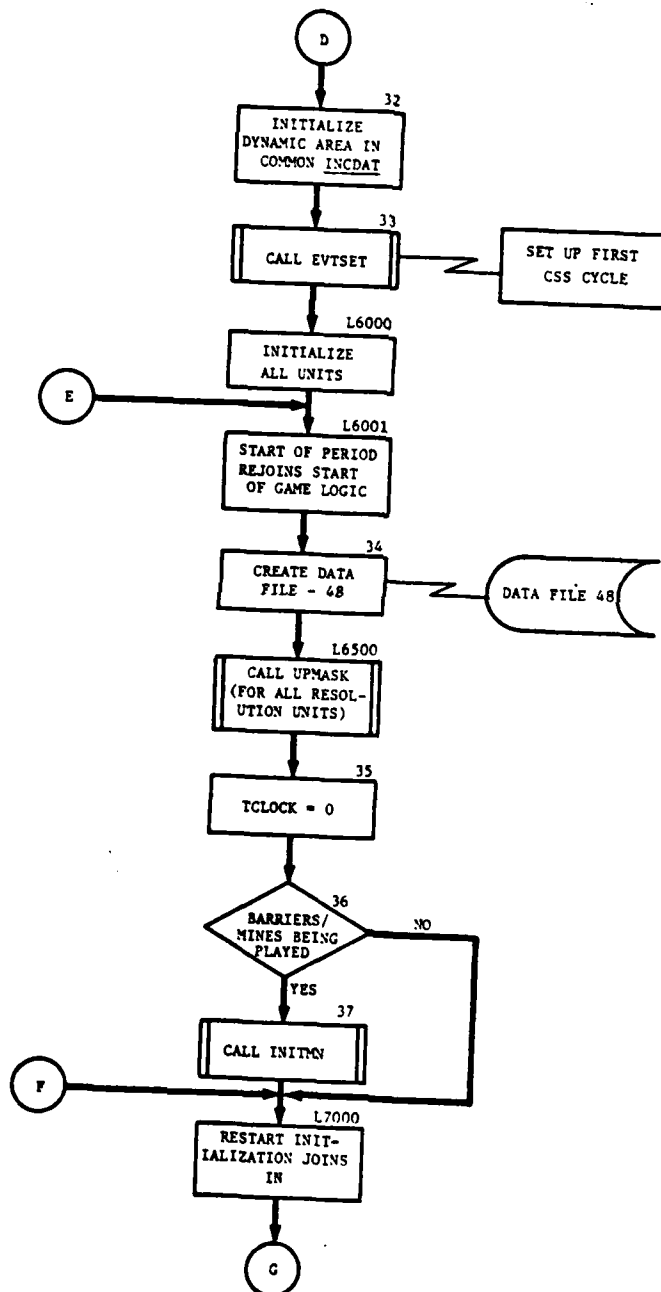


Figure IV-17-B-1. Routine INITIAL (continued)

IV-17-B-6



APR 15 1975

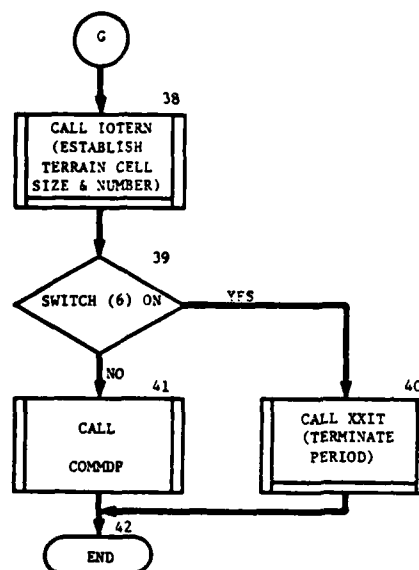


Figure IV-17-B-1. Routine INITIAL (concluded)

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<u>Name</u>	<u>Source</u>	<u>Contents</u>
IRSTI	DF36	Restart flag=REST if data tape is in a restart format.

c. Output Variables. Labeled common blocks: ONE, EQUIPT, INCDAT, USTDIA, ENGTRI, ZONDAT, TCFDTA, TWO, and ECS.

d. Logical Flow.

(1) Block 1. System routines DATA and TIME are called to get the current date and time.

(2) Block 2. The current data and time of the run are outputted.

(3) Block 3. Initialize labeled common areas to zero.

(4) Block 4. Get the file name table from the data base and store in common ONE.

(5) Block 5. Routine DSLINT is called to initialize some variables in common ONE, that were established in DSL execution.

(6) Block 6. Print pertinent information at the start of the run.

(7) Block 7. An input card is read which contains variables controlling the execution of the run. The variables and their meaning are discussed under Input Variables above.

(8) Block 8. Print data card input.

(9) Block 9. Get the restart flag from file 36 indicating the status of the data base. If the flag is blank, a start of period or game execution run must follow. If the flag contains the characters REST, a period restart execution run must follow.

(10) Block 10, 11. If the data input control card is missing input values will default as follows:

IRST - will be set equal to the restart flag on file 36.

ECSFLG - 0

IRUNT - 600

IRTME - 60

ISWCH - all print switches will be turned on.

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ITITLE - blank

MSTOP - length of period + 1 minute.

(11) Block 12, 13, 14, 15, 16. The initialization flag controls the flow of execution throughout routine INITIAL. The flag is established by comparison of the two restart flags, one as input, the other is set on file 36 by the last pass through routine EXIT1 from the last execution run. If the restart flags don't match the run is aborted, because of either a bad input value or the wrong tape has been used to load the data base. If the restart flags match blanks, routine DSLINT controls the initialization flag. Initialization flag values are:

1 - Normal start of period

2 - Period restart

3 - First period of the game

(12) Block L100, 17. If the ECS control flag ECSFLG is set to 1 the system routine OPENMS is called to open and establish a file on Extended Core Storage.

(13) Block 18. The character codes representing various equipment item codes are retrieved from file 36 and loaded into common EQUIPT.

(14) Block 19. Establish common USTDTA which contains the Blue and Red unit size estimate table. This information is loaded onto data file 36 by routine INCSLD in DIVPREP.

(15) Block 20. Establish the constant data in common TCFDTA. This consists of fire unit status and weapon parameter data for both Blue and Red. This data is originally loaded on to data file 25 by the DIVPREP routines TACLD and AFMLD.

(16) Block 21. If the first period initialization flag is set branch to L150, otherwise continue.

(17) Block 22. Establish common INC DAT by transferring INC's dynamic data from file 36. This data consists of range limits for artillery and attack helicopter, request delay times for helicopters and CAS, active target arrays, and redundant sensing report numbers for both Blue and Red.

(18) Block 23. Establish common ZON DAT by getting the previous feba characteristics and division list from file 36.

(19) Block 24. Establish common TWO from data file 36. This data consists of Blue and Red unit information and the previous event table. Unit information includes unit identification table, unit type designation table and unit location table.

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(20) Block 25. If the ECS flag, ECSFLG, is equal to zero branch to L400, otherwise continue.

(21) Block L350. The unit status file of each Blue and Red resolution unit will be created and dynamically maintained throughout the run in Extended Core Storage to eliminate disk accessing.

(22) Block L400. If the initialization flag does not indicate a period restart branch to block 28, otherwise continue.

(23) Block 26. Transfer the following dynamic data from file 36 to their respective labeled common areas: sensor locations to TWO, quadrature codes to ENGTRI, weather zones to ONE.

(24) Block 27. Set initialization flag to restart for the remainder of the routine. Then branch to L7000.

(25) Block 28. Set the IUID of the last Blue unit and the IUID of the first Red unit into BPOINT and RPOINT, and store in common ONE. Also from file 36 transfer three ENGINEER submodel control variables to common ENGTRI.

(26) Block L150. Set the weather zone data into common ONE. This data was loaded in DIVPREP routine WETHLD and stored on data file 4.

(27) Block 29. Set food consumption rates from file 11, mobility category codes and rate default table from file 14, and the move priority table from file 9 into labeled common ONE. Also set the break-point temperature to 90 degrees.

(28) Block L1300. Establish sensor location data in common TWO from file 20.

(29) Block 30. Set the initial seed from the random number generator routine RANDU to 1000 and store it in labeled common area ONE.

(30) Block 31. If the initialization indicator is set for start of period initialization branch to L6001, otherwise continue.

(31) Block L5000. Create data file 16 as a period processor scratch file.

(32) Block 5005. Using data file 5 as a scratch area transfer data file 31 to the end of the disk. This file has records periodically added to it, causing all data loaded above it to be shifted. This is a very time consuming exercise that will be eliminated by the transfer.

(33) Block L5026. Initialize all event table entries to 7000000.

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(34) Block L5035. Create data file 12 as a communication link between period processor submodels.

(35) Block 32. Initialize sensor report number array to zero and store in common INCDAT.

(36) Block 33. Call routine EVTSET to set the first CSS event to occur 1 hour into the period.

(37) Block L6000. In the DIVPREP routine TOELD unit status file skeletons were created containing unit identification, location, and their respective on-hand equipment. The identification and location data for each created unit is now transferred from the unit status file to tables in common TWO, namely, a UID, UTD, and unit location table. Since the TOELD several other DIVPREP load programs have added pertinent unit information to the data base. At initialization time this information is extracted from the data base by UTD type and loaded into the appropriate unit status file.

(38) Block L6001. The start of period logic rejoins the start of game logic.

(39) Block 34. File 48 is created at the beginning of each period. This file is dynamically filled with pertinent loss data each time a unit assessment is made due to fire-power losses. The file is then used for post period reports.

(40) Block L6500. Routine UPMASK is called for all resolution units at the first period of a game initialization. This routine creates the dominate mask array on the unit status file, and also sets the unit location at which the mask was made. The mask array is used to determine line-of-sight by various fire-power submodels.

(41) Block 35. For new period initialization set the starting period time to zero.

(42) Block 36. If either the barrier or mine field data files have not been loaded branch to L7000, otherwise continue.

(43) Block 37. Call routine INITMN to schedule an ENGINEER submodel event to continue efforts on a mine field that was started but not completed in the preceding period.

(44) Block L7000. Restart initialization logic rejoins here.

(45) Block 38. Routine IOTERN is called to establish the terrain cell size and the number of cells in the X and Y direction and to store this data in common ONE.

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(46) Block 39. Is console switch 6 on? -- not branch to block 41, otherwise continue.

(47) Block 40. Switch 6 being on indicates a desire to terminate a period which up to this point had not been normally terminated. In short, the status of some data files are in a restart format and must be converted to end-of-period format. This is accomplished by calling routine XXIT with the first calling argument equal to the characters FINI.

(48) Block 41. Routine COMMDP dumps pertinent start of run information for the ease of run verification or debug purposes.

(49) Block 42. End of routine INITIAL.

### 3. ROUTINE LOCTAP:

Not used.

### 4. ROUTINE COMMDP:

a. Purpose. This routine dumps common ONE and TWO and data file 16 at the beginning and end of each period to allow the data to be checked.

b. Input Variables. Common ONE and TWO and data file 16 data.

c. Output Variables. Listings of variables.

d. Logical Flow (Figure IV-17-B-2).

(1) Block 1. The contents of common ONE are printed with appropriate headings.

(2) Block 2. The event codes and event times are unpacked from the event table and printed.

(3) Block 3. The UID, UTD, and location tables are printed sequentially.

(4) Block 4. The barrier data, equipment code arrays, and sensor location tables are printed with identifying headings.

(5) Block 5. The DSL labels associated with the units from data file 55 and the Intelligence and Control data stored in data file 16 are obtained and printed with appropriate headers.

(6) Block 6. The secondary equipment tables are retrieved and printed with descriptive titles. Return control to the calling routine.

### 5. ROUTINE XXIT:

a. Purpose. This routine allows information to be printed and dumped before a routine EXIT1 is called to terminate the job or to make a restart tape.

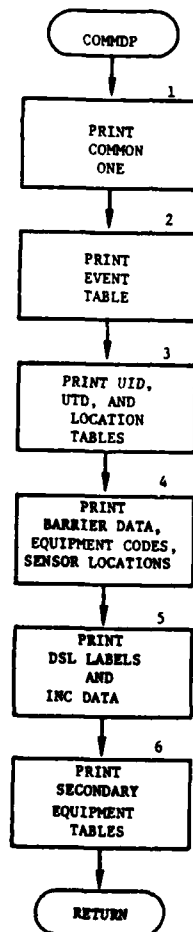


Figure IV-17-B-2. Routine CC DP



b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IALFA	Call	A four-character alphanumeric code describing the reason XXIT was called.
IER	Call	A numeric error code.

c. Output Variables. None.

d. Processing Description. If IALFA is set at 4HFINI (period completed), 4HOPER, or 4HTIME, call EXIT1 and stop processing. If IALFA is set at 4HRSTM, call EXIT1 and return control to the calling routine. If IALFA is set to any other value, call the system routine to dump common ONE and TWO, call EXIT1, and stop processing.

6. ROUTINE EXIT1:

a. Purpose. This routine adjusts parameters as required at the end of a period and writes the end-of-period dump tapes. It also writes the restart dump tapes.

b. Input Variables:

- (1) Common ONE and TWO.
- (2) Other Variable:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IALFA	TWO	A four-character alphanumeric code describing the reason EXIT1 was called.

c. Output Variables:

- (1) Common ONE and TWO.
- (2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
ONE	DF36	Data to be stored.
TWO	DF36	Data to be stored.

d. Logical Flow (Figure IV-17-B-3):

(1) Block 1. The four-character alphanumeric code IALFA indicates the reason EXIT1 was called. IALFA of OPER denotes an operator termination, TIME indicates the computer run time was exceeded, RSTM means a request to create a restart tape is being made, and FINI denotes the period is completed.

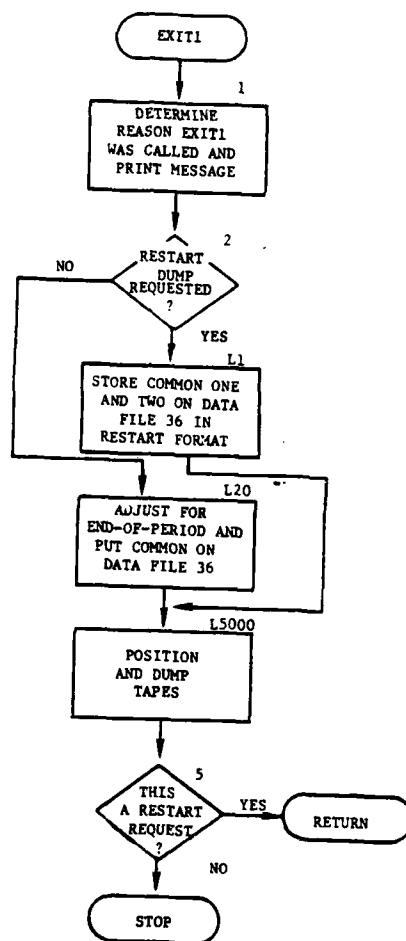


Figure IV-17-B-3. Routine EXIT1

IV-17-B-16

Any other code is assumed to indicate a fatal error. An appropriate message is printed for each error.

(2) Block 2. If a restart tape is requested, transfer control to block L1, otherwise control goes to block L20.

(3) Block L1. Data stored in common ONE and TWO are moved to data file 36 in restart format. The word IRST, indicating a restart tape is to be created, is set to REST. Control transfers to block L5000 to write the tape.

(4) Block L20. Process the necessary adjustments for termination of a period. The times stored in data file 20 associated with intelligence sensors are adjusted by subtracting TCLOCK. The unit status record of each unit is updated by subtracting TCLOCK from LTASMT and ENGTMT and by setting NTIME and BATID, to zero. All events in the table of automatic events are adjusted by subtracting TCLOCK, and all DSL-ordered events are terminated. The common ONE and TWO tables are stored on data file 36.

(5) Block L5000. This block closes the dump tapes. If a restart tape is being requested, end of files are written on logical units 39 and 40, UTILDP is called to dump the data files to logical unit 41, and control goes to block 5. If this is not a restart tape request, two consecutive end of files are written on units 39 and 40 as an end-of-data indicator. One end of file is written on logical unit 41 and the data files are dumped to it. Logical unit 41 is rewound and a request that this magnetic tape be removed and another mounted is made. When the mounting is complete, a second dump of the data files is made. The routine COMMDP is called to print areas of common ONE and TWO.

(6) Block 5. If a restart tape was requested, control is returned to the routine calling EXIT1; otherwise, a message is printed and processing is terminated.

#### 7. ROUTINE SET41:

a. Purpose. This CP COMPASS routine is used to set the operating system file environment table buffer pointers for TAPE41 to point to a user-defined array to be referenced as a circular input/output buffer. This permits the routine UTILDP to be compiled with a minimum length buffer and a larger in unused core to be utilized at object time. This routine is optional but provides greater efficiency on a CDC6000 series computer.

#### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
LFWA	Call	Address of array to be used.
LEN	Call	Length of array.
LSET	Call	Flag indicating the desired setting of buffer pointer: LSET=1, Set to array. LSET=2, Reset to initial value.

c. Output Variables: None.

d. Processing Description:

(1) LSET=1. SET41 saves the initial file environment table pointers internally, sets the pointers to the array requested, and returns control to the calling routine.

(2) LSET=2. SET41 outputs data remaining in the output buffer, restores the file environment table pointers to their initial value, and returns control to the calling routine.

#### 8. ROUTINE EAT:

a. Purpose. EAT is called by MINUET three times per game day at 0800, 1200, and 1700 hours. It computes the food consumption for each resolution unit of both the Red and Blue forces.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Content</u>
RPOINT	ONE	IUID of lowest Red unit.
BPOINT	ONE	IUID of highest Blue unit.
PRESTR	ONE	Present strength of a unit.
IBFOOD	ONE	Amount of food consumed by each man per day, Blue force.
IRFOOD	ONE	Amount of food consumed by each man per day, Red force.
UNTLOC	TWO	Unit coordinate location.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Content</u>
IAMT	TWO	Amount of food consumed by a unit each eating period.
EOH(1)	DF1	Amount of food on hand for each unit.

d. Logic Flow (Figure IV-17-B-4):

(1) Block 1. Set IPASS equal to zero. Set K equal to BPOINT to initialize the Blue force.

(2) Block 2. Compute the amount of food consumed by each man of the Blue force during this eating period.

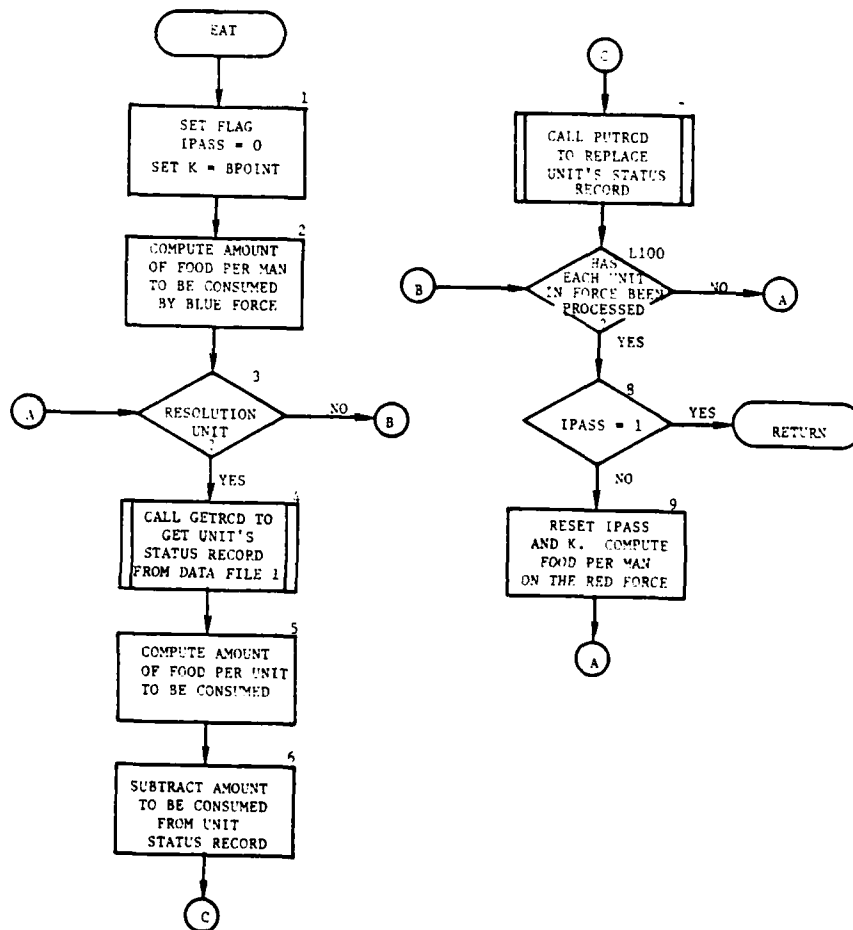


Figure IV-17-B-4. Routine EAT

(3) Block 3. Sum the X and Y coordinates of the unit. If the sum is zero, the unit is nonresolution and will not be considered.

(4) Block 4. Call GETRCD to retrieve the unit's status record from data file 1.

(5) Blocks 5 and 6. Compute the amount of food consumed by this unit during this eating period. Subtract this amount of food from the unit's status record.

(6) Block 7. Call PUTRCD to replace the unit's status record on data file 1.

(7) Block L100. If all units of the designated force have not been processed, control goes to block 3 to get the next unit.

(8) Block 8. Check IPASS. If IPASS equals one, the Red force has been processed. Control returns to the calling routine. If IPASS equals zero, processing continues.

(9) Block 9. Set IPASS equal to one. Set K equal to RPOINT to initialize Red force. Compute the amount of food to be consumed by each man of the Red force during this eating period, and transfer control to block 3.

## APPENDIX C

### OUTPUT DESCRIPTIONS OF MAJOR SPECIAL PURPOSE ROUTINES

1. INTRODUCTION. This appendix contains samples and detailed descriptions of printed output from major special purpose routines of the Period Processor. A figure depicts the format of each routine printout. In the figure an alphabetical character (descriptor) designates an appropriate line or group of lines that is explained in the paragraphs below.

2. ROUTINE INITIAL. The output of INITIAL, which initializes areas of common at the start of each period, is shown in Figure IV-17-C-1, and described as follows.

<u>Output Descriptor</u>	<u>Explanation</u>
A	The date that this Period Processor run started execution is printed.
B	The wall-clock time this Period Processor run started execution is printed.
C	After the call to DSLINT is completed, the values returned in the variables DAY, HOUR, MINUTE, LGTPER (length of period) and INTFLG (initialization flag) are printed. This information is used to verify that the correct period is on the DIVWAG data file.
D	The data that is input on the Period Processor data card is printed. This line of print contains the following: <ul style="list-style-type: none"><li>. whether the DIVWAG data file to be executed is expected to be a restart file</li><li>. the wall-clock time allowed for this computer run</li><li>. the interval in wall-clock minutes between creation of a restart dump</li><li>. the control for the print switches (1 means switch is on, otherwise it is off)</li><li>. a string of 40 characters to be printed as a heading</li><li>. the game time in centiminutes where the user desires this run to stop.</li></ul>

An additional print statement that does not appear in the figure is

RESTART CONTROL FROM FILE 36.      IRST=REST

IV-17-C-1

(A)---DIWAG START DATE= 02/14/73  
 (B)---DIWAG START TIME= 20.13.30.  
 (C)---OSLINT SET DAY HOUR MINUT LSTPER INTPLG  
                   1 5 3 24306 1  
 (D) [PERIOD PROCESSOR DATA CARD  
       ENGT 600 60 1 1 1 1 20000 4 ENGINEER SPECIAL 24111

Figure IV-17-C-1. Printed Output Sample from Routine INITIAL



The value of the restart control is obtained from the DIVWAG data file. This value can be either REST which indicates it is a restart dump or zero which prints as blanks and indicates it is not a restart dumped file.

3. ROUTINE EXIT1. This routine adjusts parameters and writes end-of-period and restart dump tapes. The output is listed as follows:

DIVWAG ENTERED EXIT1. TIME = HH.MM.SS.

- This print occurs each time this routine is entered. It contains the time in hours, minutes, and seconds.

THE PERIOD HAS ENDED. NEW DSL MUST BE WRITTEN IN ORDER TO CONTINUE WITH DIVRUN.

When this print occurs the DSL file has been set equal to zero, a double end-of-file is put on the period history tape, a call is made to COMMDP, the times in the tables in common are reduced, ongoing ordered events are stopped, common ONE and TWO are put into data file 36, data file 21 is cleared, all tapes are rewound, and a call is made to UTILDP.

THE TAPES FOR THIS RUN HAVE AN END TIME OF DAY I III HOUR I III MINUTE I III

This print contains the end of period time for this run.

A RESTART TAPE HAS BEEN CREATED AT DAY = I III HOUR = I III MINUTE = I III

This print occurs when a restart tape is to be created, indicated by RSTM in IDUM(2). An end-of-file is written on the period history tape, common ONE and TWO are put into data file 36, and a call is made to UTILDP.

DIVRUN HALTED DUE TO COMPUTER RUNNING TIME. PERIOD MAY BE CONTINUED BY A DIVRUN RESTART.

This print occurs when computer running time has been exceeded. Double end-of-files are put on the period history tape, common ONE and TWO are put into data file 36, the tapes are rewound, and calls are made to UTILDP and COMMDP.

DIVRUN TERMINATED BY THE OPERATOR. PERIOD MAY BE CONTINUED BY A DIVRUN RESTART.

This print occurs when the Period Processor run has been terminated by the operator. The value of IDUM(4094) is set equal to 32 and the program continues the same as for termination for time.

EXIT FROM SUBROUTINE AAAA BECAUSE OF ERROR. ERROR NO. IER = I IIIII

This print occurs when a call is made to this routine by any routine in the model. The calling routine is indicated by AAAA and the value of IER is printed. A call is made to COMMDP to dump core and execution stops.

4. ROUTINE COMMDP. At the beginning and end of each Period Processor run, the routine COMMDP is called to print key information as it exists at the current game time. A sample printed output from routine COMMDP appears in Figure IV-17-C-2 and is described as follows:

<u>Output Descriptor</u>	<u>Explanation</u>
A	The IFNT array is printed under the heading of FILE NAME TABLE.
B	Several values of labeled common ONE are printed. These variables and their meanings are described under the description of data file 36 in Chapter 2 of Section VII, DIVWAG Data Files.
C	The EVENT TABLE is printed after unpacking the event code and event time. It is read by counting across the line of print for each 10 entries of the event table.
D	The UNIT INFORMATION that is printed is read across the line of print as follows: the unit identification number, the unit identification code, the unit type designator, and the unit location (first X coordinate followed by Y coordinate).
E	The BARRIER DATA array is printed as read from data file 16.
F	The EQUIPMENT CODES are read from data file 16 and printed. The Blue force is printed first followed by the Red force.
G	The SENSOR LOCATIONS for each of the forces are printed as follows: five sensors per line of print with the X coordinate followed by the Y coordinate for each sensor, Blue force is the first 100 sensors followed by the Red force.
H	This is a dump of the unit battle directory table which is described in detail in Appendix C, Chapter 2, Section III.
I	The INCS DATA is the intelligence data that is stored on data file 16 beginning at word 7101 through word 10501. This data is described in the section on Data File 16 in Chapter 2 of Section VII.

5. Routine UTILDP. Routine UTILDP of the Period Processor is identical to the utility dump program described in Chapter 4 of Section VII with the following exceptions:

- a. The program card is replaced by a subroutine card.
- b. A return statement is inserted before the end card.
- c. The call to OPENMS is removed.

FILE NAME TABLE

1	27393	512	1000
2	2607A69	15	4250
3	1713610	10	15001
4	198273	9	3013
5	0	0	0
6	566273	10	400
7	1930493	310	52
8	1367620	3210	1
9	1976393	1900	5
10	0	0	0
11	976272	512	249
12	2149A42	15	3000
13	136A820	411	401
14	1984583	70	950
15	1981383	210	16
16	2129842	20010	1
17	1103710	732	157
18	2511A69	6	1300
19	20025A3	120	50
20	956222	70	1300
21	539393	256	105
22	2756619	752	20
23	2054376	5	200
24	19660A3	1212	25
25	257	27092	1
26	1527621	72	616
27	1571973	112	1010
28	2009583	199	217
29	920570	216	72
30	2462442	2149	23
31	2059376	10	4105
32	0	0	0
33	0	0	0
34	0	0	0
35	0	0	0
36	936172	21130	1
37	2517A69	60	1500
38	0	0	0
39	2101326	14250	2
40	0	0	0
41	1A24043	340	84
42	1957603	640	21
43	196FA83	1430	4
44	18804A3	110	500
45	1681973	15	4332
46	0	0	0
47	0	0	0
48	7254A42	1212	50
49	0	0	0
50	570273	222	1000
51	772273	1010	2
52	774273	212	500
53	475273	74	750
54	0	0	0
55	2315442	21	7000
56	0	0	22

Figure IV-17-C-2. Routine COMMDP Printed Output Sample (Continued on Next Page)

Figure IV-17-C-2. Routine COMMDP Printed Output Sample (Continued)



UNIT INFORMATION					
1	R127H0BT	IACI	3	0	
2	R160PNTT	UPTJ	3	0	
3	R160PNTT	UPTJ	3	0	
4	R114PNTT	UPTJ	3	0	
5	R114H0DS	IFCA	3	0	
6	R114PNTT	UPTJ	3	0	
7	R111H0AP	ITCT	3	0	
8	R110EVAAD	JAFD	3	0	
9	R112PNTT	UPTJ	3	0	
10	R114H0MT	IMCT	3	0	
11	R1000CAC	JAFD	3	0	
12	R121PNTT	UPTJ	3	0	
13	R121H0AP	ITCT	3	0	
14	R100VPAAD	JAFD	3	0	
15	R1627HNT	UPTJ	3	0	
16	R101H0CA	IMCD	3	0	
17	R1000PAP	JAFD	3	0	
18	R1000VTT	UPTJ	3	0	
19	R101THCA	IMCD	3	0	
20	R112H0DS	IFCA	3	0	
21	R124PNTT	UPTJ	3	0	
22	R127H0AT	ITCT	3	0	
23	R150PNTT	UPTJ	3	0	
24	R112H0AT	IACI	3	0	
25	R1037HNT	UPTJ	3	0	
26	R10CAVPT	JCLH	3	0	
27	R10HNPPT	VCLH	3	0	
28	R150T1PP	VCLH	134433	75200	
29	R150T2PP	VCLH	134433	45200	
30	R127H0AH	TACH	3	0	
31	R100PNTT	UPTJ	3	0	
32	R123SVAH	IACH	3	0	
33	R10TKTPT	VCLH	3	0	
34	R10TK1PP	VCLH	106203	77100	
35	R10TK2PP	VCLH	137537	36200	
36	R10TK3PP	VCLH	114733	71200	
37	R113H0AC	ITCH	3	0	
38	R173PNTT	UPTJ	3	0	
39	R113CVAC	ITCH	3	0	
40	R10007SP	EBLL	3	0	
41	R10000SP	JCLL	3	0	
42	R1000RST	JCLL	3	0	
43	R1000RST	JCLL	3	0	
44	R10007FM	ECSE	31133	95100	
45	R10100FM	JCSF	3	0	
46	R10100FM	JCSF	3	0	
47	R1000RST	ECSE	3	0	
48	R10227AT	ECMI	47333	95500	
49	R10228AT	IRMI	3	0	
50	R10229AT	IRMI	3	0	
51	R1022CAT	IRMI	3	0	
52	R1220SAT	IFGI	3	0	
53	R10007SC	ECSS	3	0	
54	R10100RM	ECOS	30133	94100	
55	R10007AP	EASD	3	0	
56	R10000AP	JMCD	99103	94100	
57	R10007TI	ETIJ	99633	94400	
58	R10000TI	IJCJ	3	0	
59	R10007TI	JCTJ	3	0	
60	R10007MN	FMLL	3	0	
61	R10007MN	JMCL	3	0	

Figure IV-17-C-2. Routine COMMDP Printed Output Sample (Continued)



IV-17-C-10

Figure IV-17-C-2. Routine COMMDP Printed Output Sample (Continued)





1	PS441880	1	202
2	P1202FA	1	208
3	Q1202FA	2	214
4	Q1202FA	1	221

Figure IV-17-C-2. Routine COMDP Printed Output Sample (Continued)



APPENDIX D

SOURCE LISTINGS FOR PERIOD PROCESSOR MAJOR SPECIAL PURPOSE ROUTINES

(AVAILABLE UNDER SEPARATE COVER)

IV-17-D-1

## CHAPTER 18

### DIVWAG SCENARIO LANGUAGE INTERFACE ROUTINES

1. GENERAL DESCRIPTION. The routines discussed in this chapter are used by the Period Processor to access the tables written by the DIVWAG scenario language compiler. The Period Processor must access these tables to acquire the next order that a unit is to execute, to obtain a list of the units participating in a particular battle, or to determine if a condition of battle termination has been met. The purpose of each routine is discussed in the subsequent paragraphs.

2. ROUTINE DOSR. The primary purpose of this routine is to provide the event scheduling routine with the next order a particular unit is to execute. This is accomplished by finding the unit identification (UID) input to DOSR in the unit battle directory table (UBT),<sup>1</sup> retrieving its unit scenario from the data file, determining the next order the unit is to execute, and returning that order, in the form of an array, to the routine calling DOSR. The orders are executed in the order in which they occur in the scenario unless the scenario contains a conditional or the pseudo order GOTO. If a GOTO is encountered, the order indicated will be returned. If a conditional is encountered, it will be passed to routine TRUTH for processing, and the order dictated by the value of the conditional as determined by TRUTH (TRUE or FALSE)--will be returned. DOSR will also return orders to be executed by a force (e.g., engineering task) upon request. This routine is also responsible for the storage of the unit scenario pointer to the order the unit is currently executing; the pointer is stored in the unit battle table.

3. ROUTINE DBSR. This routine has the task of determining if a particular battle should be concluded and setting up the orders to be executed by the participating units upon conclusion of the battle. The first part of the task is accomplished by locating the battle identification input to DBSR in the unit battle table, retrieving its battle paragraph from the data file and requesting that each conditional in the battle paragraph be processed by TRUTH until all of the conditionals have been processed or one is found to be true. The pointers to the orders that the units are to execute upon conclusion of the battle are available from the battle paragraph. DBSR substitutes these pointers for the order pointers for each unit currently stored in the unit battle table.

4. ROUTINE TRUTH. The function of this routine is to determine if the conditional is true or false. No distinction is made between unit scenario and battle paragraph conditionals. The process required to determine the truth of a conditional is dependent upon the nature of the conditional. It can be as simple as comparing the time in the conditional to the current game time, or as complex as retrieving a unit status file, finding the percentage of an

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1. See Section III, Chapter 2, DSL Compiler, for a description of the tables mentioned in this chapter.

equipment item on hand, comparing it to the value in the conditional, and negating the result.

5. ROUTINE BSUIDL. This routine's only task is to provide a list of the unit identifications of the units participating in a particular battle.

## APPENDIX A

### INPUT REQUIREMENTS FOR DIVWAG SCENARIO LANGUAGE INTERFACE ROUTINES

The input to the DIVWAG scenario language (DSL) interface routines consists of the tables generated by the DSL compiler (described in Section III, Chapter 2, DSL Compiler) and various constant data files (e.g., unit status file, terrain data file, weather data file).

## APPENDIX B

### DIVWAG SCENARIO LANGUAGE INTERFACE PROGRAM DESCRIPTIONS

1. INTRODUCTION. The routines described in this appendix access and extract data from the DIVWAG Scenario Language (DSL) order file, written by the DSL Compiler, when required by the Period Processor.

#### 2. ROUTINE DSLINT:

a. Purpose. This routine initializes the variables in Common DSL and some variables in Common ONE.

##### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IDUM	ORDFIL	Common variables set by this routine.

##### c. Output Variables:

(1) Standard Common Block Variables. DAY, HOUR, MINUTE, LGTPER, and INTFLG.

##### (2) Other Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
ORDFIL	DSL	DSL data file number.
BATPT	DSL	Pointer to first battle in unit and battle directory table.
UNTPT	DSL	Pointer to last unit in unit and battle directory table.
OUT	DSL	Logical file name of printer.

d. Processing Description. This routine initiates the values of ORDFIL and OUT with constants. It then reads and stores the appropriate values of DAY, HOUR, MINUTE, LGTPER, INTFLG, BATPT, and UNTPT from the data file designated by ORDFIL.

#### 3. ROUTINE DOSR:

a. Purpose. This routine extracts the next order that the unit (UID) is to process from its unit scenario and returns it in the DST array.

##### b. Input Variables:

(1) Standard Common Block Variable. TCLOCK.



(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
UID	Call	Identification of unit for which the order is to be returned.
DST(1)	Call	P count indicator: <ul style="list-style-type: none"><li>• If PKNT is less than zero, P counter is to be incremented (See FRCORD exceptions below).</li><li>• If PKNT is greater than zero, P counter is not to be incremented.</li><li>• If PKNT is equal to zero, P counter is not to be incremented; but, if P counter points to an order involving a series of coordinates (e.g., move, fly), P counter will be set to point to the order containing the first coordinate of the series and that order will be returned.</li><li>• If PKNT is equal to 998, a first call by FRCORD is indicated.</li><li>• If PKNT is equal to 999, a subsequent call by FRCORD is indicated.</li></ul>
ORDFIL	DSL	DSL data file number.
UNTPT	DSL	Pointer to last unit in unit and battle directory table.
OUT	DSL	Logical file name of printer.
UBT	DF ORDFIL	Unit and battle directory table.
OARY	DF ORDFIL	Unit scenario.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
UBT	DF ORDFIL	Updated P counter.
DST	Call	Next order that unit is to execute.

d. Logical Flow (Figure IV-18-B-1):

(1) Block 1. If DST(1) (IDST), is equal to 999 a subsequent FRCORD call is indicated and control is transferred to block L2010.

(2) Block L1000. Unit and battle directory table is brought into core and scanned for a UID match. If one is not found, an error message is printed; otherwise, the unit scenario of that unit is brought into core.

(3) Block 2. IDST is checked to determine what is expected of DOSR with control being transferred to blocks L2010, L2402, or L2500 for negative, zero, or positive values respectively.

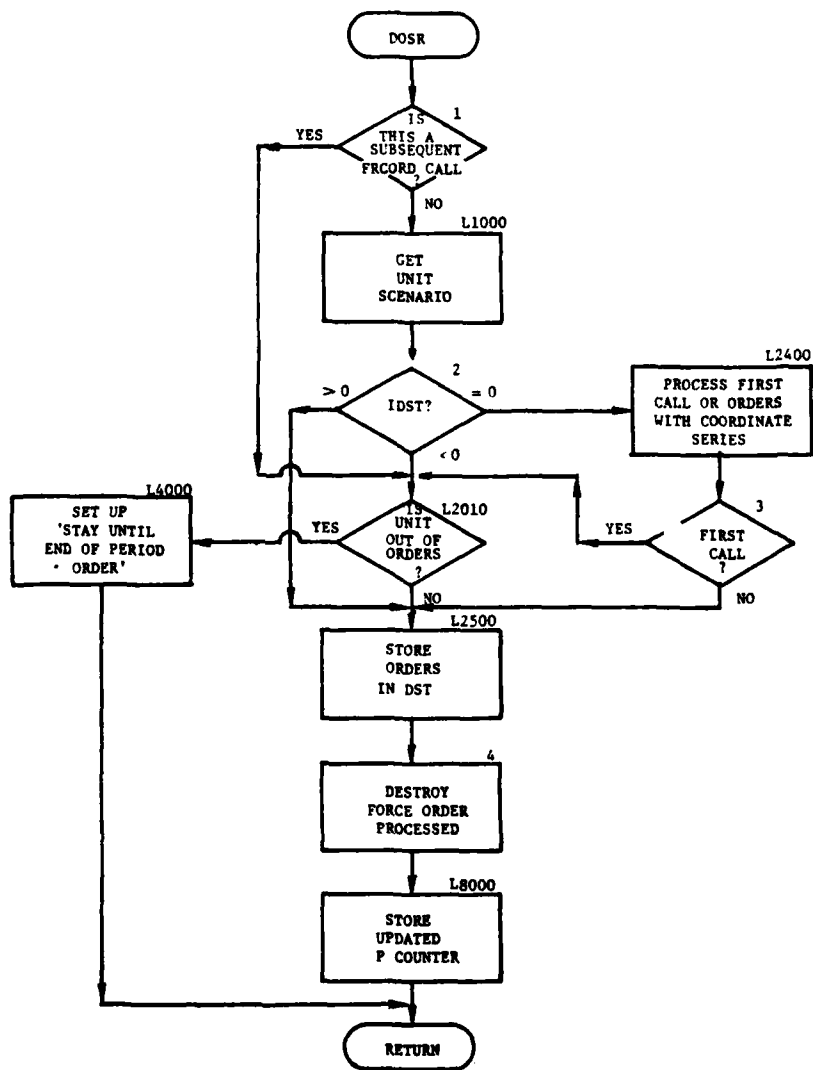


Figure IV-18-B-1. Routine DOSR

(4) Blocks L2400 and 3. The initial call to DOSR for each unit's orders is made with DST(1) set equal to zero. If the P counter (PKNT) of the unit is zero, it is reset to one and control is transferred to block L2010. If PKNT points to an order containing coordinates (e.g., fly, move), it will be decremented until it points to the unit and battle directory table order in that series and that order will be returned; otherwise, the order that PKNT points to will be returned.

(5) Block L2010. OARY(21,PKNT) is checked to determine if PKNT is to be incremented by one or set equal to OARY(21,PKNT). If PKNT points to a conditional, TRUTH is called to process the conditional, PKNT is set to the value indicated, and the process is repeated. If PKNT is greater than the number of orders in this unit scenario, control is transferred to block L4000; otherwise, control transfers to block L2500.

(6) Block L4000. When a unit has finished processing all of its DSL orders, it is assigned to stay until end of period.

(7) Block L2500. The next order to be executed by the unit is stored in DST. If the second word of DST is less than zero, it is a relative time and must have TCLOCK added to it.

(8) Block 4. Orders for a force are not necessarily executed in input sequence. As an order is returned to FRCORD for processing, its first word in the unit scenario is set to zero; therefore, it will not be returned again.

(9) Block L8000. The P counter for the unit is updated and restored in unit and battle directory table on the order data file.

#### 4. ROUTINE DBSR:

a. Purpose. This routine determines if any conditional of battle termination has been met and returns an indicator. If it has been met, the P counter associated with each participating unit is set to the order to be executed after battle termination.

##### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
BID	Call	Battle identification.
ORDFIL	DSL	DSL data file number.
BATPT	DSL	Pointer to first battle in unit and battle directory table.
OUT	DSL	Logical file name of the printer.
UBT	DF ORDFIL	Unit and battle directory table.
OARY	DF ORDFIL	Battle scenario.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IOVER	Call	Battle completion indicator: IOVER = 1, battle is completed. IOVER = 0, battle is not completed.
UBT	DF ORDFIL	Unit and battle directory table.

d. Logical Flow (Figure IV-18-B-2):

(1) Block L1010. This block searches the unit and battle directory table for the battle requested (BID), and prints an error message if it is not found. If it is found, the record pointer from the unit and battle directory table is used to retrieve the battle scenario from the order data file.

(2) Block L3010. The battle scenario is processed to determine if any of the conditions that terminate the battle have been met. If a terminating condition has been met, control is transferred to block L3020.

(3) Block L4000. IOVER is set to zero indicating the battle is not completed and control is returned to the calling routine.

(4) Block L3020. IOVER is set to one indicating the battle will terminate, and the list of participating units and the associated P counters are stored. The portion of the unit and battle directory table applying to units is brought into core.

(5) Blocks L3055 and L3060. The location of each participating unit is found in the unit and battle directory table and the unit's P counter is set to the order that the unit is to execute after battle termination.

5. ROUTINE BSUIDL:

a. Purpose. This routine returns the identification of units participating in the designated battle and the number of units in the list.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
ORDFIL	DSL	DSL order data file number.
BATPT	DSL	Pointer to first battle in unit and battle directory table.
OUT	DSL	Logical file name of printer.
BID	Call	Battle identification.
UBT	DF ORDFIL	Unit and battle directory table.

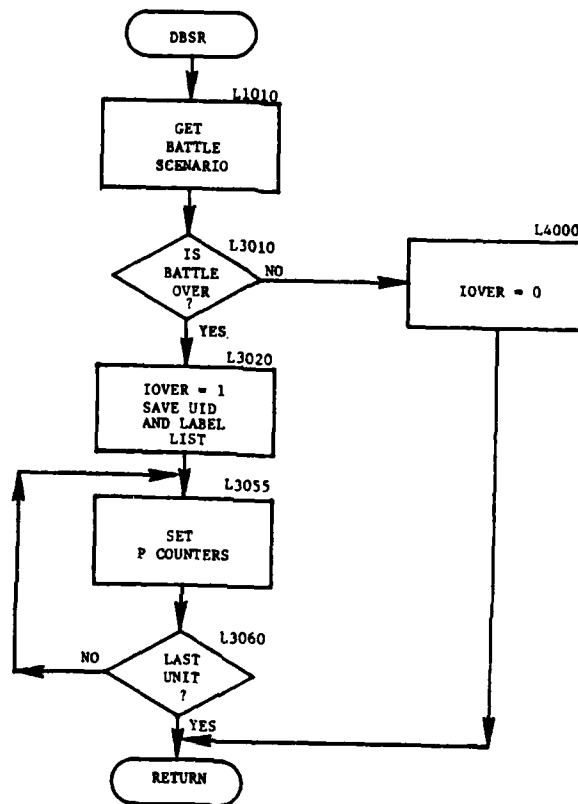


Figure IV-18-B-2. Routine DBSR

<u>Name</u>	<u>Source</u>	<u>Contents</u>
BAD	DF ORDFIL	Participating unit list.
LIST	Call	Total number of units in battle and a list of each UID.

d. Processing Description. This routine gets the unit and battle directory table (UBT) into core, and uses it to locate the battle scenario on ORDFIL. An error message is printed if it cannot be found. The unit and battle directory table also provides the total number of units in this battle that is stored in LIST(1). The UIDs are stored in reverse order beginning in LIST(2).

#### 6. ROUTINE TRUTH:

a. Purpose. This routine determines if a DSL conditional clause is true or false. If the conditional is true, a logical value of true will be returned; otherwise, a false value will be returned.

##### b. Input Variables:

(1) Standard Common Block Area. UMAIN.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
DOST	Call	Variables describing the conditional.

##### c. Output Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
TRUTH	Call	Logical (.TRUE. or .FALSE.)

##### d. Logical Flow (Figure IV-18-B-3):

(1) Blocks L75 and 1. These blocks determine the type of conditional, and the appropriate transfer is made.

(2) Blocks L8, L9, and L10. These blocks are the transfer points for the firing, moving, and stopped conditionals. J is set equal to the event code that corresponds to the type of the conditional and D is initialized.

(3) Block L91. TRUTH is set equal to D.

(4) Block 2. GET EVT is called to retrieve the event code of the unit.

(5) Blocks 3 and L88. If the event code (IE) is equal to J, TRUTH is set opposite to its initial value.

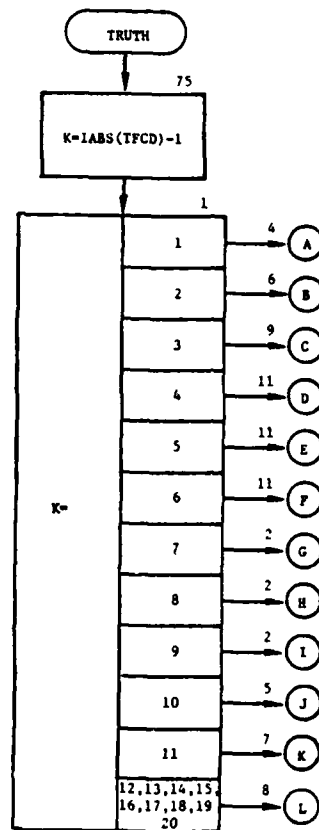


Figure IV-18-B-3. Routine TRUTH (Continued  
on Next Page)

IV-18-B-8

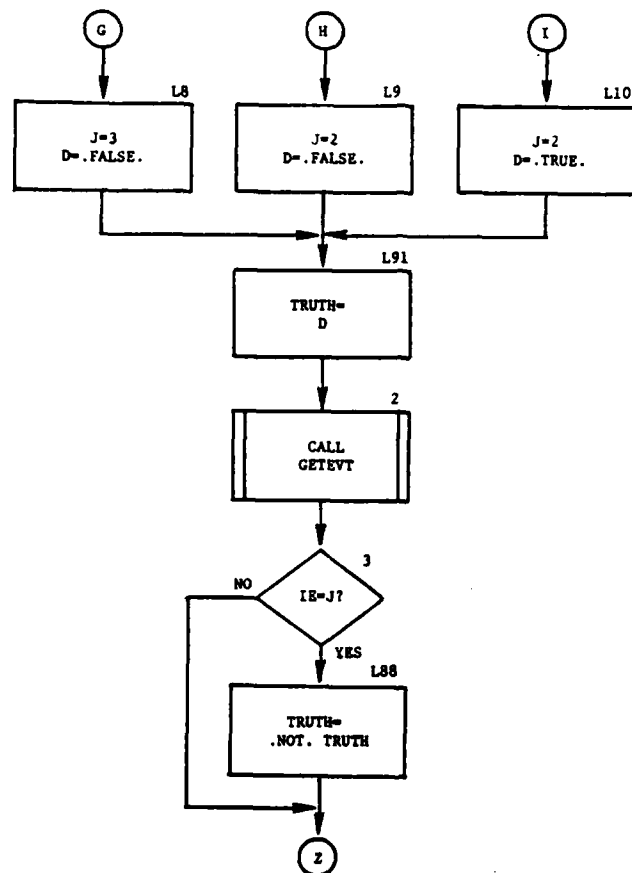


Figure IV-18-B-3. Routine TRUTH (Continued)



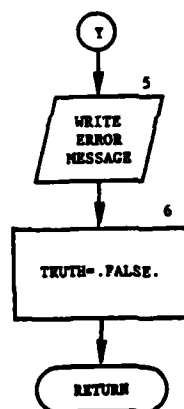
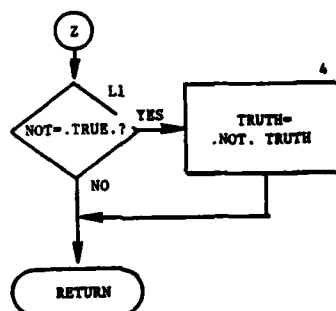


Figure IV-18-B-3. Routine TRUTH (Continued)

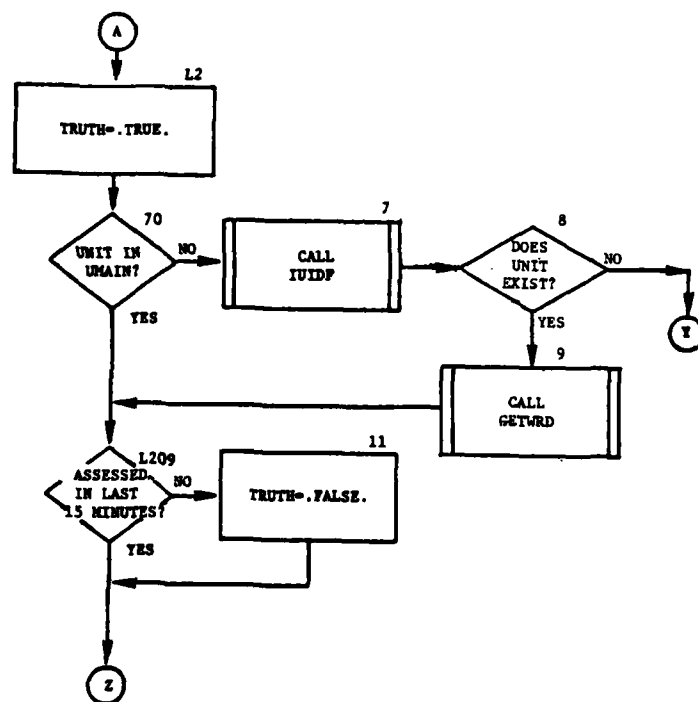


Figure IV-18-B-3. Routine TRUTH (Continued)

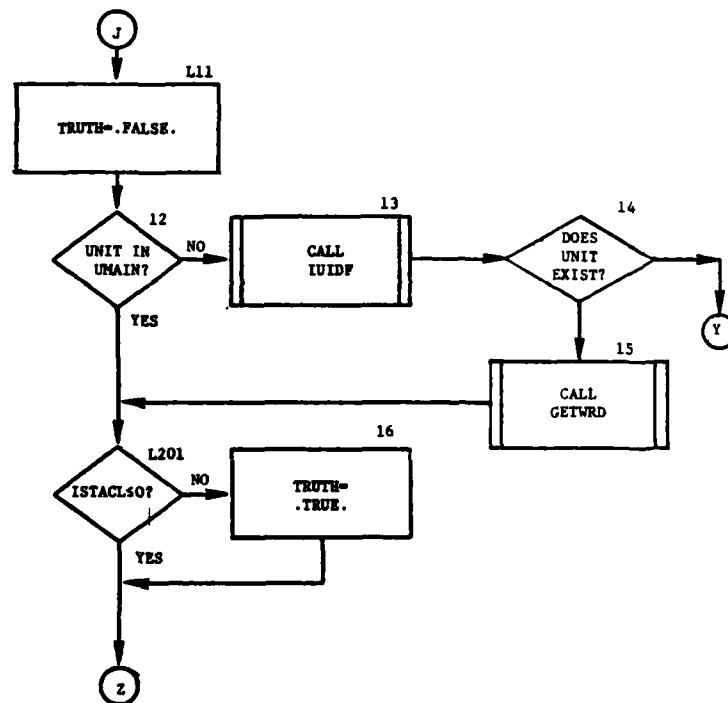


Figure IV-18-B-3. Routine TRUTH (Continued)

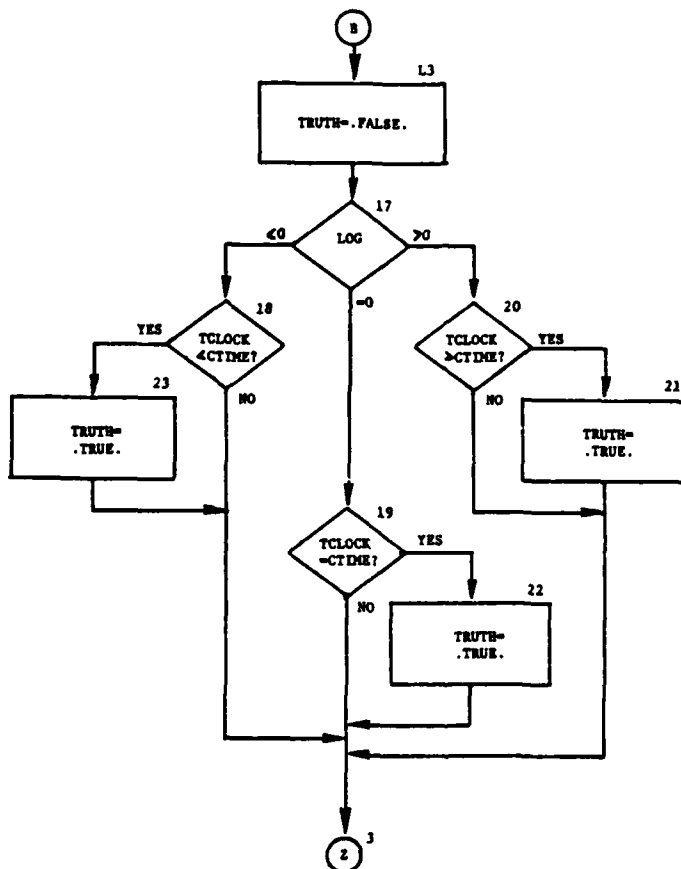


Figure IV-18-B-3. Routine TRUTH (Continued)

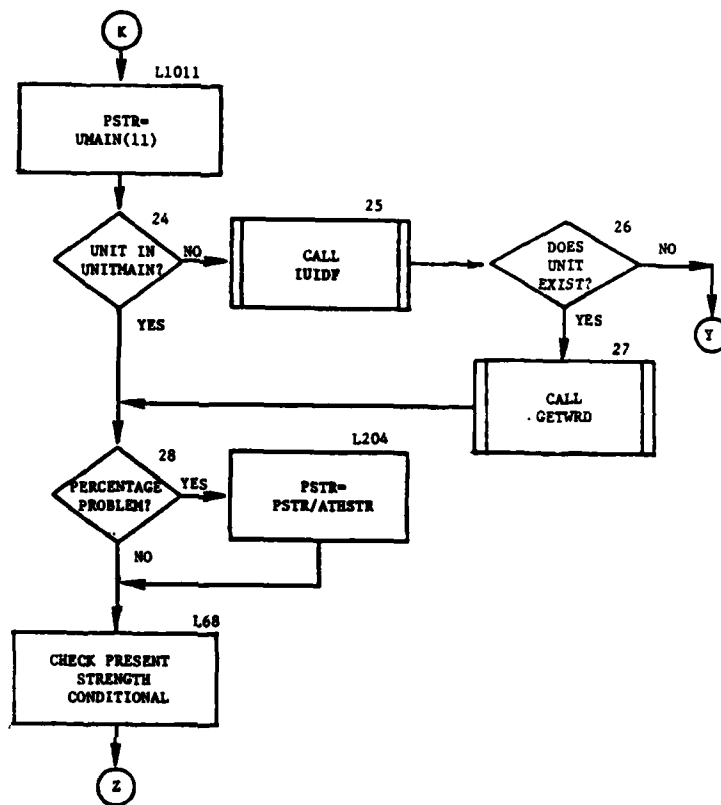


Figure IV-18-B-3. Routine TRUTH (Continued)

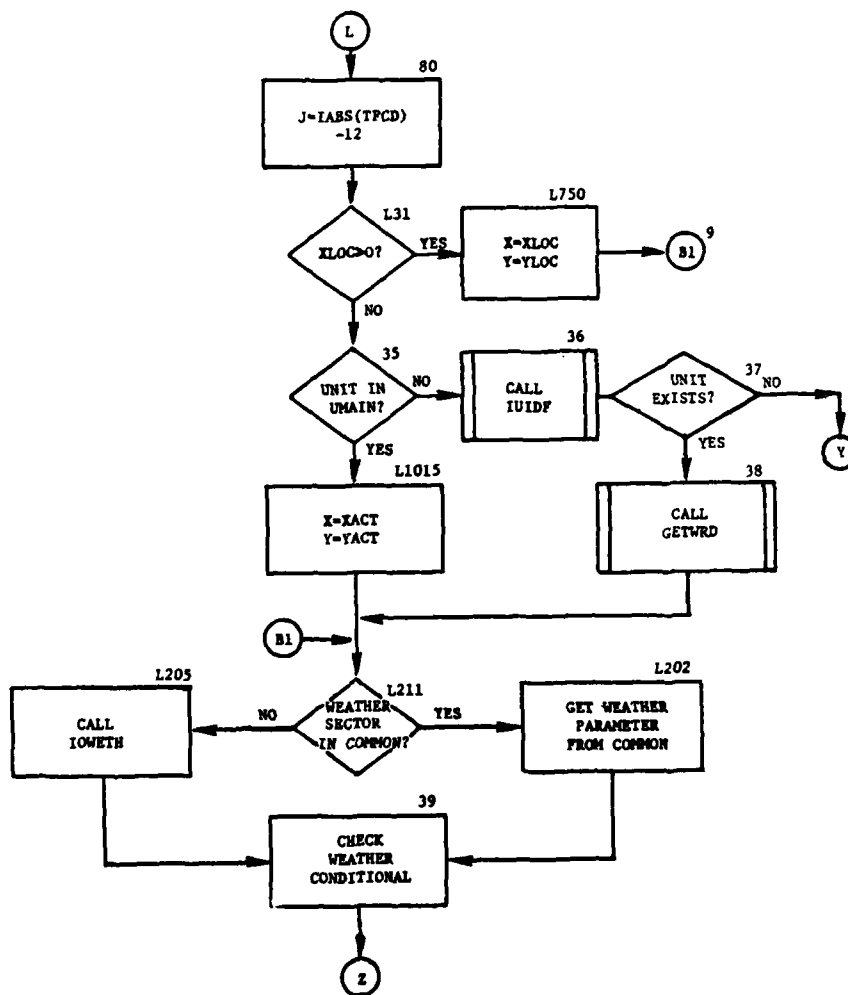


Figure IV-18-B-3. Routine TRUTH (Continued)

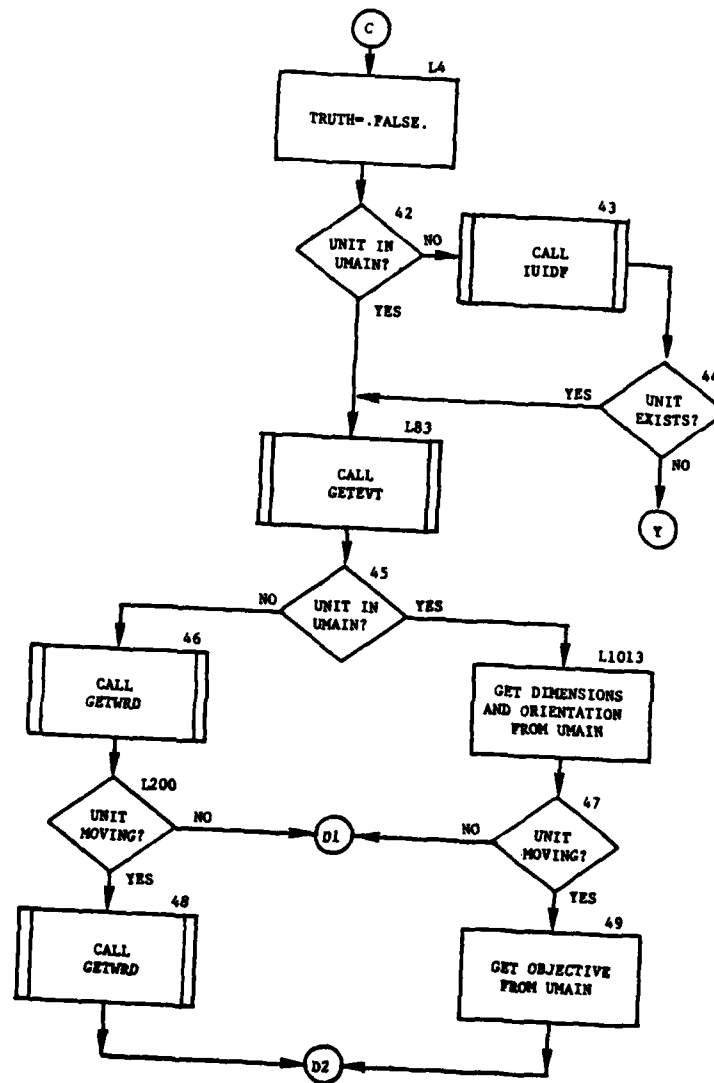


Figure IV-18-B-3. Routine TRUTH (Continued)

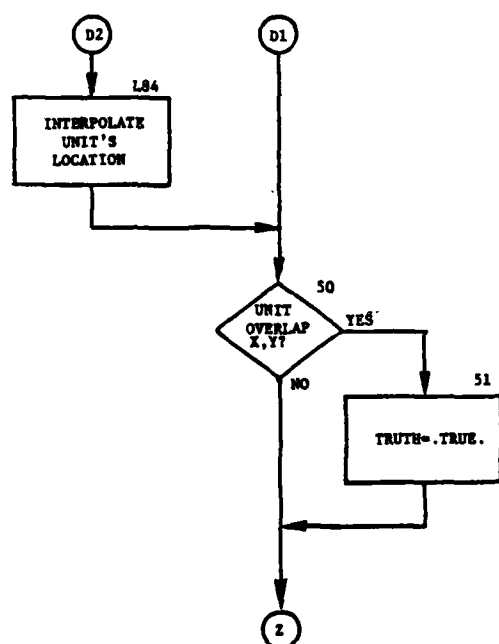


Figure IV-18-B-3. Routine TRUTH (Continued)



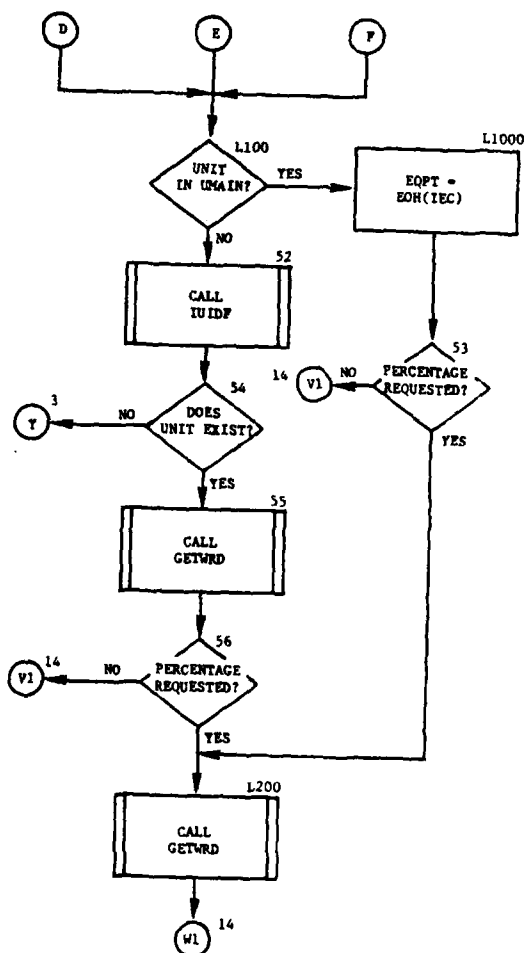


Figure IV-18-B-3. Routine TRUTH (Continued)

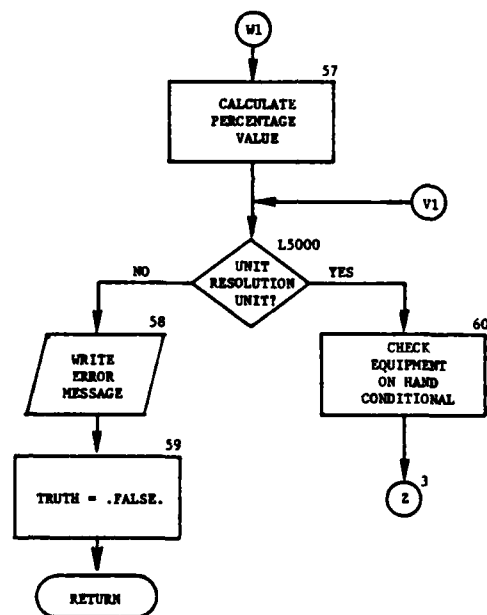


Figure IV-18-B-3. Routine TRUTH (Concluded)

(6) Blocks L1 and 4. If NOT is equal to .TRUE., TRUTH is set opposite to its initial value.

(7) Blocks 5 and 6. An error message is written stating the conditional type and that the unit does not exist. TRUTH is set equal to .FALSE..

(8) Block L2. This block is the entry point for the assessed conditional. TRUTH is set equal to .TRUE..

(9) Block L70. If the unit in the conditional is in UMAIN, the time of the last assessment (LTASMT) is in UMAIN.

(10) Blocks 7 and 8. IUIDF returns the index of the unit. If the unit does not exist, control transfers to block 5.

(11) Block 9. Routine GETWRD returns the time of last assessment.

(12) Blocks L209 and 11. If the unit has been assessed within the last 15 minutes, TRUTH is set equal to .FALSE.; control then goes to block L1.

(13) Block L11. This block is the entry point for a halted at conditional. TRUTH is set equal to .FALSE..

(14) Block 12. If the unit in the conditional is in UMAIN, the obstacle facility code (OBFACC) will be in UMAIN; and if the unit is in UMAIN, control goes to block L201.

(15) Blocks 13 and 14. IUIDF returns the index of the unit. If the unit does not exist, control goes to block 5.

(16) Block 15. Routine GETWRD returns the obstacle facility code.

(17) Blocks L201 and 16. If the obstacle facility code is less than or equal to zero, TRUTH is set equal to .TRUE., and control transfers to block L1.

(18) Block L3. This block is the entry point for the time conditional. TRUTH is set equal to .FALSE..

(19) Block 17. If the value of LOG is negative, the conditional is less than. If LOG is equal to zero, it is an equal to type conditional. If the value of LOG is positive the conditional is a greater than type.

(20) Blocks 18 and 23. If TCLOCK is less than CTIME, TRUTH is set equal to .TRUE.. Control goes to block L1.

(21) Blocks 19 and 22. If TCLOCK is equal to CTIME, TRUTH is set equal to .TRUE.. Control goes to block L1.

(22) Blocks 20 and 21. If TCLOCK is greater than CTIME, TRUTH is set equal to .TRUE.. Control goes to block L1.

(23) Blocks L1011 and 24. This is the entry point for the present strength conditional. If the unit is in UMAIN, control goes to block 28.

(24) Blocks 25 and 26. IUIDF returns the index of the unit. If the unit does not exist, control goes to block 5.

(25) Block 27. Routine GETWRD returns the present strength of the unit.

(26) Blocks 28 and L204. PVAL is checked to determine if this is a percentage type conditional. If not, control goes to block L68. If it is, the present strength is divided by the authorized strength to compute the present strength percentage.

(27) Block L68. This block determines if the amount of the unit's indicated present strength is to be compared to an absolute value or to a percentage of the unit's authorized strength. The comparison is made and TRUTH is set to .TRUE. or .FALSE. as the test dictates. Control transfers to block L1.

(28) Block 80. This block is the entry point for the following weather conditionals: Visibility index, cloud cover, temperature, precipitation index, temperature gradient, relative humidity, wind speed, wind direction, and fog index. J is set to the value that corresponds to the weather conditional being tested.

(29) Block L31. This block determines whether the conditional is a location or unit type. If XLOC is greater than zero, it is a location type and control goes to L750. If XLOC is equal to or less than zero, it is a unit type conditional; control goes to block 35.

(30) Block L750. The coordinates X and Y are set for a location type conditional, and control goes to block L211.

(31) Blocks 35, 36, and 37. If the unit is not in UMAIN, IUIDF returns the index of the unit. If the unit does not exist, control goes to block 5.

(32) Block 38. Routine GETWRD returns the location of the unit.

(33) Block L1015. X and Y coordinates are set equal to XACT and YACT.

(34) Block L211. If the weather sector is in common, control goes to block L202; if not, control goes to L205.

(35) Blocks L205 and L202. The weather parameter is obtained from IOWETH if the weather sector is not in common.

(36) Block 39. The weather parameter in the conditional is compared with the actual weather parameter and TRUTH is set to .TRUE. or .FALSE. as the test dictates. Control goes to block L1.

(37) Block L4. This block is the entry point for the at location type conditional. TRUTH is set equal to .FALSE..

(38) Block 42. If the unit is in UMAIN, control goes to block L83; if not, control goes to block 43.

(39) Blocks 43 and 44. IUIDF returns the index of the unit. If the unit does not exist, control goes to block 5; otherwise, control goes to block L83.

(40) Block L83. GET EVT returns the event code of the unit.

(41) Block 45. If the unit is in UMAIN, control goes to block L1013; if not control goes to block 46.

(42) Blocks 46 and L1013. The dimensions and orientation are obtained from the unit status record.

(43) Blocks L200 and 47. The unit's event code is checked to determine if the unit is moving. If not, control goes to block 50; if it is, control appropriately goes to block 49 (unit in UMAIN) or block 48 (unit not in UMAIN).

(44) Blocks 48 and 49. The unit's objective coordinates are obtained, and control goes to block L84.

(45) Block L84. This block determines the unit's actual location of a moving unit.

(46) Blocks 50 and 51. A check determines if the locations overlap. If they do, TRUTH is set equal to .TRUE., and control goes to block L1.

(47) Block L100. This block is the entry point for class III, class V, and equipment type conditionals. Determine if the unit is in UMAIN. If so, control goes to block L1000; if not, control goes to block 52.

(48) Block L1000. The amount of the equipment on hand is acquired from UMAIN. Control goes to block 53.

(49) Blocks 52 and 54. The index of the unit is obtained by calling IUIDF. This index is checked to determine if the unit exists. If not, control transfers to block 5.

(50) Block 55. A call to GETWRD returns the amount of equipment on hand.

(51) Blocks 53 and 56. A check determines if the conditional is a percentage type. If not, control goes to block L5000.

(52) Block L200. A call to GETWRD returns the amount of equipment authorized.

(53) Block 57. The percentage value is calculated by dividing the amount of equipment on hand by the amount of equipment authorized.

(54) Blocks L500C, 58, and 59. UNTLOC is checked to determine if the unit is a resolution unit. If it is not, an error message is written, TRUTH is set equal to .FALSE., and control returns to the calling routine. If so, control goes to block 60.

(55) Block 60. This block determines if the amount of the unit's indicated equipment item is to be compared to an absolute value or to a percentage of the unit's authorized quantity of that equipment item. The percentage is calculated if necessary, a comparison is made, and TRUTH is set to .TRUE. or .FALSE. as the test dictates. Control goes to block L1.

## APPENDIX C

### OUTPUT DESCRIPTIONS FOR DIVWAG SCENARIO LANGUAGE INTERFACE ROUTINES

The printed output produced by the DIVWAG scenario language (DSL) interface routines is shown in Figure IV-18-C-1 and is described below.

<u>Output Descriptor</u>	<u>Explanation</u>
A	This message indicates no unit scenario was written for the unit whose unit identification is listed. It usually occurs at time zero when the next order is requested for each resolution unit. This statement occurs in routine DOSR.
B	This printout lists IOVER which indicates the status of the battle named. If IOVER equals zero the battle is not to be terminated; if IOVER equals one a condition of termination was met. This statement occurs in routine DBSR and is controlled by print switch 2.

Ⓐ--\*\* UNIT ID R13308RL CANNOT BE FOUND IN THE UNIT DIRECTORY TABLE

Ⓑ--\*\* DBSR \*\* BATTLE MECH1 IOVER \* 1

Figure IV-18-C-1. DIVWAG Scenario Language Interface Printout



APPENDIX D

SOURCE LISTINGS FOR PERIOD PROCESSOR DIVWAG SCENARIO LANGUAGE INTERFACE

(AVAILABLE UNDER SEPARATE COVER)

## CHAPTER 19

### UTILITY ROUTINES

1. INTRODUCTION. This chapter contains the descriptions of the utility routines of the Period Processor. These routines are generally characterized by their small size and the fact that they are used by more than one model or by the executive control routines.
2. ORGANIZATION. The utility routines are grouped functionally into the following categories.
  - a. Real-time Clock. Routines which provide the running and restart times used by the executive control.
  - b. Geometric Calculations. Routines which calculate angles, intersection points and distances.
  - c. Location-related Calculations. Routines which return lists of terrain cells or units in a designated area and line of sight.
  - d. Numeric Operations. Routines which perform common arithmetic operations.
  - e. Specialized Processing. Routines which perform specialized functions required in the Period Processor.
  - f. Extended Storage. Routines which provide access to data file 16 (formerly chapter two common).
  - g. General Assessment Bookkeeping. Routines which perform secondary assessment, produce assessment history records, and maintain unit score boards.

## APPENDIX A

### INPUT REQUIREMENTS FOR UTILITY ROUTINES

Input to all utility routines is passed through the call or in common. No special input data are required. The reader is referred to the description of the calling routines for sources of data.

## APPENDIX B

### UTILITY PROGRAM DESCRIPTIONS

1. INTRODUCTION. Utility routines within the DIVWAG Period Processor are described in this appendix. The routines are grouped into a related processing function or association as follows:

- a. Real-time Clock. SETCLK, MINGET, and REDCLK.
- b. Geometric Calculations. ARCTAN, CHORD, DISTPL, DSTPL1, INTSPT, and PONTLN.
- c. Location Related Calculations. CELLST, LOS, and SEARCH.
- d. Numeric Orientation and Random Numbers. INTPOL, RANGEF, RANKA, RANK, SCALE, DNORM, ENORM, FNORM, RANDU, and RAND1.
- e. Specialized Processing. IUIDF, ADDUNT, BUFFIN, BUFOUT, KPICK, and BLKDAT.
- f. Access to Data File 16. GET and PUT.
- g. General Assessment Bookkeeping. EOH2OT, PUTOUT, and SCORE.

2. ROUTINE SETCLK. This routine sets the variable MINST (period start time in minutes) to the current wall clock time. It is called only once (during initialization) for each gaming simulation run.

3. ROUTINE MINGET. This routine translates the wall clock time, that is returned from the system library routine TIME in character hours, minutes, and seconds, into integer minutes. The seconds are ignored.

4. ROUTINE REDCLK. REDCLK obtains the current wall clock time, in minutes, from MINGET. If the current time is less than a previously set criterion (MINST, representing period start time), the current time is incremented one day (1440 minutes). REDCLK returns the difference between current wall clock time and period start time (MINST).

5. ROUTINE ARCTAN:

a. Purpose. This routine determines the angle and its quadrant between a local origin and a point with coordinates X and Y from that origin. The angle is measured counterclockwise from the positive X direction, in radians, between 0.0 and  $2\pi$ . The quadrant is signified by an integer variable.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
DELX	Call	X coordinate of point minus X coordinate of local origin.

<u>Name</u>	<u>Source</u>	<u>Content</u>
DELY	Call	Y coordinate of point minus Y coordinate of local origin.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
RAD	Call	Angle in radians.
IQUAD	Call	Quadrant indicator.

d. Processing Description. If the point and the origin are essentially collocated (within  $10^{-8}$  meters) the quadrant indicator is assigned a value of nine and the angle is set to zero. If DELX is essentially zero (within  $10^{-8}$  meters) and if DELY is positive, RAD is set to 1.5707963 ( $90^{\circ}$ ) and IQUAD is set to six; if DELY is negative, RAD is set to 4.7123890 ( $270^{\circ}$ ) and IQUAD is set to eight. If DELY is essentially zero (within  $10^{-8}$  meters) and if DELX is positive, RAD is set to zero. ( $0^{\circ}$ ) and IQUAD is set to five; if DELX is negative, RAD is set to 3.1415927 and IQUAD is set to seven. In all other cases, the system library routine ATAN is used to compute the angle, between zero and positive or negative  $\pi/2$ , within the quadrant. From the signs of DELX and DELY, the quadrant is determined, and IQUAD is set accordingly. If IQUAD is equal to one (first quadrant), RAD is set to the value returned by the library routine. If IQUAD is equal to two or three (second or third quadrants), RAD is set to the angle returned, plus  $\pi$ . If IQUAD is equal to four, RAD is set to the angle returned, plus  $2\pi$ .

6. ROUTINE CHORD:

a. Purpose. This routine determines the X coordinates of intersection or tangency, if any, of a line and a circle.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
XC	Call	X coordinate of center of circle.
YC	Call	Y coordinate of center of circle.
R	Call	Radius of the circle.
X1	Call	X coordinate of point 1 on line.
Y1	Call	Y coordinate of point 1 on line.
X2	Call	X coordinate of point 2 on line.
Y2	Call	Y coordinate of point 2 on line.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
XC1	Call	X coordinate of intersection point 1.
XC2	Call	X coordinate of intersection point 2.

d. Processing Description. The equations of the line and the circle are formed. The intersections of the line and the circle are then solved by the quadratic equation. If no intersection or tangency exists, both output variables are zero. If the line is tangent, or if the line is due north-south, the two output variables are equal.

7. ROUTINE DISTPL:

a. Purpose. This routine computes the perpendicular distance from a line to a point. The line is defined by two points.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	X coordinate of point 1 on line.
Y1	Call	Y coordinate of point 1 on line.
X2	Call	X coordinate of point 2 on line.
Y2	Call	Y coordinate of point 2 on line.
X0	call	X coordinate of point.
Y0	Call	Y coordinate of point.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
PDIST	Call	Perpendicular distance from line to point.

d. Logical Flow. The slope of the line is calculated. The coordinates of the independent point and a point on the line are combined with the slope of the line in the standard equation for calculating distance between a point and a line with slope M:

$$PDIST = \frac{M(X0 - X1) - (Y0 - Y1)}{\sqrt{M^2 + 1}} \quad (IV-19-B-1)$$

8. ROUTINE DSTPL1:

a. Purpose. This routine computes the perpendicular distance from a line to a point. The line is defined by one point and a slope.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	X coordinate of point 1 on line.
Y1	Call	Y coordinate of point 1 on line.
X2	Call	Slope of line.
Y2	Call	Dummy variable.
X0	Call	X coordinate of point.
Y0	Call	Y coordinate of point.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
PDIST	Call	Perpendicular distance from line to point.

d. Logical Flow. The slope of the line is returned as a parameter. The coordinates of the independent point and the point on the line are combined with the slope of the line in the standard equation for calculating the distance between a point and a line with slope M:

$$PDIST = \frac{M(X0 - X1) - (Y0 - Y1)}{\sqrt{M^2 + 1}} \quad (IV-19-B-2)$$

9. ROUTINE INTSPT:

a. Purpose. This routine finds the coordinates of an intersection of two line segments in the X,Y plane.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	X coordinate of start of line segment 1.
Y1	Call	Y coordinate of start of line segment 1.

IV-19-B-4

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X2	Call	X coordinate of end of line segment 1.
Y2	Call	Y coordinate of end of line segment 1.
X3	Call	X coordinate of start of line segment 2.
Y3	Call	Y coordinate of start of line segment 2.
X4	Call	X coordinate of end of line segment 2.
Y4	Call	Y coordinate of end of line segment 2.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
XPT	Call	X coordinate of intersection point of two line segments.
YPT	Call	Y coordinate of intersection point of two line segments.
NOT	Call	Intersection flag: 1 = no intersection, 2 = intersection.

d. Logical Flow (Figure IV-19-B-1):

(1) Block 1. The slope of each line is generated from the coordinates defining each line segment.

(2) Block 2. The slopes of the two lines are compared. If both lines are due north-south, the slope test is not made, since the slopes must be equal. Similarly, if one line is due north-south and the other is not, the slope test is not made, since the slopes cannot be equal. If slopes are equal, control goes to block L100.

(3) Block 3. Calculate the X coordinate of intersection of the two lines; the X coordinate is solved by combining the equations of both lines. The Y coordinate is calculated from the equation of the appropriate line.

(4) Block 4. Since the coordinates obtained for intersection of the two lines may not lie within the two line segments, tests are made to accept only an intersection of the line segments. If not on the lines, control goes to block L100.

(5) Block L250. If the line segments intersect, NOT is given the value of two.

(6) Block L100. If the line segments do not intersect, NOT is given the value one.



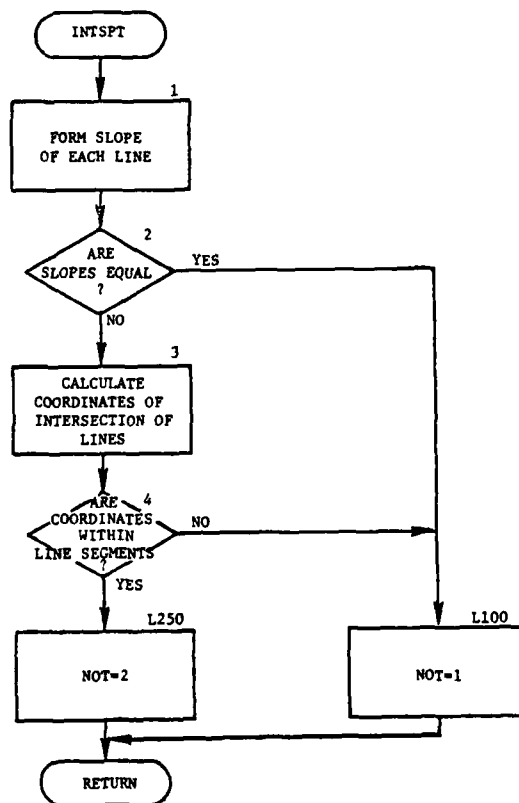


Figure IV-19-B-1. Routine INTSPT

#### 10. ROUTINE PONTLN:

a. Purpose. This routine calculates the distance between a point and a line segment. If the point is in the region between the ends of the line segment, the distance is perpendicular to the line segment; otherwise, the distance is to the nearest end of the line segment. An output variable quantifies the position of the point relative to the start and end of the line segment.

##### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
PT1X	Call	X coordinate of start of line segment.
PT1Y	Call	Y coordinate of start of line segment.
PT2X	Call	X coordinate of end of line segment.
PT2Y	Call	Y coordinate of end of line segment.
PT3X	Call	X coordinate of independent point.
PT3Y	Call	Y coordinate of independent point.

##### c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
SEP	Call	Distance between point and line segment.
THAD	Call	Relative position on the line extending through the line segment of a point subtended perpendicularly by the independent point.

##### d. Logical Flow (Figure IV-19-B-2):

(1) Block 1. If the coordinates of point 2 equal zero, there is no second point. If nonzero, control goes to block 3.

(2) Block 2. The distance between point 1 and point 3 is calculated by the differences in coordinates, then return control to the calling routine.

(3) Block 3. THAD is calculated. If the value of THAD is negative, the independent point lies beyond the start (point 1) of the line segment, and control goes to block 2. In this case the value of THAD is the negative quotient of SEP divided by the length of the line segment.

(4) Block 4. If the value of THAD is greater than one, the independent point lies beyond the end (point 2) of the line segment, and control goes to block 5. In this case, the value of THAD is one plus the quotient of SEP divided by the length of the line segment.

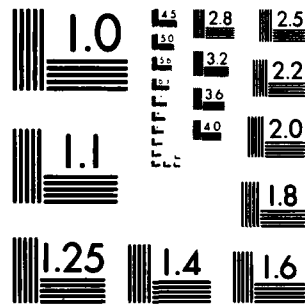
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DIVNAS MODEL DOCUMENTATION. VOLUME II. PROGRAMMER/ANALYST MANUA--ETC(U)  
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UNCLASSIFIED CACDA-TR-8-76-VOL-2-PT-4

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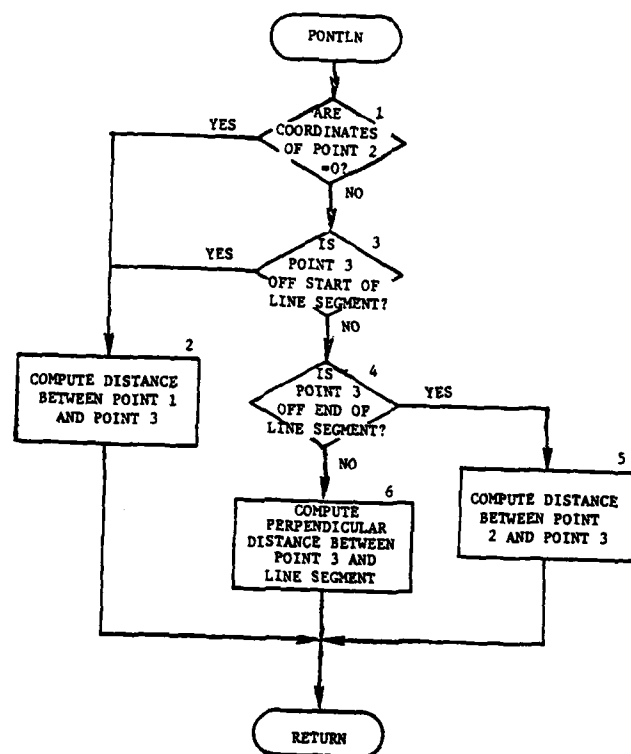


Figure IV-19-B-2. Routine PONTLN

(5) Block 5. The distance between point 2 and point 3 is calculated, and control returns to the calling routine.

(6) Block 6. Since the independent point lies in the region between the ends of the line segment, THAD is the fractional distance along the line segment, from point 1, of a point subtended perpendicularly by the independent point. This fraction, applied to the distance between point 1 and point 2, provides a side of the triangle; the distance between point 1 and point 3 provides the hypotenuse. The desired perpendicular distance is the third side of this right triangle.

#### 11. ROUTINE CELLST:

a. Purpose. This routine generates a list of terrain cells penetrated by a line segment defined by the coordinates X1,Y1 and X2,Y2.

##### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	Initial X coordinate of line segment.
Y1	Call	Initial Y coordinate of line segment.
X2	Call	Ending X coordinate of line segment.
Y2	Call	Ending Y coordinate of line segment.
NTERR	ONE	Terrain cell size.
NXTC	ONE	X dimension of map square defined by terrain cells.

##### c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
LIST(100)	Call	Array of terrain cell identification numbers.
NCELLS	Call	The number of whole cells between coordinate origin and point 2.

##### d. Logical Flow (Figure IV-19-B-3):

(1) Block 1. The number of cells defined on the map, in the X direction is the X distance over which cells are defined divided by the size of a single cell.

(2) Block 2. The number of whole cells between the X,Y coordinate origin and the initial point on the line segment (point 1) is determined for each of the X and Y directions by dividing the coordinate value by the size of a cell and truncating any fraction.

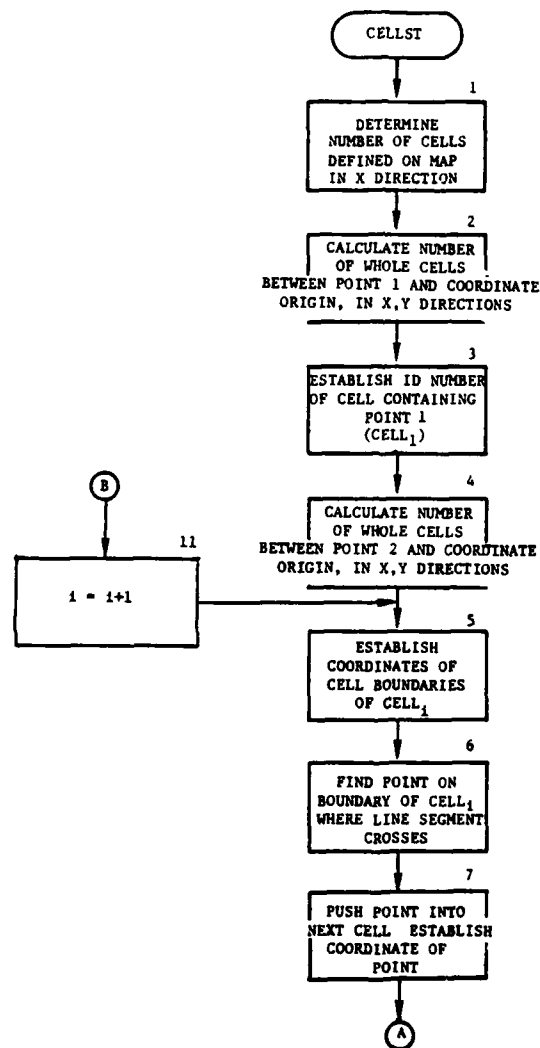


Figure IV-19-B-3. Routine CELLST (Continued on Next Page)

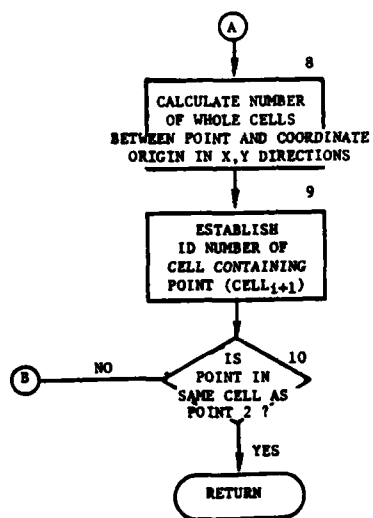


Figure IV-19-B-3. Routine CELLST (Concluded)



(3) Block 3. The identification number of the cell containing point 1 is determined from the cell size, the number of cells defined in the map in the X direction, and the number of whole cells between the origin and point 1 by the expression:

$$ID = NX * IY + IX + 2$$

(IV-19-B-3)

where:

ID = identification of first cell, stored in LIST(1)

NX = number of cells defined on the map in the X direction  
(determined in block 1)

IY = number of cells in Y direction between point 1 and coordinate origin (determined in block 2)

IX = number of cells in X direction between point 1 and coordinate origin (determined in block 2).

(4) Block 4. Point 2 is the ending point of the line segment. The number of whole cells in X and Y is determined as in block 2.

(5) Block 5. The boundaries of the cell currently being considered are determined from the cell size and the number of cells between the current point and the coordinate origin.

(6) Block 6. Routine INTSPT determines whether the line between the current point and point 2 penetrates a given boundary of the current cell and, if so, the coordinates of the point of intersection. The sides of the cell are selected one-at-a-time until the intersection is found.

(7) Block 7. The coordinates of intersection just found are adjusted slightly in the direction of point 2 so that the adjusted point lies within the next terrain cell along the line segment.

(8) Block 8. The number of whole cells between the coordinate origin and the current point are calculated (in the same manner as in block 2).

(9) Block 9. The identification number of the cell containing the current point is determined (in a manner similar to that in block 3) and entered in LIST.

(10) Block 10 and 11. The number of whole cells between coordinate origin and point 2 is compared with the corresponding number for the current point. If equal, return control to the calling routine; otherwise, control goes to block 11 to search for the next cell.

## 12. ROUTINE LOS:

a. Purpose. This routine determines whether line of sight exists between a point specified by X, Y, Z coordinates and the center of a unit being considered by the calling routine.

### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IFLAG	Call	Flag to locate unit status record: 0 = UMAIN, 1 = UCOOP.
X	Call	X coordinate of specified point.
Y	Call	Y coordinate of specified point.
Z	Call	Z coordinate of specified point.
XACT or CXACT	ONE	X coordinate of center of unit of interest.
YACT or CYACT	ONE	Y coordinate of center of unit of interest.
ZACT or CZACT	ONE	Z coordinate of center of unit of interest.
MASKF or CMASKF	ONE	Array containing range and elevation angle to dominant mask each 15° in azimuth around center of unit (24 angles).

### c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
LOS	Call	Line of sight parameter: 0 = no, 1 = yes

### d. Logical Flow (Figure IV-19-B-4):

(1) Block 1. The input IFLAG indicates whether the unit of interest is in UMAIN or UCOOP, to obtain the correct unit center coordinates and dominant mask function.

(2) Blocks 2 and L20. Unit center coordinates and dominant mask data are obtained for the unit being considered by the calling routine.

(3) Block L40. The line-of-sight parameter is initialized to indicate no line of sight.

(4) Block L100. The azimuth from unit center to input point is computed and reduced to lower and upper azimuth indexes, that specify the 15° sector containing the point, and the fractional position of the point within that sector.

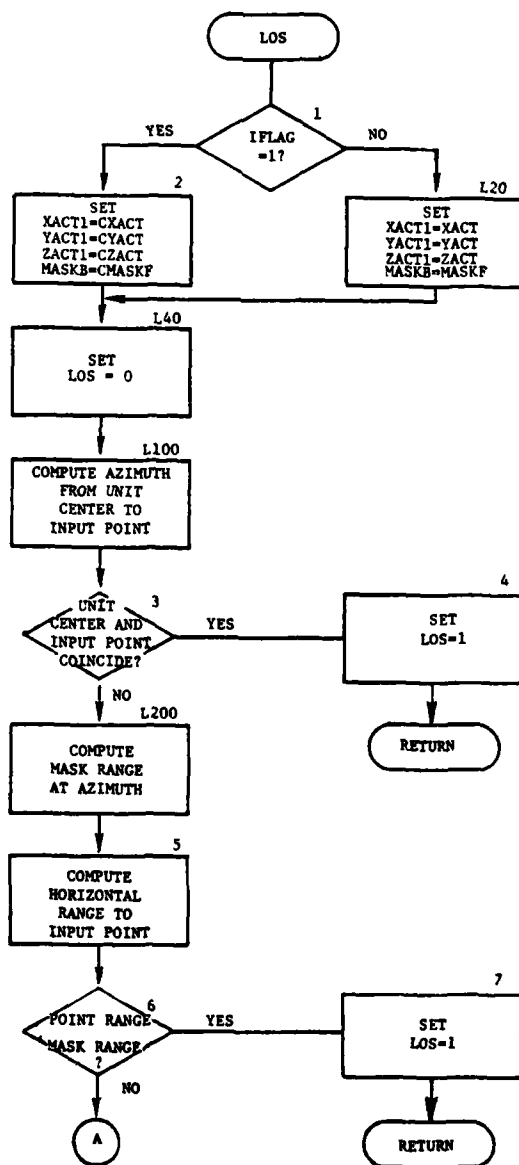


Figure IV-19-B-4. Routine LOS (Continued on Next Page)

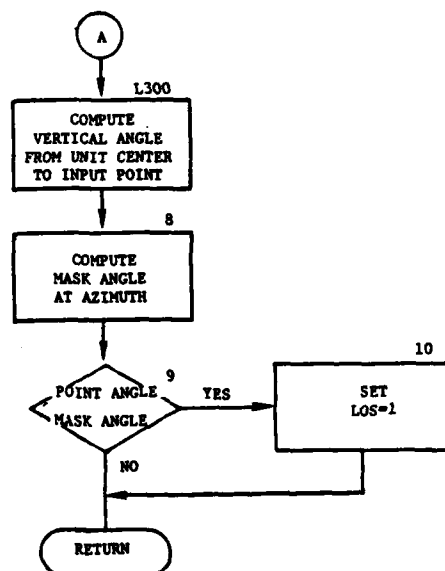


Figure IV-19-B-4. Routine LOS (Concluded)

(5) Blocks 3 and 4. If the unit center and input point coincide, set LOS equal to one, and return control to the calling routine.

(6) Block L200. The horizontal range from the unit center to the terrain mask at the computed azimuth is obtained by interpolation between the ranges obtained from mask data for each edge of the 15° sector containing the point.

(7) Block 5. The horizontal range from the unit center to the input point is computed from the X and Y coordinates.

(8) Blocks 6 and 7. The horizontal range from unit to point is compared with the horizontal range from unit to mask. If the point is within mask range, line of sight exists. Set LOS equal to one and return control to the calling routine; otherwise, continue processing at block L1300.

(9) Block L300. The angular elevation of the input point is calculated by the difference between Z coordinates of the point and the unit and the horizontal distance from point to unit.

(10) Block 8. The terrain mask angle, for the computed azimuth of the point, is interpolated from the mask angles of the upper and lower azimuth indexes of the sector containing the point.

(11) Block 9 and 10. The elevation angle of the point is compared with the mask angle. If point elevation angle exceeds mask angle, line of sight exists and LOS is set to one. Return control to the calling routine.

### 13. ROUTINE SEARCH:

a. Purpose. This routine returns a list of enemy resolution units that are located within a specified radius of a given point. For moving units, the specified radius is increased by the diagonal distance of one terrain cell. The number of units on the list is also provided.

#### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
UID	Call	Identification of the unit requesting the search.
X	Call	X coordinate of the center of the area to be searched.
Y	Call	Y coordinate of the center of the area to be searched.
S	Call	Radius of search about the center.
JMAX	Call	Maximum number of enemy units to be listed.

<u>Name</u>	<u>Source</u>	<u>Contents</u>
BPOINT	ONE	Index of last Blue unit.
RPOINT	ONE	Index of first Red unit.
NTERR	ONE	Terrain cell dimension.
ICOORD	ONE	Coordinates of a resolution unit.
IEVENT	ONE	Event code of a resolution unit.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
UNTLST	Call	List of enemy units found.
J	Call	Total number of units in UNTLST.

d. Logical Flow (Figure IV-19-B-5):

(1) Block 1. The inner radius of search is the specified input value. The outer radius includes one terrain cell's diagonal distance to ensure a listing of moving units of which coordinates have not been updated.

(2) Block 2. The first character of the unit identification is used to determine if the unit requesting search is Red or Blue. The index limits for opposing units are established accordingly, utilizing BPOINT or RPOINT. The search loop considers each opposing unit.

(3) Block 3. The X and Y coordinates of an enemy unit are returned by ICOORD to calculate distance from the center of the search area.

(4) Block 4. If the distance exceeds the outer search radius, the next enemy unit is processed.

(5) Block 5. The event code of the enemy unit is checked. If the unit is moving, control goes to block 7.

(6) Block 6. Since the unit is not moving, it must be within the inner radius of search to be added to the list.

(7) Block 7. If the list already contains the specified maximum number of units, a message is printed before control returns to the calling routine.

(8) Block 8. The enemy unit is added to the list.

(9) Block 9. If all enemy units have been considered, control is returned to the calling routine.

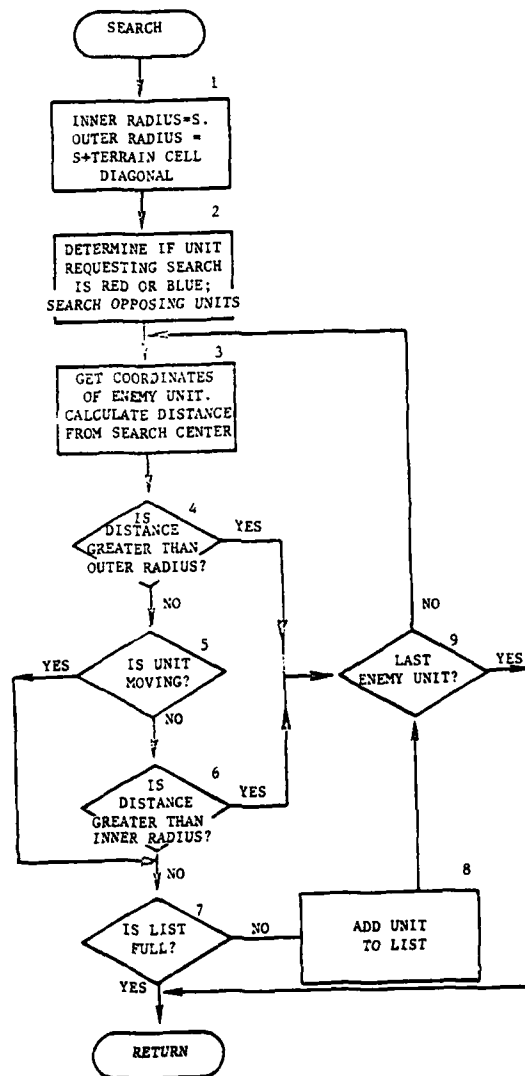


Figure IV-19-B-5. Routine SEARCH

#### 14. ROUTINE INTPOL:

a. Purpose. This routine performs linear interpolation, within an input table, to generate Y as a function of a given X value. The input table specifies a value of Y for each implicit X value entry up to 21, assumed equally spaced.

##### b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X	Call	Given X value for which Y value is sought.
FIRSTX	Call	X value of the first entry in the table.
STPSIZ	Call	X distance (assumed constant) between entries in the table.
NENTRI	Call	Total number of entries in the table.
TABLE	Call	Name and first location of the table.

##### c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
Y	Call	Y value interpolated for given X value.

##### d. Logical Flow (Figure IV-19-B-6):

(1) Block 1. The position of the given X value is established in fractional steps, relative to the X value of the first entry in the table.

(2) Block 2. The position of X, in integral steps, is the fractional position adjusted and truncated.

(3) Block 3. If the fractional position is negative, X is outside the X value of the first entry in the table. If the fractional position is zero, X is equivalent to the X value of the first entry in the table. In both cases, the entries on either side of X are the first table entry. If the integral step position of X equals or exceeds the total number of entries in the table, NENTRI, the last entry is assumed to be the entries on either side of X; otherwise, the entries on either side of X are different, based on the integral step position of X.

(4) Block 4. The interpolated value of Y is the lower side table entry plus the same fraction of the difference between lower and upper side entry as the fractional position of X within the X interval between these two entries.



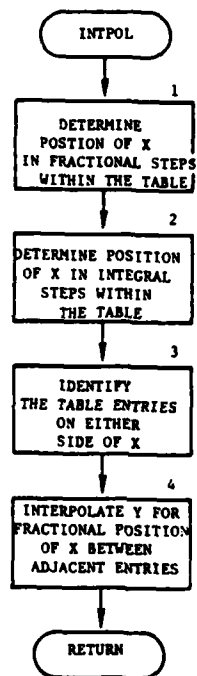


Figure IV-19-B-6. Routine INTPOL

15. ROUTINE RANGEF:

a. Purpose. This routine calculates the distance between two points in the X,Y plane.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	X coordinate of point 1.
Y1	Call	Y coordinate of point 1.
X2	Call	X coordinate of point 2.
Y2	Call	Y coordinate of point 2.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
RANGEF	Call	Distance between point 1 and point 2.

d. Processing Description. This function takes the square root of the sum of the squares of the differences in coordinates between the two points.

16. ROUTINES RANKA and RANK:

a. Purpose. These routines consider the values from a one-dimensional array of up to 36 items and generates a list of the index numbers of the input array arranged in order with the smallest array value first and the greatest last. Two versions of this routine exist. Routine RANKA has input and output variables defined as calling parameters. The other version, routine RANK is identical except that input and output variables are located in common.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
A	Call or TWO	Array of values to be ranked.
II	Call or TWO	Number of items in the array.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IPT	Call or TWO	List of index numbers of array items ranked in decreasing order of array value.

d. Logical Flow (Figure IV-19-B-7):

(1) Block 1. To find the smallest or most negative value in the input array, the input values are resigned and placed in a resigned value array (D). Each value in the resigned array is compared.

(2) Block 2. The index number of the smallest or most negative value in the resigned array (same index as input array) is placed in the Kth place in the output list, proceeding from one through the total number of array items.

(3) Block 3. The smallest value just found in the resigned array is set to a very large negative value to essentially remove it from further consideration.

(4) Block 4. The index, K, is incremented until the total number of array items has been ranked.

17. ROUTINE SCALE:

a. Purpose. This routine adjusts the value of X to fall within a specified interval. An example of use is to scale an angle in radians to between zero and  $2\pi$ .

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X	Call	The value to be scaled.
XLO	Call	The lower limit of the specified interval.
XUP	Call	The upper limit of the specified interval.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
SCALE	Call	The scaled value of X.

d. Logical Flow (Figure IV-19-B-8):

(1) Block 1. The scale interval is the difference in the specified upper and lower limits.

(2) Block L1. The current value of X is compared with the upper limit of the scale interval.

(3) Block 2. If the current value of X exceeds the upper limit, subtract one interval.

(4) Block L2. If the current value of X is within the upper limit, the current value of X is compared with the lower limit.

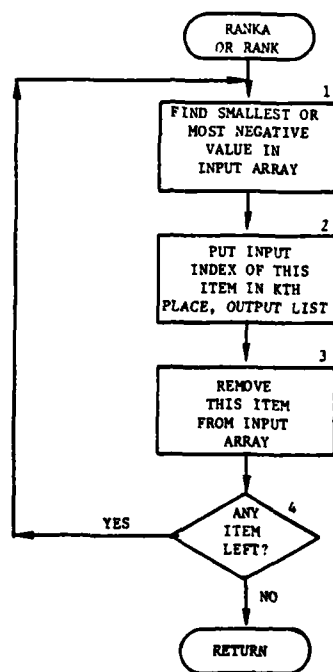


Figure IV-19-B-7. Routine RANKA and RANK

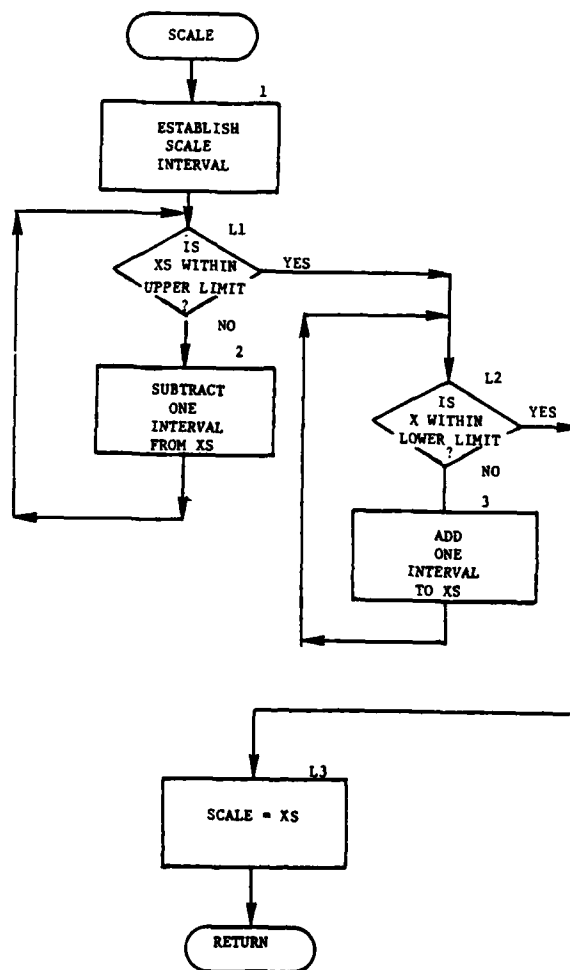


Figure IV-19-B-8. Routine SCALE

(5) Block 3. If the current value of X is below the lower limit, add one interval.

(6) Block L3. If the current value of X is above the lower limit, the current value of X is returned to the calling routine.

18. ROUTINE DNORM:

a. Purpose. This function returns an approximation of the cumulative fraction of the area beneath the normal curve, given a position along the curve in standard deviations.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
Y	Call	Position along the curve, in standard deviations from the mean.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
DNORM	Call	Cumulative fraction of the area beneath the normal curve at point Y.

d. Processing Description. Hasting's approximation number 63 is used. DNORM is set to zero or one if absolute value of Y is greater than 5.2.

19. ROUTINE ENORM:

a. Purpose. This routine generates a random variable from a normal distribution with mean of zero and standard deviation as given.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
SGM	Call	Standard deviation.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
ENORM	Call	Value of the random variable.

d. Processing description. A uniform random number is generated by a call to RANDU, that is a cumulative probability. Hasting's approximation number 68 is used to convert to a normal standard deviate, and the result is multiplied by SGM.

20. ROUTINE FNORM:

a. Purpose. This routine returns an approximation of the position along the normal curve, in standard deviations, corresponding to a given cumulative fraction of the area beneath the curve.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
A	Call	Cumulative fraction of the area beneath the normal curve.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
FNORM	Call	Position along the normal curve, in standard deviations.

d. Processing Description. Hastings approximation number 68 is used to calculate the conversion.

21. ROUTINE RANDU:

a. Purpose. This routine is used to generate a uniformly distributed random number. It uses the equation:

$$X_{i+1} = X_i(2^{10} + 3) + 1 \text{ Mod } 2^{20}$$

(IV-19-B-4)

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	The lower limit of the random number to be returned.
X2	Call	The upper limit of the random number to be returned.
RNDSER	ONE	Last random number computed.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
RANDU	Call	The random number generated.

d. Logical Flow (Figure IV-19-B-9):

(1) Block 1. The previous random number RNDSED is multiplied by  $2^{10}$  which has the effect of shifting left by 10 bits. The resulting value is added to RNDSED three times.

(2) Block 2. A one is added to the result. The four high order bits are masked out to perform the modulo  $2^{20}$ . The result is stored in RNDSED.

(3) Block 3. The interval range is computed by subtracting X1 from X2.

(4) Block 4. RANDU is calculated by multiplying the interval range by the value in RNDSED divided by  $2^{20}$ . X1 is added to the result.

22. ROUTINE RAND1:

a. Purpose. This routine is used to seed the random number generator. It is called only once per game.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
X1	Call	Seed Value.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
RNDSED	Call	Initial seed for random number generator.

d. Logical Flow (Figure IV-19-B-9): Put seed value, X1, in RNDSED, and return control to the calling routine.

23. ROUTINE IUIDF:

a. Purpose. This routine is used to determine the position of a unit in the unit identification table.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
UID	Call	The eight-character unit identification to be located.
BPOINT	ONE	The location in the unit identification table of the last Blue unit.



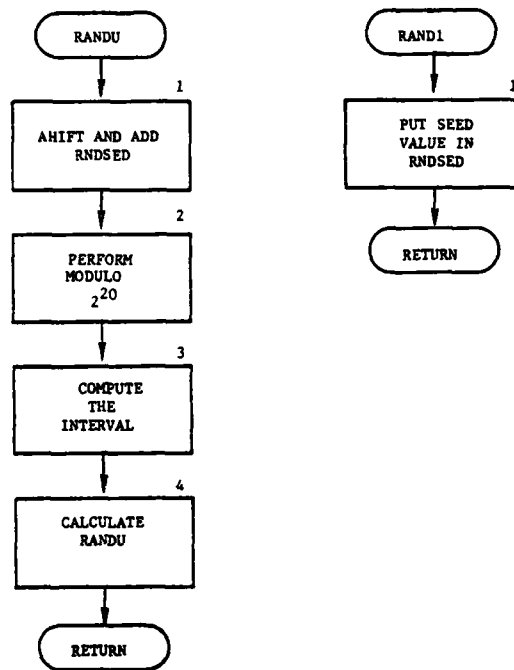


Figure IV-19-3-9. Routine RANDU and RAND1

<u>Name</u>	<u>Source</u>	<u>Contents</u>
RPOINT	ONE	The location in the unit identification table of the first Red unit.
UIDTAB(2,1000)	TWO	Table containing unit identifications of all played units.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IUIDF	Call	Relative location of unit in unit identification table.

d. Logical Flow (Figure IV-19-B-10):

- (1) Block 1. Set IUIDF to zero.
- (2) Block 2. If the unit is a Red force unit, transfer control to block 4.
- (3) Block 3. Since this is a Blue force unit, store the points where search is to be processed. Control goes to block 5.
- (4) Block 4. Since this is a Red force unit, store the points where search is to be processed. Control goes to block 5.
- (5) Block 5. If search is completed, return control to the calling routine; otherwise, it goes to block 6.
- (6) Block 6. If the first word (first four characters) of the unit identification matches, control goes to block 7; otherwise, transfer control to block 5 and continue the search.
- (7) Block 7. If the second word (last four characters) of the unit identification matches, control goes to block 8; otherwise, transfer control to block 5 and continue the search.
- (8) Block 8. A match was found; so, reset IUIDF to relative location in unit identification table and return control to the calling routine.

24. ROUTINE ADDUNT:

a. Purpose. This routine assigns IUID numbers to units defined by UIDs and accordingly stores the unit identification of each unit in common TWO.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
UID	Call	Eight-character unit identifier.

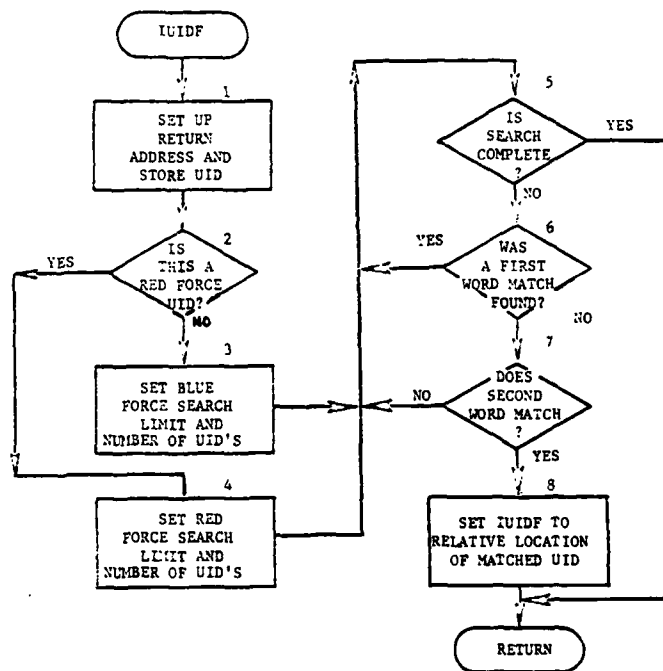


Figure IV-19-B-10. Routine IUIDF

<u>Name</u>	<u>Source</u>	<u>Contents</u>
BPOINT	ONE	The location in the unit identification table of the last Blue unit.
RPOINT	ONE	The location in the unit identification table of the first Red unit.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IUID	Call	Unit identifier (serial number).
UIDTAB(2,1000)	TWO	Unit identification table.
BPOINT	ONE	The location in the unit identification table of the last Blue unit.
RPOINT	ONE	The location in the unit identification table of the first Red unit.

d. Logical Flow (Figure IV-19-B-11):

(1) Block 1. Whether unit is Blue or Red force is determined from the first character of the unit identification code.

(2) Blocks 2 and 3. The counter of units assigned IUIDs in the respective force is adjusted.

(3) Blocks 4 and 5. The IUID is assigned.

(4) Block 6. The unit identification is stored in the unit identification table. Control returns to the calling routine.

25. ROUTINE EOH2OT:

a. Purpose. This routine computes secondary equipment losses and adds them into the equipment loss table in the IOU buffer area.

b. Input Variables:

(1) Standard Common Block Areas. IOU and IER.

(2) Other Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
JUID	Call	IUID of unit being assessed.

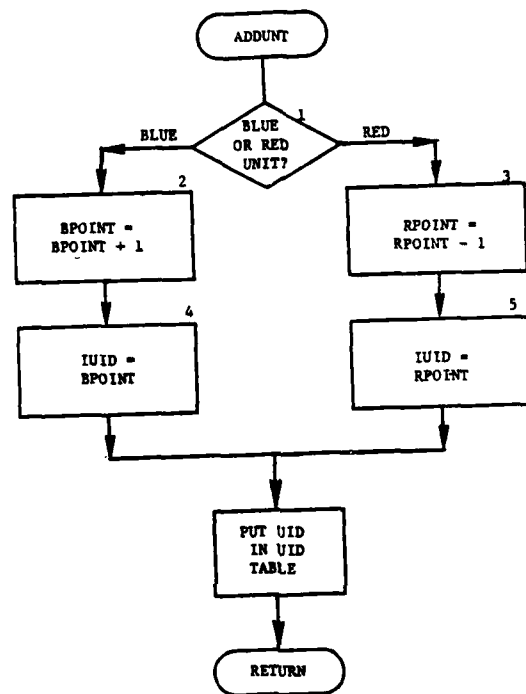


Figure IV-19-B-11. Routine ADDUNT

<u>Name</u>	<u>Source</u>	<u>Contents</u>
JFORCE	Call	Force indicator: 0 = LSEOH2 is in core. 1 = Blue force and LSEOH2 is not in core. 2 = Red force and LSEOH2 is not in core.
EOHTBL	Call	Equipment on hand table of unit being assessed.
LSEOH2	Call or DF6	Secondary loss table.
AUTEOH	DF50	Unit authorized equipment table.
EQPOUT	ONE	Primary equipment loss table.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
EQPOUT	ONE	Equipment loss table with secondary losses added.

d. Logical Flow (Figure IV-19-B-12):

(1) Block 1. If the secondary loss table (LSEOH2) is not in core, retrieve it from data file 6. The variable JUID is used as a record pointer to data file 50 to obtain the authorized equipment table (AUTEOH).

(2) Block 2. If there are no primary losses associated with first or next item or if it does not have secondary equipment, transfer control to block 4.

(3) Block 3. This code calculates the amount of each secondary item lost and adds that amount into the loss table (EQPOUT). To determine the amount of the secondary item lost, the ratio of the amount of that item on hand to the authorized amount (RATIO) is calculated. The amount of loss is equal to the product of RATIO, the number of primary items lost, and the number of secondary items per primary item.

(4) Block 4. If all items in the primary item table have not been processed, return control to block 2.

26. ROUTINE PUTOUT:

a. Purpose. This routine transfers output records from common, IOUT, to duplicate Period History tapes 39 and 40.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
J	Call	Code for portion of words to be transferred: 1 = first 128 words; 2 = second 128 words; 3 = all 256 words.

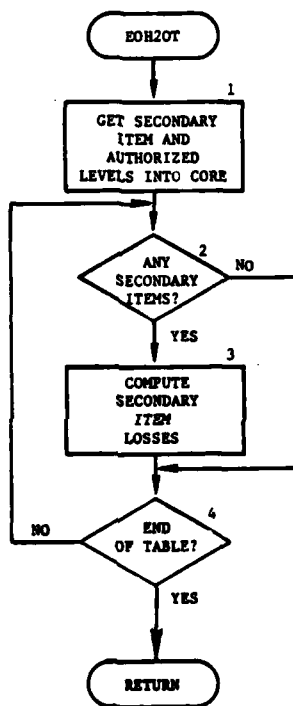


Figure IV-19-B-12. Routine EOH2OT

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IOUT(256)	ONE	Block of up to 256 words of stored output records generated by a Period Processor routine.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IOUT(256)	Period History tapes	Output records generated by a Period Processor routine.

d. Logical Flow (Figure IV-19-B-13):

(1) Block 1. The input variable J is tested. If the value is neither 1, 2, nor 3, XXIT is called with error indication. If J equals 2, control is transferred to block L10.

(2) Block 2. The first 128 words of array IOUT are written to magnetic tape files TAPE39 and TAPE40.

(3) Block 3. If J equals one, return control to the calling routine.

(4) Block L10. The second 128 words of array IOUT are written to magnetic tape files TAPE39 and TAPE40; then, control returns to the calling routine.

(5) Block L20. Routine XXIT is called to terminate processing. Control returns to the calling routine.

27. ROUTINE SCORE:

a. Purpose. This routine maintains the battle score board on data file 48 by assigning each unit that is assessed a record. On this record a running total of losses sustained by the unit during any game period is kept. The losses are kept in terms of item code and personnel versus fire type causing the assessment (KILLER). Six types of fire are recognized; ground combat, direct aerial fire support, close air support, artillery, nuclear, and air defense fire.

b. Input Variables:

<u>Name</u>	<u>Source</u>	<u>Contents</u>
IUSF	Call	Unit status record of unit suffering losses.
KILLER	Call	GCM - Ground combat DAFS - Direct aerial fire support CAS - Close air support ARTY - Artillery NUCL - Nuclear ADFR - Air defense fire



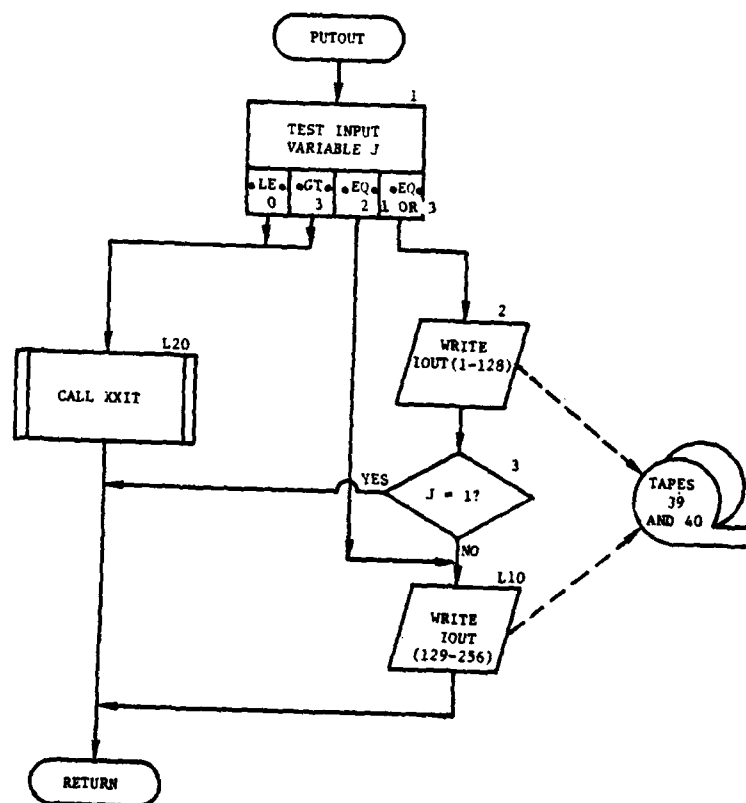


Figure IV-19-B-13. Routine PUTOUT

<u>Name</u>	<u>Source</u>	<u>Contents</u>
NUMBER	Call	Centiminutes of ground combat, number of air sorties, number of artillery rounds, or number of air defense firing units.
IARRAY	DF48	Table of losses.

c. Output Variables:

<u>Name</u>	<u>Destination</u>	<u>Contents</u>
IARRAY(202)	DF48	Updated table of losses.

d. Logical flow (Figure IV-19-B-14):

(1) Block 1. If the unit has not been assigned a score board record on data file 48, it is assigned the next one available. Each word of the record is set to zero initially.

(2) Block 2. If all the records in data file 48 have been used, five records are added to the file, by means of ADDRCD, and this unit is given the first of the new records.

(3) Block 3. Match the variable KILLER with one of the character codes described as input. If a match is not found, an error message is written and control returns to the calling routine; otherwise, the word pointer into the score board record is set to the appropriate value.

(4) Block 4. The old loss array associated with this type of fire (IARRY) is retrieved from the score board record and is updated by adding the current losses. The first word of IARRY contains a running total of the variable NUMBER, the second word contains the personnel losses, and the remaining 200 words correspond to the 200 items of equipment.

28. ROUTINE BUFOUT:

a. Purpose. This routine is used to save the 4102-word array IDUM in common TWO by writing it to data file 36. Thus, IDUM locations can be used by another routine and can be restored.

b. Input Variables. IDUM.

c. Output Variables. IDUM.

d. Logical Flow. BUFOUT calls routine PUTWRD to write the array IDUM to data file 36.

29. ROUTINE BUFFIN:

a. Purpose. This routine is used to retrieve the 4102-word array IDUM from data file 36.

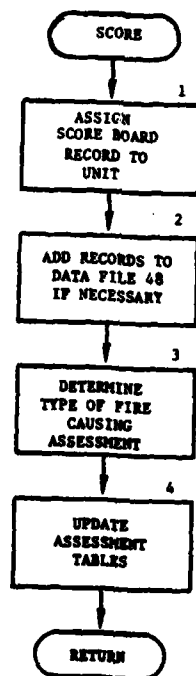


Figure IV-19-B-14. Routine SCORE

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b. Input Variables. IDUM.

c. Output Variables. IDUM.

d. Logical Flow. BUFFIN calls routine GETWRD to retrieve the array IDUM from data file 36.

30. ROUTINE KPICK:

Not used.

31. ROUTINE BLKDAT. This is a BLOCK DATA routine that is used to initialize data stored in common. See ANSI FORTRAN reference manual.

32. ROUTINE GET:

Not used.

## APPENDIX C

### OUTPUT DESCRIPTIONS FOR UTILITY ROUTINES

The utility routines of the DIVWAG Period Processor return requested data to the calling routine. There is no printed output.

APPENDIX D

SOURCE LISTINGS FOR PERIOD PROCESSOR UTILITY ROUTINES

(AVAILABLE UNDER SEPARATE COVER)

IV-19-D-1

END

DATE  
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