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16. Abstract

The Advanced Air Traffic Management System (AATMS) program is a long-range investigation of new concepts and techniques for controlling air traffic and providing services to the growing number of commercial, military, and general aviation users of the national airspace. This study of the applications of automation was undertaken as part of the AATMS program. The purposes were to specify and describe the desirable extent of automation in AATMS, to estimate the requirements for man and machine resources associated with such a degree of automation, and to examine the propsective employment of humans and automata as air traffic management is converted from a labor-intensive to a machine-intensive activity.

Volume V describes the DELTA Simulation Model. It includes all documentation of the DELTA (Determine Effective Levels of Task Automation) computer simulation developed by TRW for use in the Automation Applications Study. Volume VA includes a user's manual, test case, and test case results. Volume VB includes a programmer's manual.

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1.0 INTRODUCTION

This is Volume V-Book I of a five volume report produced for the Automation Applications Study of the Advanced Air Traffic Management System This volume describes the DELTA (Determine Effectiveness Levels for Task Automation) digital computer simulation model. The volume is divided into two books: Book I - User's Guide and Book II - Programmer's Guide.

The User's Guide is designed to permit an analyst to understand what the model simulates and how to exercise the model. It discusses the concepts from which the model was constructed. A complete input data specification and deck setup is described to show how cases are set up. A test case is provided to show how a case would look. Several auxiliary programs which are used to produce input files are described along with the Post Processor Program which is used to produce an additional output report for the DELTA model.

The Programmer's Guide is designed to give a programmer insight as to how the DELTA model was built and to enable him to make extensions or modifications to the model's code. There is a general discussion of the program structure and a description of the link structure and the system considerations.

There are detailed descriptions of the subroutines and the dynamic memory file structures. Samples of overlay structures are given and a list of subroutines which reference the files is shown.

2.0 CONCEPTS

The DELTA Model was designed to facilitate the analysis of air traffic management systems with primary emphasis on the utilization of the resources required to support such systems. This section will provide an explanation of the facilities and concepts making up the model. The model is based upon a highly generic functional analysis of air traffic control functions. For this reason, it is very generic itself, not tied to any particular air traffic management system, but capable of describing a wide variety of system concepts. For a description of this functional anlaysis, the reader is referred to Volume II of this report.

The model is composed of two principle portions: the functional analysis tasks and the algorithms. The algorithms are responsible for the motion of the aircraft through the system. They are discussed in some detail later in this section. The details of the functional analysis are to be found in Volume II of this report. Basically, the functional analysis began with seventeen functions, which were then broken into subfunctions. These subfunctions were subsequently subdivided into tasks. The task was defined to be the largest unit of work for which the man/machine allocation determination was to be made.

The systems to be modelled are composed of men, machines and aircraft. The control functions are assigned to positions or "resource pools", in the terminology of the model. Each resource pool is assigned to a "jurisdiction", which is analogous to a control position assigned to a sector. Within the resource pool, the individual "resource element" is the performer. There are two types of resource pools: manual pools, containing one or more manual resource elements representing individual controllers belonging to particular job categories; and automated resource pools, containing an individual computer with a characteristic processing rate or speed.

Each task is assigned to one and only one resource pool per jurisdiction. The tasks are prioritized and task queues are generated should a backlog of tasks awaiting performance exist. The aircraft in the system are assigned to one and only one jurisdiction at a time, depending upon their location. They may change jurisdictions as they transit the system geography. Resource utilization information is maintained on the resource element level.

The model treats eight phases of flight for the aircraft. These are as follows:

1. Preflight - the time from entering the system (before takeoff) and being given permission to takeoff
2. Takeoff - the time from being given permission to takeoff and leaving the runway
3. Departure Transition - the time from leaving the runway and being picked up by en route control
4. En Route - the time between leaving the departure airport and arriving in the arrival airport metering and sequencing pattern
5. Arrival Transition - the time between being placed in the metering and sequencing queue and being placed in the runway queue at the feeder fix arrival
6. Approach - the time the aircraft flies down the approach route, from the feeder fix to the gate and on to touch down
7. Landing - the time from touch down to leaving the runway
8. Missed Approach - the time from leaving the approach route to arriving at the feeder fix

The aircraft serve primarily as work initiators or service requestors. Each aircraft in the system under consideration requires certain controller attention, and is, therfore, responsible for using some amount of the resource pools' capabilities. For this reason, the aircraft have not been modelled in great detail with respect to kinematics. Their main purpose is to activate the functional tasks by requiring work.

The description of a particular air traffic management concepts is done through input to the model. By assigning tasks to manual or automated resource pools and defining the time requiements or instruction counts, responsible resource pool, and priority for each task, the user defines the system to be studied. By defining the geographic limits of the jurisdictions, the user controls the structure of the area under consideration. The user then determines the traffic loading for which the system will be exercised by defining the flight plans to be input. The user may cause emergencies and other exogenous events to determine how the system would react to such events. The model inputs and outputs are described in Section 3 and 5 of this volume.

It is through strict adherence to the genericity of the analysis that no changes in the software need be made in order to model a variety of air traffic management concepts. This places a heavy burden upon the user to define the system through inputs. It does, however, provide a flexible and useful tool to estimate the resource requirements of systems under study.

2.1 KINEMATIC AND ERROR ALGORITHMS

2.1.1 Jurisdiction

This section describes the jurisdiction geography and how to express this geography in the input file. Each jurisdiction defines an air space. It must be a right polygonal figure. Thus, each jurisdiction has the following properties:

- The sides are planar and are perpendicular to the ground
- The floor and ceiling are planar and are parallel to the ground
- A jurisdiction has no limit on the number of sides
- The shape of the floor and ceiling are arbitrary, i.e., these need not be convex.

Figure 2.1-1 illustrates the shape of a jurisdiction.

A jurisdiction can be made to slant by stacking right polygonal figures upon each other. Figure 2.1-2 illustrates this concept. It is called the "inverted wedding cake structure."

The input file contains data for defining the geographical structure of jurisdictions. This file contains the following information for each jurisdiction:

- Number of jurisdictions
- Maximum number of aircraft allowed in a jurisdiction
- Initial number of elements per resource pool
- Maximum number of elements per resource pool
- Indicator of resource type, manual or automated
- Altitude (feet) of the floor and ceiling of the jurisdiction
- (x,y) coordinates (n.mi) of the floor vertices (same as ceiling coordinates)
- Listing of jurisdictions adjacent to floor, ceiling, and each side of jurisdiction.

Going clockwise around the floor vertices, each vertex has associated with it a list of jurisdictions contiguous to the side of the vertex.

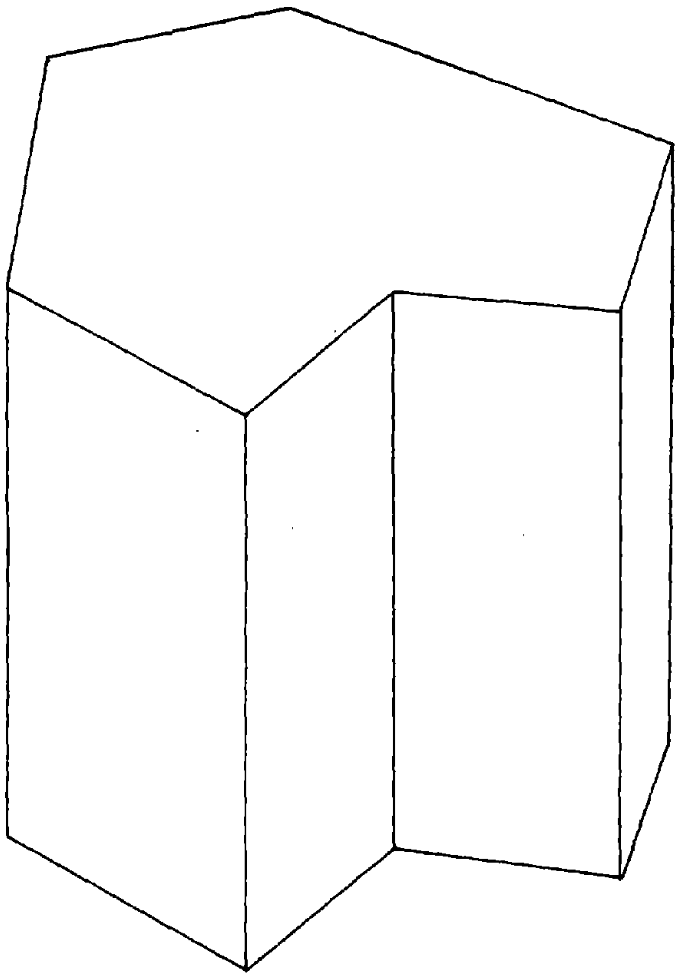


FIGURE 2.1-1 ILLUSTRATION OF THE SHAPE OF A JURISDICTION

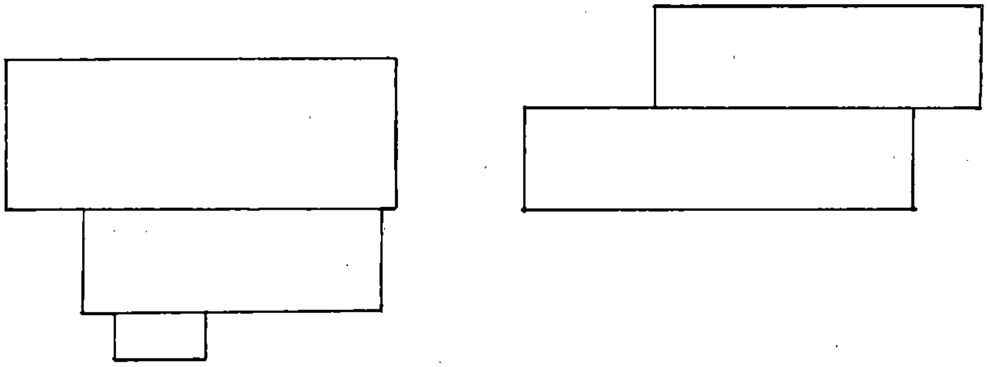


FIGURE 2.1-2 SIDE VIEWS OF TWO JURISDICTIONS USING THE INVERTED WEDDING CAKE STRUCTURE

For example, point 4 of jurisdiction A in Figure 2.1-3 has associated with it the contiguous jurisdictions B and C listed in any order. The list would also have included any jurisdictions above or below B and C if they shared any side with jurisdiction A. The user can start at any vertex of a jurisdiction floor in moving clockwise, but must not repeat the first point in this list.

The list of jurisdictions contiguous to the floor or ceiling of a jurisdiction can be specified in any order.

Following are the formats for input data. A sample data file is shown in Table 2.1-2 for the San Francisco (SFO) area.

		Data Items	Format
j times $j \geq 1$		Quantity of jurisdictions, j Quantity of resource pools, r	(2I10)
		Jurisdiction name, left justified Capacity of jurisdiction, if terminal-negative, number of runways Ceiling altitude (feet) Floor altitude (feet)	(A4, 1X, I10, 2F10.3)
		(This card present only if jurisdiction is a terminal) Random access record number on TAPE30 for terminal sequence route data Probability of missed approach	(I10, F10.0)
	r times $r \geq 1$	Initial number of elements per resource pool Maximum number of elements per resource pool Indication of resource type (MAN = manual, AUT = automated)	(2I10, 1X, A3)

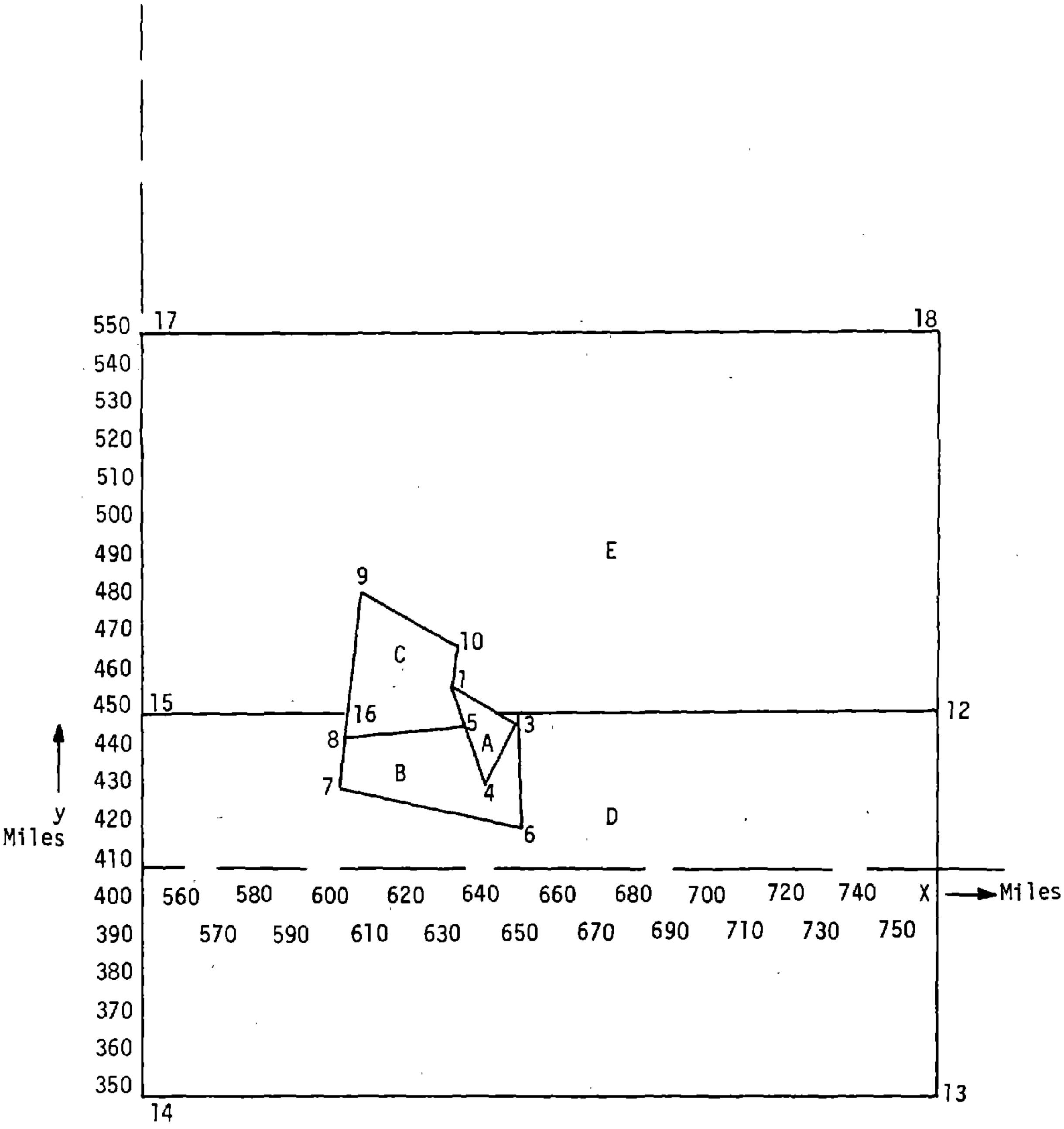


FIGURE 2.1-3 TOP VIEW OF SAMPLE JURISDICTION

TABLE 2.1-1 JURISDICTION DATA FOR EXAMPLE IN FIGURE 2.1-3

NAME	LETTER	POINT NUMBER NOT NECESSARY FOR INPUT	POINTS		ALTITUDES		ADJACENT SECTORS
			x	y	UPPER	LOWER	
Menlo Final	A	1	632.4	457.0	50,000	0	D, E
		3	647.8	448.2			B
		4	64.14	432.0			B, C
So. Feeder	B	3	647.8	448.2	50,000	0	D
		6	650.1	420.6			C
		7	602.8	433.4			D, E
		8	604.1	445.8			C
		5	635.5	448.2			A
		4	641.4	432.0			A
Sutro	C	1	632.4	457.0	50,000	0	A
		5	635.5	448.2			B
		8	604.1	445.8			D, E
		9	608.8	468.0			E
		10	632.1	468.0			E
So. Enroute	D	11	644.8	450.0	50,000	0	E
		12	760.0	450.0			-
		13	760.0	350.0			-
		14	550.0	350.0			-
		15	550.0	450.0			E
		16	604.6	450.0			E
		7	602.8	433.4			B
		6	650.1	420.6			B
		3	647.8	448.2			B
No. Enroute	E	16	604.6	450.0	50,000	0	D
		15	550.0	450.0			-
		17	550.0	550.0			-
		18	760.0	550.0			-
		12	760.0	450.0			D
		11	644.8	450.0			A
		1	632.1	468.0			C
		10	632.1	468.0			C
		9	608.8	484.5			C

TABLE 2.1-2 INPUT DATA FILE FOR JURISDICTION DATA

```
        5         5                    NO. OF JURIS., NO. OF RES. POOLS
A            50   50000.00       .000  JURIS. ID, CAPAC., CEIL & FL ALI
        2            3 MAN             RESOURCE POOLS:
        2            3 MAN
        2            3 MAN
        2            3 MAN
       12           50 AUT
B            50   50000.00       .000  JURIS. ID, CAPAC., CEIL & FLT ALT
        2            3 MAN             RESOURCE POOLS:
        2            3 MAN
        2            3 MAN
        2            3 MAN
       12           50 AUT
C            50   50000.00       .000  JURIS. ID, CAPAC., CEIL & FL ALT
        2            3 MAN             RESOURCE POOLS:
        2            3 MAN
        2            3 MAN
        2            3 MAN
       12           50 AUT
D            50   50000.00       .000  JURIS. ID, CAPAC., CEIL & FL ALT
        2            3 MAN             RESOURCE POOLS:
        2            3 MAN
        2            3 MAN
        2            3 MAN
       12           50 AUT
E            50   50000.00       .000  JURIS. ID, CAPAC., CEIL & FL ALT
        2            3 MAN             RESOURCE POOLS:
        2            3 MAN
        2            3 MAN
        2            3 MAN
       12           50 AUT
A    3                                 JURIS. ID, NO. OF FLOOR VERT.
          632.4      457.0  2          X & Y COORD., NO. ADJ. JURIS.
                            D          ADJACENT JURISDICTION
                            E          ANOTHER ADJ. JURIS.
          647.8      448.2  1
                            B
          641.4      432.0  2
                            B
                            C
     0                                 NO. OF JURIS. ADJ. TO CEIL.
     0                                 NO. OF JURIS. ADJ. TO FLOOR
```

TABLE 2.1-2 INPUT DATA FILE FOR JURISDICTION DATA (Cont'd)

```
B    6
         647.8     448.2     1
                             D
         650.1     420.6     1
                             D
         602.8     433.4     2
                             D
                             E
         604.1     445.8     1
                             C
         635.5     448.2     1
                             A
         641.4     432.0     1
                             A
     0
     0
C    5
         632.4     457.0     1
                             A
         635.5     448.2     1
                             B
         604.1     445.8     2
                             D
                             E
         608.8     484.5     1
                             E
         632.1     468.0     1
                             E
     0
     0
```

TABLE 2.1-2 INPUT DATA FILE FOR JURISDICTION DATA (Cont'd)

```
D    9
          644.8     450.0     1
                              E
          760.0     450.0     0
          760.0     350.0     0
          550.0     350.0     0
          550.0     450.0     1
                              E
          604.6     450.0     1
                              E
          602.8     433.4     1
                              B
          650.1     420.6     1
                              B
          647.8     448.2     1
                              B
     0
     0
E    9
          604.6     450.0     1
                              D
          550.0     450.0     0
          550.0     550.0     0
          760.0     550.0     0
          760.0     450.0     1
                              D
          644.8     450.0     1
                              A
          632.4     457.0     1
                              C
          632.1     468.0     1
                              C
          608.8     484.5     1
                              C
     0
     0
```

			Data Items Cont'd	Format
j times $j \geq 1$			Jurisdiction name, left justified Number of floor vertices, V	(A4, I3)
	V times $V \geq 1$ See discussion for order of vertices		x - coordinate of vertex y - coordinate of vertex Number of jurisdictions adjacent to vertex, OK asis aj	(5x, 2F10.3, I3)
		aj times $aj \geq 0$	Name of adjacent jurisdiction to vertex, left justified	(24x, A4)
			Number of jurisdictions adjacent to ceiling, c	(4x, I3)
		c times $c \geq 0$	Name of jurisdiction adjacent to ceiling, left justified	(24x, A4)
			Number of jurisdictions adjacent to floor, f	(4x, I3)
		f times $f \geq 0$	Name of jurisdiction adjacent to floor, left justified	(24x, A4)

Figure 2.1-4 shows an example of a jurisdiction. There are four jurisdictions, C, D, E and combined A and B. Although shapes A and B are acceptable right polygons, the combined shape of A and B is not a right polygon.

2.1.2 Aircraft Motion

Subroutine MOVAC is responsible for all aircraft motion outside the terminal area. The subroutine is concerned with holding patterns, conflicts in flight schedules, jurisdiction boundary crossings, change in phases of flight, speed and navigational errors, tolerance corrections, turns in flight plan, aircraft velocities, and aircraft positions.

MOVAC is evoked in three ways. Firstly, at a time frequency set by the user, MOVAC schedules aircraft motion events for each aircraft up until the beginning of the next update time interval or until the next turn, whichever comes first.

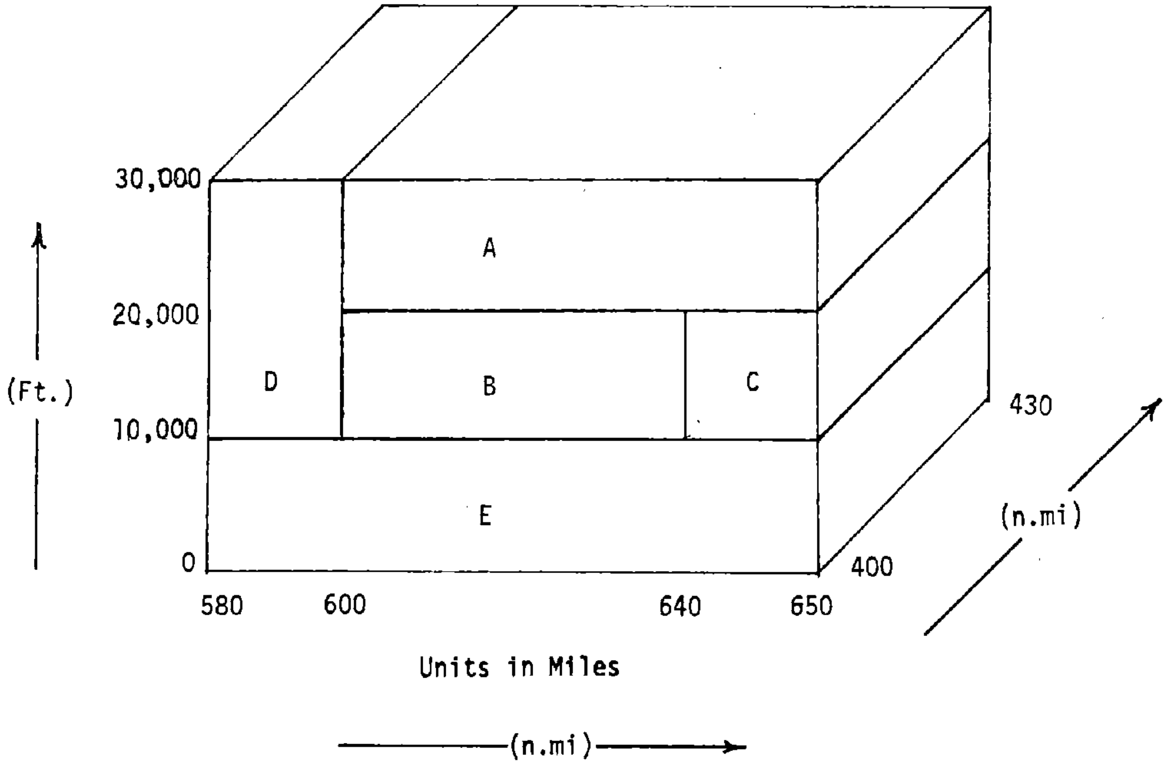


FIGURE 2.1-4 EXAMPLE OF JURISDICTION

Secondly, these scheduled events are processed by MOVAC for individual aircraft as they occur in simulation time. After each aircraft turns, MOVAC again schedules events for MOVAC up to the next turn or until the end of the current update time period. This recursive technique approximates quite adequately continuous aircraft motion.

Lastly, subroutines external to MOVAC schedule aircraft motion events for individual aircraft to be updated by MOVAC.

Following is the list of events triggering MOVAC and the resulting action by MOVAC. The motion events scheduled by MOVAC are jurisdiction boundary crossing, aircraft turning, and an aircraft flight plan being rescheduled due to a tolerance problem.

EVENT	ACTION
Periodic update of all aircraft occurs. Planted by INITIA initially and subsequently by MOVAC itself.	Move all aircraft not in a holding pattern. For each aircraft, Schedule motion events for time until next turn or until the end of current update cycle, whichever comes first.
Single aircraft is removed from metering and sequencing hold. Planted by MOVAC to occur at removal time.	Action is same as for periodic update above, but for this aircraft only.
Single aircraft crosses a jurisdiction boundary. Planted by BNDRY or ACJBC2 subroutines of MOVAC.	Count of aircraft in each jurisdiction is adjusted. The aircraft is moved to its new jurisdiction at this time by subroutine T13301.
A single aircraft incurs a conflict in its flight plan. Planted by subroutine CONDET, which discovers the conflict and modifies the aircraft flight plan.	Cancel scheduled motion events for this aircraft in the current update cycle. Reschedule aircraft motion events for this aircraft on its new flight plan until it's next turn or until the end of the current update cycle, whichever occurs first.
A single aircraft reaches its next fixed point in its flight plan. Planted by CRASH, a subroutine of MOVAC, to occur at turn time.	Change aircraft direction and velocity. Schedule a call to MOVAC to generate motion events for this aircraft.
A single aircraft reaches feeder fix. Planted by subroutine UDPOF.	Move the specified aircraft to its feeder fix.

EVENT	ACTION
A single aircraft is out of tolerance. Detection by subroutine T07401 which calls TOLFX5, a subroutine of MOVAC.	If the tolerance problem can be solved by altering the flight plan of the aircraft, TOLFX5 cancels all motion events for aircraft, alters the flight plan, and plants a call to MOVAC to reschedule the aircraft motion events until its next turn or until the end of the current update cycle, whichever occurs first.
A single aircraft takes off (i.e., changes its phase of flight from preflight to flight). Planted by subroutines UDPOF T03000, or T04401.	Initialize current velocity from zero to the intended velocity of aircraft between its first and second fixed point in its flight plan.

Following is a description of operations performed by MOVAC whenever an event above occurs.

OPERATION	ACTION
Check if aircraft metering and sequencing or en route hold is necessary.	If a hold is necessary, delay arrival times at fixed points in flight path. Place aircraft in appropriate type of hold.
An aircraft approaches terminal area.	Plant call to UDPOF to update phase of flight from "en route" to "approach". Place the aircraft in the arrival queue for metering and sequencing.
Perform operation if aircraft has not yet been processed by metering and sequencing.	A flight area is projected for aircraft, considering its navigational and speed errors. This area is used by CONDET to determine if any flight conflict exists.
A single aircraft flies out of system.	Plant a call from subroutine BNDRY to subroutine CANAC to cancel the aircraft from the system. Print an appropriate message.

2.1.3 Error Model

The DELTA error generating model consists of two subroutines. One of these, FUNCTION SPEEB, calculates a speed bias for the aircraft; the other SUBROUTINE ACNE, calculates the navigation error of the aircraft.

(1) FUNCTION SPEEB

FUNCTION SPEEB calculates a new speed bias for an aircraft. Three of the arguments are D1, D2, and the current value, VDEV, of the bias (or velocity deviation) for the specific aircraft. D1 and D2 are inputs, see p. 3.3-10. The new VDEV value is drawn from a distribution that is uniform between -D1 and +D1, with a height of 1/(D1+D2), and is triangular from -D1 to -D2 and from D1 to D2. (See Figure 2.1-5)

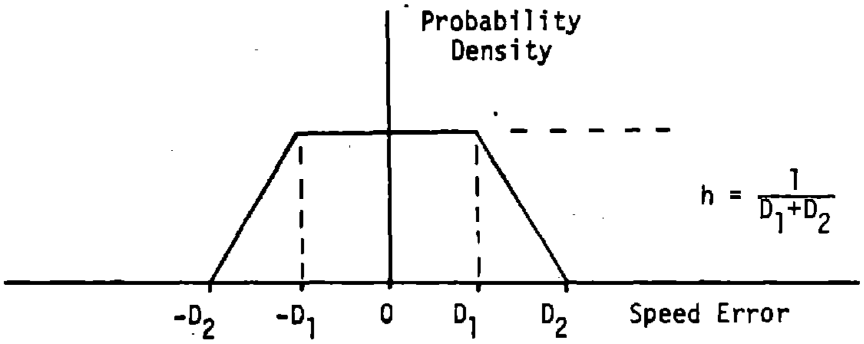


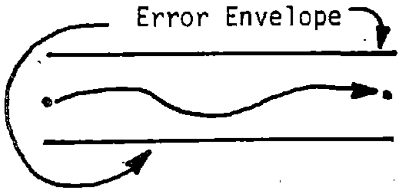
FIGURE 2.1-5

The fourth and final argument of the function is ILK. If ILK = 1, the new VDEV is drawn in a manner that is constrained by the current VDEV value. If ILK = 0 no such constraint is enformed. This value of ILK is set in the routine which calls SUBROUTINE SPEEB.

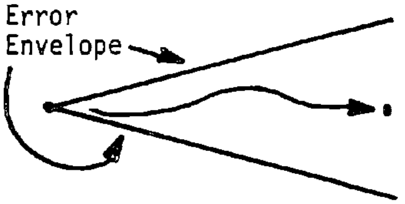
It should be noted that this bias is held constant between consecutive corrections of the speed error.

(2) SUBROUTINE ACNE

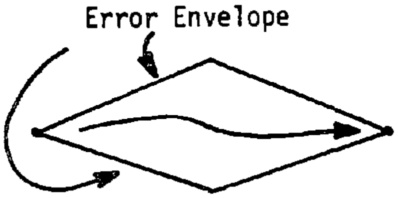
This subroutine calculates the navigation error expressed as the positional error (EX, EY, EZ). There are basically three types of errors that are applied in simulating aircraft motion from point to point.



Constant error navigation system (such as a satellite). Indicated by IERR = 1.



Error grows with passage of time, but doesn't improve. Indicated by IERR = 2.



Current system, in which plane has best information about position when passing over a navigation aid. This type of error is indicated within the subroutine by setting the variable IERR>2.

For each of these three error types, the errors applied to a given aircraft form an autocorrelated time series (within the time interval between two successive resettings of the error to 0).

These errors are summarized as follows:

a. NAVIGATION ERROR, CONSTANT σ

Formula For Generating Error

Error sampled from normal ($\mu = 0$, σ), and autocorrelated with past observation by smoothing weight of α $(0\leq\alpha\leq1)$.

Uses

Yields erroneous positions (explicitly) and (implicitly) erroneous headings. Can cause current deviations from tolerances.

b. NAVIGATION ERROR, ZERO AT FIX POINT, INCREASING σ UNTIL NEXT FIX POINT

Formula For Generating Error

Error sampled from normal [$\mu = 0$, $\sigma = (\sigma_{max})*(1-e^{-K(t-t_s)})$], where

K = a shape parameter, t = current time, and t_s = time aircraft passed starting point of current leg between Fix points). Autocorrelated (by using α) with last previous error. If last previous error was found before or at t_s, last previous error is set = zero before autocorrelating with latest sample.

Uses

Same as a.

c. NAVIGATION ERROR, ZERO AT FIX POINTS, σ INCREASES AND THEN DECREASES ALONG EACH LEG BETWEEN CONSECUTIVE FIX POINTS

Formula For Generation Error

σ here = [σ for 2.]*[$e^{-K_3(t_f-t)}$], where t_f = finish time for aircraft on current leg. Otherwise, identical to b.

Uses

Same as a.

The following variables appear in the calling list for SUBROUTINE ACNE.

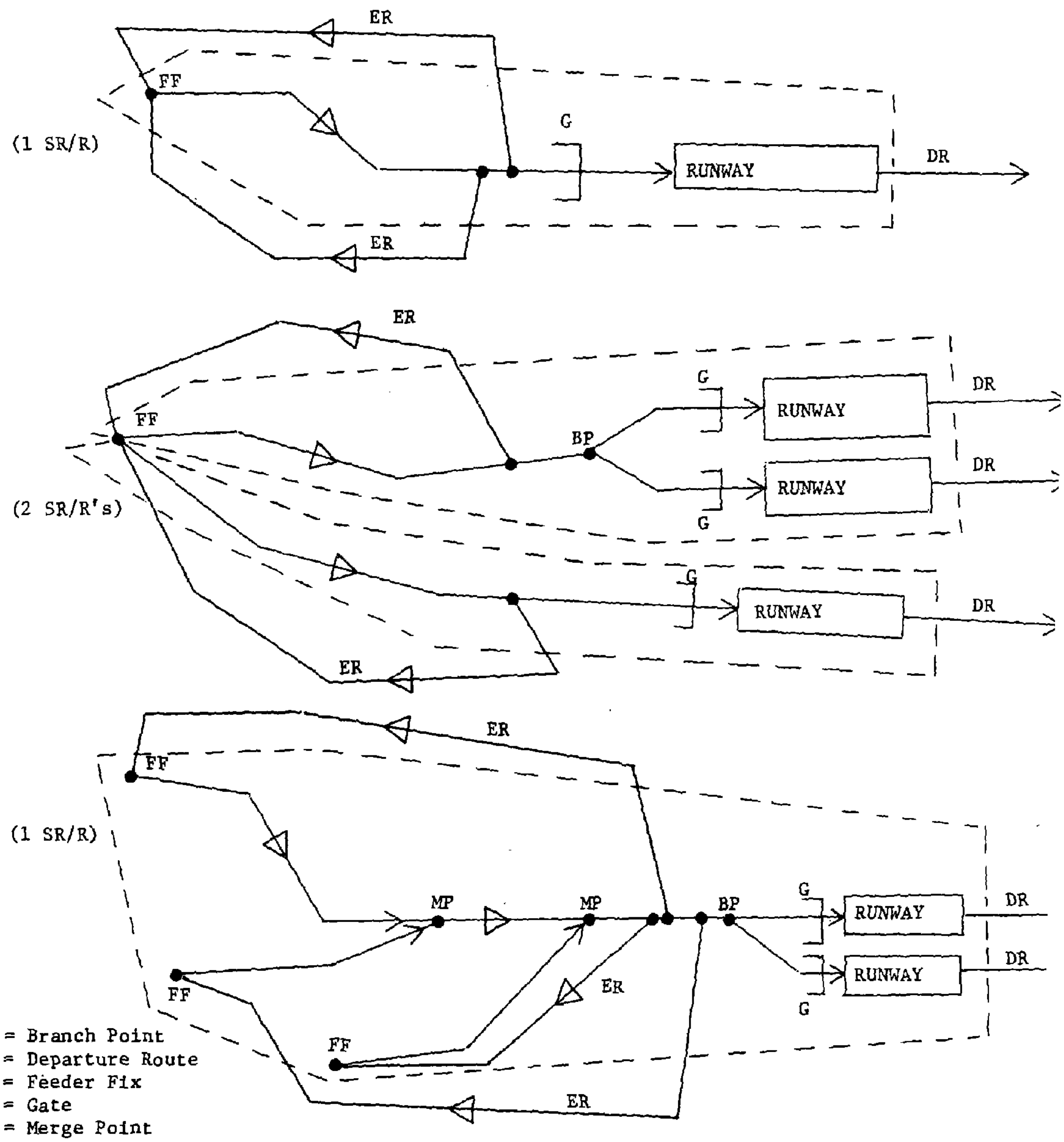
IERR	Error indicator for each aircraft. This specifies which of the three types of errors is being applied for this aircraft.
A	Autocorrelation coefficient
AK	Shape parameter for the error used. AK>0.
(SMAX, SMAY, SMAZ)	Maximum sigma necessary to generate error
TNØW	Present time
TFIXL	Time given aircraft passes the fixed point on the flight plan.
TFIXN	Time aircraft is scheduled to arrive at the next fixed point.
DELT	Time increment being used when ACNE is called.
(EX, EY, EZ)	Error computed by ACNE.

2.2 METERING AND SEQUENCING ALGORITHM

2.2.1 Terminal Structure

Each modeled terminal is considered by the Metering and Sequencing (M&S) algorithm to be one jurisdiction. Arriving traffic enters these jurisdictions through points called Feeder Fixes. (Initially, all aircraft flight plans end at a specific Feeder Fix (FF) at a specific terminal. The M&S algorithm generates the remainder of the flight plan as shown below.) From each FF one or more Sequence Routes (SR's) carry traffic to the various runways. The SR's are the representations of the 3-dimensional flight paths flown by the aircraft from the FF's to runways, and each SR consists of a finite sequence of linear legs that are connected end to end. Each SR can lead to just one runway or can branch at a "branch point" (BP) to feed two or more separate runways and each SR can have one or more branch points. Each SR may be the only SR leading to one of its runways, or there may be two or more SR's feeding the same runway. In the latter case, the SR's must merge at a "merge point" that lies on an SR leg before the runway. Each runway at a given terminal is the last leg of an SR with no merge points or is the last leg of one of the unique paths through the SR and its set of merge points. Associated with each runway there is a "gate" located on the last leg of the SR path into that gate. Thus, each BP must precede the gates associated with the runways that the BP leads to. Aircraft that are departing from a terminal follow Departure Routes which are also sequences of linear legs and which lead into the en route flight paths. Each Departure Route (DR) has as its first leg one of the runways. For arriving aircraft that suffer missed approaches, there are Escape Routes (ER) associated with the SRs. The ER's are paths (piecewise linear) from specified points on SRs to specified FFs. An ER can lead from one SR to a FF for a different SR, but it must not be possible for an aircraft that was scheduled to use a particular runway and that suffers a missed approach to follow an ER and then not be able to get back to the same runway for which it was originally scheduled. Each SR can have one or more ERs originating on it and each FF can have one or more ER terminating at it. Some examples of Terminal Structures are shown in Figure 2.2-1. Each unique combination of SR and runway is called an SR/R and is enclosed in the figure in a dashed line.

Note: The figures shown below are projections of 3-dimensional SR/R's onto the horizontal plane used to represent the Earth's surface.



BP = Branch Point
DR = Departure Route
FF = Feeder Fix
G = Gate
MP = Merge Point
ER = Escape Route

FIGURE 2.2-1 EXAMPLES OF TERMINAL STRUCTURES

2.2.2 Terminal Aircraft Motion

2.2.2.1 Arriving Aircraft

For each arriving aircraft, the FF and runway to be used are prespecified (explicitly) and thus the SR to be used is specified (implicitly). The only decision variables are the Runway Arrival Time (RAT) and Runway Clear Time (RCT) for the aircraft. Since for each aircraft we know its "type" (by some categories set up), and since for each type there is a constant Runway Occupancy Time, and since RCT = RAT + ROT, the only true decision variable is RAT. Each aircraft scheduled to arrive at a given terminal is analyzed by M&S some (specified) time interval prior to the arrival of the aircraft at the FF. In this analysis, a block of time (= in length to the ROT for aircraft) is set aside for the aircraft on the runway the aircraft is to use. This scheduling may allow the aircraft to arrive on time (or within specified tolerances of "on time") or may require the aircraft to be held for a length of time which is determined by the algorithm. Holding of an arriving aircraft is required only when other aircraft (arrivals and/or departures) have already been scheduled for blocks of time (or slots) on the same runway so as to interfere with the slot for the arriving aircraft (i.e., the slot which allows the aircraft to arrive precisely on time).

If there are no other aircraft scheduled for the same runway (arriving and/or departing) interfering with its motion, an arriving aircraft will be assigned to a specific path through a specific SR/R and will have a specified velocity vector (in 3 dimensions) for each leg of the path. This SR/R path and associated velocity vector set is called the Nominal Path (NP) for the aircraft. The runway is the last leg in the NP for an arriving aircraft which will "vanish" from the algorithm once it has reached the end of the runway.

However, if other aircraft are already scheduled for the same runway and if their schedules interfere with the NP schedule of the new arrival (see Section 2.2.3 for a discussion fo the types of interference that can arise), then the NP is adjusted by changing (within specified bounds) the velocity vectors for the legs of the NP. The velocity vector changes are made implicitly by changing the time required for the aircraft to cover the NP. The maximum increase and decrease allowed in the nominal time are, respectively, T_R (for retard) and T_A (for advance). The quantities T_A and T_R and the way in which they are used are equivalent to the actual practice of maneuvering aircraft within some physical region about the ideal flight path (i.e., sending some aircraft out to the extreme points of the heading changes, while directing other aircraft to cut corners on certain heading changes, all for the purpose of sequencing the aircraft). Both T_A and T_R are initially positive quantities. The T_A represents the absolute maximum increase in net speed over the SR, while the T_R represents the maximum allowable decrease in speed without forcing the aircraft to be held. If it is necessary because of interference from other aircraft already scheduled for the runway to hold an arriving aricraft in order to schedule it, then its T_R will be exceeded by the actual retardation made in its schedule. Whatever use is made of T_A and T_R for an arriving aircraft, it is given one speed that carries it from the FF to the start of the runway. Thus, once the runway slot has been found, the corresponding speed is determined and this speed is used as the aircraft speed for all legs of the SR but the last one. The runway speed is found from the runway length and the ROT. If a no hold slot is found for the aircraft, the velocity associated with the slot is generally different from the standard velocity for the NP. But for a hold solution, the velocity chosen for the aircraft is precisely the standard velocity since holding the aircraft takes care of any scheduling problems for the runway.

Since the last leg of the aircraft's flight coincides with the runway, it is necessary that the length of the leg = (the nominal speed for the aircraft in the SR) x (the ROT).

2.2.2.2 Departing Aircraft

For each departing aircraft, the runway to be used is prespecified as is the sequence of fix points making up the Departure Route. The decision variables for departures are the RAT and the length of time (if any) for which the aircraft is to be held prior to departure.

As is done for arriving aircraft, each departing aircraft is analyzed by M&S some time prior to the scheduled departure time, and a slot of runway time (equal in length to the aircraft ROT) is allocated to the runway. Departing aircraft can be on time or they can be delayed (in a hold). If a hold is needed, the length of the hold is determined by the algorithm. Again, holding is needed in cases in which aircraft already scheduled for the same runway interfere with the desired nominal slot for the departure.

Departing aircraft initially have $T_A = T_R = 0$. This prevents a departing aircraft from being given a departure time earlier than the original intended departure time. If a departure is to be held, T_R will be <0 for the actual slot allocated for the aircraft. Since the speed of departing aircraft on and over the runway is explicitly not used by M&S (all calculations are based upon the ROT), the speed value is set = 0 within M&S. However, the first leg of the aircraft flight plan coincides with the runway and the flight plan contains the time needed to cover this first leg and the speed of the aircraft for the leg. Therefore, the time must = ROT and the runway speed must = (the length of the runway)/(ROT).

2.2.3 Constraints on Aircraft Motion

In scheduling aircraft (both arrivals and departures) for runway slots there are certain constraints on the motion of the various aircraft. These constraints which are built into the algorithm logic are described below:

Basic Constraints

a) No two aircraft can occupy the same runway at the same time. For example, given aircraft number i-1, i, and i+1 scheduled for the same runway, we have

$$\mathrm{RCT}(i-1) \leq \mathrm{RAT}(i) < \mathrm{RCT}(i) \leq \mathrm{RAT}(I+1)$$

b) For each aircraft, RCT-RAT ≡ ROT for that aircraft

c) No two landing aircraft scheduled to use the same runway can pass each other between the gate and the start of the runway (this holds no matter how many departing aircraft use the runway between the two arrivals).

d) In attempting to schedule a landing aircraft into a slot, if there are other landing aircraft already scheduled for the same runway, with at least one in front of (earlier than) and one in back of (later than) the trial slot for the new aircraft, and if (the speed of the closest front landing aircratt) < (the speed of the new aircraft) < (the speed of the closest rear landing aircraft), then the new aircraft cannot be scheduled into the trial slot. This constraint has the effect of forming sequences of landing aircraft in which there are at least two aircraft and in which, from the front to the rear of each sequence, the aircraft speeds form a monotonic nondecreasing sequence.

Constraints on Rescheduling of Aircraft

When an attempt to schedule an aircraft onto a runway is made, it may be found that other aircraft currently scheduled for the same runway interfere with the scheduling of the new aircraft into the desired slot. These forms of interference are as follows:

a) The time slot for an already scheduled aircraft intrudes into the slot for the new aircraft (this has the effect of making the slot for the new aircraft less than the proper ROT in size).

b) If the new aircraft is a landing aircraft, another landing aircraft (already scheduled) can pass the new aircraft between the gate and the runway.

To resolve the interference between the schedules of two aircraft (one already scheduled, the other new), an attempt is made to do one (or more) of the following:

a) Reschedule an already scheduled aircraft (either forward or backward as required) so as to eliminate overlapping runway slots and/or crossings between the gate and the runway.

b) Change the slot chosen for the new aircraft.

In using either or both of these techniques to solve the problems created by interference, the following constraints must be observed:

a) New aircraft cannot be advanced more than the T_A value.

b) New aircraft cannot be retarded more than T_R without creating a hold solution.

c) No aircraft can be rescheduled forward by an amount > its current T_A.

d) No arriving aircraft can be rescheduled backwards (retarded) by any amount to accommodate a new aircraft that is departing.

e) No aircraft that is currently in a hold slot (its T_R is < 0) can be rescheduled at all.

f) No arriving aircraft that has moved physically past its feeder fix can be rescheduled.

g) A departing aircraft can be rescheduled from a non-hold slot into a hold slot.

h) An arriving aircraft cannot be rescheduled from a non-hold slot into a hold slot.

i) In rescheduling aircraft to fit a new aircraft into a trial slot, only one aircraft may be rescheduled for any given trial slot.

j) In analyzing a trial slot, if rescheduling is required, it can be done at one end (early or late) of the slot at a time. This is a consequence of constraint i) and implies that each trial slot can be analyzed twice, once with rescheduling possible at the front and once with rescheduling possible at the rear.

2.2.4 Optimization Logic in M&S

The possible types of slots for any aircraft are listed below in decreasing order of preference (i.e., from "best" to "worst"). The optimization logic in the algorithm is concerned with finding the best possible slot for an aircraft.

1) A slot starting at the nominal RAT and ending at the nominal RCT and no rescheduling of other aircraft involved.

2) A slot starting no earlier than [(nominal RAT) - (nominal T_A)] and ending no later than [(nominal RCT) + (nominal T_R)].

3) The same as 2) but with some rescheduling of one other aircraft involved.

4) Any solution requiring holding of the new aircraft.

Solution types 1), 2), and 3) do not require holding of the new aircraft while type 4) does.

In order to find the best slot for an aircraft, the time interval starting at [(nominal RAT) - (nominal T_A)] is searched by forming a sequence of trial slots and evaluating each until the best slot is found. Creation of new trial slots ends when the first slot in which a hold solution for the new aircraft is required has been found. Further details on the ranking of slots is found in the flow charts of subroutines METSEQ and BSTSLN.

2.2.5 Simplifications in the Algorithm

The current design of the M&S algorithm contains the following six major simplifications, some of which have already been mentioned.

1. All aircraft flying over the same sequency route fly over precisely the same path, and the advance and retard times (TA and TR) are used to model the control a controller has over aircraft in metering and sequencing them.

2. Along the sequence routes, landing aircraft motion is not constrained so as to maintain minimum separation standards around the aircraft. Aircraft that are in metering and sequencing holds are unconstrained in the same way.

3. The conflict detection and resolution logic is not applied to aircraft that are in the M&S holds, or that are arriving and have begun flying down their assigned sequence routes.

4. Arriving aircraft that are physically past their assigned feeder fixes, and departing aircraft that have not moved beyond the runway are not subject to errors (random or deterministic) in their motion.

5. For each arriving aircraft, the speed used in flying down the sequence route is the same for all legs of the sequence route (except for the last leg, which is the runway).

6. The initial values of TA for landing aircraft that are using the same sequence route is the same for all such aircraft regardless of the speed classes of the various aircraft. Similarly, initial TR values are assigned to each sequency route, each such value to be used for all aircraft flying down the corresponding sequence route.

2.2.6 Data Structure

There are four main parts to the data structure used by the algorithm. One of these contains data describing the terminals themselves (e.g., number of runways, number of feeder fixes, T_A and T_R for aircraft that are arriving, distances between the gates and the corresponding runways, nominal velocities for sequence routes, coordinates of points on sequence routes, etc.). Each terminal has its own such data structure.

The other three parts of the M&S data structure are all files in dynamic memory. One of these three is the runway queue (RWQUE). There is one RWQUE for each runway at each terminal. Whenever the best slot for a new aircraft has been found an entry containing the information is made in the RWQUE for the runway to be used by the new aircraft. Thus, when an already scheduled aircraft may have to be rescheduled, the algorithm finds most of the data it needs to describe the aircraft to be rescheduled in the appropriate member in the appropriate RWQUE.

The basic data contained in the RWQUE are the pointer, the aircraft data file member for the aircraft, the runway arrival and clear times for the aircraft, the amounts of T_A and T_R currently available to the aircraft (after the current solution was formed), and the velocity to be used by the aircraft in flying from the feeder fix to the runway (if the aircraft is an arrival). For a departure, the velocity = 0, as discussed above.

The second of the three file types used by M&S is the Metering and Sequencing Queue (MSQUE), one of which exists for each terminal in the modeled system. Aircraft (both departing and arriving) that are to be processed by the M&S are entered into the MSQUE for the proper terminal by other parts of the model (see Section 2.2.6 for more information on which parts of the model do this and how they interact with M&S). Periodically, M&S examines the MSQUEs for the various terminals. In this analysis, all aircraft in an MSQUE are given slots of time on the runway specified for them at the terminal owning the MSQUE, and then an entry for each of the aircraft is made in the RWQUE for the runway to be used by the aircraft. The primary purpose of the MSQUE (besides serving as a "list" of all aircraft to be processed by M&S at each terminal) is to provide a means of ranking the aircraft so that they are processed in a certain order. All aircraft entered into an MSQUE are ranked low on a function of Speed Class and ETA (at feeder fix for arrivals, at runway for departures). In this way slow moving arriving aircraft tend to be processed before faster moving arrivals. Since the RWQUE's tend to be filled up from front to back, this tends to give early slots to slow moving aircraft and thus help to form the sequence of aircraft with monotonic nondecreasing speeds.

The final type of M&S file to be discussed is the Terminal File. Each terminal has its own terminal file, which is used primarily to store pointers to the jurisdiction files, disk file entries, and aircraft in RWQUEs for the runways at the terminal.

2.2.7 Relationships Between M&S and the Aircraft Motion Algorithm (MOVAC)

Departing aircraft are placed into the MSQUE for their departure terminal by the logic for Function 3 of the Functional Analysis a specified time interval prior to the original intended departure time of the aircraft. Then at the next periodic call to M&S the aircraft is processed and is assigned to a slot in a RWQUE for one of the runways at the departure terminal. This slot may be a hold solution, in which case the aircraft will be delayed in departing. Whatever the type of slot that is found for the aircraft, the aircraft will stay in the RWQUE until the current time in the model = the actual departure time. Then the aircraft has its phase of flight changed from Preflight to Takeoff by the service routine UDPOF. The call to UDPOF contains the length of time the aircraft will be in Takeoff phase and the length of time the aircraft will remain in the next phase, Departure Transition. These two time intervals are used to plant calls to UDPOF for this aircraft for the ends of Takeoff and Departure Transition. At these times, UDPOF changes the phase of flight for the aircraft to Departure Transition and to En Route, respectively.

For arriving aircraft, MOVAC determines when each aircraft is within a specified time interval of reaching its feeder fix (this is determined by comparing current time and the intended time of arrival of the aircraft at its feeder fix). When an arriving aircraft has closed to within this time interval of its estimated time of arrival, ETA, at its feeder fix, MOVAC adds an entry for the aircraft to the MSQUE for the terminal to be used by the aircraft. Since the time interval (feeder fix ETA - insertion time) is greater than the M&S period, it is quaranteed that each arriving aircraft will be examined by M&S before arriving at the feeder fix. If M&S determines that a hold is needed for an aircraft, the variable HOLDTM is set = the length of the needed hold, the aircraft is put into M&S hold status, and the arrival of the aircraft at the feeder fix is delayed by HOLDTM. A call to UDPOF is scheduled for the ETA at the feeder fix. In this call UDPOF changes the phase of flight from Arrival Transition to Approach (MOVAC changed it from En Route to Arrival Transition at the time the aircraft was placed in the terminal's MSQUE). Part of the output from the processing of the aircraft in the next periodic call to M&S is a call to UDPOF planned to occur at the time the aircraft is first over the runway, and another call to UDPOF is planned for the time the aircraft will leave the runway. These calls serve, respectively, to change the phase of flight from Arrival Transition to Landing and to erase the aircraft from the model.

2.2.8 Algorithm Subroutines

The M&S algorithm routines and their respective basic purposes are as follows:

ADJUST - Used by RESCH and PFIND2 to store the original version of the current slots and slot data for new aircraft and to place the current trial slot (as possibly changed by PFIND1) into the RWQUE entries so that PFIND2 can read the slot as changed by PFIND1. If rescheduling of and aircraft is required by PFIND1, a similar shifting of slot data is carried out for the rescheduled aircraft.

BSTSLN - Used by METSEQ to compare two non-hold solutions for the new aircraft and find the better of the two.

FACL - Used by PFIND1 to find an advance time for the latter of a pair of landing aircraft using the same runway. This is the maximum advance time allowed without creating a gate/runway crossing for the two aircraft.

GRWCRS - Used by PFIND2 to determine if two landing aircraft scheduled for the same runway have a gate/runway crossing problem, and if so how much advance time for the later aircraft or retard time for the early aircraft is needed to solve the problem.

METSEQ - This is the main subroutine in the algorithm. It reads in all data, processes all terminals (one by one), processes all aircraft at each terminal (one by one, arrivals first and then departures), formulates trial slots, used PFIND1 and PFIND2 to evaluate the trial slots, finds (with the help of BSTSLN) the best slot for each aircraft, schedules the aircraft for the best slot, schedules calls to UDPOF for the aircraft, and changes the flight plan (TPQUE) for the aircraft as needed.

PFIND - Used by METSEQ as an intermediate driver between METSEQ and (PFIND1 and PFIND2).

PFIND1 - Used by METSEQ to analyze a potential slot for a departing aircraft and used by PFIND2 to perform initial analysis of a potential slot for an arrival. Can determine if a solution is possible in the trial slot and if rescheduling of another aircraft and/or of the new aircraft is needed to make the solution possible.

PFIND2 - Used by METSEQ to analyze a tentative slot for an arriving aircraft. Can provide the same type of information as can PFIND1.

RACIT - Used by METSEQ to store data about changes in the current solution for an aircraft when the aircraft is to be rescheduled to accommodate some other aircraft.

RACL - Used by PFIND1. Similar to FACL, but gives the retard time allowed for the earlier of the two landing aircraft without causing a gate/runway problem.

REAJST - Used by PFIND2 to reverse the data shifting accomplished by ADJUST. Puts what was the solution for an aircraft that tentatively was to be but isn't to be rescheduled back into the RWQUE entries for the aircraft.

RESCH - Used by PFIND2 to set into temporary variables a rescheduled version of the current official solution for an aircraft that must be rescheduled in order to accommodate an arriving aircraft.

R999 - USED BY PFIND1 to determine if the solution found for an aircraft is a hold solution, and if so, how long the aircraft will be held.

SLOCH - Used by PFIND2 to make temporary changes in the current slot for a new arriving aircraft and to show the solution PFIND2 found for the aircraft.

UPTPQ - Used by METSEQ to add the fix points coordinates, leg speeds, and leg times for the sequence route to the flight plan for an arriving aircraft once the aircraft has been given its best slot.

VELCAL - Used by METSEQ and ADJUST to update the value of the sequence route velocity for an arriving aircraft when the slot for the aircraft is changed.

2.3 SEPARATION ASSURANCE

A basic function of the DELTA simulation logic is to predict when aircraft motions will result in a hazardous mid-air approach, and to maneuver the aircraft to avoid this hazard. This function must be performed with sufficient precision to assure realistic aircraft motion, and to properly trigger the various Air Traffic Management (ATM) tasks which will consume system resources when such mid-air conflicts occur.

In this section, the detailed logic for performing this separation assurance is described. The model will utilize this algorithm in several contexts, and in both en route and terminal environments. This function will interact strongly with other essential model functions including metering, sequencing and spacing and en route sector capacity measures.

The separation assurance algorithm may be subdivided into three basic functions:

1. Conflict prediction - The initial detection of pairs of aircraft that may be in conflict;
2. Hazard evaluation - The assignment of a measure of risk to a possible conflict;
3. Conflict resolution - The determination of a maneuver or maneuvers that will result in a less hazardous situation for the aircraft pair and their neighbors.

2.3.1 General Algorithm Description

2.3.1.1 Conflict Prediction

The conflict prediction function is performed solely to relieve the data processing load on the hazard evaluation and conflict resolution algorithms. Since the hazard evaluation for a pair of aircraft can consume several hundred instructions, it is necessary to screen all potential aircraft pairs in the system (N(N-1)/2 total) so that only the more likely candidate pairs are processed for detailed probability calculations. This is best performed by a series of aircraft pair "filters" which, with very few computations, sequentially exclude a large fraction of the non-hazardous pairs. The particular set of filters suggested in this section was derived from real-time conflict prediction logic designed for the ARTS system. The goal of this logic is to pass through all aircraft pairs which have a non-zero probability of conflict (within the specified time period), but as few extraneous pairs as is computationally profitable.

The general method suggested for conflict prediction is grid filtering on a synchronous basis; that is, the subroutine is called at regular time intervals. The grid filter procedure consists of dividing an airspace volume into "boxes" and placing each aircraft into a series of these boxes based on the aircraft's position, velocity, uncertainty area, and required miss distance. The uncertainty area is a composite of estimated track error plus error caused by lack of knowledge of aircraft intent projected for some future time. Any two aircraft placed in the same box are candidates for a conflict.

After this initial gross geometric filter has selected a relatively small subset of aircraft pairs for further evaluation, a series of more refined filters are applied to the surviving pairs. The first of these filters is an "old conflict" test. This test must check the history files (created in the hazard evaluation function described later) to insure that the conflict has not been previously detected and evaluated. Next, an altitude separation test, and a more detailed velocity closure test, are applied.

The time that the aircraft's current position is projected into the future would, on a real time system,be approximately equal to the required warning time (a system parameter). However, in the simulation model this will not be the case since the subroutine is exercised at relatively long intervals. Thus, the look-ahead, or projection time, will be larger than the system warning time. If the aircraft is not on a flight plan, the simulation can know that a conflict will occur before the ATC system detects it. This is true, for example, if the confict is caused by a turn of an aircraft. The detection of the conflict must be entered at the time the system would detect it. Thus all turns must be represented by the proper box placement, and VFR detection must be in two phases: what the system sees assuming straight line flight, and what the simulation knows from the stored flight plan.

Generally, the model will not distinguish VFR and IFR aircraft per se, but aircraft will be identified by whether the system has intent data and the degree of controlability that can be exercised. The use of VFR here denotes the lowest degree of control - the ATM system is not involved in maintaining the aircraft on a flight plan.

2.3.1.2 Hazard Evaluation

Once a possible conflict has been identified by the prediction algorithm it must be further evaluated to determine its collision potential, or risk. Ordering the possible conflicts by risk allows the simulation to respond consistently to the basic system definition parameters input to the model. The measure of risk used in the algorithm is the probability of violating a given miss distance within the warning time that is provided by the Air Traffic Management system. This probability is calculated from the geometric configuration of the two aircraft and the uncertainties inherent in their position and velocity data. The logic approximates the conditional probability that an aircraft will turn from its current course by a separate distribution which is superimposed on the track error distribution.

Considering the aircraft's current position, velocity, and acceleration, it is possible to project an ensemble of possible paths which the aircraft could follow. The probability associated with a particular path from this ensemble is determined from two sources: variances in knowledge of the current velocity data, and uncertainty about the pilot's intent.

Uncertainty in the velocity vector (in particular, heading) is a major source of "spread" in the path ensemble. This uncertainty is usually approximated by the normal distribution of straight line paths symmetrically projected about the estimated heading of a non-turning track. Uncertainties in position are incorporated in the miss distance criteria. Uncertainties in intent will be approximated by an increase in spread of the path ensemble and a separate probability distribution. This seems consistent with the instant turn assumptions of the simulation and should give a realistic estimate of increase in workload due to lack of intent information.

It is important to model the intent uncertainties in the simulation since most future ATM system concepts include an IPC (Intermittent Positive

Control) separation mechanism. IPC commands generally consist of two types, positive commands and negative commands. Positive commands (i.e., commands that tell the pilot to take positive action) may be treated as resolution maneuvers; the only difference is in mode of communication and perhaps that the resolution algorithm will not take upon itself the responsibility of returning the pilot to his original course. Negative commands, however, are of the form "Do not turn right, Do not turn left," etc. They are preferred because they minimize interference with pilot intent. The evaluation algorithm is structured so that if it is possible to resolve a conflict by negative commands, this information will be available to the resolution and queueing module.

Output from the hazard evaluation will be a measure of risk, a minimum time before conflict, and when called from resolution, whether a negative IPC command will work. As a matter of course, once a conflict has been evaluated by the hazard evaluation algorithm, it will be entered in a history file, so that the conflict will not be reevaluated until necessary.

2.3.1.3 Conflict Resolution

The purpose of conflict resolution is to define a safe maneuver for an aircraft which is involved in a conflict. The maneuver must result in the measure of risk being reduced to an acceptable level. If appropriate, the resolution algorithm must also provide for the return of the aircraft to its intended flight path.

There are five basic maneuvers available for resolving a conflict:

- Negative IPC command (may be given to both aircraft simultaneously),
- Elimination of future scheduled fix,
- Level-off command,
- Positive horizontal maneuver, and
- Positive altitude maneuver.

The order in which these maneuvers are tried, and the elimination of any of them may be achieved via input data. The level of difficulty to the controller and thus, system response time (lag time) to initiation of maneuvers, may also be controlled by the user. If both aircraft may be maneuvered the preference as to which aircraft to try first for any maneuver is determined by the priority assigned to the aircraft by the simulation.

Once a safe maneuver has been found, the resultant new fixes are inserted in the aircraft's track file. The old fixes are made inoperative by assigning a very large number to the expected time of arrival (ETA) at that fix. An event is planted so that before it is time for the aircraft to arrive at the last fix of his maneuver course, he is checked to see whether he may resume his planned course. If it is not safe to do this, a new fix and corresponding ETA is calculated, and another event planted for resuming course. If it is possible for him to resume course, needed fixes are inserted and the ETA's of his flight plan readjusted to be reasonable numbers again. If he has flown past any fixes while on his maneuver course they are eliminated from the file.

If an IPC-controlled aircraft is the non-maneuvering aircraft of a resolution, it is assumed that he is given a negative IPC command not to turn toward the maneuvering aircraft. In the case of a negative IPC maneuver, turns in the region of the negative command are eliminated from the files.

2.3.1.4 General Flow of Safety Assurance Logic

Conflict prediction is performed on a synchronous basis. When new conflicts are found, it will plant events that will trigger hazard evaluation at the proper time. Since the hazard evaluation will occur before the next conflict prediction cycle, conflict prediction need not worry about entering the conflict into history files. The hazard evaluation should occur at the expected time the hazard is observed by the system. The output from this routine will inform the system whether a resolution maneuver need be attempted. If the conflict was considered to be nonhazardous, an event that causes the simulation to reevaluate the conflict in the future is planted. Since realistically the results of the hazard evaluation affect the system response time to the conflict, it is performed before being entered into the resource queues. The risk measure and expected time of conflict influences its placement in the queue for the resource in question. When it is approximately time for a resolution maneuver to be generated and sent, the resolution routine is called. The simulation will assign two parameters, which are used along with the level of difficulty of the maneuver to compute the system lag time for a maneuver. The maneuver is chosen considering this response or lag time information (as it will influence the risk involved in an individual aircraft's maneuver). The track file is changed to reflect the new aircraft velocity. Resolution will record the fact that a resolution maneuver has been planted. Resolution must also plant an event at the time that it expects the conflict to be resolved, and the aircraft revectored to its intended course. At the time of this revectoring, the conflict is checked to insure that it is safe to maneuver the aircraft, and a change vector is inserted into the track file if appropriate (this may not be necessary for VFR aircraft). An event must be planted to clear the history file and indicate to the track file that the conflict is resolved.

The aircraft pair must also be checked on a periodic basis for hazard since the original computation is only valid for a fixed length of time. More detailed discussion of the types of data and logic required for the different functions will now be presented.

2.3.2 Conflict Prediction Design

The major input parameters for the conflict prediction logic include:

Track Data

K_N - KNOW - (1,2,3,4,5) - state of flight knowledge. The state increases by one if:

- aircraft is on flight plan
- aircraft is controlled
- aircraft is being sequenced

$\dot{x},\dot{y},\dot{z}$ - perceived velocity components for aircraft

x,y,z - perceived position for aircraft (speed class, heading class - if these were stored it would speed processing time)

Systems Data

grid origin
grid size

BOXES (.)	This is the table that controls box placement. It will incorporate the angular error (intent + sensor) and miss distance. It is a function of (speed class, heading class, KNOW)
tw -	warning time
t_{la} -	look-ahead time (how often CP called + t_w)
t_{dt} -	time to detect unscheduled turn

Conflict prediction logic will perform all the "gross" filtering for potential conflicts. This will include the "old conflict" test. New conflicts that are detected will result in a hazard evaluation event being planted. These events may be planted at different times in the future if the look-ahead time used in conflict detection is different from the system warning time. This time difference arises only because the simulation will not be exercising conflict prediction as often as a real time system would.

There is a further programming consideration; the results of the gross filter (i.e., the filled grid, and the time that it was created) must be available to resolution so that it can insure that the maneuver it suggests does not cause a new conflict. This is accomplished by placing the grid data onto a disk file which may be accessed by resolution. In any case, CP is designed so that it is able to check one aircraft against others in its vicinity (keeping track of the fact that the times involved will not correspond) and exit without planting a conflict event (and giving instead a list of new conflicts).

CP must place aircraft in boxes on predicted flight path. These paths may include turns. If the system is not supposed to know of the turn and the conflict would not occur without it, the hazard evaluation is scheduled for an appropriate time (t_{dt}) after the turn and the conflict.

The conflict prediction logic will calculate as output the following data:

Filled grid on disk

Events containing:

IDA, IDB - track numbers of aircraft involved

KOLD - index in history file of conflict (0 - since CP only looks at new conflicts)

2.3.3 Hazard Evaluation (Hazard)

The system design for Hazard Evaluation is depicted in Figure 2.3-1. This shows how it is called, its associated subprograms and results.

2.3.3.1 Data Requirements for Hazard Evaluation

The data utilized by hazard evaluation are divided into three categories:

- Data provided by the simulation itself
- Systems parameters by which the user can adjust the results of the computation, and
- Data used by the program in order to increase computational efficiency

The information received from the simulation includes the coordinates, the velocities, flight plans, priorities, whether or not the aircraft is on IPC, class of aircraft, the metering and sequencing switch, whether or not the aircraft is controlled, whether or not the aircraft is on a flight plan, the type of aircraft, the speed that this type can attain, the turn radius that he can attain, the high and low altitude bound on his flight, normal climb rate, plus miss distance desired for this type of aircraft, horizontal and vertical. If the aircraft has altitude reporting equipment, this is also used in hazard evaluation since if there is no altitude known on the aircraft the hazard must be calculated on a two-dimensional model rather than a three-dimensional model.

The systems parameters needed are the combined probability distributions of the intent and sensor uncertainities, the high and low risk thresholds, the warning time used by the simulation, and the time between re-looks at non-hazardous conflicts.

The internal parameters include information such as the bounds on the sensor vs. intent areas, the number of steps in the ensembles of paths, and information from which the ensembles are calculated. Both of the latter two categories of information may be generated from simple input to an initialization routine.

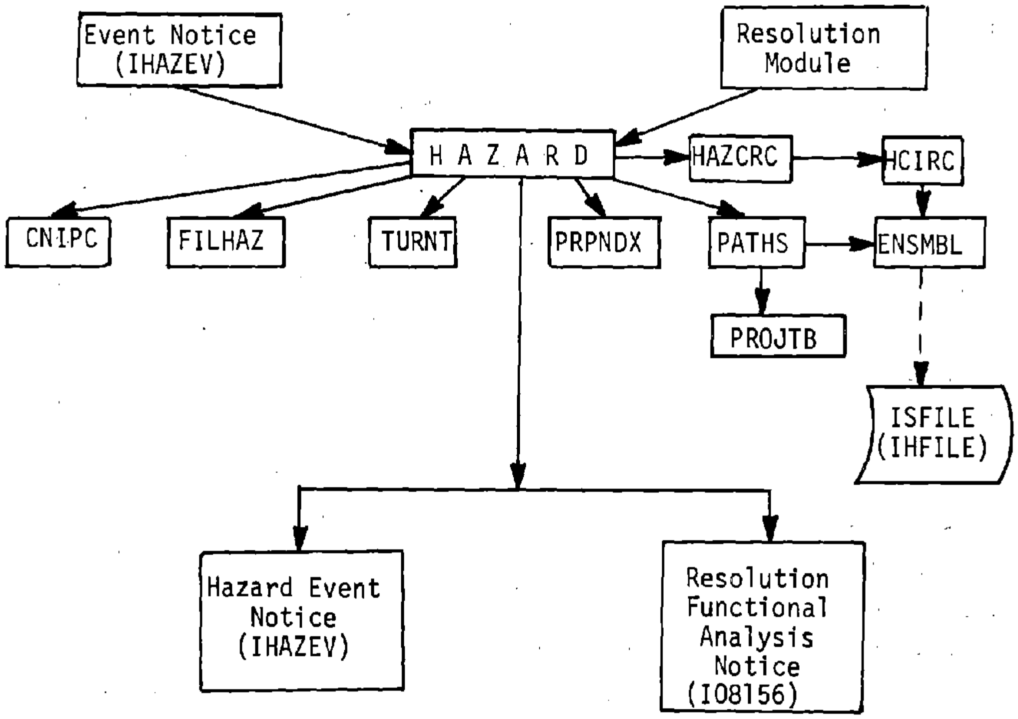


FIGURE 2.3-1 SYSTEM DESIGN - HAZARD EVALUATION

2.3.3.2 Description of Flow

The hazard evaluation module may be called in three different ways: the first is by an event notice, the second is a call from the resolution model in order to recalculate the necessary parameters needed for the resolution of the conflict; and the third is as a calculator of hazard which is used by the various resolution routines to determine the effects of resolution maneuvers. When called by event notice, the event could have been planted either by the conflict prediction module, hazard evaluation itself, or the resolution module. Hazard evaluation will plant an event when the conflict is considered non-hazardous. It must keep checking to make sure that the aircraft don't change course and come into a hazardous situation, or that the current courses aren't hazardous beyond the look-ahead time. The resolution module plants a hazard evaluation event on a synchronous basis because three is only a fixed look-ahead time for the planned resolution maneuver. Thus, we can only guarantee that a maneuver will be safe a certain amount of time into the future. This time is a system parameter (SP).

The first task of hazard evaluation, when it is called by event notice or the first call from resolution, is to put into various internal common blocks information regarding the aircraft. This is done by calls on routines FILHAZ and TURNT. FILHAZ fills up a common block that contains the information provided dynamically by the simulation. TURNT will fill what is called a turn table. This table contains the fixes scheduled for the aircraft during the look-ahead time in question. It uses the aircraft's flight plan file for this information. These two common blocks are then written out on a scratch file so that if the routine was really called from resolution, resolution can re-initialize the blocks whenever it needs to. Subroutine PATHS is then called and this subroutine will calculate the ensembles of paths for each aircraft. Since there may be various fixes for each aircraft within the look-ahead time, there can be more than one group of ensembles of paths. The ensembles will be written out on a temporary scratch file in the order in which they will occur. Whenever a turn occurs, the aircraft is moved along its expected value path up to the point of that turn and then the new expected value path is projected backwards in time from that point to the start time of the run. Thus, all ensembles are created from the same start time. Hazard evaluation will then operate on each ensemble only in the time period for which it is valid. There will be three records written for each time slice. The first two records will contain velocities and the positions for the two aircraft. The third record will contain the difference in X position, the difference in Y position, the time in which the aircraft can violate minimum altitude requirements, the horizontal distance apart, and the beginning and the end time of these ensembles' validity.

Hazard evaluation now does some housekeeping functions such as zeroing out arrays, and choosing which index to use for the outer and inner loops. It will then start processing the ensembles that are on the file. After reading the data for a time slice of ensembles, HAZARD first calculates some parameters that will simplify the hazard calculation, and then chooses the direction of processing for each of the aircraft. This is done so that the processing can be speeded up by jumping out of the loop once the hazardous portion of the ensemble has been evaluated. Each combination of paths will be inspected to see the closest that the aircraft could come toward each other within the period in question. If they can violate the miss distance, they will be considered hazardous and the probability will be added to cumulative probability if this particular combination of paths has not created a risk before. The risk associated with each combination of paths will be stored in a matrix PMAT. Via this matrix we can insure that we do not add risk for a path twice. PMAT is also used later in order to calculate the risk given a negative IPC command. On calculations of risk caused other than by the event notice or initial resolution call, once a risk has exceeded the risk threshold the program will jump out of the loops as it is not interested in the total amount of risk involved, but just whether it exceeds the threshold. All ensembles on the file are processed in this manner. Upon conclusion of the risk calculation, the program, if it has been called as a first call from resolution, will find the risk given negative IPC commands.

If the call was from an event notice, the routine will see whether the risk is greater than the higher threshold and if so, will create a notice for resolution to occur. In all cases for these new conflicts a history file will be created for the conflict. This is so conflict prediction will not have to be checking continually for conflicts that are already known, and for which hazard evaluation should be maintaining a lookout. An interface file will be set up for conflicts that require resolution so that the resource allocation routine that is appropriate can know the minimum time to conflict, the risk involved in the conflict and the aircraft pair. This routine will then eventually call the resolution module. After adjusting the appropriate files, HAZARD returns control either to the simulation or the calling program.

There is one further complication in hazard evaluation and that is if one of the aircraft is circling. If both are circling, the risk will then automatically be set higher than the risk threshold. However, if only one aircraft is circling, a routine called HAZCRC will be called and this routine will calculate the hazard, given that one aircraft is circling. It does this in essentially the same way that HAZARD itself works, except that it calculates the results of one ensemble of paths against a circle created by the other aircraft. If the ensemble comes into contact with this circle within the time period in question, again risk will be accumulated into the variable RISK and the risk threshold may or may not be exceeded. HAZCRC counts on the whole pattern being placed into the aircraft flight plan as a series of points on a square. It will then calculate the center of that square and the radius of a circle that would inscribe it, and use this circle for calculation of the hazard. Upon conclusion of calculating the hazard, given one aircraft in a hold pattern, HAZCRC returns control to HAZARD and the housekeeping functions described previously will be performed.

2.3.4 Conflict Resolution

2.3.4.1 Data Requirements

The data required for conflict resolution is the same as for hazard evaluation with the addition of:

- Two parameters sent by functional analysis, and
- Internal arrays that describe the turn increments and associated values (these are generated by an initialization routine).

2.3.4.2 Logic Flow

RESOLV is the main driver of the resolution routines. Its design is shown in Figure 2.3-2. The five types of resolutions that may result from this driver were described in Section 2.3.1.3. These five levels of resolution may require different lag times, (i.e., different times at which the maneuver will start) which correspond to different levels of difficulty for the controller. Therefore, the program has been written so that the user can both choose the order in which he would like these five different types of resolution maneuvers to be tried, plus assign to them a value, which may or may not be the same for all five types. This value will be used in combination with two parameters sent to the resolution routines by the functional analysis. A linear combination of these three values produces a lag time for the maneuver. Every maneuver will be checked to see whether it is safe in the "near future," defined by a system parameter, TLOOK, which is different from the warning time of hazard evaluation. The concept of safety will include both safety with the present conflicting aircraft and safety with all other aircraft in this system. For maneuvers involving a change in flight plan there will also be calculated a time to resume course. This time will result in a planting of an event for the routine RSCRSE which will turn the aircraft back on its course. RSUME calculates this time and insures that the aircraft will not be turned more than ninety degrees in either direction. In other words, RSUME chooses the fix (via FNDFX) that is along his path in the forward direction if at all possible. If this is not possible, for instance if he's going to land, the aircraft has to be turned back on its course. If one aircraft is circling, in a hold pattern, the other aircraft will be selected for a horizontal meneuver. No other types of resolution maneuvers are considered for this case.

The first task of RESOLV is to call HAZARD to recalculate all the parameters needed by HAZARD or RESOLV and find the risk of the conflict. If the risk is now lower than the risk threshold, no more is done with this case and the routine will act like it is a non-hazardous maneuver which HAZARD would have found. The routine next performs some housekeeping, such as zeroing out certain arrays and finding indices in the maneuver history table for both aircraft, if the indices exist (Subroutine FMAN). The

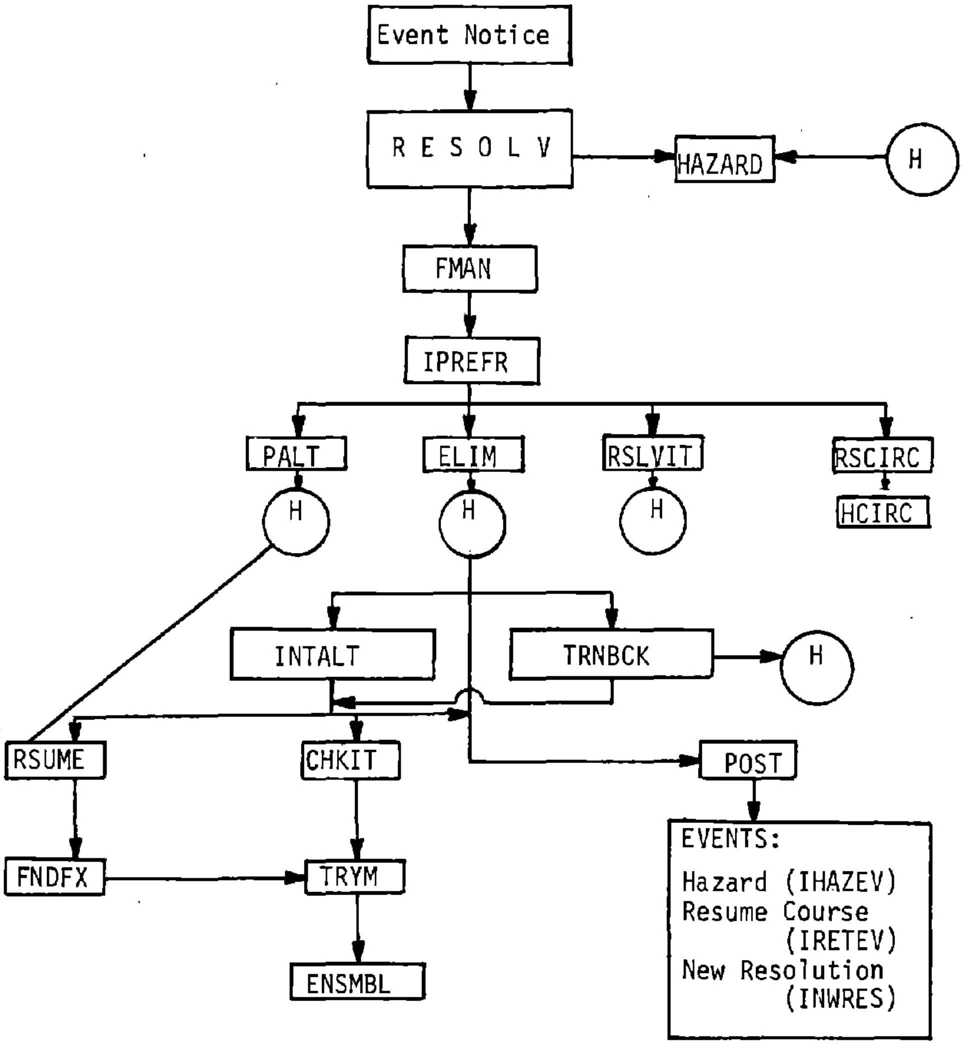


FIGURE 2.3-2 SYSTEM DESIGN - CONFLICT RESOLUTION

maneuver history table indicates the types of maneuvers that have been given to each aircraft previously. This is needed since one does not wish to give conflicting maneuvers. Next, the preference for maneuvering the aircraft is chosen by the routine IPREFR. This preference is based solely on the priority given to it in the aircraft file. Each aircraft is assigned a priority and it is assumed that the aircraft with the higher priority is the one that should be maneuvered, if possible. The order in which the aircraft are selected will be the same for all levels of maneuver. Within each level both aircraft are looked at for maneuver, if it is possible to maneuver both. From this point on, the routine simply goes through the levels of resolutions according to the input parameters. If at any point a resolution maneuver is found, the routine files the maneuver using a routine called POST.

The calculation of RISK, given an elimination of fix or a level-off command, is performed directly by RESOLV using calls to ELIM and HAZARD. ELIM is used to create a file which reflects the change of course desired. It works from the master file created on RESOLV's initial call to HAZARD. If the maneuver is deemed safe by HAZARD, INTALT is called to determine the safe time to resume course, whether the maneuver is conflict free with other aircraft, and eventually, in the case of a safe maneuver, the maneuver is posted via POST.

2.3.4.3 Horizontal Maneuvers (RSLVIT)

The horizontal maneuver routine is named RSLVIT. This routine first forces the aircraft to fly level after the lag time (TLAG) that is computed according to the level of difficulty of the maneuver. It then calculates a direction of turn. This direction of turn will be away from the other aircraft. Here, "away" is defined as being in the opposite direction of the cross product between the aircraft's position and velocity. If the desired direction of maneuver is different from a previous command that has been given to the aircraft and this command is still active then the aircraft will not be processed any further. If this were not done, then we would have the rather ridiculous situation of having an aircraft snake through the sky. Besides, presumably he will be turned back on course at the soonest possible time. Thus, if the maneuvers in the opposite direction of a previously given command were allowed, we would be turning the aircraft back into a conflict that had just been resolved. The aircraft is then stepped through various maneuvers. This is acheived by precomputed tables which consist basically of sines and cosines and are based on an input delta turn that is required. This turn that is chosen for the difference between successive attempts at resolution should be picked such that turns of 90 degrees and 180 degrees come out even in the table. The finer the turn increment chosen, such as 10 degrees, the more time the routine will take, and the less drastic the maneuvers that will be given. Thirty degrees is the maximum delta step that should ever be tried.

When a maneuver is being considered for resolution the new velocities or bearings can be computed from the original expected value bearings. The position that the aircraft will be on his turn circle is calculated. The distance of closest approach is then calculated and if this is greater than the miss distance the maneuver is checked via HAZARD with the entire ensemble of the other aircraft to see whether it is safe. If so, the entire ensemble of the maneuvering aircraft is turned the appropriate amount and checked against the other aircraft's ensemble. Since each vector in the ensemble of paths will have to turn a different amount to achieve the same bearing there are different times to turn involved in this checking of the whole ensemble. The aircraft will be in a different position on his turn circle, and this position is projected backwards to the start time of the calculations. HAZARD is then called to see the risk involved between this one vector and all the vectors in the ensemble of paths for the other aircraft. This risk will be accumulated over all vectors of the maneuvering aircraft's ensemble and if the total risk exceeds the risk threshold a more severe maneuver is tried. If a maneuver is chosen, the results are placed into various arrays and control returned to the driver routine RESOLV.

RESOLV will then call TRNBCK which will set up the interface file for the checking for new conflicts caused by this maneuver. This rechecking is done by subroutine CHKIT, which calls RECHEK, an entry in conflict prediction, then further evaluates any conflicts that conflict prediction may find to see whether it is in truth a real hazard. This is done, of course, through subroutine HAZARD. If the maneuver is still deemed to be safe, RSUME is called in order to calculate the time that the aircaft can turn back to its original course. RSUME tries various times to turn back in time increments and interpolates backwards once a safe time to turn back is found until the time that is safe and the time that is unsafe are within a pre-specified bound. Once a time to resume course (given the horizontal maneuver) has been found, TRNBCK will check whether it is quicker to hold the aircraft in a pattern and return him on his course after executing the hold pattern a specified number of times. First, a simple calculation is made to see whether the other aircraft's path intersects the holding pattern. If this is true, the horizontal maneuver is used as the maneuver of choice. However, if not true, a hold of an even number of circles is tried until a safe hold pattern is found that does not exceed the look-ahead time set by the simulation. If it is not safe to hold an aircraft beyond this time the horizontal maneuver will be chosen. The calculation of whether it is safe to hold an aircraft is acheived by retarding the holding aircraft's path by the amount of time required. Thus, there is adjusting of the existing ensemble file which will change the position and the velocities of the aircraft for that amount of time. This in effect creates a new intermeshing of fixes, since the time that the aircraft will reach each fix has been changed. This sorting of the existing file is performed and a new file is created without requiring any new computation of ensembles. This file is then used with the call to HAZARD to see whether the hold maneuver is safe. If the hold maneuver turns out to be safe and results in a return to course in shorter time than the horizontal maneuver did, then an interface file is set up so that this maneuver can be checked to make sure that it does not cause any new conflicts either. If it does, the horizontal maneuver is chosen. If it doesn't, then the hold maneuver will be chosen. The results of these calculations are sent to POST in order to change the aircraft fix file and post the maneuver.

2.3.4.4 Positive Altitude Maneuvers (PALT)

The routine to calculate positive altitude maneuver is PALT. This routine tries successive increments of altitude change. The increments are specified by system parameter, AINC. If the new altitude that would be acheived by this maneuver is either greater than the high altitude threshold of the aircraft or lower than the lowest altitude he can fly, then the altitude maneuver will not be chosen. If it puts him at an altitude higher than the required minimum altitude separation then we know the risk of this maneuver is zero. Otherwise HAZARD must be called to calculate the hazard with this new maneuver. If a positive altitude maneuver has been chosen, the routine INTALT will be called in order to calculate the time the aircraft can resume its course and to post the maneuver. This same routine is also called in case of elimination of scheduled turns. INTALT fills up the interface array for CHKIT, which is the routine that checks for new conflicts caused by a resolution. If the maneuver was conflict free, it calls RSUME which calculates the time to resume course from the maneuver in question and then posts the resolution by subroutine POST.

2.3.4.5 Subsidiary Routines

Important routines that have been mentioned in connection with the resolution algorithms and as yet to be explained in detail are the routines CHKIT, RSUME, and TRYM. RSUME takes the interface file that was filled up for the routine CHKIT and figures out the time that it would take the aircraft to resume its course from that maneuver. To do this it must call FNDFX which takes a location and velocity vector and calculates the next fix where the aircraft will not be executing more than a 90° turn with respect to its current path, if at all possible. This routine starts checking fixes from a given fix or from the beginning of the aircraft's queue (indicated by an initial fix value of zero). Besides calculating the horizontal fix that it should turn to it also calculates two other values, TILEV and TIFIX. TIFIX is the time the aircraft takes to get to that fix and TILEV is the time that it will take the aircraft to acheive the altitude of that fix. These two numbers may be different. If the numbers are different, then a new fix must be inserted into the file which will bring the aircraft to the intended altitude at its nominal climb or dive rate. The direction in which the aircraft must change altitude is returned via a parameter in the call sequence ZDT. It is not desired to calculate this time to level-off, this is indicated by the calling parameter NDCLEV. When TILEV and TIFIX are different, RSUME inserts a new fix at TILEV and then calculates the time to the actual fix. It sets an interface table for the routine TRYM, which when called, can take this table and process it, interleaving it with the already known fixes of the other aircraft. After the aircraft has gotten back to the assigned fix, the routine will automatically pick up the remaining fixes on his original course. Thus, it is not necessary to fill up this interface table all the way to the look-ahead time desired. RSUME is called with a special parameter TSART, which is the time that the user desires the aircraft to stay on a level course. This is used primarily when an aircraft is changing altitude. Since it would not be good to have an aircraft dive for two minutes and then immediately start climbing again, there is a parameter that the user can set which requires the aircraft to fly level for a certain amount of time before any new change of course is directed for him. Currently, the programs are set up so that on a horizontal maneuver the aircraft will resume course as soon as possible. However, on a change of altitude course, the aircraft will level-off for a given amount of time (TIMLEV) before he can resume his old altitude.

TRYM operates from a common block or fills up the block from the common that was set up for the CHKIT function. Basically, it projects ahead the non-maneuvering aircraft to the time of the first fix for the maneuvering aircraft. It then interleaves the fixes as they go along from the interface table. When that runs out, if there is still time left in the lookahead interval, it picks up the fixes that are recorded in the fix file for the maneuvering aircraft. Its output is an ensemble of paths or a group of ensembles of paths that reflect these new fixes for both aircraft within the time-frame in question.

CHKIT is a routine that checks a maneuver for new conflicts that the maneuver itself may cause. It works from an interface file which is set up by other programs and immediately calls RECHEK (an entry in the conflict prediction routine). RECHEK will fill up an interface file which will contain the number of conflicts in it and the IDs of the conflicting aircraft. If there are any new conflicts then CHKIT calls TRYM in order to establish a file from which it can work. It then starts processing the new conflicts one by one to insure that they are real conflicts in the sense that hazard detection would consider them conflicts. It calls FILHAZ to create a file for both aircraft and TURNT to create the turn table. TURNT is called with the parameter ID of the maneuvering aircraft. This is so that his current flight plan fixes will not be put into the turn table and only the non-maneuvering aircraft's fixes are in the table. CHKIT will then process this table and create ensembles of paths for the non-maneuvering aircraft. It interleves them with the ensembles for the maneuvering aircraft and creates a file from which hazard evaluation can work. If at any point the hazard involved in the new conflict exceeds the threshold, the maneuver is rejected and a parameter (IRES) is set to one so the calling program will know that this maneuver is hazardous. If the maneuver is accepted as non-hazardous then the parameter IRES is set to zero and the calling program will know to post the maneuver. At the end of its processing CHKIT reads in from the master file created at the beginning of RESOLV to refill the common blocks with parameters that were calculated at that point, since they were destroyed with this operation.

POST is always the last subroutine called by the resolution module. Only after the maneuver has been accepted will the subroutine be called and the actual fixes in the file will be changed for the aircraft. Any new fixes will be inserted and all the fixes remaining in the file will be set to a maximum value that is internally set by the program. In addition, if any non-controlled aircraft that is IPC equipped has any turns in the near future toward the maneuvering aircraft the turns are eliminated from his flight plan. POST creates an entry and some internal history files which record the maneuver to an aircraft so that the aircraft was forced to level-off from perhaps a climb or a dive. This is also recorded in the files as it was probably important in resolving the conflict. Finally, the POST routine creates event notices so that the conflict will be looked at again within the next cycle and, if appropriate, also sets an event at the time to resume course. If the time to resume course for this maneuver was less than it was for a previous maneuver this event will not be generated. However, there may be spurious events generated. The resume course routine will handle these cases appropriately.

2.3.5 Resume Course Routine (RSCRSE)

RSCRSE will be called by an event notice in order to try to maneuver an aircraft back on course after a resolution maneuver. This aircraft will have been maintained in an internal history file so it is known by RSCRSE what the expected time to return to course should be.

This will be the greatest time calculated for any maneuver. If the time that the routine is called is not this time it simply returns and waits for the event planted at the proper time. If it is the proper time, it sets up the interface file used in checking for new conflicts which may have been created by a change of course (this has been previously described). It then calls subroutine CHKIT and checks for these conflicts. If there are no new conflicts created by returning to course, it removes the entries in the maneuver history files to indicate that this aircraft is no longer on a positive maneuver. It inserts any needed fixes into the course, removing the fixes that were inserted for the change of course, and returns the aircraft to its normal flight plan. This includes updating the expected time of arrival for all current fixes on the course to the new expected time of arrival. If it is not possible to return an aircraft to its course, it will simply reschedule another event in the future to try and turn the aircraft back on its course.

The system design of RSCRSE is shown in Figure 2.3-3.

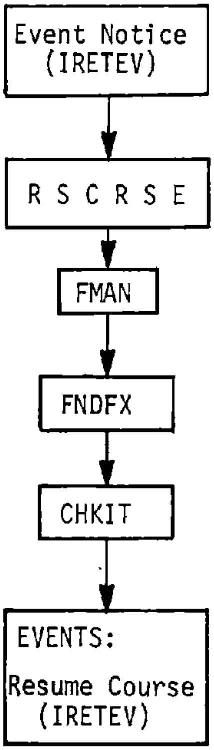


FIGURE 2.3-3 SYSTEM DESIGN - RESUME COURSE EVENT

3.0 INPUT DATA SPECIFICATION

3.1 METHODOLOGY

The DELTA simulation reads input data from two files: TAPE5 and TAPE30. The TAPE5 file is composed of card images which define the particular scenario to be run. The TAPE30 file is a random access file containing terminal sequence route and escape route information beginning at the feeder fix and ending at the touchdown point. This file must be prepared previously using the off-line Terminal Generation Program. See Section 8.0 for a description of this program and its input specifications.

To set up a scenario, a number of different types of data are required. Figure 3.1-1 illustrates the relative order of these types of data and shows the DELTA subroutine which reads the data. The input value card which is read by XXSTRT contains the maximum size for the dynamic memory. This value should never exceed the dimension of the dynamic memory array IV in the MAIN routine. It is difficult to estimate accurately what value this dimension should be. To aid in estimating it, the "high water mark" or highest value of dynamic memory actually used is printed out in the DELTA run summary. Should it be necessary to increase the maximum size of dynamic memory, then the MAIN routine will have to be recompiled to change the dimension of IV. The variable MAXKXX on the SALSIM card should be changed to the same value as the dimension of IV to ensure the proper creation of data blocks in the dynamic memory.

The variables for each type of data are described in Section 3.3.

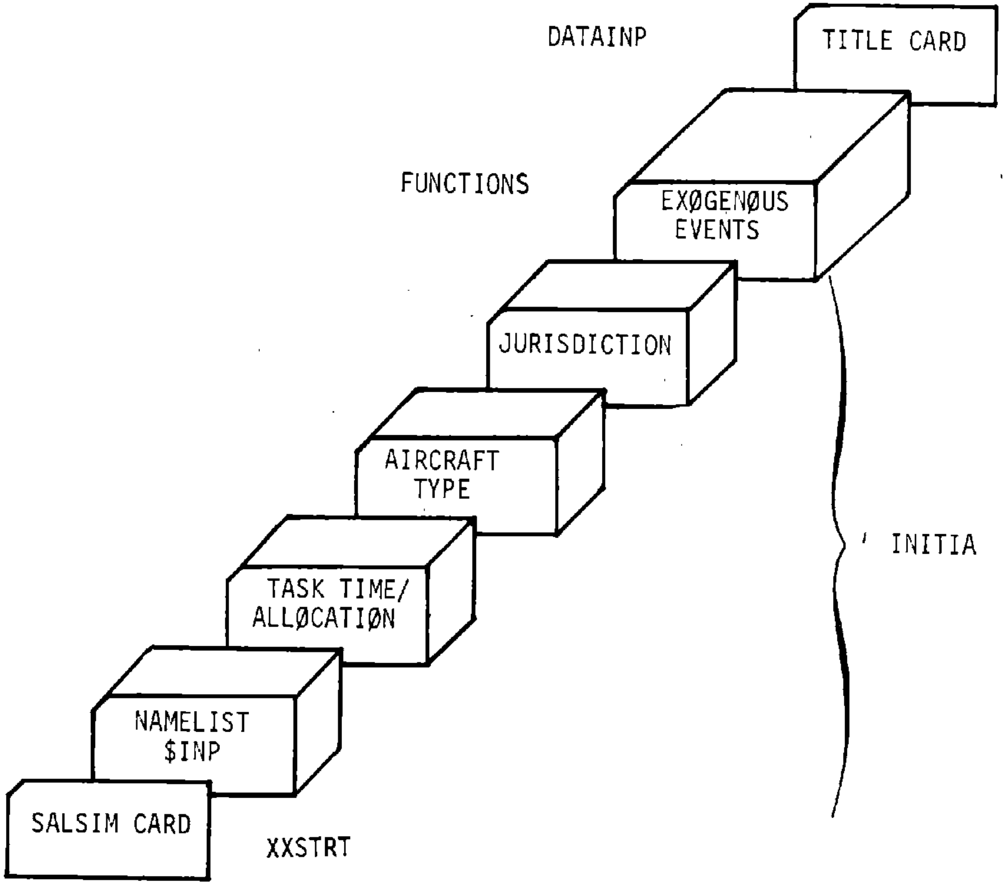


FIGURE 3.1-1 TAPE5 DATA ORGANIZATION

3.2 NOMENCLATURE

The names of subroutines and certain variables related to the functional tasks were created according to the following convention:

affstt

where ff is the Function number

s is the Subfunction number

tt is the Task number

and a is an alphabetic with the following characteristic:

C = Duration of one cycle of a periodic task (hrs.).

F = Rate (inverse of frequency) of a periodic task.

I = ELIST block pointer (defined in Block Data).

M = Mask for a test under mask.

P = Probability of condition occurring.

R = Requirement (comparison word for test under mask).

T = Subroutine name containing referenced task.

For example T07105 would be the name of the subroutine modeling Task 7.1.5; P05103 would be a probability related to Task 5.1.3. In a few cases multiple entries were required in the same task. In those cases (e.g., E07401, H08107, P082PR, P082RV) the letter assignment were necessarily arbitrary and do not possess mnenomic significance.

3.3 DATA SPECIFICATIONS

This section will describe each of the input variables which are read from the file TAPE5. The data is divided into the following groups:

SALSIM specifications

Namelist $INP variables

Task allocations and times

Jurisdictions

Aircraft type

Exogenous events

Date and title card.

3.3.1 XXSTRT - SALSIM Specifications

CARD NO.	NAME	COLUMNS	FORMAT	VALUE/DESCRIPTION
1	MAXEVT	1-6	I6	Largest type number used for the events in ELIST. Default = 168. Max = 275.
	MAXKXX	7-12	I6	Size of the IV array (dynamic memory) in the user's program.
	MDESX	13-18	I6	Maximum size block to be destroyed. Blank = 16.
	MCXX	19-24	I6	Maximum number of memory request allowed if the memory capacity is exceeded. If -1, no memory requests will be allowed. Blank = 10.
	IREQXX	25-30	I6	Maximum size block for each memory request. Blank = 1024.
	MAXBLK	31-36	I6	Largest block size the user expects to create or use during the simulation. Blank = 130,000.

3.3.2 INITIA - Namelist $INP Variables

P03000 - Probability that the preliminary flight plan needs no modification. Function 3 reflects the system resources utilized by a pilot when he prepares a flight plan. This probability is an indication of the pilot's skill in preparing the flight plan or the number of times he must review and restructure his flight plan until he is satisfied that it is suitable for submittal to the system. Two probabilities are used: 1) the probability that a single pass through the steps in preparing the flight plan will be adequate to submit the plan and 2) the probability that, given the first pass resulted in a plan that required further work, each subsequent pass through the function will result in an acceptable flight plan for submittal.

P04201 - Probability of no discrepancy in the flight plan because of aircraft capability or status. This is the probability that the flight plan submitted by the pilot and renewed by the system will be consistent with aircraft capability and current status. It is handled as two probabilities. The first probability represents the first time the test is made. The second probability represents the subsequent tests of the same flight plan assuming that the flight plan was modified as a result of the original discrepancy.

P04202 - Probability of no discrepancy in the flight plan because of operational or environmental conditions. This is the probability that the flight plans submitted by the pilot and reviewed by the system will be consistent with such factors as weather, airspace restrictions, airport status, communications and navaid status, and other air traffic management facilities. It is handled as two probabilities. The first probability represents the first time the test is made. The second probability represents the subsequent tests of the same flight plan assuming that the flight plan was modified as a result of the original discrepancy.

P04203 - Probability of no discrepancy in the flight plan because of probed conflict detection. This is the probability that the flight plan submitted by the pilot and reviewed by the system will not have inconsistencies or create conflicts with other approved flight plans. It is handled as two probabilities. The first probability represents the first time the test is made. The second probability represents the subsequent tests of the same flight plan assuming that the flight plan was modified as a result of the original discrepancy.

P04205 - Probability of no discrepancy in the flight plan because of rules and procedures. This is the probability that the flight plan submitted by the pilot and reviewed by the system will be consistent with rules, regulations, minimum standards, and procedures. It is handled as two probabilities. The first probability represents the first time the test is made. The second probability represents the subsequent tests of the same flight plan assuming that the flight plan was modified as a result of the original discrepancy.

P04206 - Probability of no discrepancy in an airfiled flight plan because of flight progress. Given that a pilot airfiles a flight plan, this is the probability that the aircraft will be at the beginning point of the airfiled flight plan at the specified time.

P04207 - Probability of no discrepancy in the flight plan because of user class and pilot for that flight. It is handled as two probabilities. The first probability represents the first time the test is made. The second probability represents the subsequent tests of the same flight plan assuming that the flight plan was modified as a result of the original discrepancy.

P04401 - Probability that the pilot will not accept the flight plan with modifications. Given that the pilot's original flight plan had to be modified, this is the probability that the pilot will not accept the approved flight plan with the modifications.

P04402 - Probability of the pilot resubmitting a flight plan after rejecting. Given that the pilot rejected the flight plan because of revisions made by the system, this is the probability that he submits a new (revised flight plan).

P05101 - Probability that the aircraft identification code is required. This probability depends upon the particular air traffic management system. Up to eight user class categories can be used.

C05102 - Maximum permissible duration of one repetition of Task 5.1.2. This is the length of time to determine if the aircraft is approaching the limits (X, Y, altitude, time) of its clearance.

P05103 - Probability of a retry in approach. Given that an approach is missed, this is the probability that an aircraft will attempt again to land at the same airport, as opposed to going to the alternate airport.

TLKAHD - Look ahead time for 7.1.1 used in 5.2.3. When determining the clearance limit (X, Y, altitude, time) it is necessary to look ahead to determine if there are no medium term conflicts with other intended time-position profiles.

C05302 - Maximum acceptable time for pilot response to clearance. After the system transmits a clearance to the pilot, it allows a certain time for the pilot to respond. It is also the maximum time allowed if no response is forthcoming.

F06100 - Time between updating Task 6.1. Task 6.1 consists of updating the aircraft current position. This input represents how often aircraft position is updated by the system.

C061AU - Maximum permissible duration of the processing period for the automated portion of the aggregated tasks: Subfunction 6.1, Task 6.2.2, Task 6.3.1, Task 6.3.2. The definition of these tasks are:

Subfunction 6.1	- Determine Present Aircraft Position
Task 6.2.2	- Update Aircraft Actual Time and Position Profile
Task 6.3.1	- Derive Rate of Change of Position
Task 6.3.2	- Compute Short-Range Extrapolations

C061MN - Maximum permissible duration of the processing period for the manual portion of the aggregated tasks: Subfunction 6.1, Task 6.2.2, Task 6.3.1, Task 6.3.2. This input is similar to C061AU except it represents manual times.

F07103 - Time between repeating Task 7.1.3. The purpose of this task is to determine the correct portion of the time-position profiles to be compared for long-term conflicts.

C07103 - Maximum permissible duration of the processing period for Task 7.1.3. This time is the maximum time that the resource pool may be set busy doing the large block of processing done by Task 7.1.3. Since the number of aircraft to be processed are derived from this time, it may be sensitive to the maximum time for Tasks 7.1.3 or 7.1.4.

P07104 - Probability that there will be no long-range conflicts among flight plans for this aircraft. The long-range time is defined by input TLKAHD in Function 5.

P07201 - Probability that there will be no current out-of-tolerance when the tolerances have been expanded. Given that the flight has exceeded the specified tolerances, the tolerances may be expanded on a temporary basis to cover certain situations. This is the probability that the flight will not exceed the expanded tolerances.

E07401 - Maximum time that expanded tolerances can be applied. This is the upper limit on how long the tolerances may be expanded on a temporary basis to cover certain situations.

F07201 - Time between repeating Task 7.2.1. Task 7.2.1 determines the time associated with the latest report of aircraft position and determines the aircraft's intended position at current time.

F07301 - Time between repeating Task 7.3.1. Task 7.3.1 determines future time-position data points by selecting the portions of the intended time-position profile corresponding in time and length to the short and long range predictions.

P07302 - Probability that there is not a short-range deviation exceeding tolerances for aircraft. This figure is based on a forecast that looks several minutes ahead to predict whether an aircraft may exceed tolerances.

F08101 - Time between repeating Task 8.1.1. Task 8.1.1 selects an airspace volume and time interval to be used for conflict prediction.

F08102 - Time between repeating Task 8.1.2. Task 8.1.2 predicts the path of an aircraft in terms of the probability that the aircraft will be located in a given area at a given time.

F08103 - Time between repeating Task 8.1.3. Task 8.1.3 identifies path prediction profiles in the selected airspace and time frame. This time determines the rate at which conflict prediction is carried out.

F08105 - Inverse of F08103.

H08107 - Conflict imminence threshold. This input is used to determine whether a pair has a high imminence of conflict. It is the minimum time to conflict if an aircraft moves directly toward another aircraft. If the imminence determined by the hazard evaluation algorithm is less than H08107, then the pair is considered to have high imminence. Imminence and probability of conflict are evaluated to determine required action.

F08108 - Frequency of careful monitoring task. Given that a low probability of conflict, high imminence pair exists; this input is the number of times the pair is monitored for unexpected deviations each time the potential hazard exists.

P082PR - Probability that a pilot will respond to conflict resolution message. After the hazard evaluation algorithm determines that a performance change is needed, the performance change is determined and transmitted to the pilot. This input is the probability that the pilot will respond to the message.

P082RV - Probability that a performance change revision is required if there is no pilot response. Given that the pilot does not respond to the original performance change request, this is the probability that a further change is required, such as having another aircraft change performance.

REPLYT - Maximum time allowed for pilot to respond to performance change message. Given that the pilot does not respond to the original performance change request, this is the time the system will wait before deciding if a performance change revision is required.

F09100 - Time (in hours) between repetitions of subfunction 9.1, Maintain Predicted Arrival/Departure Schedule for Each Airport. That is, F09100 is the rate of this periodic subfunction.

C09100 - The maximum permissible duration (hours) of one repetition of subfunction 9.1. More specifically, one repetition of 9.1 ideally would encompass all aircraft in the jurisdiction; however, due to the work load on a controller, he may be required to accomplish other tasks in his task queue before this subfunction could be completed. Thus, the controller normally would work on this subfunction for some maximum amount of time before going to his next task. This time is C09100.

P09202 - The probability that there will be an acceptable distribution of arrivals and departures at a terminal. Specifically, P09202 is the probability that there will be no excess demand and/or slack in the predicted schedule of arrivals and departures.

P11000 - Probability that further vectoring is not required.

P11101 - P11101 is a three element vector, containing probability that vectoring is not required for (1) course, (2) speed, or (3) altitude respectively. This probability occurs in the DELTA model in three parts of the program corresponding to the type of vectoring desired.

C11502 - Maximum permissible time for pilot to respond to a vectoring message from the controller.

P11503 - The probability that no retransmission of a vectoring message is required. That is, when a vectoring message has been given, the pilot may

(1) respond as commanded

(2) not respond as commanded, requiring a retransmission

(3) not respond as commanded, requiring a declaration of emergency.

The probability P11503 refers to (2).

P12104 - When the pilot requests information, this is the probability that this information requested is available. This information is provided under the function, Provide Flight Advisories and Instructions (Function 12).

M12202 - Maximum number of aircraft for the selective distribution of flight advisories. The system has the choice of distributing these advisories individually to aircraft or to all the aircraft simultaneously.

C12207 - Maximum permissible duration (hours) of one repetition of Task 12.2.7, Correlate Present Position with Distribution Position (task from Provide Flight Advisories and Instructions). When a flight advisory is to be issued, aircraft must be issued the advisory at the advisory distribution point. This task monitors the aircraft to determine when they arrive at this distribtuion position.

C12301 - Maximum permissible duration (hours) of one repetition of task 12.3.1, Determine Endangered Aircraft, (i.e., determine aircraft that must be issued a flight advisory).

P12304 - This is the probability that the pilot desires vectoring around the advisory region (perhaps a thunderstorm).

F13100 - The maximum possible duration (hours) of one repetition of subfunction 13.1.

P13201 - The probability that no communication channel change is required. A channel change may occur at the time of handoff.

F17300 - Time (hours) between repetitions of subfunction 17.3, Data Base Maintenance.

RISKT - Risk threshold. If the risk computed by the hazard evaluation is greater than RISKT, then that pair is considered to be a high probability pair and the potential conflict must be resolved. RISKT is a probability and is unit-free.

RISKL - Low risk threshold. This threshold, set much lower than RISKT, is used to eliminate the many very low risk pairs. RISKL is a probability and is unit-free.

0LTRP - Two dimensional variable. One level threshold for manual (0CTRP(1)) and automatic (0LTRP(2)). If controller is busy more than 0LTRP of the time, he is too busy. There are percent thresholds and are unit-free.

ST0LT - Short term overload threshold for a man. That is, a controller who is busy 100% of the time should not continuously work longer than ST0LT (hours).

MIPSAP - Model movement in MIPS. Specifically, this is the number of MIPS the model will increment the machine (computer) in order to add resources to the given task.

ISEED - Seed for random number generators. Any large odd integer will suffice as an input value.

SIDE - Lentth of the side of a grid square used for conflict detection (C0NDET) in n.mi.

DSEPSQ - Minimum separation distance (n.mi) squared. That is, this is the ATM system safety criteria of miss distance.

DTERR - Maximum error in estimated (i.e., predicted) time of conflict occurrence. This number is multiplied by a number drawn from a (-1, 1) uniform distribution (U(-1, 1)). DTERR is in hours.

WARNTM - Warning time for conflict detection. Specifically, this is the time the controller requires, before a predicted conflict, to begin and complete a precise hazard evaluation and notify the pilot to perform a resolution maneuver, if necessary, in hours.

ITYPER - Type of navigation error.

If ITYPER = 1, the error is constant (uniformly distributed) between two fixed points.

If ITYPER = 2, the error increases (beginning at 0) from one fixed point to the next.

If ITYPER = 3, the error increases to the midpoint of the segment joining the two fixed points, and then decreases to zero.

ALPHA - Autocorrelation coefficient for the navigation error. That is, this is a smoothing constant, necessary to prevent the error from oscillating erratically, over a time span. ($0 \leq \text{ALPHA} \leq 1$).

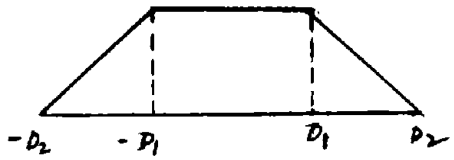
SHAPE - This constant defines the shape of the navigation error (i.e., it is the coefficient of negative exponential distribution, defining the navigation error).

SMAXX - Maximum allowable navigation error is the X coordinate of the aircraft position (n.mi).

SMAXY - Maximum allowable navigation error is the Y coordinate of the aircraft position (n.mi).

SMAXZ - Maximum allowable navigation error in altitude (coordinate) of the aircraft.

D1, D2 - The trapezoidal distribution used for speed bias is uniform in the internal [-D1, D1] and triangular in the intervals, [-D2, -D1] and [D1, D2].



SDNUM - The number of standard deviations used for the conflict detection error.

TIMMS - Time between calls to the metering and sequencing algorithm, in hours.

XLANDT - Time before metering and sequencing assumes control over the aircraft (i.e., this is the time, before aircraft arrival at the feeder fix, to update the aircrafts' phase of flight to arrival transition), in hours.

FØRCST - Model look ahead increment. All aircraft will be examined FØRCST into the future, in hours.

3.3.3 INITIA - Task Allocations and Times

	Card No.	Name	Column	Format	Value/Description
	1	NTASKS	3-5	I5	Number of tasks
		MTASK	23-25	Ø20	Mask word used in FUNCTIØN IDESCN (Should contain Ø777 right justified).
NTASKS Times	2	KTASK(I)	11-15	I4	I=1, NTASKS LCC (logic control chain) number
		KPØØL(I)	16-19	I4	I=1, NTASKS Number of the resource pool that performs task
		KPRIØ(I)	20-23	I4	I=1, NTASKS Priority
		KTIME(I)	24-31	I8	I=1, NTASKS If KTIME(I) -- <0, Number of 100 instructions for automated task =0, task is bypassed >0, pointer to vector in TMAN
	3	NTMAN	4-5	I5	Number of task times
NTMAN Times	4	TMAN(I,J)	32-41 42-51 52-61	F10.7 F10.7 F10.7	I=1,3; J=1, NTMAN distribution of performance time required for manual resource to perform task J
	5	NRSPNC	5	I5	Number of pilot responses
		MRSPNC	23-25	Ø20	Mass word used in FUNCTIØN IDESCN
NRSPNC Times	6	KRSPNC(I)	7-10	I4	I=1, NRSPNC Task number
		KRSPNT(I)	11-14	I4	I=1, NRSPNC Pointer to time
	7	NRSPNT	5	I5	Number of response times
NRSPNT Times	8	RSPNCT(I,J)	15-24 25-34 35-44	F10.7 F10.7 F10.7	I=1,3; J=1, NRSPNT Response time for pilot resource to perform task J

3.3.4 INITIA - Jurisdictions

		Card No.	Name	Column	Format	Value/Description
		1	NJURD	1-10	I10	Quantity of jurisdictions
			NRP	11-20	I10	Quantity of resource pools
NJURD Times		2	MEMID(MJURFL)	1-4	A4	Jurisdiction name, left justified
			ICAP(MJURFL)	6-15	I10	Capacity of jurisdiction; if negative, number of runways
			CEIL(MJURFL)	16-25	F10.3	Ceiling altitude; units-feet
			FL00R(MJURFL)	26-35	F10.3	Floor altitude; units-feet
	Terminal Only	3	IDSKRW(K)	1-10	I10	Disk record number for terminal file
			PMSDAP(K)	11-20	F10.0	Probability of a missed approach for terminal
	NRP Times	4	N0ELMT(JRPFIL)	1-10	I10	Initial number of elements per resource pool
			MXELMT(JRPFIL)	11-20	I10	Maximum number of elements per resource pool
			IMAN	22-24	A3	Indication of resource typed (MAN=Manual, AUT=Automated)
NJURD Times		5	JURID	1-4	A4	Jurisdiction name, left justified
			NVERT	5-7	I3	Number of floor vertices
	NVERT Times	6	XVERT(IPTRV)	6-15	F10.3	X-coordinate of vertex
			YVERT(IPTRV)	16-25	F10.3	Y-coordinate of vertex
			NADJS	26-28	I3	Number of jurisdictions adjacent to vertex

Card No.	Name	Column	Format	Value/Description
NADJS Times 7	IJUR	25-28	A4	Name of adjacent jurisdiction to vertex, left justified
8	NADJC	5-7	I3	Number of jurisdiction adjacent to ceiling
NADJC Times 9	IJUR	25-28	A4	Name of jurisdiction adjacent to ceiling, left justified
10	NADJF	5-7	I3	Number of jurisdiction adjacent to floor
NADJF Times 11	IJUR	25-28	A4	Name of jurisdiction adjacent to floor, left justified

3.3.5 INITIA - Aircraft Type

Card No.	Name	Column	Format	Value/Description
1	NTYPE	1-5	I5	Number of aircraft type
2	MEMID(KTYPE)	1-4	A4	Aircraft type identifier
	ITYPAC(KTYPE)	7	I3	Type number of the aircraft type file
	JSPD(KTYPE)	8-10	I3	Speed class
	THETT(KTYPE)	11-20	F10.0	Turn rate; units - rad/sec
	RMSQA(KTYPE)	21-30	F10.0	Desired aircraft horizontal miss distance squared; units - $(\text{nmi})^2$
	RALTA(KTYPE)	31-40	F10.0	Desired aircraft vertical miss distance; units - nmi.
NTYPE Times	IALT(KTYPE)	41-45	I5	Indication of availability of altitude information $\text{IALT} = \begin{cases} 0, & \text{if no information available} \\ 1, & \text{altitude information available} \end{cases}$
	ALTL(KTYPE)	46-55	F10.0	Minimum altitude, units - nmi.
	ALTH(KTYPE)	56-65	F10.0	Maximum altitude, units - nmi.
	CRATE(KTYPE)	1-10	F10.0	Climb or dive rate; units nmi.
	TLEAD(KTYPE)	11-20	F10.0	Δ (delta) time before aircraft enters Metering and Sequencing, measured from feeder fix to feeder fix; units - hrs.
	FSF(KTYPE)	21-30	F10.0	Difference between nominal flight time and endurance from current location to feeder fix; units - hrs.

INITIA - Aircraft Type (Cond't)

Card No.	Name	Column	Format	Value/Description
Cond't of 2	ACR0T(KTYPE)	31-40	F10.0	Runway occupancy time; units - hrs.
	THETH(KTYPE)	41-50	F10.0	Turn rate in hold pattern
	DTRTM(KTYPE)	51-60	F10.0	Departure transition time interval; units - hrs.

3.3.6 Exogenous Event Formats

T03000 - Prepare Flight Plan

Card No.	Name	Column	Format	Value/Description
1	LCCNO	3	I3	16
	TIME	4-14	F11.6	Time of filing for flight plan (hr)
2	ACID	1-4	A4	Aircraft identification, unique identifier
	ICLASS	5-7	I3	User class (avionics), not examined
	ITYPE	9-12	A4	Aircraft type, matching an existing aircraft type file MEMID.
	IPRTY	13-16	I4	Priority of flight plan, not examined.
	IPHASE	17-19	I3	Current phase of flight, between 1 and 8, see section 2.0.
	ENDUR	20-30	F11.4	Endurance (hr)
	IØRGAP	32-35	A4	Origination airport or current jurisdiction (if airborne)
	ACETD	36-46	F11.4	Estimated time of departure
	ICTL	47-48	I2	Controlled aircraft - 0=no, 1=yes
	INTND	49-50	I2	Intentions known -)=no, 1=yes
	IDEST	52-55	A4	Destination
	IALTD	57-60	A4	Alternate destination
	IFR	61-62	I2	IFR aircraft - 0=no, 1=yes
	IVFR	63-64	I2	VFR aircraft - 0=no, 1=yes
	NFIX	65-66	I2	Number of points in time/position queue
3	X	1-10	F10.4	Initial x-coordinate (nmi)
	Y	11-20	F10.4	Initial y-coordinate (nmi)
	Z	21-30	F10.4	Initial z-coordinate (feet)

Card No.	Name	Column	Format	Value/Description
3 Cont'd	XVEL	31-40	F10.4	Initial x-component of speed (kt)
	YVEL	41-50	F10.4	Initial y-component of speed (kt)
	ZVEL	51-60	F10.4	Initial z-component of speed (ft/sec)
	IENTER	61-62	I2	Intentions known and entering ATM system for first time - 0=no,1=yes
	IDPRW	63-64	I2	Departure runway number
4 (NFIX+3)	XINTND	1-11	F11.4	X-coordinate of intended position (nmi)
	YINTND	12-22	F11.4	Y-coordinate of intended position (nmi)
	ZINTND	23-33	F11.4	Z-coordinate of intended position (ft)
	SPDLEG	34-44	F11.4	Average speed during this leg (kt) [for landing aircraft, last speed = -(feeder fix*100 + runway number)]

T01101 - Accept Data Link Request

Card No.	Name	Column	Format	Value/Description
1	LCCNO	3	I3	3
	TIME	4-14	F11.6	Time of request
2	AC	1-4	A4	Aircraft id - e.g., U234

T01102 - Accept Telephone Request

Card No.	Name	Column	Format	Value/Description
1	LCCNO	3	I3	4
	TIME	4-14	F11.6	Time of request
2	AC	1-4	A4	Aircraft id - e.g., U234

T06400 - Capability Change/Status Change/Emergency

Card No.	Name	Column	Format	Value/Description
1	LCCNO	3	I3	58
	TIME	4-14	F11.6	
2	ACNAME	1-4	A4	Aircraft id - e.g., U234

Card No.	Name	Column	Format	Value/Description
	ISTAT	5-6	I2	1 = status change; 0 = none
	ICAP	7-8	I2	1 = capability change; 0 = none
	IEMER(1)	9-10	I2	1 = emergency; 0 = none
	IEMER(2)	11-12	I2	1 = previously recognized; 0 = none
	IEMER(3)	13-14	I2	1 = description adequate; 0 = not
	IEMER(4)	15-16	I2	1 = ground support required; 0 = not
	IEMER(5)	17-18	I2	1 = other aircraft required; 0 = not
	IEMER(6)	19-20	I2	1 = technical instructions required; 0 = not
	IEMER(7)	21-22	I2	1 = comm link required; 0 = not
	IEMER(8)	23-24	I2	1 = guidance required; 0 = not
	IEMER(9)	25-26	I2	1 = other aircraft available; 0 = not
	ETIME	27-46	F11.4	Duration of emergency (hr)

T15102 - Acquire and Analyze Data on Progress of Service

Card No.	Name	Column	Format	Value/Description
1	LCCNO	3	I3	161
	TIME	4-14	F11.6	Time of event
2	ACNAME	1-4	A4	Aircraft id - e.g., U234
	IRQST	5-6	I2	0 = initial request, 1 = update
	ISAFE	7-8	I2	1 = cease service due to safety; 0 = continue
	IQUIT	9-10	I2	1 = service no longer needed; 0 = continue
	ISPEC(1)	11-12	I2	1 = need new flight plan priority

Card No.	Name	Column	Format	Value/Description
2 Cont'd	ISPEC(2)	13-14	I2	1 = need for guidance
	ISPEC(3)	15-16	I2	1 = need for advisories

3.3.7 DATAFIL - Date and Title Card

Card No.	Name	Column	Format	Description
1	Title	2-65	16A4	Date and title of run.

4.0 CARD DECK PREPARATION

4.1 DATA PREPARATION

The data described in the previous section can be prepared by punching paper tape off-line and loading onto a disk file through the use of the RTAPE command or by loading directly from the on-line terminal through the use of the TRW/EDITOR. All data is loaded according to standard FORTRAN rules. The program reads data in two forms: formatted input and namelist input.

The formatted input is described explicitly in Section 3.3. Data should be entered in the indicated columns. If a data item has an "I" or integer format, then it must be input as a right-justified integer value with no decimal. Data items with an "F" or fractional format are input anywhere within the specified columns as long as a decimal is specified. A blank entry within a specified field will be read as a zero.

The namelist variables are described in Section 3.3.2. The namelist is initiated by a $INP card. All data read by namelist must be between columns 2-80. Data is input by specifying the variable name, an equal sign, the value, and a comma as a delimiter. For an array the array name and equal sign are specified, then the list of values for the array beginning with the first element and proceeding to the last. The variable name may be specified in any order. If a variable should be specified more than once, then the last occurrence of the variable is used. The namelist data is terminated by a $END card. For example,

```
Column
2
$INP
M04210=2077
P03000=.90,.96, P04201=.98,1.0,
.
.
.
ISEED=12345,
.
.
.
$END
```

4.2 JOB STREAM SETUP

Table 4.2-1 shows a control card setup for executing the DELTA simulation and the Post Processor on the TRW CDC6X00/CYBER74 computers. The first seven cards are Administrate and general control cards. The user should provide his own user ID and password on the account card.

The directives begin with the GET command. This command brings a copy of the permanent files into the working storage area. The SET card presets core to an indefinite value as a debug aid in finding variables which have not been properly set before use. The LINK card causes the loader to read directives and load binary files. The X parameter causes execution of the loaded programs; the LO parameter specifies the desired load map options. The output file TAPE14 is sorted using the SORTC utility. The LOAD and EXECUTE cards are a simpler version of the LINK card and are used to run the DELTA Post Processor. The EXIT card defines where processings is to resume following an abnormal termination in one of the programs.

The user is referred to the TRW/TSS System Reference Manual for a more detailed discussion of each of the directives. In the example in Table 4.2-1, the input files contain the following information:

OV - overlay directives,
RJSMNB - binary deck of the MAIN program,
BN - binary deck of any modified routines; used to override BBEST,
BBEST - binary decks of DELTA simulation
NSALSIM- library of SALSIM binary decks
TAPE5 - scenario input data
TAPE30 - terminal input data; random access file produced by Terminal Generation Program,
BPOST - binary deck of Post Processor.

For a more detailed description of the rules and options available with various formats, the user is referred to the Fortran Reference Manual, CDC No. 60174900. A sample of the input data is shown with the test case in Section 6.0.

TABLE 4.2-1 JOB STREAM SETUP FOR DELTA SIMULATION AND POST PROCESSOR

```
ACCOUNT,LG54201,PASSWORD.
NAME,672200,54201,GREEN,L.
PROBLEM,9996E7.
PROGRAM,ATMS60A.
PRIORITY,N.
MAXTIM,300.
BANNER,OUTPUT,W1,1653.
GET,BBEST,OV=OVNEW,NSALSIM,BN=BNEWLIB,RJSMNB=BBATCH,ACCOUNT=LG54201.
GET,TAPE5=SF060A,ACCOUNT=LG54201.
GET,TAPE30=SFOTRMF,ACCOUNT=LG54201.
SET,INDEF,ADDR.
LINK,I=OV,I1=RJSMNB,I2=BN,I3=BBEST,P=NSALSIM,X,LO=SB,L=MAP60A.
TIME.
REPLACE,MAP60A.
REPLACE,TAPE6=T660A.
COPYBF,TAPE6,OUTPUT.
REPLACE,TAPE14=T1460A.
GET,TAPE7=T1460A.
SORTC,TAPE7,K=17,25,L=4,4.
GET,TAPE8=T1460A.
SORTC,TAPE8,K=21,17,L=4,4.
GET,BPOST,ACCOUNT=LG54201.
SET,INDEF,ADDR.
LOAD,BPOST.
EXECUTE,POSTPRC,OUTPUT=POST60A.
REPLACE,POST60A.
REWIND,POST60A.
COPYBF,POST60A,OUTPUT.
COPYDF,DAY60A.
TIME.
REPLACE,DAY60A.
EXIT.
CLEARSW,SY.
DMP,113500.
REWIND,MAP60A.
COPYBF,MAP60A,OUTPUT.
REWIND,TAPE6,TAPE14.
REPLACE,TAPE6=T660A.
REPLACE,TAPE14=T1460A.
COPYBF,TAPE6,OUTPUT.
COPYDF,DAY60A.
REPLACE,DAY60A.
```

5.0 OUTPUT REPORT SPECIFICATIONS

5.1 INTRODUCTION

The DELTA simulation generates two reports for the user: the DELTA Run Summary and the DELTA Post Processor Report. The Run Summary gives a detailed description of the resource utilization of each element in each resource pool by jurisdiction, the state of any aircraft remaining in the system, and the utilization of dynamic memory for this run. The Post Processor Report counts the occurrences of each task which was performed within a jurisdiction and within the total model and presents a summary of the tasks performed for each aircraft and a list of the phases of flight through which each aircraft passed.

5.2 DELTA RUN SUMMARY

This section contains examples of the DELTA Run Summary which is produced by the routine DATAFIL in the DELTA simulation. The examples are presented in five figures which are computer printouts of an actual run. The printouts are annotated with circled numbers which are described below. Figures 5.2-2 to 5.2-4 show the different formats for a jurisdiction summary. Figure 5.2-2 illustrates the format for a terminal jurisdiction. The different formats which can occur for an en route jurisdiction are shown in Figures 5.2-3 to 5.2-4. Figure 5.2-3 shows the extra print resulting from an aircraft remaining in the jurisdiction at the end of the simulation run.

The parameters on the Summary Report are described below. The number preceding the description corresponds to the circled number on the figure.

1. Report title.
2. Run title (from TAPE5).
3. Max time for this simulation run (hours).
4. "High water mark" of dynamic memory actually used in this run.
5. Max value of dynamic memory allocated for this run.
6. Jurisdiction name. Terminal is added when a jurisdiction is a terminal.
7. Number of aircraft remaining in the en route jurisdiction.
8. Input capacity for the en route jurisdiction.
9. Number of aircraft remaining in the terminal jurisdiction.
10. Number of aircraft awaiting to be sequenced for the terminal.
11. Number of aircraft being sequenced by the terminal.
12. Description of aircraft remaining in the jurisdiction. The description consists of a sequential count, the aircraft id, the aircraft type, its phase of flight, the game time at which its input endurance will be

expended, the last game time when this aircraft was updated by MOVAC, and the ACBITS states vector for this aircraft.

13. The type of resource pool--manual in this case.

14. The resource pool number.

15. The current number of resource elements available at the end of the run.

16. The maximum number of resource elements available during the run.

17. The number of tasks in the resource pool queue awaiting to be processed at the end of the run.

18. The dynamic memory pointer for the resource element.

19. Game time at which the resource element was created--i.e., time first available (hr).

20. Time next available = time first available + cumulative busy time/overload threshold (hr).

21. Cumulative busy time is the sum of all the element's busy time (hr).

22. Percentage busy time = cumulative busy time/(max time - time first available) (hr).

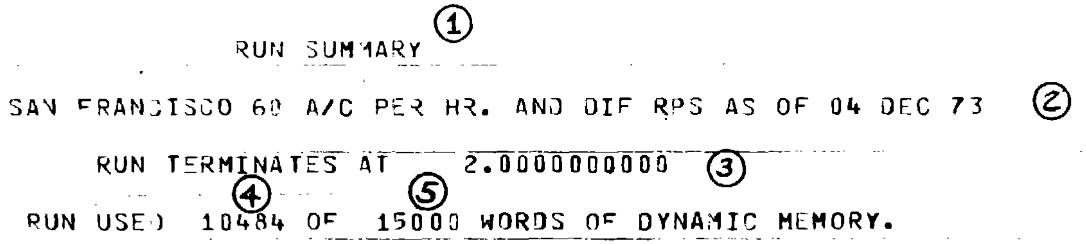
23. The type of resource pool--automated in this case.

24. The current automated computing rate in use at the end of the run (hundreds of instructions/sec).

25. The maximum automated computing rate available during the run (hundreds of instructions/sec).

26. End of report heading.

FIGURE 5.2-1. DELTA RUN SUMMARY, FIRST PAGE



```
                RUN SUMMARY
SAN FRANCISCO 60 A/C PER HR. AND DIF RPS AS OF 04 DEC 73
     RUN TERMINATES AT    2.0000000000
 RUN USED  10484 OF  15000 WORDS OF DYNAMIC MEMORY.
```

```
                                    ⑥
           TERMINAL JURISDICTION: SFO
                                             ⑨
               CONTAINED     1 AIRCRAFT               ⑩
             0 AIRCRAFT WERE AWAITING SEQUENCING
             8 AIRCRAFT WERE BEING SEQUENCED          ⑪

                     AIRCRAFT DATA
 NO  A/C TYPE P ENDURANCE UPDATE TIME      STATE VECTOR
                                                           ⑫
  1 2330 AC03 7 3.49794000 1.99992000 00000000000020721000


                     RESOURCE DATA
 ⑬                  ⑭         ⑮      ⑯       ⑰
MAN   RESOURCE POOL  1 USING      6 OF     6 MEN     21 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT     FIRST  ⑲   NEXT  ⑳   BUSY TIME㉑ BUSY TIME  ㉒
         234 ⑱ 0.00000000  1.57003642  1.57003642   78.501821
         277   0.00000000  1.58067681  1.58067681   79.033841
         270   0.00000000  1.58309056  1.58309056   79.154528
         263   0.00000000  1.58217032  1.58217032   79.108541
         256   0.00000000  1.57966320  1.57966320   78.983160
         249   0.00000000  1.58818225  1.58818225   79.409113

MAN   RESOURCE POOL  2 USING      3 OF     3 MEN      0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT     FIRST       NEXT      BUSY TIME  BUSY TIME
      10477    1.90506568  1.91400285   .00893716    9.414044
      10470    1.89801287  1.90936008   .01134721   11.126119
         300   0.00000000  1.05083380  1.05083380   52.541690
 ㉓                            ㉔          ㉕
AUTO  RESOURCE POOL  3 USING     50 OF  1000 HI/S     0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT     FIRST       NEXT      BUSY-TIME  BUSY TIME
         316   0.00000000   .91401022   .91401022   45.700511

MAN   RESOURCE POOL  4 USING      1 OF     1 MEN      0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT     FIRST       NEXT      BUSY TIME  BUSY TIME
         332   0.00000000  0.00000000  0.00000000    0.000000
```

FIGURE 5.2-2. DELTA RUN SUMMARY, EXAMPLE 1

FIGURE 5.2-2. DELTA RUN SUMMARY, EXAMPLE 1 (contd.)

```
MAN  RESOURCE POOL  5 USING      1 OF      5 MEN       0 TASKS LEFT
                AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST         NEXT      BUSY TIME  BUSY TIME
       343     0.00000000  0.00000000  0.00000000    0.000000
```

```
                                      ⑥
               JURISDICTION: AR-5
                          ⑦       ⑧
           CONTAINED      1 OF     50 AIRCRAFT

                     AIRCRAFT DATA
 NO  A/C TYPE P ENDURANCE UPDATE TIME      STATE VECTOR

  1 3406 AC04 6 3.46350000 1.99932000 000000000000020700000     ○


                    RESOURCE DATA
⑬                 ⑭          ⑮           ⑯           ⑰
MAN   RESOURCE POOL  1 USING      6 OF      6 MEN       46 TASKS LEFT
                   AVAILABILITY TIMES      CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST  ⑲     NEXT  ⑳    BUSY TIME ㉑BUSY TIME  ㉒
        416   ⑱ 0.00000000  1.71640176  1.71640176   85.820088
        409     0.00000000  1.71188756  1.71188756   85.594378
        402     0.00000000  1.72344991  1.72344991   86.172495
        395     0.00000000  1.72001514  1.72001514   86.000757
        388     0.00000000  1.70715401  1.70715401   85.357701
        381     0.00000000  1.71561291  1.71561291   85.780645

MAN   RESOURCE POOL  2 USING      1 OF      3 MEN        0 TASKS LEFT
                   AVAILABILITY TIMES      CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT       BUSY TIME  BUSY TIME
        432     0.00000000   .80537144   .80537144   40.268572
㉓                               ㉔         ㉕
AUTO  RESOURCE POOL  3 USING     50 OF   1000 HI/S       0 TASKS LEFT
                   AVAILABILITY TIMES      CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT       BUSY TIME  BUSY TIME
        448     0.00000000   .75625000   .75625000   37.812500

MAN   RESOURCE POOL  4 USING      1 OF      1 MEN        0 TASKS LEFT
                   AVAILABILITY TIMES      CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT       BUSY TIME  BUSY TIME
        464     0.00000000  0.00000000  0.00000000    0.000000

MAN   RESOURCE POOL  5 USING      2 OF      5 MEN        0 TASKS LEFT
                   AVAILABILITY TIMES      CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT       BUSY TIME  BUSY TIME
       4901      .37830000   .64010968   .26130968   16.118288
```

FIGURE 5.2-3. DELTA RUN SUMMARY, EXAMPLE 2

FIGURE 5.2-3. DELTA RUN SUMMARY, EXAMPLE 2 (contd.)

```
490     0.00000000     .65386272     .65386272     32.693136
```

```
                 JURISDICTION: AP-3  ⑥
                   ⑦          ⑧
          CONTAINED    0 OF      50 AIRCRAFT

                    AIRCRAFT DATA
  NO  A/C TYPE P ENDURANCE UPDATE TIME      STATE VECTOR


                    RESOURCE DATA
 ⑬                   ⑭          ⑮         ⑯          ⑰
 MAN  RESOURCE POOL  1 USING     6 OF      6 MEN      63 TASKS LEFT
                    AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT ⑱     FIRST   ⑲    NEXT  ⑳  BUSY TIME ㉑ BUSY TIME ㉒
        548     0.00000000  1.80221406  1.80221406   90.110703
        541     0.00000000  1.79225798  1.79225798   89.612899
        534     0.00000000  1.79995537  1.79995537   89.997768
        527     0.00000000  1.78944555  1.78944555   89.472277
        520     0.00000000  1.79195512  1.79195512   89.597756
        513     0.00000000  1.79945334  1.79945334   89.972667

 MAN  RESOURCE POOL  2 USING     1 OF      3 MEN       0 TASKS LEFT
                    AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
        564     0.00000000  1.06752538  1.06752538   53.376269
 ㉓                             ㉔        ㉕
 AUTO RESOURCE POOL  3 USING    50 OF   1000 HI/S      0 TASKS LEFT
                    AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
        530     0.00000000   .90455556   .90455556   45.227778

 MAN  RESOURCE POOL  4 USING     1 OF      1 MEN       0 TASKS LEFT
                    AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
        596     0.00000000  0.00000000  0.00000000    0.000000

 MAN  RESOURCE POOL  5 USING     1 OF      5 MEN       0 TASKS LEFT
                    AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
      ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
        612     0.00000000   .47836018   .47836018   23.918009
```

FIGURE 5.2-4. DELTA RUN SUMMARY, EXAMPLE 3

FIGURE 5.2-5. DELTA RUN SUMMARY, LAST PAGE

```
**********END DELTA**********
```

㉖

5.3 DELTA POST PROCESSOR REPORT

This section contains examples of the DELTA Post Processor Report which is produced by executing the DELTA Post Processor following a DELTA Simulation run. The examples are presented in three figures which are computer printouts of an actual run. The printouts are annotated with circled numbers which are described below. Figure 5.3-1 shows a page from the Task Summary by jurisdiction. It contains a count of each task occurrence by jurisdiction and by total. Figure 5.3-2 shows the first page of the Aircraft Summary. It shows the count for all tasks performed for this aircraft, the program states, and changes in the phase of flight.

The parameters on the Report are described below. The number preceding the description corresponds to the circled number on the figures.

1. Task number.
2. Jurisdiction id.
3. Number of occurrences of this task for this jurisdiction.
4. Task number.
5. Number of occurrences of this task during the run.
6. Aircraft id.
7. Task number.
8. Number of occurrences of this task for this aircraft.
9. Aircraft id.
10. Entry of this aircraft into the simulation.
11. Game time for the specified event (hr).
12. Jurisdiction id in which this event occurred.
13. Boundary crossing event.
14. Cancelled in an en route jurisdiction implies that the aircraft flew out of the jurisdictions being modelled for this run.

15. Indicates a change in the phase of flight.

16. Name of the new phase of flight.

17. Cancelled at a terminal while in landing phase implies the aircraft has landed and was removed from the system.

18. Indicates where the aircraft was at the end of the simulation run.

FIGURE 5.3-1. POST PROCESSOR TASK SUMMARY BY JURISDICTION

```
  ①      ②          ③
  49     AR-5        31
  49     ER-N         3
  49     SFO         28
                       ④        ⑤
TOTAL  COUNT FOR TASK   49 IS     81.

  50     AR-3        15
  50     AR-5        22
  50     ER-N         3
  50     SFO         22

TOTAL  COUNT FOR TASK   50 IS     62.

  51     AR-3         6
  51     AR-5         8
  51     ER-N         6
  51     SFO         11

TOTAL  COUNT FOR TASK   51 IS     31.

  54     AR-3       385
  54     AR-5       374
  54     ER-N       345
  54     ER-S       446
  54     SFO        3CO

TOTAL  COUNT FOR TASK   54 IS   1850.

  55     AR-3       385
  55     AR-5       372
  55     ER-N       345
  55     ER-S       450
  55     SFO        289

TOTAL  COUNT FOR TASK   55 IS   1841.

  56     NULL        18
```

```
            AIRCRAFT LIST

AIRCRAFT  TASK  COUNT
   ⑥       ⑦      ⑧
  0303      16     1
  0303      48     1
  0303      49     1
  0303      50     1
  0303      51     1
  0303      56     1
  0303      67     1
  0303      68     1
  0303      69     1
  0303      71     1
  0303      72     1
  0303      76     1
  0303     121     1
  0303     123     1
  0303     124     1
  0303     125     1
  0303     126     1
  0303     127     1
  0303     128     1         ⑨    ⑩                ⑪           ⑫
                    AIRCRAFT 0303 ENTERED AT     .4545600000 IN AR-5.
                  ⑬AIRCRAFT 0303 HANDED OFF AT     .5074995749 TO FR-N.
                  ⑭AIRCRAFT 0303 CANCELLED AT      .5306829835 IN FR-N.
  0311      16     1
  0311      48     2
  0311      49     1
  0311      50     1
  0311      51     1
  0311      56     1
  0311      67     1
  0311      68     1
  0311      69     1
  0311      71     1
  0311     121     1
  0311     123     1
  0311     124     1
  0311     125     1
  0311     126     1
  0311     127     1
```

FIGURE 5.3-2. POST PROCESSOR AIRCRAFT SUMMARY, EXAMPLE 1

FIGURE 5.3-3. POST PROCESSOR AIRCRAFT SUMMARY, EXAMPLE 2

```
                                   (9)          (15)                     (11)                    (16)
                          AIRCRAFT  1233 CHANGED PHASE  AT     3.3520700000 TO ARRIVAL TRANSITION.
                          AIRCRAFT  1233 CHANGED PHASE  AT     3.5427865946 TO APPROACH.
                          AIRCRAFT  1233 CHANGED PHASE  AT     3.8248426272 TO LANDING.
                          AIRCRAFT  1233 CANCELLED AT    3.8409537939 IN SFO .   (17)
  1237      59       1
                          AIRCRAFT  1237 ENTERED AT   3.9179400000 IN ER-S.
                          AIRCRAFT  1237 CHANGED PHASE  AT     3.9179400000 TO ARRIVAL TRANSITION.
                          AT END OF RUN, AIRCRAFT 1237 IN ER-S.  (18)
  1239      59       1
                          AIRCRAFT  1239 ENTERED AT   3.9697700000 IN ER-S.
                          AIRCRAFT  1239 CHANGED PHASE  AT     3.9697700000 TO ARRIVAL TRANSITION.
                          AT END OF RUN, AIRCRAFT 1239 IN ER-S.
  1301      48       3
  1301      49       3
  1301      50       3
  1301      51       3
  1301      59       4
  1301      71       5
  1301      72       4
  1301      73       2
  1301      74       2
  1301      75       2
  1301      76       5
  1301     121       3
  1301     123       3
  1301     124       3
  1301     125       3
  1301     126       3
  1301     127       3
  1301     128       3
                          AIRCRAFT  1301 ENTERED AT      .2464500000 IN ER-S.
                      (19)AIRCRAFT  1301 HANDED OFF  AT        .4969993713 TO AR-3.
                          AIRCRAFT  1301 HANDED OFF  AT        .5914943040 TO AR-5.
                          AIRCRAFT  1301 HANDED OFF  AT        .6763189268 TO SFO .
                          AIRCRAFT  1301 CHANGED PHASE  AT        .2464500000 TO ARRIVAL TRANSITION.
                          AIRCRAFT  1301 CHANGED PHASE  AT        .4305798268 TO APPROACH.
                          AIRCRAFT  1301 CHANGED PHASE  AT        .7074567939 TO LANDING.
                          AIRCRAFT  1301 CANCELLED AT       .7210679605 IN SFO .
  1302      48       3
  1302      49       3
  1302      50       3
  1302      51       2
```

6.0 TEST CASE

6.1 INTRODUCTION

The example shown in this section is the model verification case run for the San Francisco terminal using the "raw data" flight plans provided by Stanford Research Institute; Menlo Park, CA. This case is referred to as SFORAW. The section is divided into four sub-sections: a description of the namelist inputs defined by TRW, a list of the complete TAPE5 file, the DELTA Summary Report, and the DELTA Post Processor Report.

6.2 NAMELIST INPUTS FOR SFORAW

This section defines the namelist input used in the TAPE5 input file for the SFORAW case. The list includes a short definition of the variable and the input values. An example of how these variables appear in the input file is shown in Section 6.3.

LOCAL NAME	SHORT DEFINITION	INPUT VALUES	COMMENTS
F02000	Time between repetitions of Function 2	0.	Hours
P03000	Probability that preliminary flight plan needs no modification	.90 .96	First pass Subsequent passes
P04201	Probability of no flight plan discrepancy due to aircraft capability or status	.98 1.0	First pass Subsequent passes
P04202	Probability of no flight plan discrepancy due to operational or environmental conditions	.95 .98	First pass Subsequent passes
P04203	Probability of no flight plan discrepancy due to probed conflict detection	1.0 1.0	First pass Subsequent passes
P04205	Probability of no flight plan discrepancy due to rules and procedures	.95 1.0	First pass Subsequent passes
P04206	Probability of no flight plan discrepancy due to flight progress	.95 1.0	First pass Subsequent passes
P04207	Probability of no flight plan discrepancy due to user class/ pilot qualifications	.98 1.0	First pass Subsequent passes
P04401	Probability of pilot rejection of modified flight plan	.02	
P04402	Probability of pilot resubmitting flight plan after rejection	.98	
P05101	Probability that aircraft Id code is required	0.	Up to 8 categories may be assigned. Not needed in todays' systems
C05102	Maximum permissible duration of one repentition of Task 5.1.2	.013722	Hours
F05102	Time between repetitions of Task 5.1.2	.333333	Hours

LOCAL NAME	SHORT DEFINITION	INPUT VALUES	COMMENTS
P05103	Probability of retry in approach	1.0	
C05302	Maximum acceptable time for pilot response to clearance	.003332	Hours
F06100	Time between repetition of Subfunction 6.1	.008333	Hours
C061AU	Maximum possible duration for the processing period of the aggregated tasks 6.1, 6.2.2, 6.3.1, and 6.3.2 (automated portion)	.008300	Hours
C061MN	Maximum possible duration for the processing period of 6.1, 6.2.2, 6.3.1, 6.3.2 (manual portion)	.014639	Hours
F07103	Time between repetitions of Task 7.1.3	0.	Hours. Not performed in today's system
C07103	Maximum permissible duration of one repetition of Task 7.1.3	.283333	Hours
P07104	Probability of no long range conflicts due to flight plans for given aircraft	1.0	
P07201	Probability of no current out-of-tolerance expansion of tolerances	.98	
F07201	Time between repetitions of Task 7.2.1	.041667	Hours
F07301	Time between repetitions of Task 7.3.1	.166667	Hours
P07302	Probability of no short-range deviation for aircraft	.90	
E07401	Maximum time expanded tolerances can be enforced	.083333	Hours

LOCAL NAME	SHORT DEFINITION	INPUT VALUES	COMMENTS
F08101	Time between repetitions of Task 8.1.1	0.	Hours
F08102	Time between repetitions of Task 8.1.2	.008333	Hours
F08103	Time between repetitions of Task 8.1.3	.008333	Hours
F08105	Inverse of time for Task 8.1.3 (F08103)	120.	Cycles/hours
H08107	Conflict imminence threshold	.000278	Hours
F08108	Frequency of careful monitoring Tasks 8.1.8	.008333	Checks/cycle
P082PR	Probability that pilot will respond to conflict resolution message	.99	
P082RV	Probability of performance change revision if no pilot response	.99	
D08201	Task time for 8.2.1	.000833	Hours
D08202	Task time for 8.2.2	.002764	Hours
D08203	Task time for 8.2.3	.000833	Hours
D08204	Task time for 8.2.4	.000928	Hours
D08205	Task time for 8.2.5	.003508	Hours
F09100	Time between repetitions of Subfunction 9.1	.5	Hours
C09100	Maximum permissable duration of one repetition of Subfunction 9.1	.013736	Hours. Totally automated in current system
P09202	Probability of no excess slack and demand is predicted arrival/departure schedules	.50	
P11000	Probability that further vertoring is not required	.50	

LOCAL NAME	SHORT DEFINITION	INPUT VALUES	COMMENTS
P11101	Probability of no vectoring for 1. Course 2. Speed 3. Altitude	 .20 .40 .40	 Three parts
C11502	Maximum acceptable pilot response time to vectoring message	.001110	Hours
P11503	Probability that no retransmission of vectoring message is required	.95	
P12104	Probability that information required by pilot is available	.98	
M12202	Maximum number of aircraft for selective distribution of advisories	3.	
C12207	Maximum permissible duration of one repetition of Task 12.2.7	.005667	Hours
C12301	Maximum permissible duration of repetition of Task 12.3.1	.004678	Hours
P12304	Probability that vectoring is desired	.95	
C13100	Maximum permissible duration of one repetition of Subfunction 13.1	.011333	Hours
F13100	Time between repetitions of Subfunction 13.1	.016667	Hours
P13201	Probability that no communication channel change is required	.05	
F17300	Time between repetitions of Subfunction 17.3	.432432	Hours

LOCAL NAME	SHORT DEFINITION	INPUT VALUES	COMMENTS
AINC	Altitude climb distance for CONPLRT avoidance	100.	Feet
ALPHA	Smoothing coefficient (auto correlation coefficient)	6* .5	Six number array $0 \le ALPHA \le 1$ for each speed class
ANGTN	Turn increment	30.	Degrees
D1 D2	Interval designation for trapezoidal speed bias	10. 25.	Speed class dependent, but same for all classes
DSEPSQ	Minimum separation distance squared	9.0	$(n.mi)^2$
DTERR	Error in time of conflict occurrence	.016666	Hours
FØRCST	Model look ahead increment	.083333	Hours
ISEED	Seed for random number generators	123456789	Large odd integer
ITYPER	Error type - navigation	1 1 2 3 2 3	Values are 1, 2, or 3. Speed class dependent
JPRNT	Print suppression variable	8*1 2*0 60*1 10*0	These are arrays
LEVS	Priority sequence of revolution maneuvers	1 2 3 4 5 6	
MIPSAD	Increment in MIPS	1	No receiving for today's system
NSTEP	Number of steps in paths ensemble	5	Odd number
NUMLEV	Number of resolution maneuvers	6	
ØLTRP	Overlook threshold for 1. Manual (ØLTRP(1)) 2. Automatic (OLTRP(2))	 100. 100..	 Percent of this difference

LOCAL NAME	SHORT DEFINITION	INPUT VALUES	COMMENTS
OUTIN	Sensor data	1.	
OUTSN	Sensor data	1.	
PLOTMX	Maximum time for pilot to respond to performance change message	.000834	Hours
RISKL	Low risk threshold	.001	
RISKT	Risk threshold	.15	
SKNUM	Number of standard deviations used for conflict detection error	3.	
SHAPE	Navigation error shape constant	3.5 3.0 2.5 2.0 1.5 1.0	Speed class dependent longer for lower speeds
SIDE	Grid square side length	60.0	n.mi
SIGIN	Sensor data	40. 30. 20. 10. 5.	
SIGSN	Sensor data	40. 30. 20. 10.	
SMAXX SMAXY SMAXZ	Maximum allowable navigation error in the X, Y, and Z deviation respectively	6*10. 6*10. 6*1.	n.mi Six number arrays
STOLT	Short term overload threshold	8.	Controller should be busy no longer than STOLT 100% of the time. Hours
TIME	Current time	0.	Input starting time of model. Hours
TIMMS	Time between calls to metering and sequencing routine	25.	Hours

LOCAL NAME	SHORT DEFINITION	INPUT VALUES	COMMENTS
TLKAHD	Look ahead time for 7.1.1 used in 5.2.3	.5	Hours 7.1.1 not performed in today's system
TL00K	Look ahead time	300.	
TRL00K		30.	
TW	Warning time	60.	Seconds
WARNTM	Warning time for conflict detection	.116666	Hours
XLANDT	Time before M&S assuming control over aircraft	.5	Hours

6.3 LIST OF TAPE5

This section shows a complete list of the card images contained in the TAPE5 input file used in the SFORAW case. The example shows the SALSIM specifications, the namelist inputs, the task times and allocations, the aircraft types, the jurisdictions, and the exogenous flight plans.

```
 180 10000    23    -1                                      SALSIM CARD
 $INP
 M04210=2077
 R04210=100
 M04302=100
 R04302=30377
 P03000=.90,.96, P04201=.98,1.0, P04202=.95,.98,
 P04203=1.0,1.0, P04205=.95,1.0, P04206=.95,1.0,
 P04207=.98,1.0, P04401=.02, P04402=.98, P05101=0., C05102=.013722,
 F05102=.333333, P05103=1.0, TLKAHD=.5, C05302=.003332,
 F06100=.008333,
 C061AU=0.00830,
 C061MN=.014639, F07103=0., C07103=.283333,
 P07104=1.0, P07201=.98, E07401=.083333,
 F07201=.041667, P07302=.90, F08101=0., F08102=.008333,
 F08103=.008333, F08105=120.,
 H08107=.000278, F08108=.008333, P082PR=.99,
 P082RV=.99,        PLOTMX=.000834
 D08201=0.00083333, F07301=.166667,
 D08202=.002764,
 D08203=.000833,
 D08204=.000928,
 D08205=.003508,
 F09100=.5,
 C09100=.013736,
 P09202=.50,
 P11000=.50,
 P11101=.20,.40,.40,
 C11502=.083333,
 P11503=.95,
 P12104=.98,
 M12202=3,
 C12207=.005667,
 C12301=.004678,
 P12304=.95,
 C13100=.011333,
 F13100=.016667,
 P13201=.05,
 F17300=.4324432,
 RISKT=.15,
 RISKL=.001,
 OLTRP=1.,1.,
```

```
 STOLT=8.,
 MIPSAD=1,
 ISEED=123456789,
 SIDE=60.0,
 DSEPSQ=3.0,
 DTERR=.016666,
 WARNTM=.116666,
 ITYPER=1,1,2,2,3,3,
 ALPHA=6*0.5,
 SHAPE=3.5,3.0,2.5,2.0,1.5,1.0,
 SMAXX=6*0.,
 SMAXY=6*0.,
 SMAXZ=6*0.,
 D1=6*0.,
 D2=6*0.,
 SONUM=3.,
 TIMMS=0.160,
 FORCST=.08333,
 NSTEP=5,  TW=60.,  TLOOK=300.,  TRLOOK=30.,
 ANGIN=30.,  AINC=100.,  OUTSN=1., OUTIN=1.,
 SIGSN=40., 30., 20., 10.,
 SIGIN=40., 30., 20., 10., 05.,
 JPRNT=8*1, 2*0, 60*1, 10*0,
 $END
  156                 777  NTASKS AND MTASK (I5,020)  **********
TASKNO*POOL LCC RSP PRI   ITIME****MEDIAN****LOW*QT*****HI*QT
T01101   *S00030002000100000000  IGNORE
T01102    S0004   20001        1+00.003194-00.000606+00.000706
T01103    S0005   20001        2+00.002369-00.000646+00.002739
T01201   *S0006   200010000000  IGNORE
T01202    S0007   20001        3+00.002431-00.000747+00.002292
T01301    S0008   20001        4+00.004361-00.002767+00.001528
T01302   *S0009   200010000000  IGNORE
T01303    S0010   20001        5+00.002611-00.000800+00.000733
T02MAN    F0012   40002        6+00.042442-00.014122+00.021905
T02AUT    A0013   30002   -4650  AUTO
T02202    A0015   30002    -100  AUTO
T03000    P0016   50001        7+00.164690-00.047046+00.099037
T04101    A0018   30001    -200  AUTO
T04102    E0019   10001        8+00.004658-00.001750+00.003611
T04201    S0020   20001        9+00.005658-00.001472+00.002667
T04202    S0021   20001       10+00.005047-00.001333+00.007583
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T04203   *S0022   200010000000   IGNORE
T04204    S0023   20001        11+00.008153-00.002791+00.004069
T04205    S0024   20001        12+00.006019-00.001944+00.003333
T04206    S0025   20001        13+00.009667-00.003600+00.004722
T04207    S0026   20001        14+00.001667-00.000556+00.000556
T04208    S0027   20001        15+00.003194-00.000972+00.000972
T04209    S0028   20001        16+00.003500-00.001361+00.003611
T04210    S0029   20001        17+00.001667-00.000555+00.000555
T04211   *S0030   200010000000   IGNORE
T04212   *S0031   200010000000   IGNORE
T04213    S0032   20001        18+00.004492-00.001528+00.002917
T04301    S0033   20001        19+00.019290-00.004896+00.015549
T04302    S0034   20001        17 D .001667-00.000555+00.000555
T04303    S0035   20001        20+00.006250-00.002083+00.002083
T04304    S0036   20001        21+00.050000-00.016667+00.016667
T04401   *S0037   200010000000   IGNORE
T04402   *S0038   200010000000   IGNORE
T04403    S0039   20001        15 D .003194-00.000972+00.000972
T04404   *S0040   200010000000   IGNORE
T05101   ET0042   10005        22+00.000417-00.000139+00.000139
T05102   ET0043   10005        23+00.007472-00.003128+00.006250
T05103    T0044   10005        24+00.005431-00.000322+00.000558
T05201   ET0045   10005        22 D .000417-00.000139+00.000139
T05302   ET0046   10005        25+00.005175-00.001711+00.003611
T05203   ET0047   10005        26+00.004286-00.001494+00.002389
T05204   ET0048   10005        27+00.008508-00.003044+00.002694
T05301   ET0049   10005        20 D .006250-00.002083+00.002083
T05302   ET0050   10005        28+00.004236-00.001403+00.001486
T05303   ET0051   10005        29+00.002342-00.000592+00.000572
T061AU    A0054   30010        -5   AUTO
T061MN   ET0055   10010        30+00.000278-00.000139+00.000139
T06201  *ET0056   100050000000   IGNORE
T06303  *ET0057   100100000000   IGNORE
T06401  *ET0059   100100000000   IGNORE
T06402    T0060   10010        31+00.000717-00.000094+00.000089
T06403    T0061   10010        32+00.002975-00.001056+00.000700
T06404   ET0062   10010        31 D .000717-00.000094+00.000089
T06405   ET0063   10010        33+00.001047-00.000047+00.000003
T06406   ET0064   10010        34+00.002278-00.000322+00.000514
T06407   ET0065   10010        35+00.002608-00.000325+00.000428
T07101  *ET0066   100010000000   IGNORE
T07102  *ET0067   100010000000   IGNORE
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T07103  *ET0068   1000100000000   IGNORE
T07104  *ET0069   1000100000000   IGNORE
T07105  *ET0070   1000100000000   IGNORE
T07201   ET0071   10006       36+00.004759-00.002119+00.003111
T07202   ET0072   10006       37+00.003925-00.001517+00.001167
T07301    E0073   10006       38+00.004239-00.001667+00.003497
T07302   ET0074   10006       39+00.005453-00.001933+00.001583
T07303   ET0075   10006       15 D .003194-00.000972+00.000972
T07401   ET0076   10006       15 D .003194-00.000972+00.000972
T07402   ET0077   10006       14 D .001667-00.000556+00.000556
T07403   ET0078   10006       40+00.000781-00.000158+00.000128
T07404   ET0079   10006       41+00.006597-00.002383+00.001611
T08101  *ET0080   1001100000000   IGNORE
T08102    A0081   30011     -250   AUTO
T08103   ET0082   10011       42+00.002431-00.000500+00.001319
T08104   ET0083   10011       43+00.012500-00.004167+00.004167
T08105   ET0084   10011       44+00.006111-00.002161+00.001483
T08107   ET0085   10011       45+00.000833-00.000278+00.000278
T08108   ET0086   10011       46+00.004281-00.001686+00.002261
T08109   ET0087   10011       47+00.001125-00.000100+00.001411
T08201   ET0089   10011       45 D .000833-00.000278+00.000278
T08202   ET0090   10011       48+00.002764-00.000875+00.001525
T08203   ET0091   10011       45 D .000833-00.000278+00.000278
T08204   ET0092   10011       49+00.000923-00.000150+00.000175
T08205   ET0093   10011       50+00.003508-00.001183+00.001656
T09101    A0094   30006    -1000   AUTO
T09201    T0095   10006       51+00.003103-00.001486+00.002036
T09202   *T0096   1000600000000   IGNORE
T09301    T0097   10006       52+00.020981-00.007183+00.006889
T09401    T0098   10006       53+00.032303-00.011239+00.013667
T09501   ET0099   10006       54+00.015664-00.006033+00.006825
T09505   ET0100   10006       55+00.003056-00.001125+00.002592
T09506   *T0101   1000600000000   IGNORE
T11101   ET0142   10009       45 D .000833-00.000278+00.000278
T11102   ET0143   10009       56+00.003092-00.001239+00.000889
T11201   ET0144   10009       37 D .003925-00.001517+00.001167
T11202   ET0145   10009       56 D .003092-00.001239+00.000889
T11203   ET0146   10009       14 D .001667-00.000556+00.000556
T11204   ET0147   10009       56 D .003092-00.001239+00.000889
T11301   ET0148   10009       14 D .001667-00.000556+00.000556
T11302   ET0149   10009       22 D .000417-00.000139+00.000139
T11303   ET0150   10009       14 D .001667-00.000556+00.000556
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T11401   ET0151   10009       22 D .000417-00.000139+00.000139
T11402   ET0152   10009       22 D .000417-00.000139+00.000139
T11403   ET0153   10009       45 D .000833-00.000278+00.000278
T11501   ET0154   10009       45 D .000833-00.000278+00.000278
T11502   ET0155   10009       57+00.000867-00.000128+00.000203
T11503   ET0156   10009       58+00.000731-00.000186+00.000081
T12101    S0102   20003       59+00.003550-00.001419+00.000986
T12102    S0103   20003       60+00.000694-00.000183+00.000278
T12103   *S0105   2000300000000   IGNORE
T12104    S0106   20003       61+00.004689-00.001708+00.002903
T12105    S0107   20003        4 D .004361-00.002767+00.001528
T12106   *S0108   2000300000000   IGNORE
T12107    S0109   20003       62+00.002361-00.000858+00.000761
T12201    S0110   20003       14 D .001667-00.000556+00.000556
T12202    S0111   20003       63+00.003831-00.001339+00.001958
T12204    S0112   20003       64+00.002042-00.000744+00.002311
T12205    S0113   20003       64 D .002042-00.000744+00.002311
T12206    S0114   20003       65+00.005000-00.008333+00.008333
T12207    S0115   20004       66+00.004647-00.002156+00.001619
T12301    E0116   10009       67+00.005256-00.002022+00.002292
T12302    E0117   10009        4 D .004361-00.002767+00.001528
T12303    E0118   10009       68+00.001200-00.000367+00.000272
T12304    E0199   10009       69+00.000861-00.000306+00.000528
T13100   ET0120   10007       70+00.012417-00.004767+00.008628
T13102   ET0121   10007       45 D .000833-00.000278+00.000278
T13104    T0122   10007       71+00.003575-00.000483+00.001467
T13105   ET0123   10007       72+00.006003-00.001578+00.002719
T13201   ET0124   10007       73+00.002394-00.000506+00.000703
T13202   ET0125   10007       74+00.001853-00.000367+00.001203
T13203   ET0126   10007       75+00.002803-00.000522+00.000628
T13301    A0127   30007      -20  AUTO
T13302    A0128   30007      -10  AUTO
T15101   ET0160   10003       76+00.005647-00.001850+00.001483
T15102   ET0161   10003       77+00.002033-00.000831+00.001350
T15201   ET0162   10003       78+00.003500-00.001361+00.003639
T15202   ET0163   10003       79+00.001986-00.000411+00.001397
T15203   ET0164   10003       80+00.001643-00.000440+00.010024
T15204   ET0165   10003       81+00.004353-00.001436+00.001572
T15205   ET0166   10003       82+00.001908-00.000553+00.000544
T15206   ET0167   10003       83+00.002106-00.000531+00.000239
T16101  EST0129   20009       45 D .000833-00.000278+00.000278
T16102  EST0130   20009       84+00.006722-00.003625+00.002289
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T16103  EST0131   20009        85+00.007014-00.002161+00.002009
T16201  EST0132   20009        86+00.002222-00.000647+00.000839
T16202  EST0133   20009        14 D .001667-00.000556+00.000556
T16203  EST0134   20009        37+00.004194-00.001603+00.001300
T16204  EST0135   20009        15 D .003194-00.000972+00.000972
T16205  EST0136   20009        14 D .001667-00.000556+00.000556
T16206  EST0137   20009        88+00.004339-00.001422+00.001000
T16207  EST0138   20009        89+00.001575-00.000300+00.001272
T16208  EST0139   20009        90+00.002828-00.000389+00.001292
T16209  EST0140   20009        91+00.001642-00.000439+00.010025
T16210  EST0141   20009        92+00.002533-00.000589+00.001553
T17100    S0157   20001        93+00.202050-00.022847+00.022344
T17200   ST0158   20001        94+00.202500-00.067500+00.067500
T17300  EST0159   20003        95+00.412650-00.137928+00.138428-
   95  NTMAN  NUMBER OF TASK TIMES  (SKIP NEXT CARD)  **********
TASKNO*POOL*LCC*RSP*PRI***ITIME     MEDIAN     LOW QT      HI QT
T01102    S0004   20001         1+00.003194-00.000606+00.000706
T01103    S0005   20001         2+00.002369-00.000646+00.002739
T01202    S0007   20001         3+00.002431-00.000747+00.002292
T01301    S0008   20001         4+00.004361-00.002767+00.001528
T01303    S0010   20001         5+00.002611-00.000800+00.000733
T02MAN    F0012   40002         6+00.042442-00.014122+00.021905
T03000    P0016   50001         7+00.164699-00.047046+00.099037
T04102    E0019   10001         8+00.004658-00.001750+00.003611
T04201    S0020   20001         9+00.005658-00.001472+00.002667
T04202    S0021   20001        10+00.005047-00.001333+00.007583
T04204    S0023   20001        11+00.008153-00.002781+00.004069
T04205    S0024   20001        12+00.006019-00.001944+00.003333
T04206    S0025   20001        13+00.009667-00.003600+00.004722
T04207    S0026   20001        14+00.001667-00.000556+00.000556
T04208    S0027   20001        15+00.003194-00.000972+00.000972
T04209    S0028   20001        16+00.003500-00.001361+00.003611
T04210    S0029   20001        17+00.001667-00.000555+00.000555
T04213    S0032   20001        18+00.004492-00.001528+00.002917
T04301    S0033   20001        19+00.019290-00.004896+00.015549
T04303    S0035   20001        20+00.006250-00.002083+00.002083
T04304    S0036   20001        21+00.050000-00.016667+00.016667
T05101   ET0042   10005        22+00.000417-00.000139+00.000139
T05102   ET0043   10005        23+00.007472-00.003128+00.006250
T05103    T0044   10005        24+00.005431-00.000322+00.000558
T05302   ET0046   10005        25+00.005175-00.001711+00.003611
T05203   ET0047   10005        26+00.004286-00.001494+00.002389
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T05204   ET0048   10005      27+00.008508-00.003044+00.002694
T05302   ET0050   10005      28+00.004236-00.001403+00.001486
T05303   ET0051   10005      29+00.002342-00.000592+00.000572
T061MN   ET0055   10010      30+00.000278-00.000139+00.000139
T06402    T0060   10010      31+00.000717-00.000094+00.000089
T06403    T0061   10010      32+00.002975-00.001056+00.000700
T06405   ET0063   10010      33+00.001047-00.000047+00.000003
T06406   ET0064   10010      34+00.002278-00.000322+00.000514
T06407   ET0065   10010      35+00.002608-00.000325+00.000428
T07201   ET0071   10006      36+00.004758-00.002119+00.003111
T07202   ET0072   10006      37+00.003925-00.001517+00.001167
T07301    E0073   10006      38+00.004239-00.001667+00.003497
T07302   ET0074   10006      39+00.005453-00.001933+00.001583
T07403   ET0078   10006      40+00.000781-00.000158+00.000128
T07404   ET0079   10006      41+00.006597-00.002383+00.001611
T08103   ET0082   10011      42+00.002431-00.000500+00.001319
T08104   ET0083   10011      43+00.012500-00.004167+00.004167
T08105   ET0084   10011      44+00.006111-00.002161+00.001483
T08107   ET0085   10011      45+00.000833-00.000278+00.000278
T08108   ET0086   10011      46+00.004281-00.001686+00.002261
T08109   ET0087   10011      47+00.001125-00.000100+00.001411
T08202   ET0090   10011      48+00.002764-00.000875+00.001525
T08204   ET0092   10011      49+00.000928-00.000150+00.000175
T08205   ET0093   10011      50+00.003508-00.001183+00.001656
T09201    T0095   10006      51+00.003103-00.001486+00.002036
T09301    T0097   10006      52+00.020981-00.007183+00.006889
T09401    T0098   10006      53+00.032908-00.011239+00.013667
T09501   ET0099   10006      54+00.015664-00.006033+00.006825
T09505   ET0100   10006      55+00.003056-00.001125+00.002592
T11102   ET0143   10009      56+00.003092-00.001239+00.000889
T11502   ET0155   10009      57+00.000867-00.000128+00.000203
T11503   ET0156   10009      58+00.000731-00.000186+00.000081
T12101    S0102   20003      59+00.003550-00.001419+00.000986
T12102    S0103   20003      60+00.000694-00.000183+00.000278
T12104    S0106   20003      61+00.004689-00.001708+00.002903
T12107    S0109   20003      62+00.002361-00.000858+00.000761
T12202    S0111   20003      63+00.003831-00.001339+00.001958
T12204    S0112   20003      64+00.002042-00.000744+00.002311
T12206    S0114   20003      65+00.005000-00.008333+00.008333
T12207    S0115   20004      66+00.004647-00.002156+00.001619
T12301    E0116   10009      67+00.005256-00.002022+00.002292
T12303    E0118   10009      68+00.001200-00.000367+00.000272
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T12304    E0199   10009     69+00.000861-00.000306+00.000528
T13100   ET0120   10007     70+00.012417-00.004767+00.008628
T13104    T0122   10007     71+00.003575-00.000483+00.001467
T13105   ET0123   10007     72+00.006003-00.001578+00.002719
T13201   ET0124   10007     73+00.002394-00.000506+00.000703
T13202   ET0125   10007     74+00.001853-00.000367+00.001203
T13203   ET0126   10007     75+00.002803-00.000522+00.000628
T15101   ET0160   10003     76+00.005647-00.001850+00.001483
T15102   ET0161   10003     77+00.002033-00.000831+00.001350
T15201   ET0162   10003     78+00.003500-00.001361+00.003639
T15202   ET0163   10003     79+00.001986-00.000411+00.001397
T15203   ET0164   10003     80+00.001643-00.000440+00.010024
T15204   ET0165   10003     81+00.004353-00.001436+00.001572
T15205   ET0166   10003     82+00.001908-00.000553+00.000544
T15206   ET0167   10003     83+00.002106-00.000531+00.000239
T16102  EST0130   20009     84+00.006722-00.003625+00.002289
T16103  EST0131   20009     85+00.007014-00.002161+00.002008
T16201  EST0132   20009     86+00.002222-00.000647+00.000839
T16203  EST0134   20009     87+00.004194-00.001603+00.001300
T16206  EST0137   20009     88+00.004339-00.001422+00.001000
T16207  EST0138   20009     89+00.001575-00.000300+00.001272
T16208  EST0139   20009     90+00.002828-00.000339+00.001292
T16209  EST0140   20009     91+00.001642-00.000439+00.010025
T16210  EST0141   20009     92+00.002533-00.000589+00.001553
T17100    S0157   20001     93+00.202050-00.022847+00.022344
T17200   ST0158   20001     94+00.202500-00.067500+00.067500
T17300  EST0159   20003     95+00.412650-00.137928+00.138428
    6                  777  NRSPNC AND MRSPNC  (I5,020) **************
TASKNO LCC PTR****MEDIAN****LOW*QT*****HI*QT
T05302  50    1+00.002778-00.000556+00.000556
T07402  77    2+00.001667-00.000556+00.000556
T08200  88    3+00.000556-00.000278+00.000278
T11502 155    4+00.000833-00.000278+00.000278
T12303 118    5+00.001389-00.000278+00.000278
T16102 130    5 0 .001389-00.000278+00.000278
    5  NRSPNT  NUMBER OF RESPONSE TIMES (SKIP NEXT CARD) *********
TASKNO*LCC*PTR     MEDIAN     LOW QT      HI QT
T05302  50    1+00.002778-00.000556+00.000556
T07402  77    2+00.001667-00.000556+00.000556
T08200  88    3+00.000556-00.000278+00.000278
T11502 155    4+00.000833-00.000278+00.000278
T12303 118    5+00.001389-00.000278+00.000278
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    6      NO. OF A/C TYPES
ACO1  1  5   1.5      6000.      500.       1   6000.  45000.
  33.       .167      .75       1.16667   1.5       .033
ACO2  2  5   1.5      6000.      500.       1   6000.  45000.
  33.       .167      .75       .96667    1.5       .033
ACO3  3  5   1.5      6000.      500.       1   6000.  40000.
  33.       .167      .75       .81667    1.5       .033
ACO4  4  3   1.5      6000.      500.       0   6000.  28000.
  25.       .25       .75       .8000     1.5       .05
ACO5  5  1   3.0      4000.      400.       0   6000.  19000.
  15.       .25       .5        .8500     1.5       .05
ACO6  6  2   1.5      6000.      500.       0   2000.  19000.
  8.3       .25       .5        1.100     1.5       .05
         5         5                   NO. OF JURIS., NO. OF RES. POOLS
SFO           -1    50000.      .000   JURIS. ID, CAPAC., CEIL ^ FL ALT
        12   0.0          TERMINAL DATA DISK FILE AND PROB MSDAP
         3          3 MAN    T/E       RESOURCE POOLS:
         1          3 MAN    S
        12         50 AUT    A
         1          1 MAN    F
         1          5 MAN    P
AR-5         50     50000.      .000   JURIS. ID, CAPAC., CEIL ^ FL ALT
         3          3 MAN    T/E       RESOURCE POOLS:
         1          3 MAN    S
        12         50 AUT    A
         1          1 MAN    F
         1          5 MAN    P
AR-3         50     50000.      .000   JURIS. ID, CAPAC., CEIL ^ FL ALT
         3          3 MAN    T/E       RESOURCE POOLS:
         1          3 MAN    S
        12         50 AUT    A
         1          1 MAN    F
         1          5 MAN    P
ER-S         50     50000.      .000   JURIS. ID, CAPAC., CEIL ^ FL ALT
         3          3 MAN    T/E       RESOURCE POOLS:
         1          3 MAN    S
        12         50 AUT    A
         1          1 MAN    F
         1          5 MAN    P
ER-N         50     50000.      .000   JURIS. ID, CAPAC., CEIL ^ FL ALT
         3          3 MAN    T/E       RESOURCE POOLS:
         1          3 MAN    S
```

```
         12          50 AUT     A
          1           1 MAN     F
          1           5 MAN     P
SFO    4     AIRPORT                    JURIS. ID, NO. OF FLOOR VERT.
            631.7      458.0  1         X^Y COORD., NO. ADJ. JURIS.
                           ER-N         ADJACENT JURISDICTION
            640.5      452.2  1
                           AR-5
            639.9      451.4  1
                           AR-5
            631.1      457.2  1
                           ER-N
       0                                NO. OF JURIS. ADJ. TO CEIL.
       0                                NO. OF JURIS. ADJ. TO FLOOR
AR-5   7     MENLO FINAL
            631.1      457.2  1
                           ER-N
            627.0      448.0  1
                           AR-3
            627.0      441.9  1
                           AR-3
            650.0      432.0  1
                           ER-S
            648.0      448.1  2
                           ER-S
                           ER-N
            640.5      452.2  1
                           SFO
            639.9      451.4  1
                           SFO
       0
       0
AR-3   7     SOUTH FEEDER
            606.0      474.9  2
                           ER-N
                           ER-S
            597.9      438.5  1
                           ER-S
            657.0      408.0  1
                           ER-S
            650.0      432.0  1
                           AR-5
```

```
         627.0      441.9   1
                          AR-5
         627.0      448.0   1
                          ER-N
         620.0      464.8   1
                          ER-N
     0
     0
ER-N 12    ENROUTE NORTH
         500.0      550.0   0
         500.0      450.0   1
                          ER-S
         600.5      450.0   1
                          AR-3
         606.0      474.9   1
                          AR-3
         620.0      464.8   1
                          AR-3
         627.0      448.0   1
                          AR-5
         631.1      457.2   1
                          SFO
         631.7      458.0   1
                          SFO
         640.5      452.2   1
                          AR-5
         644.5      450.0   1
                          ER-S
         760.0      450.0   0
         760.0      550.0   0
     0
     0
ER-S 10    ENROUTE SOUTH
         500.0      450.0   0
         500.0      300.0   0
         760.0      300.0   0
         760.0      450.0   1
                          ER-N
         644.5      450.0   1
                          AR-5
         648.0      448.1   1
                          AR-5
```

```
          650.0      432.0  1
                            AR-3
          657.0      408.0  1
                            AR-3
          597.9      438.5  1
                            AR-3
          600.5      450.0  1
                            ER-N
     0
     0
016 0.000001         SRI FLIGHT-1         FF5   RWY1
N504  1 AC05   1  4           2. ER-S     0.0     1 1 SFO   XYZ   1 003
708.0     403.8      8000.     -160.      0.0         0.0         0000
708.0       403.8      8000.      160.
668.8       400.2      8000.      160.
657.6       409.8      8000.      -0501.
016 .22              SRI FLIGHT-3         FF4   RWY1
PA87  1 AC02   1  4           2. ER-S     0.0     1 1 SFO   XYZ   1 003
516.0     380.4      31000.    338.       338.        0.0         0000
516.0       380.4      31000.     478.
539.0       396.0      31000.     406.5
586.8       428.5      12000.     -0401.
016 .29              SRI FLIGHT-4         FF1   RWY1
UA78  1 AC03   1  4           2. ER-S     0.0     1 1 SFO   XYZ   1 005
728.5     359.6      24000.    -496.      0.0         0.0         0000
728.5       359.6      24000.     496.
669.0       367.8      24000.     496.
667.2       371.6      23000.     496.
655.6       387.8      17800.     496.
654.2       394.6      16000.     -0101.
016 .44              SRI FLIGHT-5         FF1   RWY1
PS67  1 AC03   1  4           2. ER-S     0.0     1 1 SFO   XYZ   1 005
728.5     359.6      24000.    -496.      0.0         0.0         0000
728.5       359.6      24000.     496.
669.0       367.8      24000.     496.
667.2       371.6      23000.     496.
655.6       387.8      17800.     496.
654.2       394.6      16000.     -0101.
016 0.47             SRI FLIGHT-2         DEPARTURE
N310  1 AC05   1  4           3. AR-5     0.0     1 1 FAT   XYZ   1 003
634.0     450.0      4000.     150.0      0.0         0.0         0100
634.0       450.0      4000.      160.
```

```
646.5      445.0      5500.      160.
670.0      430.0      7500.      0.0
016 .53             SRI FLIGHT-8        FF6  RWY1
SWT1  1 AC06   1  4         2. ER-S     0.0    1 1 SFO  XYZ  1 002
692.0     440.0     2400.     -150.     0.0       0.0       0100
692.0      440.0      2400.      150.
653.8      441.2      2400.      -0601.
016 .66             SRI FLIGHT-11       FF7  RWY1
N458  1 AC05   1  4         2. ER-S     0.0    1 1 SFO  XYZ  1 002
691.8     426.0     4000.     -160.     0.0       0.0       0100
691.8      426.0      4000.      160.
652.0      439.0      4000.      -0701.
016 .67             SRI FLIGHT-6        DEPARTURE
N175  1 AC04   1  4         3. AR-3     0.0    1 1 MRY  XYZ  1 003
632.0     438.0     5000.     0.0       -200.     0.0       0100
632.0      438.0      5000.      200.
634.0      428.0      9000.      235.
636.0      418.0      9500.      0.0
016 .72             SRI FLIGHT-7        DEPARTURE
R372  1 AC04   1  4         2. AR-5     0.0    1 1 NUQ  XYZ  1 002
633.2     450.0     3500.     235.      0.0       0.0       0100
633.2      450.0      3500.      235.
647.0      444.0      3500.      0.0
016 .75             SRI FLIGHT-10       FF2  RWY1
CIOO  1 AC02   1  4         2. ER-N     0.0    1 1 SFO  XYZ  1 004
660.6     507.0     30000.    -478.     0.0       0.0       0000
660.6      507.0      30000.     478.
641.8      508.4      30000.     406.5
611.8      510.8      20500.     406.5
608.8      484.5      15500.     -0201.
016 .79             SRI FLIGHT-12       FF1  RWY1
UA28  1 AC02   1  4         2. ER-S     0.0    1 1 SFO  XYZ  1 005
728.5     359.6     24000.    -478.     0.0       0.0       0000
728.5      359.6      24000.     478.
669.0      367.8      24000.     478.
667.2      371.6      23000.     478.
655.6      387.8      17800.     478.
654.2      394.6      16000.     -0101.
016 .87             SRI FLIGHT-15       FF1  RWY1
WA72  1 AC03   1  4         2. ER-S     0.0    1 1 SFO  XYZ  1 005
728.5     359.6     24000.    -496.0    0.0       0.0       0000
728.5      359.6      24000.0    436.
```

```
669.0       367.8       24000.0     496.
667.2       371.6       23000.0     496.
655.2       387.8       17800.0     496.
654.2       394.6       16000.0     -0101.
016 .91                SRI FLIGHT-16        FF1  RWY1
UA51  1 AC03   1  4           2. ER-S       0.0     1 1 SFO   XYZ  1 005
728.5      359.6      24000.    -496.       0.0        0.0        0000
728.5       359.6       24000.      496.
669.0       367.8       24000.      496.
667.2       371.6       23000.      496.
655.6       387.8       17800.      496.
654.2       394.6       16000.     -0101.
016 .95                SRI FLIGHT-17        FF1  RWY1
PS99  1 AC03   1  4           2. ER-S       0.0     1 1 SFO   XYZ  1 005
728.5      359.6      24000.    -496.       0.0        0.0        0000
728.5       359.6       24000.      496.
669.0       367.8       24000.      496.
667.2       371.6       23000.      496.
655.6       387.8       17800.      496.
654.2       394.6       16000.     -0101.
016 .96                SRI FLIGHT-19        FF1  RWY1
AA81  1 AC02   1  4           2. ER-S       0.0     1 1 SFO   XYZ  1 005
728.5      359.6      24000.    -478.       0.0        0.0        0000
728.5       359.6       24000.      478.
669.0       367.8       24000.      478.
667.2       371.6       23000.      478.
655.6       387.8       17800.      478.
654.2       394.6       16000.     -0101.
016 .97                SRI FLIGHT-9         DEPARTURE
S842  1 AC05   1  4           3. AR-5       0.0     1 1 ER-N XYZ  1 002
639.0      451.0      3800.     160.0       0.0        0.0        0100
639.0       451.0       3800.       160.
659.0       456.0       4500.       0.0
016 .99                SRI FLIGHT-20        FF8 RWY1
N524  1 AC06   1  4           2. ER-S       0.0     1 1 SFO   XYZ  1 002
647.0      373.0      8000.     185.0       0.0        0.0        0100
647.0       373.0       8000.       185.
645.0       420.0       6000.      -0801.
016 .99                SRI FLIGHT-18        FF1  RWY1
PA84  1 AC01   1  4           2. ER-S       0.0     1 1 SFO   XYZ  1 005
728.5      359.6      24000.    -523.       0.0        0.0        0000
728.5       359.6       24000.      523.
```

```
669.0      367.8      24000.     523.
667.2      371.5      23000.     523.
655.6      387.8      17800.     523.
654.2      394.6      16000.     -0101.
016 1.05            SRI FLIGHT-22       FF7  RWY1
C721  1 AC05   1  4         2. ER-S     0.0    1 1 SFO  XYZ  1 002
691.8     426.0     4000.     -160.     0.0       0.0       0100
691.8      426.0      4000.      160.
652.0      439.0      4000.      -0701.
016 1.08            SRI FLIGHT-13       DEPARTURE
N365  1 AC05   1  4         2. AR-5     0.0    1 1 ER-N XYZ  1 003
642.8     437.2     4000.     -110.0    110.0     0.0       0100
642.8      437.2      4000.      160.
641.0      439.0      4000.      160.
646.0      460.0      4000.      0.0
016 1.10            SRI FLIGHT-14       DEPARTURE
R373  1 AC05   1  4         2. AR-5     0.0    1 1 ER-N XYZ  1 002
641.5     448.2     2700.     -100.     0.0       0.0       0100
641.5      448.2      2700.      100.
630.0      455.0      3000.      0.0
016 1.14            SRI FLIGHT-21       FF2  RWY1
HA61  1 AC03   1  4         2. ER-N     0.0    1 1 SFO  XYZ  1 004
575.0     545.0     25000.    0.0       -489.     0.0       0000
575.0      545.0      25000.     489.
602.8      523.8      25000.     412.
604.0      521.8      24000.     412.
608.8      484.5      15500.     -0201.
016 1.47            SRI FLIGHT-23       DEPARTURE
N300  1 AC03   1  4         2. AR-5     0.0    1 1 ER-N XYZ  1 002
643.0     438.0     3000.     0.0       250.      0.0       0100
643.0      438.0      3000.      250.
642.0      457.0      5500.      0.0
180  2.0              STOP
  SAN FRANCISCO RAW DATA - SRI INPUTS AS OF 29 NOV 73
```

6.4 DELTA SUMMARY REPORT

This section contains the summary report generated by the DELTA simulation for the SFORAW case. It shows the utilization of dynamic memory and the utilization statistics for the resources in each jurisdiction.

```
              RUN SUMMARY
      SAN FRANCISCO RAW DATA - SRI INPUTS AS OF 29 NOV 73
          RUN TERMINATES AT     2.0000000000
      RUN USED   3425 OF  10000 WORDS OF DYNAMIC MEMORY.
```

```
                JURISDICTION: ER-N

        CONTAINED    0 OF      50 AIRCRAFT

                     AIRCRAFT DATA
 NO  A/C TYPE P ENDURANCE UPDATE TIME     STATE VECTOR


                     RESOURCE DATA

MAN  RESOURCE POOL  1 USING     3 OF      3 MEN       0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST        NEXT      BUSY TIME  BUSY TIME
       707     0.00000000  1.16199846  1.16199846   58.099923
       700     0.00000000  1.16106809  1.16106809   58.053404
       693     0.00000000  1.17086348  1.17086348   58.543174

MAN  RESOURCE POOL  2 USING     1 OF      3 MEN       0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST        NEXT      BUSY TIME  BUSY TIME
       723     0.00000000  1.34108143  1.34108143   67.054072

AUTO RESOURCE POOL  3 USING    12 OF     50 HI/S      0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST        NEXT      BUSY TIME  BUSY TIME
       739     0.00000000   .27129630   .27129630   13.564815

MAN  RESOURCE POOL  4 USING     1 OF      1 MEN       0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST        NEXT      BUSY TIME  BUSY TIME
       755     0.00000000  0.00000000  0.00000000    0.000000

MAN  RESOURCE POOL  5 USING     1 OF      5 MEN       0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST        NEXT      BUSY TIME  BUSY TIME
       771     0.00000000  0.00000000  0.00000000    0.000000
```

```
                 JURISDICTION: ER-S

         CONTAINED   0 OF      50 AIRCRAFT

                       AIRCRAFT DATA
 NO   A/C TYPE P ENDURANCE UPDATE TIME      STATE VECTOR


                       RESOURCE DATA

MAN  RESOURCE POOL  1 USING      3 OF      3 MEN        0 TASKS LEFT
                  AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT        FIRST       NEXT      BUSY TIME  BUSY TIME
       596      0.00000000  1.63066298  1.63066298   81.533149
       589      0.00000000  1.64562269  1.64562269   82.281134
       582      0.00000000  1.64271325  1.64271325   82.135662

MAN  RESOURCE POOL  2 USING      3 OF      3 MEN        0 TASKS LEFT
                  AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT        FIRST       NEXT      BUSY TIME  BUSY TIME
      2426       .68425471   .74629607   .06204136    4.715301
      2419       .68425471   .73988134   .05562663    4.227766
       612      0.00000000   .95179985   .95179985   47.589993

AUTO RESOURCE POOL  3 USING     12 OF     50 HI/S       0 TASKS LEFT
                  AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT        FIRST       NEXT      BUSY TIME  BUSY TIME
       628      0.00000000   .90648148   .90648148   45.324074

MAN  RESOURCE POOL  4 USING      1 OF      1 MEN        0 TASKS LEFT
                  AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT        FIRST       NEXT      BUSY TIME  BUSY TIME
       644      0.00000000  0.00000000  0.00000000    0.000000

MAN  RESOURCE POOL  5 USING      2 OF      5 MEN        0 TASKS LEFT
                  AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT        FIRST       NEXT      BUSY TIME  BUSY TIME
      2266       .66000000  1.12238699   .46238699   34.506491
       660      0.00000000   .48325901   .48325901   24.162950
```

```
            JURISDICTION: AR-3

        CONTAINED    0 OF      50 AIRCRAFT

                   AIRCRAFT DATA
 NO   A/C TYPE P ENDURANCE UPDATE TIME     STATE VECTOR


                   RESOURCE DATA


MAN  RESOURCE POOL  1 USING     3 OF      3 MEN       0 TASKS LEFT
                 AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
       485     0.00000000  1.40791127  1.40791127   70.395564
       478     0.00000000  1.40086918  1.40086918   70.043459
       471     0.00000000  1.41652232  1.41652232   70.826116

MAN  RESOURCE POOL  2 USING     3 OF      3 MEN       0 TASKS LEFT
                 AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
      3404     1.31900430  1.34625246   .02724816    4.001224
      3397     1.31900430  1.34672832   .02772402    4.071101
       501     0.00000000  1.38379863  1.38379863   69.189932

AUTO RESOURCE POOL  3 USING    12 OF     50 HI/S      0 TASKS LEFT
                 AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
       517     0.00000000   .52222222   .52222222   26.111111

MAN  RESOURCE POOL  4 USING     1 OF      1 MEN       0 TASKS LEFT
                 AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
       533     0.00000000  0.00000000  0.00000000    0.000000

MAN  RESOURCE POOL  5 USING     1 OF      5 MEN       0 TASKS LEFT
                 AVAILABILITY TIMES     CUMULATIVE  PERCENTAGE
     ELEMENT       FIRST        NEXT      BUSY TIME  BUSY TIME
       549     0.00000000   .13850132   .13850132    6.925066
```

```
                JURISDICTION: AR-5

          CONTAINED   0 OF ,    50 AIRCRAFT

                    AIRCRAFT DATA
 NO  A/C TYPE P ENDURANCE UPDATE TIME     STATE VECTOR


                    RESOURCE DATA

MAN  RESOURCE POOL  1 USING     3 OF     3 MEN      0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT     FIRST       NEXT     BUSY TIME  BUSY TIME
       374    0.00000000  1.49241302  1.49241302   74.620651
       367    0.00000000  1.48863734  1.48863734   74.431867
       360    0.00000000  1.50199027  1.50199027   75.099513

MAN  RESOURCE POOL  2 USING     3 OF     3 MEN      0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT     FIRST       NEXT     BUSY TIME  BUSY TIME
      3418    1.43522125  1.44078112   .00555988     .984434
      3411    1.42824069  1.43967882   .01143813    2.000514
       390    0.00000000   .73869226   .73869226   36.934613

AUTO RESOURCE POOL  3 USING    12 OF    50 HI/S     0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT     FIRST       NEXT     BUSY TIME  BUSY TIME
       406    0.00000000   .61736111   .61736111   30.868056

MAN  RESOURCE POOL  4 USING     1 OF     1 MEN      0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT     FIRST       NEXT     BUSY TIME  BUSY TIME
       422    0.00000000  0.00000000  0.00000000    0.000000

MAN  RESOURCE POOL  5 USING     3 OF     5 MEN      0 TASKS LEFT
               AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT     FIRST       NEXT     BUSY TIME  BUSY TIME
      3148    1.10000000  1.32456189   .22456189   24.951321
      3103    1.08000000  1.27049588   .19049588   20.706074
       433    0.00000000   .86355562   .86355562   43.177781
```

```
        TERMINAL JURISDICTION: SFO

             CONTAINED    0 AIRCRAFT
          0 AIRCRAFT WERE AWAITING SEQUENCING
         -0 AIRCRAFT WERE BEING SEQUENCED

                  AIRCRAFT DATA
 NO  A/C TYPE P ENDURANCE UPDATE TIME     STATE VECTOR


                  RESOURCE DATA

MAN  RESOURCE POOL  1 USING     3 OF      3 MEN      0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST       NEXT      BUSY TIME  BUSY TIME
       263     0.00000000  1.32335061  1.32335061   66.167530
       256     0.00000000  1.33847348  1.33847348   66.923674
       249     0.00000000  1.32670888  1.32670888   66.335444

MAN  RESOURCE POOL  2 USING     1 OF      3 MEN      0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST       NEXT      BUSY TIME  BUSY TIME
       279     0.00000000   .79552204   .79552204   39.776102

AUTO RESOURCE POOL  3 USING    12 OF     50 HI/S     0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST       NEXT      BUSY TIME  BUSY TIME
       295     0.00000000   .64895833   .64895833   32.447917

MAN  RESOURCE POOL  4 USING     1 OF      1 MEN      0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST       NEXT      BUSY TIME  BUSY TIME
       311     0.00000000  0.00000000  0.00000000    0.000000

MAN  RESOURCE POOL  5 USING     1 OF      5 MEN      0 TASKS LEFT
                 AVAILABILITY TIMES    CUMULATIVE  PERCENTAGE
     ELEMENT      FIRST       NEXT      BUSY TIME  BUSY TIME
       327     0.00000000  0.00000000  0.00000000    0.000000
```

**********END DELTA**********

6.5 DELTA POST PROCESSOR REPORT

This section shows the DELTA Post Processor Report which was generated for the SFORAW case. It contains a count of task occurrence by jurisdiction and by aircraft and a list of model events for each aircraft.

```
                 JURISDICTION LIST

TASK JURISDICTION COUNT

   16    AR-3           1
   16    AR-5           6
   16    ER-S           5

TOTAL COUNT FOR TASK   16 IS    12.

   18    AR-3           1
   18    ER-S           4

TOTAL COUNT FOR TASK   18 IS     5.

   19    AR-3           1
   19    ER-S           4

TOTAL COUNT FOR TASK   19 IS     5.

   20    AR-3           1
   20    ER-S           4

TOTAL COUNT FOR TASK   20 IS     5.

   21    AR-3           1
   21    ER-S           4

TOTAL COUNT FOR TASK   21 IS     5.

   22    NULL           2

TOTAL COUNT FOR TASK   22 IS     2.

   23    AR-3           1
   23    ER-S           4
```

```
TOTAL COUNT FOR TASK   23 IS      5.

   24    AR-3            1
   24    ER-S            4
TOTAL COUNT FOR TASK   24 IS      5.

   25    AR-3            1
   25    AR-5            1
TOTAL COUNT FOR TASK   25 IS      2.

   26    AR-3            1
   26    ER-S            4
TOTAL COUNT FOR TASK   26 IS      5.

   27    AR-3            1
   27    AR-5            1
TOTAL COUNT FOR TASK   27 IS      2.

   28    AR-3            1
   28    ER-S            4
TOTAL COUNT FOR TASK   28 IS      5.

   29    AR-3            1
   29    AR-5            1
TOTAL COUNT FOR TASK   29 IS      2.

   30    NULL            2
```

```
TOTAL COUNT FOR TASK   30 IS      2.

   31    AR-3            1
   31    AR-5            1

TOTAL COUNT FOR TASK   31 IS      2.

   32    AR-3            1
   32    AR-5            1

TOTAL COUNT FOR TASK   32 IS      2.

   37    NULL            2

TOTAL COUNT FOR TASK   37 IS      2.

   39    AR-3            1
   39    AR-5            1

TOTAL COUNT FOR TASK   39 IS      2.

   40    AR-3            1
   40    AR-5            1

TOTAL COUNT FOR TASK   40 IS      2.

   42    AR-3            1
   42    AR-5            1

TOTAL COUNT FOR TASK   42 IS      2.

   43    AR-3            1
   43    AR-5            2
   43    ER-N            2
   43    SFO             1
```

```
TOTAL COJNT FOR TASK   43 IS      6.

   45    AR-3           1

TOTAL COUNT FOR TASK   45 IS      1.

   46    AR-3           1
   46    AR-5           1

TOTAL COUNT FOR TASK   46 IS      2.

   47    AR-3           2
   47    AR-5           7
   47    ER-S           4

TOTAL COUNT FOR TASK   47 IS     13.

   48    AR-3          13
   48    AR-5          16
   48    ER-N           3
   48    ER-S           1
   48    SFO           16

TOTAL COUNT FOR TASK   48 IS     49.

   49    AR-3          12
   49    AR-5           8
   49    ER-N           3
   49    SFO            7

TOTAL COUNT FOR TASK   49 IS     30.

   50    AR-3           9
   50    AR-5           4
   50    ER-N           3
```

```
   50    SFO            5

TOTAL COUNT FOR TASK   50 IS    21.

   51    AR-3           5
   51    AR-5           4
   51    ER-N           2
   51    SFO            5

TOTAL COUNT FOR TASK   51 IS    16.

   54    AR-3         107
   54    AR-5         130
   54    ER-N          69
   54    ER-S         162
   54    SFO           82

TOTAL COUNT FOR TASK   54 IS   550.

   55    AR-3         109
   55    AR-5         129
   55    ER-N          69
   55    ER-S         162
   55    SFO           85

TOTAL COUNT FOR TASK   55 IS   554.

   56    NULL          11

TOTAL COUNT FOR TASK   56 IS    11.

   57    NULL           2

TOTAL COUNT FOR TASK   57 IS     2.

   59    NULL          64
```

```
TOTAL COUNT FOR TASK   59 IS    64.

   67    NULL          13
TOTAL COUNT FOR TASK   67 IS    13.

   68    NULL          13
TOTAL COUNT FOR TASK   69 IS    13.

   69    NULL          13
TOTAL COUNT FOR TASK   69 IS    13.

   71    AR-3          13
   71    AR-5          18
   71    ER-N          11
   71    ER-S          25
   71    SFO           21
TOTAL COUNT FOR TASK   71 IS    88.

   72    AR-3          12
   72    AR-5          10
   72    ER-N          11
   72    ER-S          21
   72    SFO            8
TOTAL COUNT FOR TASK   72 IS    62.

   73    AR-3           2
   73    AR-5           1
   73    ER-N           2
   73    ER-S          16
   73    SFO            5
```

```
TOTAL COUNT FOR TASK   73 IS    26.


   74    AR-3           4
   74    AR-5           9
   74    ER-N           2
   74    ER-S           1
   74    SFO            3

TOTAL COUNT FOR TASK   74 IS    19.


   75    AR-3           4
   75    AR-5           9
   75    ER-N           2
   75    ER-S           1
   75    SFO            3

TOTAL COUNT FOR TASK   75 IS    19.


   76    AR-3          18
   76    AR-5          18
   76    ER-N          15
   76    ER-S          22
   76    SFO            7

TOTAL COUNT FOR TASK   76 IS    80.


   81    AR-3         182
   81    AR-5         171
   81    ER-N         209
   81    ER-S         140
   81    SFO          178

TOTAL COUNT FOR TASK   81 IS   880.


   82    AR-3         171
   82    AR-5         169
```

```
   82    ER-N           178
   82    ER-S           165
   82    SFO            175

TOTAL COUNT FOR TASK   82 IS   858.

   83    AR-3           170
   83    AR-5           168
   83    ER-N           177
   83    ER-S           164
   83    SFO            173

TOTAL COUNT FOR TASK   83 IS   852.

   94    SFO             14

TOTAL COUNT FOR TASK   94 IS    14.

   96    NULL             3

TOTAL COUNT FOR TASK   96 IS     3.

   97    SFO              1

TOTAL COUNT FOR TASK   97 IS     1.

   98    SFO              1

TOTAL COUNT FOR TASK   98 IS     1.

  100    AR-5             1

TOTAL COUNT FOR TASK  100 IS     1.

  120    AR-3            67
```

```
   120    AR-5          76
   120    ER-N          36
   120    ER-S         133
   120    SFO           46

TOTAL COUNT FOR TASK  120 IS   358.

   121    AR-3          14
   121    AR-5          21
   121    ER-N           2
   121    ER-S          14

TOTAL COUNT FOR TASK  121 IS    51.

   123    AR-3          13
   123    AR-5          16
   123    ER-N           4
   123    ER-S           2
   123    SFO           15

TOTAL COUNT FOR TASK  123 IS    50.

   124    AR-3          18
   124    AR-5           8
   124    ER-N           2
   124    ER-S           7
   124    SFO           14

TOTAL COUNT FOR TASK  124 IS    49.

   125    AR-3          18
   125    AR-5           8
   125    ER-N           2
   125    ER-S           7
   125    SFO           13

TOTAL COUNT FOR TASK  125 IS    48.
```

```
  126    AR-3          18
  126    AR-5           8
  126    ER-N           2
  126    ER-S           7
  126    SFO           13

TOTAL COUNT FOR TASK  126 IS    48.

  127    AR-3          13
  127    AR-5          16
  127    ER-N           3
  127    ER-S           1
  127    SFO           16

TOTAL COUNT FOR TASK  127 IS    49.

  128    AR-3          13
  128    AR-5          16
  128    ER-N           3
  128    ER-S           1
  128    SFO           16

TOTAL COUNT FOR TASK  128 IS    43.

  142    AR-5           1

TOTAL COUNT FOR TASK  142 IS     1.

  143    AR-5           1

TOTAL COUNT FOR TASK  143 IS     1.

  144    AR-5           1

TOTAL COUNT FOR TASK  144 IS     1.
```

```
  145    AR-5              1

TOTAL COUNT FOR TASK  145 IS      1.

  147    AR-5              1

TOTAL COUNT FOR TASK  147 IS      1.

  149    AR-5              1

TOTAL COUNT FOR TASK  149 IS      1.

  153    AR-5              1

TOTAL COUNT FOR TASK  153 IS      1.

  159    AR-3              2
  159    AR-5              2
  159    ER-N              2
  159    ER-S              2
  159    SFO               2

TOTAL COUNT FOR TASK  159 IS     10.
```

```
                   AIRCRAFT LIST

 AIRCRAFT TASK COUNT

    AA81      48      2
    AA81      49      2
    AA81      59      4
    AA81      71      3
    AA81      72      2
    AA81      73      1
    AA81      74      1
    AA81      75      1
    AA81      76      2
    AA81     121      3
    AA81     123      3
    AA81     124      3
    AA81     125      2
    AA81     126      2
    AA81     127      3
    AA81     128      3
                        AIRCRAFT AA81 ENTERED AT     .9600000000 IN ER-S.
                        AIRCRAFT AA81 HANDED OFF AT    1.2179412200 TO AR-3.
                        AIRCRAFT AA81 HANDED OFF AT    1.3135815393 TO AR-5.
                        AIRCRAFT AA81 HANDED OFF AT    1.3993333281 TO SFO .
                        AIRCRAFT AA81 CHANGED PHASE AT      .9600000000 TO ARRIVAL TRANSITION.
                        AIRCRAFT AA81 CHANGED PHASE AT    1.1507165946 TO APPROACH.
                        AIRCRAFT AA81 CHANGED PHASE AT    1.4309496272 TO LANDING.
                        AIRCRAFT AA81 CANCELLED AT    1.4470607939 IN SFO .
    CI00      48      3
    CI00      49      1
    CI00      50      1
    CI00      51      1
    CI00      59      4
    CI00      71      9
    CI00      72      7
    CI00      73      3
    CI00      74      2
    CI00      75      2
    CI00      76     10
    CI00     121      3
    CI00     123      3
    CI00     124      3
```

```
  CI00    125    3
  CI00    126    3
  CI00    127    3
  CI00    128    3
                    AIRCRAFT CI00 ENTERED AT    .7500000000 IN ER-N.
                    AIRCRAFT CI00 HANDED OFF AT     .9823114156 TO AR-3.
                    AIRCRAFT CI00 HANDED OFF AT    1.1622133521 TO AR-5.
                    AIRCRAFT CI00 HANDED OFF AT    1.2369514531 TO SFO .
                    AIRCRAFT CI00 CHANGED PHASE AT     .7500000000 TO ARRIVAL TRANSITION.
                    AIRCRAFT CI00 CHANGED PHASE AT     .9287254720 TO APPROACH.
                    AIRCRAFT CI00 CHANGED PHASE AT    1.2675594903 TO LANDING.
                    AIRCRAFT CI00 CANCELLED AT    1.2836706570 IN SFO .
  C721     16    1
  C721     18    1
  C721     19    1
  C721     20    1
  C721     21    1
  C721     22    1
  C721     23    1
  C721     24    1
  C721     25    1
  C721     26    1
  C721     27    1
  C721     28    1
  C721     29    1
  C721     30    1
  C721     31    1
  C721     32    1
  C721     37    1
  C721     39    1
  C721     40    1
  C721     42    1
  C721     48    1
  C721     56    1
  C721     57    1
  C721     59    4
  C721     67    2
  C721     68    2
  C721     69    2
  C721     71    3
  C721     72    2
  C721     73    2
```

```
C721      74   1
C721      75   1
C721      76   2
C721     121   2
C721     123   2
C721     124   2
C721     125   2
C721     126   2
C721     127   2
C721     128   2
                 AIRCRAFT C721 ENTERED AT   1.0500000000 IN ER-S.
                 AIRCRAFT C721 HANDED OFF AT    1.3511169306 TO AR-5.
                 AIRCRAFT C721 HANDED OFF AT    1.4579518782 TO SFO .
                 AIRCRAFT C721 CHANGED PHASE AT    1.0500000000 TO ARRIVAL TRANSITION.
                 AIRCRAFT C721 CHANGED PHASE AT    1.3116832532 TO APPROACH.
                 AIRCRAFT C721 CHANGED PHASE AT    1.5255765872 TO LANDING.
                 AIRCRAFT C721 CANCELLED AT    1.5397432539 IN SFO .
N175      16   1
N175      56   1
N175      67   1
N175      68   1
N175      69   1
N175      71   1
N175      72   1
N175     121   1
N175     123   1
N175     124   1
N175     125   1
N175     126   1
                 AIRCRAFT N175 ENTERED AT    .6700000000 IN AR-3.
                 AIRCRAFT N175 CANCELLED AT     .7644936490 IN AR-3.
N300      48   1
N300      49   1
N300      50   1
N300      51   1
N300      56   1
N300      67   1
N300      68   1
N300      69   1
N300      71   1
N300     121   1
N300     123   1
```

```
   N300    124     1
   N300    125     1
   N300    126     1
   N300    127     1
   N300    128     1
                     AIRCRAFT N300 ENTERED AT    1.4700000000 IN AR-5.
                     AIRCRAFT N300 HANDED OFF AT    1.5229395749 TO ER-N.
                     AIRCRAFT N300 CANCELLED AT    1.5461229835 IN ER-N.
   N310     16     1
   N310     18     1
   N310     20     1
   N310     21     1
   N310     23     1
   N310     24     1
   N310     26     1
   N310     28     1
   N310     56     1
   N310     67     1
   N310     68     1
   N310     69     1
   N310     71     2
   N310     72     2
   N310     76     2
   N310    121     1
   N310    123     1
   N310    124     1
   N310    125     1
   N310    126     1
   N310    127     1
   N310    128     1
                     AIRCRAFT N310 ENTERED AT    .4700000000 IN AR-5.
                     AIRCRAFT N310 HANDED OFF AT    .5693395040 TO ER-S.
                     AIRCRAFT N310 CANCELLED AT    .7284145124 IN ER-S.
   N365     16     1
   N365     48     1
   N365     49     1
   N365     50     1
   N365     56     1
   N365     67     1
   N365     68     1
   N365     69     1
   N365     71     1
```

```
 N365    121     1
 N365    123     1
 N365    124     1
 N365    125     1
 N365    126     1
 N365    127     1
 N365    128     1
                   AIRCRAFT N365 ENTERED AT   1.0800000000 IN AR-5.
                   AIRCRAFT N365 HANDED OFF AT    1.1693952559 TO ER-N.
                   AIRCRAFT N365 CANCELLED AT    1.2308288597 IN ER-N.
 N458     16     1
 N458     18     1
 N458     20     1
 N458     21     1
 N458     23     1
 N458     24     1
 N458     26     1
 N458     28     1
 N458     48     2
 N458     49     2
 N458     50     2
 N458     51     2
 N458     56     1
 N458     59     4
 N458     67     1
 N458     68     1
 N458     69     1
 N458     71     2
 N458     72     1
 N458     76     1
 N458    121     2
 N458    123     2
 N458    124     2
 N458    125     2
 N458    126     2
 N458    127     2
 N458    128     2
                   AIRCRAFT N458 ENTERED AT    .6600000000 IN ER-S.
                   AIRCRAFT N458 HANDED OFF AT     .9606106433 TO AR-5.
                   AIRCRAFT N458 HANDED OFF AT    1.0657064271 TO SFO .
                   AIRCRAFT N458 CHANGED PHASE AT     .6600000000 TO ARRIVAL TRANSITION.
                   AIRCRAFT N458 CHANGED PHASE AT     .9216832532 TO APPROACH.
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                         AIRCRAFT N458 CHANGED PHASE AT    1.1320946221 TO LANDING.
                         AIRCRAFT N458 CANCELLED AT    1.1462612888 IN SFO .
N504     46      1
N504     48      3
N504     49      2
N504     50      2
N504     51      2
N504     59      4
N504     71     12
N504     72     10
N504     73      4
N504     74      3
N504     75      3
N504     76     16
N504    100      1
N504    121      3
N504    123      3
N504    124      3
N504    125      3
N504    126      3
N504    127      3
N504    128      3
N504    142      1
N504    143      1
N504    144      1
N504    145      1
N504    147      1
N504    149      1
N504    153      1
                         AIRCRAFT N504 ENTERED AT    .0000010000 IN ER-S.
                         AIRCRAFT N504 HANDED OFF AT      .3857798050 TO AR-3.
                         AIRCRAFT N504 HANDED OFF AT      .5666959303 TO AR-5.
                         AIRCRAFT N504 HANDED OFF AT      .7371260714 TO SFO .
                         AIRCRAFT N504 CHANGED PHASE AT      .0000010000 TO ARRIVAL TRANSITION.
                         AIRCRAFT N504 CHANGED PHASE AT      .3382274386 TO APPROACH.
                         AIRCRAFT N504 CHANGED PHASE AT      .8124377174 TO LANDING.
                         AIRCRAFT N504 CANCELLED AT     .8266043841 IN SFO .
N524     16      2
N524     18      1
N524     19      1
N524     20      1
N524     21      1
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```
N524     23     1
N524     24     1
N524     26     1
N524     28     1
N524     48     3
N524     49     1
N524     50     1
N524     56     1
N524     59     4
N524     67     1
N524     68     1
N524     69     1
N524     71     4
N524     72     2
N524     73     2
N524     74     1
N524     75     1
N524     76     4
N524    121     3
N524    123     3
N524    124     3
N524    125     3
N524    126     3
N524    127     3
N524    128     3
                  AIRCRAFT N524 ENTERED AT     .9900000000 IN ER-S.
                  AIRCRAFT N524 HANDED OFF AT    1.2121657785 TO AR-3.
                  AIRCRAFT N524 HANDED OFF AT    1.3467092704 TO AR-5.
                  AIRCRAFT N524 HANDED OFF AT    1.4795224474 TO SFO .
                  AIRCRAFT N524 CHANGED PHASE AT      .9900000000 TO ARRIVAL TRANSITION.
                  AIRCRAFT N524 CHANGED PHASE AT    1.2442901919 TO APPROACH.
                  AIRCRAFT N524 CHANGED PHASE AT    1.5397532539 TO LANDING.
                  AIRCRAFT N524 CANCELLED AT    1.5580865872 IN SFO .
PA84     48     2
PA84     49     1
PA84     50     1
PA84     59     4
PA84     71     3
PA84     72     1
PA84     73     1
PA84     74     1
PA84     75     1
```

```
PA84      76      1
PA84     121      3
PA84     123      3
PA84     124      3
PA84     125      3
PA84     126      3
PA84     127      3
PA84     128      3
                     AIRCRAFT PA84 ENTERED AT      .9900000000 IN ER-S.
                     AIRCRAFT PA84 HANDED OFF AT     1.2321362847 TO AR-3.
                     AIRCRAFT PA84 HANDED OFF AT     1.3286369297 TO AR-5.
                     AIRCRAFT PA84 HANDED OFF AT     1.4150851337 TO SFO .
                     AIRCRAFT PA84 CHANGED PHASE AT      .9900000000 TO ARRIVAL TRANSITION.
                     AIRCRAFT PA84 CHANGED PHASE AT     1.1643069450 TO APPROACH.
                     AIRCRAFT PA84 CHANGED PHASE AT     1.4470607939 TO LANDING.
                     AIRCRAFT PA84 CANCELLED AT     1.4665052939 IN SFO .
PA87      48      2
PA87      49      2
PA87      50      1
PA87      51      1
PA87      59      4
PA87      71      4
PA87      72      2
PA87      73      2
PA87      74      2
PA87      75      2
PA87      76      4
PA87     121      3
PA87     123      3
PA87     124      3
PA87     125      3
PA87     126      3
PA87     127      3
PA87     128      3
                     AIRCRAFT PA87 ENTERED AT      .2200000000 IN ER-S.
                     AIRCRAFT PA87 HANDED OFF AT      .4859216523 TO AR-3.
                     AIRCRAFT PA87 HANDED OFF AT      .6118234357 TO AR-5.
                     AIRCRAFT PA87 HANDED OFF AT      .6891955096 TO SFO .
                     AIRCRAFT PA87 CHANGED PHASE AT      .2200000000 TO ARRIVAL TRANSITION.
                     AIRCRAFT PA87 CHANGED PHASE AT      .4205435974 TO APPROACH.
                     AIRCRAFT PA87 CHANGED PHASE AT      .7211759344 TO LANDING.
                     AIRCRAFT PA87 CANCELLED AT      .7372871011 IN SFO .
```

```
PS67     48     3
PS67     49     3
PS67     50     3
PS67     51     2
PS67     59     4
PS67     71     4
PS67     72     3
PS67     73     1
PS67     74     1
PS67     75     1
PS67     76     5
PS67    121     3
PS67    123     3
PS67    124     3
PS67    125     3
PS67    126     3
PS67    127     3
PS67    128     3
                  AIRCRAFT PS67 ENTERED AT    .4400000000 IN ER-S.
                  AIRCRAFT PS67 HANDED OFF AT     .6913003870 TO AR-3.
                  AIRCRAFT PS67 HANDED OFF AT     .7873395365 TO AR-5.
                  AIRCRAFT PS67 HANDED OFF AT     .8734141698 TO SFO .
                  AIRCRAFT PS67 CHANGED PHASE AT     .4400000000 TO ARRIVAL TRANSITION.
                  AIRCRAFT PS67 CHANGED PHASE AT     .6237954279 TO APPROACH.
                  AIRCRAFT PS67 CHANGED PHASE AT     .9051970617 TO LANDING.
                  AIRCRAFT PS67 CANCELLED AT     .9188082284 IN SFO .
PS99     48     2
PS99     49     2
PS99     50     1
PS99     51     1
PS99     59     4
PS99     71     3
PS99     72     1
PS99     73     1
PS99     74     1
PS99     75     1
PS99     76     1
PS99    121     3
PS99    123     3
PS99    124     2
PS99    125     2
PS99    126     2
```

```
PS99   127    3
PS99   128    3
               AIRCRAFT PS99 ENTERED AT    .9500000000 IN ER-S.
               AIRCRAFT PS99 HANDED OFF AT    1.2018140836 TO AR-3.
               AIRCRAFT PS99 HANDED OFF AT    1.2985840679 TO AR-5.
               AIRCRAFT PS99 HANDED OFF AT    1.3852502963 TO SFO .
               AIRCRAFT PS99 CHANGED PHASE AT     .9500000000 TO ARRIVAL TRANSITION.
               AIRCRAFT PS99 CHANGED PHASE AT    1.1337954279 TO APPROACH.
               AIRCRAFT PS99 CHANGED PHASE AT    1.4173384605 TO LANDING.
               AIRCRAFT PS99 CANCELLED AT    1.4309496272 IN SFO .
R372    56    1
R372    67    1
R372    68    1
R372    69    1
R372    71    1
R372    72    1
R372    76    1
               AIRCRAFT R372 ENTERED AT    .7200000000 IN AR-5.
               AIRCRAFT R372 CANCELLED AT    .7840337168 IN AR-5.
R373    16    1
R373    56    1
R373    67    1
R373    68    1
R373    69    1
R373    71    1
R373   121    1
R373   123    1
R373   124    1
R373   125    1
R373   126    1
               AIRCRAFT R373 ENTERED AT   1.1000000000 IN AR-5.
               AIRCRAFT R373 CANCELLED AT    1.2336010620 IN AR-5.
SWT1    16    1
SWT1    18    1
SWT1    20    1
SWT1    21    1
SWT1    23    1
SWT1    24    1
SWT1    26    1
SWT1    28    1
SWT1    48    2
SWT1    49    2
```

```
    SWT1      50     2
    SWT1      51     2
    SWT1      56     1
    SWT1      59     4
    SWT1      67     1
    SWT1      68     1
    SWT1      69     1
    SWT1      71     2
    SWT1      72     1
    SWT1      73     1
    SWT1      74     1
    SWT1      75     1
    SWT1      76     3
    SWT1     121     2
    SWT1     123     2
    SWT1     124     2
    SWT1     125     2
    SWT1     126     2
    SWT1     127     2
    SWT1     128     2
                       AIRCRAFT SWT1 ENTERED AT     .5300000000 IN ER-S.
                       AIRCRAFT SWT1 HANDED OFF AT      .8469321495 TO AR-5.
                       AIRCRAFT SWT1 HANDED OFF AT      .9268378375 TO SFO .
                       AIRCRAFT SWT1 CHANGED PHASE AT      .5300000000 TO ARRIVAL TRANSITION.
                       AIRCRAFT SWT1 CHANGED PHASE AT      .7847922901 TO APPROACH.
                       AIRCRAFT SWT1 CHANGED PHASE AT      .9947190759 TO LANDING.
                       AIRCRAFT SWT1 CANCELLED AT     1.0130524092 IN SFO .
    S842      16     1
    S842      48     1
    S842      49     1
    S842      50     1
    S842      51     1
    S842      56     1
    S842      67     1
    S842      68     1
    S842      69     1
    S842      71     2
    S842      72     2
    S842      76     2
    S842     121     1
    S842     123     1
    S842     124     1
```

```
  S842    125    1
  S842    126    1
  S842    127    1
  S842    128    1
                   AIRCRAFT S842 ENTERED AT     .9700000000 IN AR-5.
                   AIRCRAFT S842 HANDED OFF AT     .9863352577 TO ER-N.
                   AIRCRAFT S842 CANCELLED AT    1.0988490627 IN ER-N.
  UA28     48    3
  UA28     49    1
  UA28     50    1
  UA28     51    1
  UA28     59    4
  UA28     71    2
  UA28     73    1
  UA28    121    3
  UA28    123    3
  UA28    124    3
  UA28    125    3
  UA28    126    3
  UA28    127    3
  UA28    128    3
                   AIRCRAFT UA28 ENTERED AT     .7900000000 IN ER-S.
                   AIRCRAFT UA28 HANDED OFF AT    1.0456595696 TO AR-3.
                   AIRCRAFT UA28 HANDED OFF AT    1.1380537901 TO AR-5.
                   AIRCRAFT UA28 HANDED OFF AT    1.2211779315 TO SFO .
                   AIRCRAFT UA28 CHANGED PHASE AT      .7900000000 TO ARRIVAL TRANSITION.
                   AIRCRAFT UA28 CHANGED PHASE AT      .9807165946 TO APPROACH.
                   AIRCRAFT UA28 CHANGED PHASE AT     1.2514383237 TO LANDING.
                   AIRCRAFT UA28 CANCELLED AT    1.2675494903 IN SFO .
  UA51     48    2
  UA51     49    1
  UA51     59    4
  UA51     71    3
  UA51     72    2
  UA51     73    1
  UA51     74    1
  UA51     75    1
  UA51     76    2
  UA51    121    3
  UA51    123    2
  UA51    124    2
  UA51    125    2
```

```
UA51     126      2
UA51     127      3
UA51     128      3
                    AIRCRAFT UA51 ENTERED AT    .9100000000 IN ER-S.
                    AIRCRAFT UA51 HANDED OFF AT    1.1615973445 TO AR-3.
                    AIRCRAFT UA51 HANDED OFF AT    1.2580589746 TO AR-5.
                    AIRCRAFT UA51 HANDED OFF AT    1.3444755970 TO SFO .
                    AIRCRAFT UA51 CHANGED PHASE AT      .9100000000 TO ARRIVAL TRANSITION.
                    AIRCRAFT UA51 CHANGED PHASE AT    1.0937954279 TO APPROACH.
                    AIRCRAFT UA51 CHANGED PHASE AT    1.3764349605 TO LANDING.
                    AIRCRAFT UA51 CANCELLED AT    1.3900461272 IN SFO .
UA78      48      3
UA78      49      1
UA78      50      1
UA78      51      1
UA78      59      4
UA78      71      3
UA78      72      1
UA78      73      1
UA78      74      1
UA78      75      1
UA78      76      1
UA78     121      3
UA78     123      3
UA78     124      3
UA78     125      3
UA78     126      3
UA78     127      3
UA78     128      3
                    AIRCRAFT UA78 ENTERED AT    .2900000000 IN ER-S.
                    AIRCRAFT UA78 HANDED OFF AT     .5402787522 TO AR-3.
                    AIRCRAFT UA78 HANDED OFF AT     .6348644242 TO AR-5.
                    AIRCRAFT UA78 HANDED OFF AT     .7197624985 TO SFO .
                    AIRCRAFT UA78 CHANGED PHASE AT      .2900000000 TO ARRIVAL TRANSITION.
                    AIRCRAFT UA78 CHANGED PHASE AT      .4737954279 TO APPROACH.
                    AIRCRAFT UA78 CHANGED PHASE AT      .7509382677 TO LANDING.
                    AIRCRAFT UA78 CANCELLED AT     .7645494344 IN SFO .
WA61      19      1
WA61      22      1
WA61      25      1
WA61      27      1
WA61      29      1
```

```
  WA61       30      1
  WA61       31      1
  WA61       32      1
  WA61       37      1
  WA61       39      1
  WA61       40      1
  WA61       42      1
  WA61       45      1
  WA61       46      1
  WA61       48      3
  WA61       49      3
  WA61       50      2
  WA61       51      1
  WA61       57      1
  WA61       59      4
  WA61       67      1
  WA61       68      1
  WA61       69      1
  WA61       71     18
  WA61       72     19
  WA61       73      2
  WA61       74      2
  WA61       75      2
  WA61       76     23
  WA61      121      3
  WA61      123      3
  WA61      124      3
  WA61      125      3
  WA61      126      3
  WA61      127      3
  WA61      128      3
                      AIRCRAFT WA61 ENTERED AT   1.1400000000 IN ER-N.
                      AIRCRAFT WA61 HANDED OFF AT    1.3610123145 TO AR-3.
                      AIRCRAFT WA61 HANDED OFF AT    1.5365904445 TO AR-5.
                      AIRCRAFT WA61 HANDED OFF AT    1.6095322719 TO SFO .
                      AIRCRAFT WA61 CHANGED PHASE AT    1.1400000000 TO ARRIVAL TRANSITION.
                      AIRCRAFT WA61 CHANGED PHASE AT    1.3085139912 TO APPROACH.
                      AIRCRAFT WA61 CHANGED PHASE AT    1.6392043909 TO LANDING.
                      AIRCRAFT WA61 CANCELLED AT    1.6528155576 IN SFO .
  WA72       19      1
  WA72       48      3
  WA72       49      1
```

```
WA72      59     4
WA72      71     3
WA72      72     2
WA72      73     1
WA72      74     1
WA72      75     1
WA72     121     3
WA72     123     3
WA72     124     3
WA72     125     3
WA72     126     3
WA72     127     3
WA72     128     3
                  AIRCRAFT WA72 ENTERED AT     .8700000000 IN ER-S.
                  AIRCRAFT WA72 HANDED OFF AT    1.1216347859 TO AR-3.
                  AIRCRAFT WA72 HANDED OFF AT    1.2176739354 TO AR-5.
                  AIRCRAFT WA72 HANDED OFF AT    1.3037485686 TO SFO .
                  AIRCRAFT WA72 CHANGED PHASE AT     .8700000000 TO ARRIVAL TRANSITION.
                  AIRCRAFT WA72 CHANGED PHASE AT    1.0541298268 TO APPROACH.
                  AIRCRAFT WA72 CHANGED PHASE AT    1.3355314605 TO LANDING.
                  AIRCRAFT WA72 CANCELLED AT    1.3491426272 IN SFO .

16 LANDINGS,   17.476 LANDINGS/HOUR.

    23 TOTAL AIRCRAFT PROCESSED.
```

7.0 ERROR AND WARNING MESSAGES

7.1 INTRODUCTION

There are four types of messages which a user might receive using the DELTA simulation: operating system, Fortran, SALSIM and DELTA. The first two types are CDC standard messages which are not unique to DELTA. Operating system messages are displayed in the user dayfile and are usually self-explanatory - e.g., "TIME LIMIT" indicates that the user did not specify sufficent run time in the MAXTIM parameter card. Descriptions of these messages can be found in the CDC SCOPE Reference Manual.

Fortran diagnostics will usually occur from incorrect data setups. These messages will be displayed in the TAPE 6 output file and will usually list the offending input and give a brief description of the error. Descriptions of these messages can be found in the CDC FORTRAN Reference Manual, CDC #60174900.

The remaining diagnostics are generated either by the SALSIM utility routines or by the DELTA routines. These are described in the following sections.

7.2 SALSIM DIAGNOSTIC

The SALSIM utilities perform a variety of data checks to ensure the proper execution of the software. If an error is detected, a message is printed and execution is terminated by calling the ABORTT routine. These messages are described below along with the routine which writes the message.

7.2.1 CREATE Diagnostics

```
**AVAILABLE MEMRY PTRS ALTERED
TIME=                 REQUEST=
```

A check is made to see if IV(1) = 3. This value is usually altered by the use of a subscripted variable with a subscript which has not been set prior to use and is equal to zero.

```
**MEMORY REQUEST IS TOO LARGE.  TIME=       REQUEST=
```

This message will occur if the requested length for a block of dynamic memory is zero or exceeds MDESX.

```
**MEMORY CAPACITY EXCEEDED AT TIME=         REQUEST=
```

This is the most likely message to be received. It indicates that the dynamic memory provided for this run is too small. The user must expand the dimension of IV by recompiling the MAIN routine and set the MAXKXX value on the SALSIM specification card to the new dimension of IV.

7.2.2 DESTRO Diagnostics

```
**ILLEGAL DESTROY PARAMETER
LOC=      LENGTH=     TIME=
```

Either LOC and/or LENGTH are zero.

7.2.3 CAUSE Diagnostics

```
** NON ZERO SUCCESSOR IN CAUSE
```

The first word of an event notice to be processed by CAUSE should be zero.

7.2.4 FILE Diagnostics

**NON ZERO SUCCESSOR IN FILE

The member to be filed has a successor - i.e., the first word of its event notice is non-zero.

7.2.5 RSPEC Diagnostics

**RESPEC ARGUMENT IS NOT MEMBER OF SET

The pointer to the member to be removed is not part of the specified set.

7.3 DELTA DIAGNOSTICS MESSAGES

The DELTA model contains a large number of both diagnostics (messages preceeding calls to Subroutine ABØRTT) and warning messages. The more likely to occur are described below. The others are self descriptive and are not expected to occur unless the code is altered. All messages are written to TAPE 6.

7.3.1 ABØRTT Diagnostics

```
**ABØRTT CALLED AT time
TASK lcc number EVENT event notice pointer AND ERRØR error number
STØP RUN.
```

Any time ABØRTT is called, this message is output. The SALSIM routines generate different error numbers, the DELTA diagnostics do not set this parameter.

```
IV(1:20)
```

If ABØRTT is called for error type 3 (see first diagnostic for CREATE, 7.2.1), the first twenty words of the IV array are written out in octal format.

7.3.2 ACT4 Messages

```
IN ACT4  AIRCRAFT aircraft id IS CANCELED AT time.
```

When an aircraft reaches the end of its time/position queue (flight plan), this message is written. It is a warning message, useful in keeping track of the aircraft.

7.3.3 ALLØC Messages

```
IN ALLØC EVENT DESTRØYED
```

After an aircraft is canceled, the tasks being performed for it must be stopped. Those being pulled from queues or parts of chains are found by tests in ALLØC utility and this warning message generated each time one is found.

7.3.4 BNDRY Messages

A/C aircraft id LEAVES SYSTEM AT x,y,z-coordinates THRU $\left\{\begin{matrix}\text{side}\\ \text{floor}\\ \text{ceiling}\end{matrix}\right\}$ ØF
jurisdiction id TIME time

When an aircraft crosses out of the jurisdictions being modelled, this message is written. The aircraft will be canceled at the time shown. This is a warning message.

ERRØR IN BNDRY. EXIT PØINT NØT FØUND.
A/C aircraft id AT location and velocity IN jurisdiction id

This warning message is written when an aircraft is not in the jurisdiction indicated in its AIRCRAFT FILE. An attempt is made to find the correct jurisdiction. This warning may be used to detect aircraft which are input in the wrong jurisdiction either due to errors in x, y or z coordinates or jurisdiction id.

7.3.5 CRASH Messages

ERRØR IN CRASH. LØØK-AHEAD BEYØND NEXT FIXED PØINT
NØW, BUT THERE ARE NØ MØRE FIXED PØINTS.
TIME = time   ID = aircraft id

When a non-landing aircraft is approaching the final fixed point of its time/position queue (flight plan), this message is output. It is a warning message, providing status information.

7.3.6 ELIST Message

EL lcc number EXØG time

This message is output for each exogenous event.

ERRØR IN ELIST
TIME time
TASK lcc number, function, task number
TASK PØINTER pointer to event notice

This is an error message which results when an erroneous lcc is triggered. It is followed by a call to ABØRTT.

7.3.7 INITIA Messages

number of errors JURISDICTION B0UNDRY ERR0RS F0UND IN INITIA

If there are an inconsistancies found in the jurisdiction definitions this message is written and AB0RTT is called. While these tests are capable of finding many types of errors, they are not fool proof, so BNDRY and associated routines contain other tests of consistancy which are not described here. These INITIA tests are primarily to detect bad mnemonics.

7.3.8 METSEQ Messages

A/C aircraft id IN METSEQ HAS BAD FF 0R RW ff number, rw number

If METSEQ detects a non-positive feeder fix number or a non-positive runway number, this message is written and AB0RTT called. This diagnostic may be generated if a non-landing aircraft contains sufficient data to get past other tests. It may be corrected by modifying the input time/position queues final fix point or departure runway.

A/C aircraft id HAS FFIX ERR0R

This diagnostic is generated if either the feeder fix number is greater than the number of feeder fixes in TAPE 30 or no feeder fix is found at the same location as the final fix point in the time position queue. In the latter case, the entire set of feeder fixes has been searched and no match could be found. A distance tolerance of 10^{-6} nmi is used. In either case, AB0RTT is called after the message is written.

TERMINAL P0INTER ERR0R A/C aircraft id

This diagnostic is generated when the destination of a landing aircraft contains a non-positive value. The destination is set in T03000 from an input mnemonic. This error results in the calling of AB0RTT. The use of an incorrect destination mnemonic would be the cause of this error. The destination of an aircraft expected to land within the model constraints must have a mnemonic which identifies a terminal jurisdiction. Similarly, a departing aircraft with an invalid originating jurisdiction will cause this error.

A/C aircraft id HAS RUNWAY ERR0R

This diagnostic is generated if an arrival or departure runway number greater than the terminal's number of runways. This error causes AB0RTT to be called.

7.3.9 M0VAC Messages

While M0VAC contains several diagnostic messages and error traps, they are self-explanatory in content and need not be listed here. Consult a subroutine listing for more information.

7.3.10 T03000 Messages

AIRCRAFT aircraft id CANN0T BE ADDED IN F3.0

This message denoted the failure of an Aircraft Data File being input to pass one of the following tests:

a) the number of fix points is less than two - hence the time/position queue is incomplete; b) the aircraft id is redundent with another aircraft currently in the system; or c) either the originating jurisdiction, the aircraft type or the phase of flight is invalid. The message is only a warning, though other problems, especially I/O errors may terminate the run. The aircraft and its time/position queue are eliminated from the system.

8.0 TERMINAL GENERATION PROGRAM

8.1 INTRODUCTION

Program DSKWRT reads input cards and writes the off-line random access (mass storage) disk file used in the METSEQ subroutine of the DELTA model to read in sequence route information for the terminals. Subroutine ESCRT is called by DSKWRT to write escape route information for missed approaches onto the disk file.

The output of Program DSKWRT is written on the disk file, TAPE30. DSKWRT first reads the number of terminals from the file SFØTERM on TAPE2, then reads the terminal mnemonic and the number of runways. Subroutine ESCRT is called to process escape route data, and the error switch is checked before further processing of DSKWRT. The sequence route records and feeder fix records are written after all feeder fix data has been read, and the number of records written on TAPE30 is used in writing the terminal record. At the completion of processing terminal information, the terminal mnemonic and pointer are displayed for the user before completion of execution. This pointer is input for the IDSKRW variable. See Page 3.3-12.

The escape route data on the file ESCAPE is read by Subroutine ESCRT on TAPE3. This routine writes the escape route records and the escape record which contains starting points of each escape route.

The following sections describe the input specification of TAPE2 and TAPE3 and give the values used in the SFO runs.

Figure 8.1-1 illustrates the run procedures and the generated outputs.

FIGURE 8.1-1. PROCEDURES FOR RUNNING TERMINAL GENERATION PROGRAM ON CDC 6X00/TSS

```
                                                    Notes
[GET,DSK,ACCØUNT = EB54195                   File DSK contains Program
                                             DSKWRT and Subroutine ESCRT(IESW)

[GET,TAPE2 = SFØTERM,ACCØUNT = CA66028       Tape 2 - input data to DSKWRT

[GET,TAPE3 = ESCAPE,ACCOUNT = EB54195        Tape 3 - input data to ESCRT

[RUNX,I = DSK,G                              Load and execute DSKWRT

1 FIRST RECØRD WRITTEN =     1              {Program output written by system
TERMINAL SFØ PØINTER =               12

[REPLACE,TAPE30 = DSK30                      Places output on permanent storage
                                             under the file name DSK30
```

8.2 SEQUENCE ROUTE INPUT SPECIFICATION

8.2.1 TAPE2 INPUTS

Card No.	Name	Column	Format	Value/Description
1	NØTRM	1-2	I2	Number of terminals
2	ATERM	1-4	A4	Terminal mnemonic
3	NØRWY	1-2	I2	Number of runways
4	NØFF	1-2	I2	Number of feeder fixes for runway
5	TA	1-10	F10.5	Maximum advance time; units-minutes.
	TR	11-20	F10.5	Maximum retard time; units-minutes
	DGATE	21-30	F10.5	Distance from gate to runway, units-nmi.
6	SRVEL(J)	1-10	F10.5	J=1, 25 average velocity on sequence route by aircraft
7	SRLNG	1-10	F10.5	Not used
	NØSR	11-12	I2	Number of nodes along sequence route
8	SRXYZ(J,K)	1-12 13-24 25-36	F12.5 F12.5 F12.5	J=1,3; K=1, NØSR X,Y,Z coordinate of noder; first at feeder fix; last at start of runway; units (nmi, nmi, ft.)

8.2.2

The following pages in this section are a computer listing of the TAPE2 inputs used in the SFO runs.

```
01                                NO. OF TERMINALS
SFO   SAN FRANCISCO
01                                NORWY
08                                NOFF RWY 1
3.    3.     8.                   TA,TR,DGATE-FF1 S.CRZ
260.                              VEL 1
247.                              VEL 2
249.                              VEL 3
187.5                             VEL 4    DUMMY
117.5                             VEL 5    DUMMY
137.5                             VEL 6     DUMMY
0.                          VEL 7
0.                          VEL 8
0.                          VEL 9
0.                          VEL 10
0.                          VEL 11
0.                          VEL 12
0.                          VEL 13
0.                          VEL 14
0.                          VEL 15
0.                          VEL 16
0.                          VEL 17
0.                          VEL 18
0.                          VEL 19
0.                          VEL 20
0.                          VEL 21
0.                          VEL 22
0.                          VEL 23
0.                          VEL 24
0.                          VEL 25
69.   08                          SRLNG,NOSR
    654.2      394.6    16000.    SRXYZ 1
    651.5      410.5    12000.    SRXYZ 2
    647.4      427.6     8000.    SRXYZ 3
    643.0      446.0     4000.    SRXYZ 4
    640.2      451.8     2400.    SRXYZ 5
    636.4      454.2     1000.    SRXYZ 6    ESC. PT
    632.0      457.2       10.    SRXYZ 7
    633.5      456.2        0.    SRXYZ 8
2.5   3.5    8.             TA,TR,DGATE  FF2 PT REYES HI
266.0                       VEL 1
257.5                       VEL 2
```

```
258.0                  VEL 3
187.5                  VEL 4
117.5                  VEL 5
137.5                  VEL 6
0.                     VEL 7
0.                     VEL 8
0.                     VEL 9
0.                     VEL 10
0.                     VEL 11
0.                     VEL 12
0.                     VEL 13
0.                     VEL 14
0.                     VEL 15
0.                     VEL 16
0.                     VEL 17
0.                     VEL 18
0.                     VEL 19
0.                     VEL 20
0.                     VEL 21
0.                     VEL 22
0.                     VEL 23
0.                     VEL 24
0.                     VEL 25
85.0  11               SRLNG,NOSR
608.8  484.5  15500.   SRLNG,1
608.5  473.2  12000.   SRXYZ 2
608.2  450.0  9000.    SRXYZ 3
613.5  443.0  8000.    SRXYZ 4
630.5  443.8  5500.    SRXYZ 5
636.2  444.0  4000.    SRXYZ 6
640.0  447.0  3200.    SRXYZ 7
640.2  451.8  2400.    SRXYZ 8
636.4  454.2  1000.    SRXYZ 9
632.0  457.2  10.      SRXYZ 10
633.5  456.2  0.0      SRXYZ 11
2.    4.    8.         TA,TR,DGATE FF3 PT REYES LO
266.0                  VEL 1
257.5                  VEL 2
258.0                  VEL 3
187.5                  VEL 4
117.5                  VEL 5
137.5                  VEL 6
```

```
0.                                        VEL  7
0.                                        VEL  8
0.                                        VEL  9
0.                                        VEL  10
0.                                        VEL  11
0.                                        VEL  12
0.                                        VEL  13
0.                                        VEL  14
0.                                        VEL  15
0.                                        VEL  16
0.                                        VEL  17
0.                                        VEL  18
0.                                        VEL  19
0.                                        VEL  20
0.                                        VEL  21
0.                                        VEL  22
0.                                        VEL  23
0.                                        VEL  24
0.                                        VEL  25
73.0      09                              SRLNG,NOSR
608.8       484.5       12000.            SRXYZ 1
621.5       449.5       7000.             SRXYZ 2
630.5       443.8       5500.             SRXYZ 3
636.2       444.0       4000.             SRXYZ 4
640.0       447.0       3200.             SRXYZ 5
640.2       451.8       2400.             SRXYZ 6
636.4       454.2       1000.             SRXYZ 7
632.0       457.2       10.               SRXYZ 8
633.5       456.2       0.0               SRXYZ 9
3.0       3.6       8.                    TA,TR,DGATE FF4 BRINY
260.0                                     VEL  1
242.5                                     VEL  2
249.0                                     VEL  3
187.5                                     VEL  4
117.5                                     VEL  5
137.5                                     VEL  6
0.                                        VEL  7
0.                                        VEL  8
0.                                        VEL  9
0.                                        VEL  10
0.                                        VEL  11
0.                                        VEL  12
```

```
0.                                          VEL  13
0.                                          VEL  14
0.                                          VEL  15
0.                                          VEL  16
0.                                          VEL  17
0.                                          VEL  18
0.                                          VEL  19
0.                                          VEL  20
0.                                          VEL  21
0.                                          VEL  22
0.                                          VEL  23
0.                                          VEL  24
0.                                          VEL  25
74.        10                               SRLNG,NOSR
586.8        428.5        12000.            SRXYZ 1
608.0        442.8        8500.             SRXYZ 2
613.5        443.0        8000.             SRXYZ 3
630.5        443.8        5500.             SRXYZ 4
636.2        444.0        4000.             SRXYZ 5
640.0        447.0        3200.             SRXYZ 6
640.2        451.8        2400.             SRXYZ 7
636.4        454.2        1000.             SRXYZ 8
632.0        457.2        10.               SRXYZ 9
633.5        456.2        0.0               SRXYZ 10
1.5        4.5        8.                     TA,TR,DGATE FF5  MOSS
260.0                                       VEL  1
247.0                                       VEL  2
249.0                                       VEL  3
187.5                                       VEL  4
117.5                                       VEL  5
137.5                                       VEL  6
0.                                          VEL  7
0.                                          VEL  8
0.                                          VEL  9
0.                                          VEL  10
0.                                          VEL  11
0.                                          VEL  12
0.                                          VEL  13
0.                                          VEL  14
0.                                          VEL  15
0.                                          VEL  16
0.                                          VEL  17
```

```
0.                                            VEL  18
0.                                            VEL  19
0.                                            VEL  20
0.                                            VEL  21
0.                                            VEL  22
0.                                            VEL  23
0.                                            VEL  24
0.                                            VEL  25
56.0      07                                  SRLNG,NOSR
657.6       409.8       8000.                 SRXYZ 1
647.4       427.6       8000.                 SRXYZ 2
643.0       446.0       4000.                 SRXYZ 3
640.2       451.8       2400.                 SRXYZ 4
636.4       454.2       1000.                 SRXYZ 5
632.0       457.2       10.                   SRXYZ 6
633.5       456.2       0.0                   SRXYZ 7
1.        2.        8.                        TA,TR,DGATE FF6 SAN JOSE
210.0                                         VEL  1
247.0                                         VEL  2
200.0                                         VEL  3
187.5                                         VEL  4
117.5                                         VEL  5
130.0                                         VEL  6
0.                                            VEL  7
0.                                            VEL  8
0.                                            VEL  9
0.                                            VEL  10
0.                                            VEL  11
0.                                            VEL  12
0.                                            VEL  13
0.                                            VEL  14
0.                                            VEL  15
0.                                            VEL  16
0.                                            VEL  17
0.                                            VEL  18
0.                                            VEL  19
0.                                            VEL  20
0.                                            VEL  21
0.                                            VEL  22
0.                                            VEL  23
0.                                            VEL  24
0.                                            VEL  25
```

```
27.0      05                            SRLNG,NOSR
653.8      441.2      2400.             SRXYZ 1
640.2      451.8      2400.             SRXYZ 2
636.4      454.2      1000.             SRXYZ 3
632.0      457.2      10.               SRXYZ 4
633.5      456.2      0.0               SRXYZ 5
1.        2.        8.                  TA,TR,DGATE FF7 COYOTE
260.0                                   VEL 1
247.0                                   VEL 2
249.0                                   VEL 3
187.5                                   VEL 4
130.0                                   VEL 5
130.0                                   VEL 6
0.                                      VEL 7
0.                                      VEL 8
0.                                      VEL 9
0.                                      VEL 10
0.                                      VEL 11
0.                                      VEL 12
0.                                      VEL 13
0.                                      VEL 14
0.                                      VEL 15
0.                                      VEL 16
0.                                      VEL 17
0.                                      VEL 18
0.                                      VEL 19
0.                                      VEL 20
0.                                      VEL 21
0.                                      VEL 22
0.                                      VEL 23
0.                                      VEL 24
0.                                      VEL 25
28.0      06                            SRLNG,NOSR
652.0      439.0      4000.             SRXYZ 1
643.0      446.0      4000.             SRXYZ 2
640.2      451.8      2400.             SRXYZ 3
636.4      454.2      1000.             SRXYZ 4
632.0      457.2      10.               SRXYZ 5
633.5      456.2      0.0               SRXYZ 6
2.        4.        8.                  TA,TR,DGATE FF8 HERMON
260.0                                   VEL 1
200.0                                   VEL 2
```

```
249.0                                           VEL  3
187.5                                           VEL  4
130.0                                           VEL  5
145.0                                           VEL  6
0.                                              VEL  7
0.                                              VEL  8
0.                                              VEL  9
0.                                              VEL  10
0.                                              VEL  11
0.                                              VEL  12
0.                                              VEL  13
0.                                              VEL  14
0.                                              VEL  15
0.                                              VEL  16
0.                                              VEL  17
0.                                              VEL  18
0.                                              VEL  19
0.                                              VEL  20
0.                                              VEL  21
0.                                              VEL  22
0.                                              VEL  23
0.                                              VEL  24
0.                                              VEL  25
43.0      06                                    SRLNG,NOSR
645.0       420.0       6000.                   SRXYZ 1
643.0       446.0       4000.                   SRXYZ 2
640.2       451.8       2400.                   SRXYZ 3
636.4       454.2       1000.                   SRXYZ 4
632.0       457.2       10.                     SRXYZ 5
633.5       456.2       0.0                     SRXYZ 6
```

8.3 ESCAPE ROUTE INPUT SPECIFICATION

8.3.1 TAPE3 Inputs

Card No.	Name	Column	Format	Value/Description
1	NØER	1-2	I2	Number of escape routes per sequence route
2	NØERPT	1-2	I2	Number of escape route points in SRXYZ
	IEFFX	3-4	I2	Number of feeder fixes for escape routes
3	ERVEL(J)	1-10	F10.5	J=1, 25 average velocity over escape route by speed class
4	NØEPTS	1-2	I2	Number of branch points over escape route
	EDIST	3-12	F10.5	Distance from feeder fix to escape point via sequence route; units - nmi.
	ELNTH	13-22	F10.5	Not used
5	ERXYZ(J,K)	1-12	F12.5	J=1,3; K=1, NØEPTS
		13-24	F12.5	X,Y,Z coordinate of branch points; units - (nmi, nmi, ft.)
		25-36	F12.5	X,Y,Z coordinate of branch points; units (nmi, nmi, ft.)

8.3.2

The following pages in this section are a computer listing of the TAPE3 inputs used in the SFO runs. These inputs are dummies since there were no missed approaches for the set of runs made and are presented merely as an example of the format.

```
01
0301
145.5
150.5
160.5
139.5
110.5
150.5
300.8
289.8
145.9
87.6
95.3
169.4
73.3
211.2
105.3
301.6
70.8
405.6
260.7
297.8
433.4
159.6
388.8
477.7
160.8
03000000100.000000150.
0000007876.10000006743.20000005978.3
0000005643.20000004892.30000005987.2
0000002843.50000003751.80000001432.3
01
0101
101.2
102.2
103.3
104.4
105.5
106.6
107.7
108.8
109.9
```

```
110.0
112.2
111.2
113.3
114.4
115.5
116.6
117.7
118.8
119.9
120.0
121.1
122.1
123.3
124.4
1255.5
03000000100.000000150.
00000000100.0000000105.60000005432.2
00000000200.0000000105.70000003421.2
0000003460.10000001110.60000002134.6
01
0201
201.1
202.2
203.3
204.4
205.5
206.6
207.7
208.8
209.9
210.1
211.1
213.3
212.2
214.4
215.5
216.6
217.7
218.8
219.9
220.0
```

```
221.1
222.2
223.3
224.4
225.5
03000000100.000000150.
00000000200.00000000300.00000000300.
00000000300.00000000400.00000000500.
00000000600.00000000700.00000000800.
01
0301
145.5
150.5
160.5
139.5
110.5
150.5
300.8
289.8
145.9
87.6
95.3
169.4
73.3
211.2
105.3
301.6
70.8
405.6
260.7
297.8
433.4
159.6
388.8
477.7
160.8
03000000100.000000150.
0000007876.10000006743.20000005978.3
0000005643.20000004892.30000005987.2
0000002843.50000003751.80000001432.3
01
0101
```

```
101.2
102.2
103.3
104.4
105.5
106.6
107.7
108.8
109.9
110.0
112.2
111.2
113.3
114.4
115.5
116.6
117.7
118.8
119.9
120.0
121.1
122.1
123.3
124.4
1255.5
03000000100.000000150.
00000000100.0000000105.60000005432.2
00000000200.0000000105.70000003421.2
0000003460.10000001110.60000002134.6
01
0201
201.1
202.2
203.3
204.4
205.5
206.6
207.7
208.8
209.9
210.1
211.1
```

```
213.3
212.2
214.4
215.5
216.6
217.7
218.8
219.9
220.0
221.1
222.2
223.3
224.4
225.5
03000000100.000000150.
00000000200.00000000300.00000000300.
00000000300.00000000400.00000000500.
00000000600.00000000700.00000000800.
```

9.0 INTERARRIVAL TIMES GENERATION PROGRAM

Program SDATA generates interarrival times an aircraft will enter a system at a point 80 - 100 n.mi. from the terminal, based on the considerations that 1) aircraft interarrival times at a route point 80 - 100 n.mi. from the terminal conform to the first order Erlang distribution with a mean equal to the desired flow rate along that route, 2) this flow rate will be defined as a percentage of the total flow rate at runway. For example, if the total flow rate is 60 aircraft per hour and 20% of the flights approach along a given route, the flow rate used for defining the mean of the Erlang distribution along that route will be (.20) (60) = 12.

SDATA reads data from the file VALUES on TAPE5 and the output is written on the teletype when execution is performed in a time sharing mode. VALUES contains the name list inputs read by SDATA. The name list variables are NUMX, the loop terminator; XMU, the mean separation time; RNDPRM, the random number seed.

Figure 9.0-1 shows a sample input and corresponding output produced by SDATA. The output lists the mean which was input and then two columns of interarrival times for this distribution. The left column gives the time to the next arrival relative to the last arrival while the right column sums these times relative to a starting value of zero.

```
 LIST,VALUES

 $VALUES
 NUMX=10,XMU=.056818,RNDPRM=1234567.,XMAX=1.$
 $VALUES
 NUMX=0$

[

[ RUNX,I=SDATA
[ LGO
MEAN =  .056818
  .004337   .004337
  .044886   .049222
  .005136   .054358
  .000281   .054640
  .150251   .204891
  .092633   .297524
  .064904   .362428
  .024143   .386571
  .192249   .578820
  .034593   .613413
[
```

FIGURE 9.0-1 SAMPLE INPUT AND CORRESPONDING OUTPUT PRODUCED BY SDATA

10.0 POST PROCESSOR PROGRAM

The DELTA Post Processor Program, PPROC, is a separate executable program which produces an additional report for a DELTA simulation run. The program processes a file which is produced by sorting the DELTA output file TAPE14. The procedure for sorting TAPE14 and executing PPROC is illustrated in Table 4.2-1. A detailed description of the Post Processor Report is presented in Section 5.3.

APPENDIX: A REPORT OF INVENTIONS

A diligent review of the work performed under this contract has revealed no new innovation, discovery, improvement or invention.