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A USER'S MANUAL FOR SAMSOM II: THE SUPPORT AVAILABILITY MULTI-SYSTEM OPERATIONS MODEL

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SANTA MONICA • CALIFORNIA

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PREFACE

This Memorandum describes the RAND Support-Availability Multi-System Operations Model called SAMSOM II. Its purpose is to help model users define, set up, and simulate aircraft operations and logistic support problems. Although it is meant to be a complete user's manual, it has a companion document: G. D. Brown, Robert Moulenbelt, and H. J. Shukiar, A Programmer's Guide to SAMSOM II, The RAND Corporation, RM-5235-PR, 1967. This guide is a technical manual oriented toward programmers concerned with understanding and implementing the model.

SAMSOM II is the latest version of a series of maintenance-operations models begun at RAND in 1956 (see Bibliography). It is the successor to SAMSOM I, reported in T. C. Smith, SAMSOM: Support-Availability Multi-System Operations Model, The RAND Corporation, RM-4077-PR, June 1964.

Although readers of this manual should be able to simulate their problems with a minimum of technical support from computer programmers, they will find it necessary to be thoroughly familiar with their computer installation and SIMSCRIPT, or have programmer support in these areas. Users will be provided with this manual, a Programmer's Guide, and, upon receipt of a request accompanied by a blank tape, the necessary program tape for implementing the model. A complete listing of the program may be obtained from the program tape.

This Memorandum should be of interest to operations and logistics managers at all command levels. It will be most useful to staff planners, analysts, and managers responsible for monitoring weapon system developments, estimating operations capabilities, and determining logistics support requirements.

SUMMARY

This Memorandum provides information for using the RAND Support-Availability Multi-System Operations Model, SAMSOM II. It identifies and explains model inputs, summarizes its logic, and describes available outputs.

SAMSOM II is a Monte Carlo model programmed in SIMSCRIPT for large-scale digital computers. It simulates weapon system operations and logistics support requirements. The model is activated by aircraft sortie requirements and alert postures and accepts inputs describing resource availability, work schedules, and hardware design parameters reflecting system reliability, maintainability, and inspection requirements.

The model simulates operations events (alert requirements, sortie-generation capabilities, and readiness postures) and associated logistics support requirements (manpower, equipment, facilities, and, to a limited extent, parts) for one or more aircraft at one or more bases. It also takes into account weather constraints, resource shortages, flying schedules, alert commitments, sortie configuration requirements, abort rates, attrition and battle-damage estimates, and operations policies governing sortie cancellation and make-up practices.

All of these resource assumptions, operations policies and constraints, and hardware parameters are identified and described on eight different forms, providing for over one hundred different inputs. Many inputs are optional, however, and need not be specified for any given simulation. Simple simulations may be designed that require only a few inputs; on the other hand, multibase, multisystem simulations might require numerous inputs for all of the different input formats.

Although SAMSOM II logic is summarized in this manual, users desiring additional explanations of program logic and details are urged to refer to the Programmer's Guide, published as a separate Memorandum. Users do not need to be computer experts or programmers to use the model, but will find a knowledge of SIMSCRIPT helpful. Such knowledge will be required if the user is to become completely familiar with the program and to understand the complex network of routines used to

provide the flexible capability of the model. The Programmer's Guide and programming experience will be essential for fully exploring the impact of any program changes that might be desirable to meet special simulation requirements.

Model outputs are recorded on transaction tapes that are further analyzed to provide several different output reports. All outputs are optional. They may be requested to fit users' requirements. Eight output reports provide both summary and detailed information on simulation results. Their content ranges from general statistics on simulated operations capability, aircraft status conditions, and turnaround-time averages to specific resource utilization and delay statistics, hourly status changes, and detailed frequency distributions of simulated repair times and queue situations. Three other outputs provide simulation evaluation and debugging information. In general, users will require as much computer time for generating output as they use to execute simulations. In both cases, the time required will depend upon the complexity of the simulation and the amount of output detail required for analysis.

SAMSOM II is not a simple model. It has been designed to accommodate a wide range of simulation requirements. Given appropriate inputs reflecting a set of support resources and operations concepts, it will simulate operations capability for either wartime or peacetime conditions. On the other hand, given a set of operations concepts and requirements, it will simulate the resources required to support the capability. Thus, it can be used to evaluate the impact of changes in concepts, policies, and resource mixes upon operational capability. In particular, it can be used to compare the sortie-generation capabilities of different aircraft, examine alternative mixes of aircraft and supporting resources, and determine the operational losses caused by having "n" fewer resources or the benefits resulting from "n" more resources.

The model focuses attention on direct support requirements. It does not directly accommodate all indirect support interactions, such as supply inventory considerations, off-equipment shop repairs, and AGE repairs. These and similar indirect support requirements must be appropriately aggregated for inclusion in SAMSOM II simulations.

The model also may be constrained by computer memory. Although it will handle situations involving multiple bases and multiple aircraft, missions, resources, systems, maintenance, inspections, etc., it was not designed for broad-scale war-gaming. Extensive use of multiples will exceed the capability of 32K computers to accept and execute SAMSOM II simulations.

The model was not conceived as a substitute for field tests, but is useful for projecting test data parameters into other circumstances and for examining alternative contingency plans. Although SAMSOM II will neither accommodate all contingency plans nor simulate all kinds of operation requirements, it has been used successfully to simulate several kinds of Air Force operations, ranging from single-squadron fighter operations to multiroute air transport operations serving overseas requirements. Its most extensive application to date has been an examination of alternative ways to enhance the capability of Tactical Air Command fighter squadron and wing organizations. Given reasonable operations concepts and appropriate data for inputs, the model can be a useful management planning and evaluation tool for examining aircraft capabilities and logistic support requirements.

CONTENTS

I. INTRODUCTION

The RAND Support-Availability Multi-System Operations Model, called SAMSOM II, is a Monte Carlo model programmed in SIMSCRIPT to run on large-scale digital computers.* The model simulates operations and logistics support interactions in various kinds of aircraft organizations. Although designed primarily to simulate typical Air Force operations, it may be used to examine the operational capabilities of Army, Navy, Marine, and other organizations or combinations of aircraft and logistics support elements. It also simulates operations for one or more weapon systems at one or more bases involving multiple resource allocations and operational requirements.

This Memorandum describes SAMSOM II and provides details on input requirements, model logic, and running instructions for users. It also describes model outputs and includes a sample simulation to familiarize the user with model operational details. A companion Memorandum** provides additional computer programming information of primary interest to programmers.

The model is composed of three separate programs. The first program accepts and checks inputs, the second executes the simulation, and the third produces output.

As illustrated in Fig. 1, the model Running Deck is composed of a small number of cards used to initiate computer instructions and

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*SAMSOM II should not be confused with SAMSOM I, which was programmed in SOS to run on IBM 7090/7094 computers. The current model was programmed to run on the RAND 7044 installation; it has also run on IBM 7090/7094 computers at the Pentagon and Wright-Patterson Air Force Base. See T. C. Smith, SAMSOM: Support-Availability Multi-System Operations Model, The RAND Corporation, RM-4077-PR, June 1964. Also see H. M. Markowitz, Bernard Hausner, and H. W. Karr, SIMSCRIPT: A Simulation Programming Language, The RAND Corporation, RM-3310-PR, November 1962.

**G. D. Brown, Robert Moulenbelt, and H. J. Shukiar, A Programmer's Guide to SAMSOM II, The RAND Corporation, RM-5235-PR, 1967. Users also may be interested in other models.

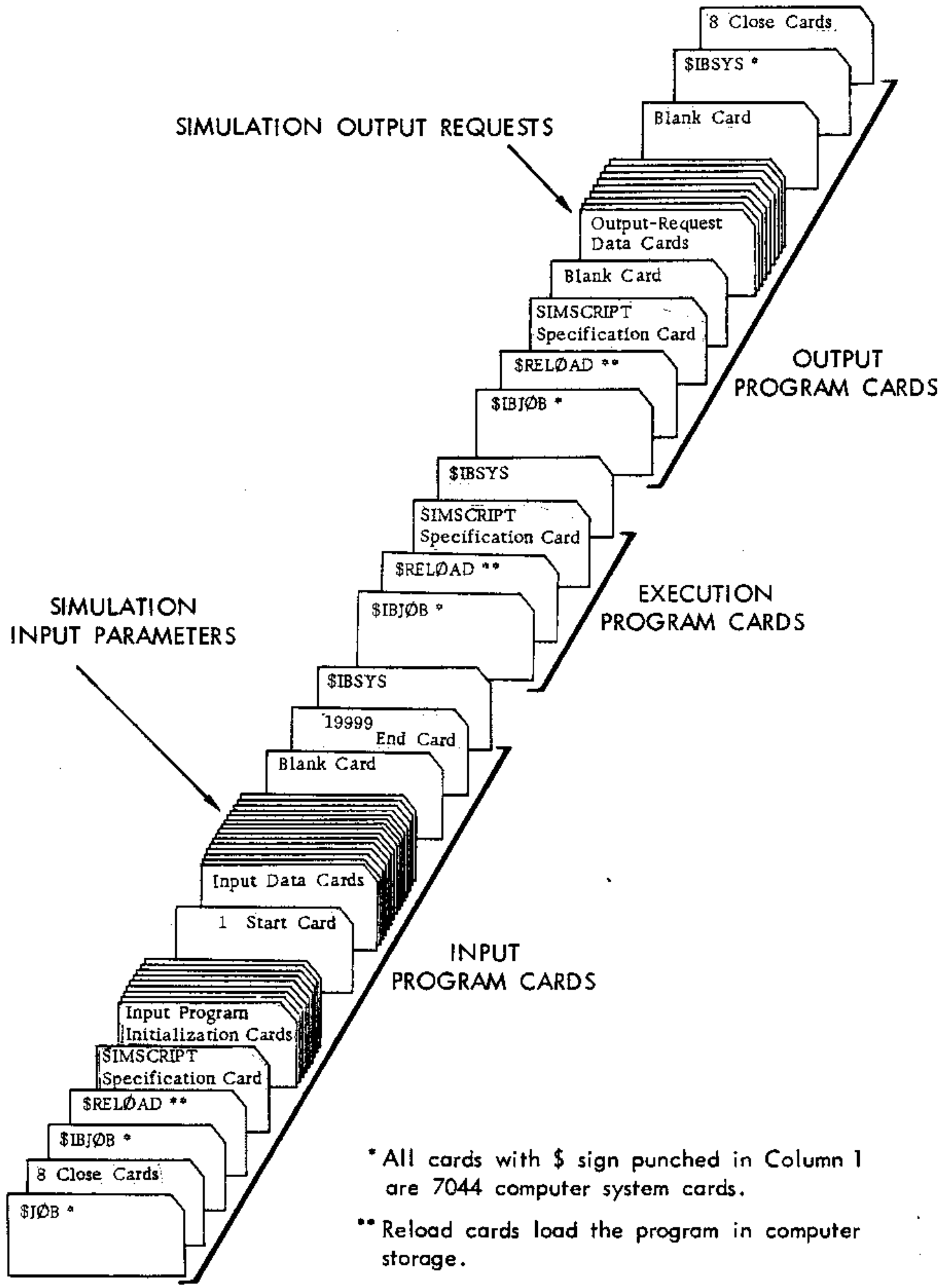


Fig. 1 -- SAMSOM II Running Deck

routines which have been recorded on the SAMSOM II program tape. The figure also identifies the different parts of the model Running Deck and shows the proper sequencing of inputs and output request cards. Inclusion or exclusion of selected cards in the Running Deck determines how much of the model will be activated for any given simulation. For example, the user may want only to check out a set of inputs in preparation for a simulation. He may do this by inserting the desired inputs into the appropriate set of cards from the Running Deck. Adding the execution cards to the Running Deck activates the simulation and writes a transaction tape containing simulation records and statistics. Output, in turn, may be obtained at the same time by including the appropriate output request cards in the deck. On the other hand, the user does not have to obtain output at the time of simulation. He may use the appropriate set of cards from the Running Deck to call up the output program and obtain all or selected outputs from the simulation transaction tape. Additional operations details and a listing of the model Running Deck will be found in Appendix A.

SAMSOM II inputs are described and illustrated in Sec. II and Appendix B. As indicated therein, inputs identify and define all variables in each simulation. They define bases, aircraft types, operations policies, sortie requirements, resources, system reliability or break rates, repair times, inspection requirements, and ground abort rates. They also include many other kinds of data and information required to complete a simulation.

Model logic is summarized and described in a series of Model Logic Schematics or flow diagrams in Sec. III. These schematics identify the major elements of the model and focus attention upon its primary components. The section also describes the important interactions and interrelationships among the different routines and simulated events they generate and control. The separate schematics discussed in Sec. III are integrated into a single flow diagram or schematic included in Appendix C.

Section IV is a complete description of SAMSOM outputs. It not only identifies each kind of output, but also explains what it includes and excludes and how it is derived in the simulation. Output

formats are illustrated in Appendix D, and Appendix E includes an abbreviated sample set of outputs derived from a demonstration simulation.

SAMSOM outputs may be divided into two categories: (1) simulation inputs, model initialization parameters, computer-memory maps, error diagnostics and simulation statistics, and (2) simulation results printed out on eleven different kinds of output formats. Additional outputs are also available, providing details primarily used for simulation trouble-shooting and debugging.

All outputs are optional and, in some cases, the user may select specific data or statistics from within a set of outputs. For example, if he is interested only in the availability, utilization, and shortages of a particular resource, he can select it from among corresponding outputs on all resources. Similarly, he may select statistics peculiar to one base, one aircraft type, or a single mission, and ignore comparable data compiled for other bases, aircraft, etc.

Section V summarizes SAMSOM II capabilities, limitations, and potential applications for user consideration. It includes a brief discussion of some of its major uses to illustrate the general usefulness of such simulators. The section also reviews data requirements, sources, and special considerations. It concludes with a discussion of potential management applications of the model suggested by RAND and Air Force experience with it during the past two years.

II. INPUTS

GENERAL RULES AND PROCEDURES

SAMSOM II inputs may be written on eight different forms, illustrated in Appendix B. Input cards prepared from the data entered on each form will be identified by the appropriate form number in Col. 3 on all forms. All cards of the same number should be grouped together for proper ordering in the Running Deck. As illustrated in Appendix A, each group of input cards must be preceded by a card containing only the form number in Col. 3. Each group of input cards, in turn, should be arranged and inserted in the Running Deck in numerical order by form number.

Care must be taken to identify all inputs and their associated values desired in each simulation. Although inputs and values on some forms (Form No. 7) may apply to several runs in a set of simulations, users are cautioned to carefully review and withdraw inputs not used, to avoid possible errors.

Columns 73 through 80 on all forms are available for comments, identification, card sequencing, or other information. They never contain input data. All blank columns shaded in the sample formats shown in Appendix B separating different kinds of inputs on each form should be left blank. Columns not used in fields set aside for data will be ignored by the program. Zeros should be written "0", as contrasted with the letter "O", which should be written Ø. (This practice may vary for different computer installations.)

Alphanumeric and numeric entries should be made in the different fields as follows:

1. All alphanumeric information such as names of bases, missions, etc., used in a simulation must be left-justified. For example, the correct entry for designating Home Base with an abbreviation would be to write HB1 in a field as follows:

H	B	1		

2. All names appearing in several places on input forms must occupy the same relative columns in the field. For example, if a base is identified ØGDEN as follows,

Ø	G	D	E	N	

and it appears on another form as

	Ø	G	D	E	N

the computer will not recognize it as the same base. Using the general rule to begin all names in the leftmost column of the field will avoid such errors. All such names may contain any combination of alphanumeric characters.

3. All numeric information must end in the rightmost column. For example, numbers 200 and 3 should be written as follows:

		2	0	0

			3

4. Numeric fields may contain either a number representing some value, or the number of a distribution used to determine the value. A distribution is indicated by a minus (-) sign. If a distribution is desired in a decimal field, the distribution must be written to the left of the decimal. For example:

-	2	.		

-	1	6	.		

5. Decimal points have been provided on all forms, and probabilities are always written in decimal form. Elapsed times, such as sortie lengths and repair times, are written in hours, to the nearest hundredth. Simulation times, such as sortie-schedule time, end-of-run time, etc., are always written as specific days, hours, and minutes. Finally, the following names have a special meaning for the model and must not be used to identify bases, missions, aircraft types, etc.

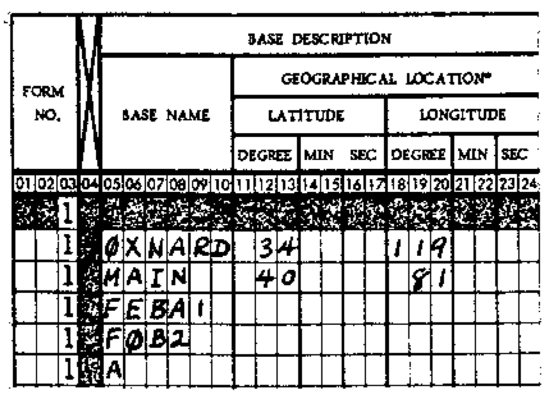
ABØRT	ALL	PØSTFT	
ALERT	PERØD	STAND	END

INPUT FORM 1

Input Form 1 identifies the bases, establishes any weather constraints, makes initial assignment of aircraft to bases, and identifies the simulation.

Base Description includes the name of the base and, if desired, its latitude and longitude. At least one base must be identified for each simulation. All bases used in the simulation must be listed; they may be given locations. The locations are optional and must be used in conjunction with mission, i.e., aircraft, speed on Input Form 2 to determine the flying time between bases.

1. As shown below,* any combination of alphanumeric characters may be used for base names.



FORM NO.	BASE NAME	LATITUDE DEGREE	LATITUDE MIN	LATITUDE SEC	LONGITUDE DEGREE	LONGITUDE MIN	LONGITUDE SEC
1							
1	ØXNARD	34			119		
1	MAIN	40			81		
1	FEBA1						
1	FØB2						
1	A						

Input Illustration 1
(Form 1)

2. Latitude and longitude entries must be in the form shown. They have no meaning for a single-base simulation, but may be useful to designate forward sites or strips, multiple bases in a network, or points in the forward edge of the battle area (FEBA).

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*All input illustrations are contrived to illustrate the particular set of inputs. Since a single, general purpose set of inputs is almost impossible to conceive, they are not interrelated.

<u>Weather</u> inputs are optional. If none are provided, the simulation will proceed as if all weather were good. Since weather may vary at different bases, it may be identified for each base. Although all bases may be given the same weather, any base not specifically identified will have good weather all the time. These inputs also must be associated with appropriate missions on Input Form 2.

The model is programmed so that levels of weather proceed from good (level 1) to worse (2, 3, ..., n). Severity increases as the numbers grow large. Associated with each level are a probability of its occurrence and a distribution used to determine the length of time, in hours, that the weather level will last if it occurs. It should be noted that a <u>distribution</u> must be used even though it may consist of only one point representing an average time.

A probability for a given weather level may be zero, but the probabilities for the n levels of weather at a base must sum to 1.0. Weather affects only sortie launches. If the weather level at a base is greater (worse) than the permissible weather level for a mission (given on Input Form 2), the mission cannot be launched.

Weather inputs include the following:

1. The base name for which the weather is to apply. If several bases are to have the same weather, they may be listed down the column.

2. The weather levels written down the column for each base or combination of bases.

3. For each level, the probability of its occurring. The probabilities for all levels at each base should sum to 1.0.

4. For each level, the number of the distribution used to determine the hours the weather condition will last. (Distributions are defined on Input Form 7.)

WEATHER*			
BASE NAME (26–31)	WEATHER LEVELS 1 - N (32–33)	PROBABILITY (34–38)	DURATION of DISTRIBUTION (39–41)
HBI	1	.5	-1
	2	.5	-2

Input Illustration 2
(Form 1)

INITIAL AIRCRAFT ASSIGNMENT		
BASE NAME (43–48)	AIRCRAFT TYPE (49–54)	QUANTITY (55–57)
HBI	F-111A	25
ØXNARD	F-4C	3
REPLAC	F-111A	4

Input Illustration 3
(Form 1)

The model begins weather at time zero and continues or changes to another level at the end of each level. Thus, a new "draw" is made at the end of each level to determine how long the next level will last.

Aircraft or Weapon Assignments inputs specify all of the different types of aircraft included in the simulation. In addition, all aircraft, including attrition replacements, must be initially assigned to some base. Later, they may be flown from base to base as the simulation directs. Input Illustration 3 from Input Form 1 shows how 29 F-111A and 3 F-4C aircraft types might be specified on this form. The aircraft types should agree with the types identified on other input forms, such as Input Form 4, which establishes periodic and postflight inspection policy.

Simulation Identification is entered on the first card in the deck (row 1 on Input Form 1); this card may contain any information. The identification will appear on all printed output.

INPUT FORM 2

Input Form 2 contains three kinds of information: mission routings and associated inputs; mission description and configuration data; and standing failure (ground malfunction) information.

Mission Routings (origin, intermediate stops, and terminal destination) must be specified for all aircraft. As illustrated

below, missions may be identified in any convenient way in the mission list field. All missions identified in a simulation must begin, stop at, and end at a base identified in the base list field. As indicated in Input Illustration 4, a mission may begin and end at different bases (MISS1), or begin at one base, include landing at specified bases along a route, and end at the original base (MISS2) or at some other base (MISS3).

FORM NO. (01–03)	(04)	MISSION ROUTING: MISSION LIST (05–10)	BASE LIST (11–16)	FLYING TIME (17–23)	ATTRITION POLICY* (24–26)
2					
2		MISS1	BASE1	1.00	
2			BASE2	.	
2		MISS2	BASE1	1.00	
2			FØB1	.50	1
2			FØB2	1.00	1
2			BASE1	.	1
2		MISS3	BASE1	1.00	
2			BASE2	2.00	
2			BASE3	.	
2		CS1	BASE1	1.00	
2			BASE2	-9.00	3
2			BASE3	.	3
2		CS2	FØB1	-1.00	
2			FØB1	.	3
2		INTDIC	FØB1	-2.00	
2			FØB1	.	3
2		CS3	FØB1	-1.00	
2			FØB1	.	3
2		CS4	BASE1	1.00	
2			BASE2	-9.00	
2			BASE3	.	

Input Illustration 4
(Form 2)

Flying Time to next base, or between bases, for a given mission may be specified in hours, to the nearest hundredth (MISS1, 2 and 3), or be drawn from a distribution (CS1). Such inputs are optional and may be skipped if the flying speed option is used. The flying time to the "next base" must be shown even if the mission takes off

and lands at the same base (CS2). Flying time to the next base should not be given for the last stop on the route.

Flying time inputs may be used to: (1) specify the flying time for selected missions or types of activity (training sorties last four hours, combat missions two hours, etc.); (2) reflect distances and flying speeds between bases or along routes; and (3) represent random flying times (sortie lengths) or simulate combinations of these characteristics of a mission. For example, assume a route (MISS3) beginning at base 1 and ending at base 3, with an intermediate stop at base 2. The flying time from base 1 to base 2 may be one hour; from base 2 to base 3 it may be two hours. Alternatively, for close support (CS1) missions the time between base 1 and base 2 may be one hour, but the time between base 2 and base 3 may be "drawn" from a distribution (No. 9) reflecting the range of flying times experienced in providing close support for Army operations out of base 2. Similarly, it may be assumed that close support or interdiction (INTDIC) missions flown from a single base (mission begins and ends at the same base) might be different and vary in length. To illustrate, close support missions (CS2) might be drawn from a distribution reflecting the average and range of times; interdiction missions (INTDIC) would be drawn from a second distribution.

Attrition Policy may be specified for any or all missions. It is optional but, if used, it brings the aircraft down (for repairs) at the next landing place or base, unless a "diversion mission" has been specified on Input Form 4. Such diversion missions allow one to specify the location of logistics support for combat damage repairs when they are included in the simulation. As explained later, attrition policy, denoted by any convenient number on this form, applies to damaged and lost aircraft and to simple air aborts (mission failures that may or may not be associated with maintenance requirements). All entries should be the same as those used on Input Form 4 because these numbers are the only way available in the model to associate selected attrition probabilities with given missions or mission legs. Since the model checks the attrition policy just prior to the

aircraft's landing at a base, attrition must not be specified for the initial launch base. See MISS2, CS1, CS2, INTDIC, and CS3 for illustrations. Additional explanation and uses of this input will be found in the discussion of Input Form 4.

<u>Mission Description</u> includes six elements of information: mission names or numbers, priorities, weather constraints, air speeds, status pools, and configurations. Since some outputs are identified by base and mission only, it is important to remember that mission inputs associate the <u>different aircraft types</u> with each mission identified in the simulation. One or more missions must be described for each simulation. Each mission must be associated with <u>only</u> one type of aircraft; however, different aircraft may fly the same mission if it is given different names.

<u>Mission Names</u> may be in any convenient form. Although mission routings do not have to parallel (be listed on the same rows) the mission name list, care should be taken to make the mission route list agree with the mission names. Both lists must contain the same names. A routing may apply to one or more missions, but a mission cannot have more than one routing.

<u>Mission Priority</u> refers to the launch priority from the three different status pools described later in this section. Priority begins with 0, and higher numbers indicate higher priorities. As shown in Input Illustration 5, close support (CS) missions given

MISSION DESCRIPTION

MISSION NAME (28–33)	PRIORITY* (34)	MIX. LAUNCH WEATHER (35)	X (36)	AIR SPEED* (37–40)	STATUS POOL* (41)	AIRCRAFT TYPE (42–47)
CS1	2				2	F5A
CS2	2				3	F4C
INTDIC	1				2	F4C
CS3	5				3	F4C
MISS1				300	1	C130
MISS2				400	1	C130
MISS3					1	C130
CS4	2				2	F4C

Input Illustration 5
(Form 2)

priority 2 will receive launch priority (within the flying program inputs) over interdiction (INTDIC) missions assigned to priority 1. These priorities establish maintenance (launch service) priority to meet outstanding launch requirements from the different status pools. In this example, close support missions would be uploaded before interdiction missions

Priorities affect not only the relationship of missions, but also the relationship of the aircraft status pools. Only scheduled alert flights (CS2) will fly aircraft from the alert pool. However, high priority* missions (CS3) may be used to preempt aircraft from the alert pool whether or not scheduled alert flights are required. Mission priorities also can be used to preempt aircraft in noncritical maintenance associated with lower priority missions. If no priority is selected, the model assumes that the lowest priority (0) was intended for the given mission (MISS1, 2, and 3).

Weather Constraints are identified as "maximum launch weather." Weather levels established on Input Form 1 must be used. It should be noted that levels identified on Input Form 1 should agree with those specified in this input. Weather severity levels higher than those entered on this form will prohibit launch during periods of such weather. Maximum launch weather specifies the highest (worst) level of weather in which the mission can be launched. If it is left blank, the mission can be launched only when good (level 1) weather prevails.

Mission Airspeed may be used with the base latitude and longitude option described on Input Form 1. The speed must be specified in nautical miles per hour, or it may be drawn from a distribution specifying different probabilities for different speeds in nautical miles per hour. Airspeed can be used if base locations have been given on Input Form 1 for the bases on the mission route. The airspeed is used to compute the flying time between bases. Since the flying time between bases can be input directly, flying speed is optional and may be determined by a draw from a distribution.

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*Arbitrarily defined in the model as any priority of 5 or over; lower priorities will not preempt from the alert pool.

Status Pool(s) to fly from should be specified for each simulation, or the model automatically flies all missions from the flyable pool. (Some entry is preferred.) Three readiness status pools have been established for the model as follows:

No.	Name	Remarks
1	Flyable Pool	Aircraft in the flyable pool are immediately ready to fly. No launch service is performed. Unless other constraints (launch service routines described later) are established, all aircraft are made available for operations through this pool. Given an appropriate launch service activity (mission configuration), aircraft will be moved from the flyable pool to the ready pool. Thus, uploaded aircraft will not be flown from the flyable pool even if an error* has called for such action in the inputs.
2	Ready Pool	Aircraft must be uploaded, i.e., go through launch service, before they are ready to be flown from this pool. In other words, ready aircraft not only are considered flyable, but also have been configured for missions flown from the ready pool. If an aircraft is uploaded for a sortie but for some reason is not flown (bad weather may cause the sortie to be cancelled), the aircraft will not be uploaded again for the same mission. If another mission calls for it, the aircraft will be downloaded** and uploaded again.

*This will be indicated by an error message, Number 105. Such an error does not stop the simulation.

**If inputs have not specified download resource requirements, the model will not reflect download time even though it "runs" the aircraft through the download routine.

3	Alert Pool	This pool is activated by the alert schedule (Input Form 5) and is used when ground alert is a part of the simulation. The alert pool contains aircraft that have been properly serviced or uploaded for alert missions. If an aircraft is launched from the alert pool, it will be replaced immediately by another aircraft, if available, from another pool unless overridden by priorities (5 or greater) established in the preceding priority inputs. Whichever pool-mission combination gets higher priority, aircraft in lower priorities will be downloaded and uploaded to meet outstanding higher mission requirements.

Aircraft Type-Mission combinations must be specified. Only the specified aircraft type can be flown on a given mission. The aircraft type given must also appear on Input Form 1. As indicated in Input Illustration 5, if a single mission (CS) is to be performed by more than one aircraft type (F-5A and F-4C), it must be given different mission names (CS1 and CS4). The same aircraft type (C-130) may be given different aircraft speeds for different missions (MISS1 and MISS2). Missions also may be given different flying times. For example, the entry for MISS3 shows no airspeed; therefore it will last as long as specified in the flying time inputs.

Although the number of theoretical combinations of aircraft, speeds, missions, and priorities is very large, practical identification of these inputs should result in a manageable set. In any event, careful and proper identification and specification of aircraft-speed, mission-priority combinations is required to avoid simulation errors and confusion in interpreting outputs.

Standing Failures are optional inputs and refer to ground malfunctions and unscheduled maintenance requirements which, in actual operations, do not seem to be directly associated with sorties. It is assumed that they are generated at random by standing stresses and are more likely to be associated with standing or readiness

status than with flying stresses. It is likewise assumed that standing failures may be discovered at any time through casual observation or during walkarounds, preflights, or other inspections. They also may be used to simulate minor tech-order compliance actions, special inspections, and random quality-control checks. As already indicated, their use in a simulation is optional, depending upon the user's assumptions and/or the availability of data. They occur only on an aircraft in the flyable, ready, and alert pools, never when it is in a maintenance status.

Standing failures may differ at various bases according to weather, policy or other reasons; therefore, each base at which the routine is to be activated must be identified and assoicated with its own standing failure inputs. The base name must agree with a base listed on Input Form 1.

Aircraft Types also may exhibit different levels or kinds of standing failures or requirements. They must be identified separately and agree with the aircraft type listed on Input Form 1.

Failure Check-Periods represent the times that failures are "checked" and may be discovered in the simulation. The model "checks" at specified intervals, such as every four hours, every hour, every 24 hours, etc. Input Illustration 6 shows checks on the F-111 every

STANDING FAILURE*			
BASE NAME	AIRCRAFT TYPE	FAILURE	
		CHECK PERIOD (−)	PROBABILITY
49–54	55–60	61–67	68–72
FTW	F-111	4.00	.003
PØPE	C-130	6.00	.001
PØPE	C141	-7.00	.002

Input Illustration 6
(Form 2)

four hours and on the C-130 every six hours. Continuous monitoring is not possible to simulate on a computer, but it can be approximated by frequent monitoring over discrete time intervals. However, if the

aircraft are monitored too frequently, computer run-time can be expected to increase. If a random check pattern is preferred, a random draw from a distribution ("-7" in the illustration) may be used. The checks begin at time zero and continue to the end of the simulation.

Failure Probabilities are written in terms of the probability that a single aircraft will fail at each specified check period. Thus, the computer checks all aircraft currently at a base one at a time (no failure, or failure) that are in alert, ready, or flyable status. In other words, aircraft in the air or in any maintenance status, including queues, awaiting parts, etc., are not subject to ground malfunctions or standing failures. All maintenance status conditions are excluded on the theory that available data inputs reflect such standing failures without distinction along with other maintenance activities. That is, they are likely to be coded, along with items broken during maintenance, as "discovered during other maintenance activities." A failed aircraft goes immediately into the appropriate maintenance specified for standing failures (STAND) on Input Form 6.

INPUT FORM 3

Input Form 3 contains two kinds of inputs: resource availability and shift alignments, and sortie make-up policy. The first identifies types and quantities of resources; the second prescribes the operations cancellation or sortie make-up policy for each mission. Since the construction of the resource shifts closely resembles that of make-up policy periods, a brief explanation may clarify the process for defining their durations and combinations.

A week is defined as a pattern of days that is repeated over and over. Although there are seven days in a week, for simulation purposes there need not be. If seven days are not accounted for, the computer will print a warning message to that effect.

Each week is composed of days, and a day is defined as a combination of resource shifts or make-up policies. Several days in the week may include similar combinations, in which case the user should define how many times any specific day will be repeated. For example, if the

five weekdays are to be identical, the user may define the day once and have it repeated five times and then define the remaining two days of the seven-day week.

Each day is composed of resource shifts or sortie make-up/cancel periods. There may be any number of shifts or periods in a day. For simulation purposes, the durations of all shifts or periods in a day need not sum to twenty-four. The program prints a warning message if twenty-four hours have not been defined and repeats the given shift pattern.

Base names defined on Input Form 1 will be used to specify where the resources are located. Resources cannot be moved among bases. However, the following inputs provide a very flexible means of specifying when any given quantity of resources will be available. Shift arrangements may be changed at any point in time by appropriate inputs, and may be different at each base included in the simulation.

The resource list identifies all resources by name and type or number. Only PT (personnel), ET (equipment), or PA (parts) are acceptable resource names. The resource type or number may be any combination of alphanumeric characters.* Unlike personnel and equipment, parts (PA) resources are used up when demanded. The present model does not include a replacement routine to simulate inventory policy or stock replenishment parameters; therefore, PA resources are of limited simulation value, i.e., for accounting for units of consumables such as fuel, ordnance, etc.

Each base-resource combination must be identified with a workweek which, in turn, must be composed of one or more working days. The user may indicate when the workweek becomes effective (Cols. 16-22; or these columns may be left blank, indicating that the week will begin at the start of the run).

Each workweek day must be defined by a number and show the number of times it is to be repeated. The number of the first day should be one, and the total number of days accounted for in a week should, but need not be, seven. As shown in Input Illustration 7,

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*Time delays (TD), identified on a subsequent form (6) and reflected in outputs, are not considered or treated as resources on Input Form 3.

the weekdays might be defined as one (1) and repeated five times in succession, and the weekend could be defined as another day (2) repeated twice (HB1, PT1). Other workweeks are defined for other bases and resources in the sample. Note that they also must be defined for equipment (ET6).

FORM NO. (01–03)	(04)	BASE NAME (05–10)	RESOURCE LIST: PT ET PA (11–12)	RESOURCE LIST: TYPE or NO. (13–15)	WEEK BECOMES EFFECTIVE: DAY (16–18)	WEEK BECOMES EFFECTIVE: HR (19–20)	WEEK BECOMES EFFECTIVE: MIN (21–22)	WORKWEEK DAY: Day No. (23–24)	WORKWEEK DAY: Times Reported (25–26)	SHIFT DEFINITION: Shift No. (27–28)	SHIFT DEFINITION: DURATION (29–34)	SHIFT DEFINITION: RESOURCE QUANTITY (35–38)
3												
3		HB1	PT	1	0	0	0	1	5	1	24.00	15
3								2	2	1	24.00	5
3		HB2	PT	1	0	0	0	1	5	1	8.00	20
3										2	8.00	10
3										3	8.00	3
3								2	1	1	24.00	4
3								3	1	1	24.00	2
3		HB2	ET	6				1	5	1	24.00	6
3								2	2	1	24.00	4

Input Illustration 7
(Form 3)

The beginning of a workweek is a key input on Form 3. Any workweek may be associated with any number of bases and resources, but whenever a new workweek is defined (a new workweek day No. 1 occurs), the bases and associated resources must be relisted. In other words, whenever a new workweek is defined, all previously listed bases and resources and aggregations thereof for previous workweeks are lost and must be repeated if they apply to the new resource.

Shift definitions include three kinds of information, all of which must agree with their corresponding workweek/resource/base combinations:

Shifts will be numbered from one to n. Each working day must be composed of one or more shifts.

Shift duration will be specified by the user in terms of hours and hundredths, and the sum of these shifts will usually, but need not, be 24 hours.

> Resource quantities will be specified or be determined by a distribution designed to represent variations in availability from shift to shift. Several examples are provided in the illustration. At HB1, PT1 works a 24-hour shift for 5 days a week, and a 24-hour shift on the weekend. During the week, 15 personnel of this type are available around the clock; over the weekend the number available is reduced to 5. In this case, we might interpret the actual shifting arrangement several ways: as 2 twelve-hour shifts, 3 eight-hour shifts, or as some other combination of shifts, each of which would provide the same number of resources available for work.

Shift arrangements at HB2 are different. PT1 works a 5-day week, and two more separate days complete the week. There are three shifts for day 1 (5-day week), each 8 hours in duration. The number of PT1 personnel available over the three shifts is 20 for Shift 1, 10 for Shift 2, and 3 for Shift 3. The arrangement for equipment ET6 at HB2 shows 6 pieces available during the week and 4 over the weekend. Perhaps the two missing units were in maintenance.

Finally, it should be understood that personnel (PT) resources may be specified either in terms of individuals (from a manning document) or as teams or crews. In both cases, the user must correctly relate them to demands on Input Form 6; i.e., teams should be used (normally one at a time) or one or more individuals should be used to make up a team (average number of some number specified by a distribution). As discussed later, the number of people forming a crew or team may be determined by a distribution of team sizes.

Sortie make-up policy must be identified for each mission included in the simulation, or the model assumes that sorties will be saved and made up indefinitely. Since these policies usually are cycled on a daily basis, the sortie make-up policy is very similar in composition to the workweek and resource-shift policy. The only difference is that a shift for a resource indicates a duration of time that some quantity of a resource is available. The period for a make-up policy indicates the duration that a certain policy will be in effect.

The mission list is self-explanatory and should agree with mission information provided on Input Forms number 1 and 2.

Policy becomes effective at a time specified in terms of the day, hour, and minute desired for the given simulation. If the effective time is left blank, the policy will begin at the start of the run. However, the user is cautioned that mission make-up policy should be defined starting from time zero, because undefined mixes cause model logic problems.

The flying week is composed of flying days that are repeated some number of times during the week. The first day is always numbered 1. Any number of repetitions may be specified but usually will be similar to workweek arrangements.

The policy code identifies the policy for each given period. A sortie make-up policy may have two actions, one when it goes into effect and another during the time it is effective. The possible make-up policies are as follows:

Policy Number	Name	Action When It Goes Into Effect	Action While It Is Effective
1	Make-up	Model attempts to makeup any sorties previously saved. If they cannot be made up, they will be cancelled.	All sorties that cannot be launched on schedule will be cancelled.
2	Save	Any sorties previously saved will continue to be saved.	Any sorties not made will be saved. Make-up will not be attempted.
3	Make-up and Save	Model attempts to make up any sorties previously saved. If they cannot be made up, they will be saved.	Any sorties not made, including those previously saved, will be saved. When an aircraft becomes available, make-up will be attempted. If the make-ups are not successful, sorties will be saved.

Policy Number	Name	Action When It Goes Into Effect	Action While It Is Effective
4	Cancel	All sorties previously saved are cancelled.	All sorties not made when scheduled are cancelled.
5	Cancel then Save	All sorties previously saved are cancelled.	All sorties not made when scheduled are saved. Make-up will not be attempted.
6	Save then Cancel	All sorties previously saved will continue to be saved.	All sorties not made when scheduled will be cancelled but those brought forward from a previous period will continue to be saved.

Illustrative examples of sortie make-up policies are given in the following Input Illustration 8. The policy for RT1 becomes effective when the simulation begins and is continuous. All sorties scheduled on Input Form 5 will be made, made up, or saved until the simulation ends. The policy for RT2 begins on Day 30, Hour 0, and Minute 0, and is a sequence of different policies. Day 1, which is repeated five times in succession, is divided into four periods. The first period lasts 12 hours. At 1200 hours, the next policy (4) goes into effect and lasts 6 hours. At 1800 hours, policy number 2 goes into effect and lasts 4 hours. Policy number 3 is in effect the last two hours of the day, and the sequence begins again. After five sequences (days), Day 2 is in effect for two days. This day is divided into two 12-hour periods during which policies 3 and 4, respectively, are in effect. When these two days are over, the 5-day sequence will be repeated. Policy number 3 will be effective around the clock for missions named RT6, RT7, and RT8.

Many other combinations are possible. The primary precaution is that all policies and periods should be constructed so that they agree with the sortie schedules and requirements established on Input Form 5. The two forms should be cross-checked for consistency because is is possible to set up a schedule that the make-up policy will change after a few hours of simulated operations. In addition,

SORTIE MAKE-UP POLICY								
MISSION LIST	POLICY BECOMES EFFECTIVE			FLYING WEEK		FLYING-DAY DEFINITION		
	DAY	HR	MIN	Day No.	Times Reported	Period No.	PERIOD DURATION	Code No.
40 41 42 43 44 45	46 47 48	49 50	51 52	53 54	55 56	57 58	59 60 61 62 63 64	65
RT1	0	0	0	1	7	1	24.00	3
RT2	30	0	0	1	5	1	12.00	3
						2	6.00	4
						3	4.00	2
						4	2.00	3
				2	2	1	12.00	3
						2	12.00	4
RT6	0	0	0	1	7	1	24.00	3
RT7							.	
RT8							.	

Input Illustration 8
(Form 3)

one should be careful to identify a continuous set of policies and avoid automatic model assignments of make-up policy No. 3, which might not be desirable for the given simulation.

INPUT FORM 4

Input Form 4 includes two kinds of inputs: (a) attrition and air abort constraints and policy, and (b) aircraft inspection policies and ground abort rates.

Attrition and air abort constraints and associated policies are optional inputs. They allow the user to simulate combat conditions. They also allow some flexibility in the scheduling of missions by allowing missions to be rescheduled if they fail, permitting aircraft to be diverted when damaged.

The policy number ties the attrition policy to missions or mission legs identified on Input Form 2. The attrition policy is checked immediately prior to the arrival at a base. Thus, the policy defined for a stop on a route would encompass all exposures, evasive actions, etc., from the last to the present stop. This allows considerable

flexibility. For example (see Input Illustration 9), if a dummy base is defined as a target, it becomes an intermediate stop on a route. Therefore, policies may be different before aircraft reach the target (Policy 1) and after they pass over the target (Policy 2).* In addition, the user might wish to replace (Code 3)* all lost aircraft, whether they were lost before or after reaching the target, but wish to reschedule (Code 1) only those missions that fail prior to reaching the target. Finally, it should be noted that the policy number should agree with a policy number listed in the routing on Input Form 2.

		ATTRITION AND AIR ABORT CONSTRAINTS*										
			POLICY BECOMES EFFECTIVE			ATTRITION AND AIR ABORT PROBABILITIES			REPLACEMENT POLICY		MISSION FAILURE POLICY	
FORM NO.		POLICY NO.	DAY	HR	MIN	COMBAT DAMAGE	LOST AIRCRAFT	AIR ABORT	Code No.	REPLACEMENT MISSION	Resched. code	DIVERSION MISSION
01 02 03	04	05 06 07	08 09 10	11 12	13 14	15 16 17 18 19	20 21 22 23 24	25 26 27 28 29	30	31 32 33 34 35 36	37	38 39 40 41 42 43
4												
4		1				.001	.000	.002	3	REPLAC	1	DIVERT
4		2				.005	.004	.001	3	REPLAC	0	

Input Illustration 9
(Form 4)

Policy becomes effective on some specified simulation day, hour, and minute. If these columns are left blank, the policy becomes effective at the beginning of the run. This feature allows the user to redefine attrition and air abort policies at any point in time. In terms of SIMSCRIPT, this is an exogenous event and must be specified for all policies and changes.

Attrition and air abort probabilities are similar kinds of inputs and are interrelated in their impact upon the given mission. Occurrence of either kind of event on a given sortie causes the

*Replacement and reschedule codes are explained in subsequent paragraphs.

sortie, but not necessarily the mission, to fail.* Regardless of the probabilities used, only one of the following kinds of events can happen to a single aircraft on a single mission. Their sum cannot be greater than 1.0, and if it is 1.0, there will be no successful missions.

The probability of combat damage (referring to a single aircraft) is used to simulate combat damage and the resulting aircraft downtime and repair requirements. Separate maintenance can be performed on combat-damaged aircraft, as specified on Input Form 6. Such an aircraft cannot be lost, but it may result in mission failure.*

The probability of aircraft being lost is used to simulate combat attrition losses, i.e., to identify aircraft that are totally destroyed and therefore lost to the available force. Lost aircraft disappear from the simulation and may or may not be replaced, as provided in subsequent inputs. A lost aircraft may cause mission failure but will not result in demands for damage repairs.

Air abort probabilities are used to simulate air aborts due to operational causes (weather, pilot error navigation error, etc.). Unlike combat damage, they are not connected with subsequent special maintenance requirements; however, sorties that air abort are similar to any other sortie in their generation of regular maintenance requirements. As explained later, an air abort may be used to represent single-mission failures and target misses.

Combat-damaged and lost aircraft may be replaced by aircraft from another base or source, including dummy bases that have no other purpose but to serve as "replacement" pools.

Replacement policy may be specified by one of the following four codes:

Code	Policy Meaning
1	Do not replace
2	Replace combat damage only
3	Replace lost aircraft only
4	Replace both lost and combat-damaged aircraft.

---

*Given multiple sorties (sortie elements) in a mission, a single sortie may fail but the mission fails only if all sorties in it fail.

Replacement aircraft, if any, must be flown in over a designated replacement mission or route. Although a mission must be identified on Form 4, it will not be scheduled on Input Form 5. The routing of these missions on Input Form 2 specifies the base to get the aircraft from, their flying time, and their destination. Thus, replacement flying time may be fixed or be a variable drawn from a distribution. Special inspection or maintenance can be performed on the aircraft when they arrive by specifying the maintenance for the mission on Input Form 6.

Mission failure policy also involves other alternatives that may be included in the simulation. A code has been provided to indicate whether or not a failed mission may be rescheduled. If failed missions are to be rescheduled, place a "1" in this column. Note that if an aircraft receives combat damage, is lost, or suffers air abort, it constitutes a "mission failure" for the given aircraft. In addition, if more than one aircraft must be used to perform the mission,* all the aircraft on the mission must fail their objective for the mission to be rescheduled. To specify that more than one aircraft must be used on a mission, the minimum number of aircraft on a mission on Input Form 5 is made greater than 1.

If a sortie is to be diverted in the event of mission failure or if combat-damaged aircraft or air aborts are to be diverted to some alternative base for repairs, a "diversion mission" must be identified.** This option permits one to establish a location of logistics support for combat-damaged aircraft and provide for landing at alternate bases. In effect, such diversion missions interrupt other mission-routing sequences. In such arrangements the diversion mission must begin at the base where diversion occurs, and the next base would be the alternate or the repair base.

---

*This reference to "mission" should not be confused with single-sortie missions involving varying numbers of aircraft used one at a time. A mission also may include multiple sorties or sortie elements involving more than one aircraft.

**The identification "DIVERT" shown in Illustration 9 is not mandatory; any convenient identification may be used.

<u>Inspection and ground abort policy</u> involves three inputs. Each aircraft type must be identified with the policy desired for the simulation. Periodic and postflight inspections are generated for each aircraft as a function of flying time since its last inspection. All aircraft in a simulation are initialized to spread their entry into inspection evenly, i.e., they are assigned times-to-next-inspection so that some aircraft will be just ready for the next inspection when the simulation begins, but one or more will begin inspection as soon as the aircraft return from their first sorties.

<u>Periodic inspection</u> intervals are stated in terms of flying time (hours) between inspections, as shown in Input Illustration 10.

INSPECTION AND GROUND ABORT POLICY*			
AIRCRAFT TYPE	INSPECTIONS		GROUND ABORT RATE
	PERIODIC	POST FLIGHT	
45-50	51-54	55-58	59-63
F-101	100	50	.001
F-102	30		.075
F-106		40	.

Input Illustration 10
(Form 4)

<u>Postflight</u> inspection intervals are provided in a similar manner.

In general, periodic inspection intervals will be some multiple of postflight intervals, as shown in the illustration. The model will not put the same aircraft in both inspection categories at once; the periodic will be done and the postflight will be cancelled. Separate maintenance will be specified on Input Form 6 for both periodic and postflight inspections. Sorties triggering inspections when they land also may generate unscheduled maintenance requirements, if provided for in the inspection (PERØD or PØSTFT) inputs. If inspections are not desired in a simulation, the interval entry should be left blank. This bypasses the routine. A large number (999)

provides approximately the same results except that the initialization routine puts one or more aircraft in the relevant inspection after the first sortie. Even if such inspections last zero time, the simulator causes the aircraft to miss the other maintenance the user might want them to receive. Such cancellation occurs because inspections (PERØD or PØSTFT) are identified in the "mission" field and cancel other mission maintenance requirements.

Aircraft may be inspected at a designated base other than where they are initially located or where they land when the inspection comes due. If this is desirable, appropriate inputs must be provided on Input Forms 6 (NRTS policy) and 8 (designated base and flying time).

Ground aborts are the source of another kind of unscheduled maintenance, except that they are generated by attempts to fly. Hence, every simulated flying schedule designed to achieve a given level of flying should be scaled upward to account for the ground abort rate used in the simulation. If ground abort is desired, the probability of a single aircraft failing during takeoff should be given. Separate maintenance can be specified on Input Form 6 to repair aircraft that have suffered ground abort. Note that a ground abort rate is associated with an aircraft type without regard to mission configuration or base location. However, ground aborts generate make-up sorties according to the sortie make-up and cancel policy in effect for the given period and mission at the time the ground abort occurs. (See Input Form 3 for discussion of make-up policies.)

INPUT FORM 5

Input Form 5 includes all inputs controlling (1) sortie requirements and schedules, and (2) alert schedules.

Sortie schedules and requirements inputs identify missions, launch times, cycling options, configurations or launch service*

---

*Launch service includes arming actions, uploads, downloads, pod and pylon installation and preflight activities.

lead times, sortie launch probabilities, and flight-element or sortie-group size.

Missions must be the same as those defined on Input Forms 2, 3, and 6.

Launch time means the day, hour, and minute during the simulation the specific mission-sortie package (one or more sorties) will be launched, if possible, or the time some repetitive cycle of operations or flying schedule will begin.

Sortie cycling inputs are optional, but they often provide an easy way to prepare a repetitive sequence of sortie requirements ranging from one every minute* to a large number once each day or some other peiord of time. Such cycles of "schedules" or requirements may be discontinued at any time and begun again later. Many, but not all, sortie-generation requirements may be set up using these input alternatives.

If the sorties are to be cycled, the user provides a cycle interval to control launches. This time is specified in hours and hundredths or may be determined by a draw from a distribution if random intervals are desired.

Discontinue cycle inputs are used to adapt sortie requirements or schedules to the simulation. Unless discontinued, the cycle will repeat until the simulation ends.

Launch service lead time is an optional input that may be used to provide a lead time for making resource assignments to upload weapons, complete preflights, etc. Typically, lead times are used to generate personnel and equipment requirements early in the morning or prior to selected missions. They also may be used to differentiate between a situation in which warning may be assumed and one for which launch service requirements cannot be anticipated.

---

*Users should not schedule repetitive sequences to occur less than one minute apart. Otherwise the program may enter a loop.

As scheduled* sorties are generated by the program, resources begin to upload at launch time minus lead time for launch service. Care must be taken to avoid negative lead times when a simulation begins. For example, if a sortie scheduled at Hour 1 of Day Zero is preceded by a two-hour lead time, an error results. Lead times may not be used with missions flown from the flyable status pool. It is used with missions flown from the ready and alert pools. It also should be noted that aircraft uploaded for a given mission that is cancelled for some reason will not be uploaded twice if they are required for the same kind of mission at a later time. On the other hand, priority mission requirements may cause some aircraft to be uploaded, downloaded, and re-uploaded, whether or not such action is realistic.

Combinations of sortie launch probabilities provide a capability to generate requirements to launch a random number of sorties at different times. This feature, together with the capability to use a distribution to determine when to repeat some random number of sorties, and the sortie cancellation and make-up policies, allows sortie-generation requirements** to be completely random but controlled to fit some desired pattern. For example, a combination of these inputs may be used to generate requirements for a random number of sorties every hour during daylight hours, or a specific sortie requirement at a random time each day along with a specific number at fixed times.

Sortie-element size or flight-element inputs permit the user to specify any number of sorties (and only the specified number) at a time; or some minimum and maximum number (which, in turn, may be drawn from a distribution) within some range of numbers specified

---

*Make-up sorties generated by previous ground aborts or schedule deficits are not included in the lead-time routine; therefore, it may not be useful for some kinds of schedules which generate many of these kinds of events.

**Sortie-generation requirements do not necessarily produce sorties. Under some circumstances, the requirements may exceed the capability of the simulated organization to launch the required sorties.

by the distribution that can be launched at the scheduled time. Thus, the user may effect a policy of "never launch less than two aircraft on this kind of mission, but launch any number available above two that may be possible at the time to satisfy the requirement."

Care must be taken that the minimum number of aircraft to fly in a sortie is not greater than the maximum number called for. The sortie-element will not be launched unless the minimum number of aircraft can get into the air. A minimum of 1 is assumed if no minimum is specified. When a minimum number of aircraft greater than 1 is specified, the aircraft are flown in "formation," and even if the flying time for the mission is random, all of the aircraft in the sortie-element will take off and land together on all stops on the mission. A minimum greater than 1 also affects the mission failure routines, as explained in the discussion of Input Form 4.

The maximum number of aircraft to fly must be given. If desired, maximums can be obtained by a draw from a distribution. If a distribution is specified, care must be taken to insure that all values in the distribution are equal to or greater than the minimum size. When a minimum and a maximum are used, the sortie will not be launched unless the minimum number of aircraft is available. If the minimum is available, as many aircraft as possible up to the maximum will be launched.

Combinations of random and fixed sortie-generation requirements are illustrated by the following entries on Input Illustration 11. Corresponding distributions and reference to sortie cancellation and make-up policies are included. The distributions are used as examples for Input Form 7.

The entries for close support missions (CS1) show a schedule of requirements being generated each hour from 0703 through 1800,* beginning at Day 0 and ending at Day 10. The sortie launch probability is 0.5 that some number of sorties will be required

*In this case, we generated the requirement at 3 minutes after the hour. It could have been generated at any time or at different points in time between the hours.

Form No.	Mission	Launch Time: Day	Launch Time: HR	Launch Time: MIN	Sortie Cycles*: Cycle Interval	Discontinue Cycle: Day	Discontinue Cycle: HR	Discontinue Cycle: MIN	Launch Service Lead Time*	Sortie Launch Probability	Sortie Element Size: MN	−	Sortie Element Size: MAX
5													
5	CSI	0	7	3	24.00	10	00	00	4.000	0.500			-1
5	CSI	0	8	3	24.00	10	00	00	4.000	0.500			-1
5	CSI	0	9	3	24.00	10	00	00	4.000	0.500			-1
5	CSI	0	10	3	24.00	10	00	00	4.000	0.500			-1
5	CSI	0	11	3	24.00	10	00	00	2.00	.			-2
5	CSI	0	12	3	24.00	10	00	00	2.00	.			-2
5	CSI	0	13	3	24.00	10	00	00	2.00	.			-2
5	CSI	0	14	3	24.00	10	00	00	2.00	.			-2
5	CSI	0	15	3	24.00	10	00	00	2.000	0.700			-1
5	CSI	0	16	3	24.00	10	00	00	2.000	0.600			-1
5	CSI	0	17	3	24.00	10	00	00	2.000	0.500			-1
5	CSI	0	18	3	-3.00	10	00	00	2.000	0.400			-1
5	RECØN1	1	00	00	-3.00	12	00	00	1.00	.	1		3
5	INT	5	05	30	-3.00	6	00	00	2.00	.			-1
5	INT	7	08	00	-3.00	8	00	00	2.00	.			-2
5	INT	9	09	45	-3.00	10	00	00	2.00	.			-2
5	INT	5	15	00	4.00	15	00	00	2.00	.	5		5
5	INT	7	18	00	2.00	30	00	00	2.00	.	4		4
5	INT	9	19	00	24.00	45	00	00	2.00	.	2		2

Input Illustration 11
(Form 5)

for each of the hours 7 through 10. From hours 11 through 14 it is 1.000 (no entry required). From hours 15 through 18, the probability changes from 0.700 down to 0.400 that some number of sorties will be required at each launch time. The number of sorties required will be determined by draws from distributions* numbered 1 and 2, which follow:

---

*Sortie-element minimum is not required when using the distribution routine signified by a minus sign, because the model translates no entry to mean 1.

Distribution No. 1

Probability	Sortie-Element Maximum
.300	2
.300	3
.200	4
.100	5
.005	6
.005	7

Distribution No. 2

Probability	Sortie-Element Maximum
.100	3
.500	4
.200	6
.100	8
.100	9

Although not shown here, the corresponding sortie cancellation, make-up and save policy (Input Form 3) for CS1 might be policy number 4 (cancel all sorties not made on time) for 24 hours a day beginning at Day 0. Obviously, the policy could be different for different days or time periods.

The entries for CS1 also provide for a random number of sorties from 2 to 7 (Distribution Number 1) during the first and last parts of the day, and from 3 to 9 (Distribution Number 2) during the middle part of the day. In addition, the random number of sorties generated for the different hours might or might not actually be required as dictated by chance and the sortie-launch probabilities entered for the different hours.

Reconnaissance missions (RECON1), on the other hand, would be generated at different times during the 12-day period. The specific time for each day would be generated from Distribution Number 3* according to the probabilities for each cycle interval, as shown below.

Distribution Number 3

Probability	Cycle Interval (hours)
.50	9
.55	12
.70	14
1.00	16

*Cumulative probabilities have been used in this distribution to illustrate the alternatives. See discussion on Input Form 7 for additional information on distributions.

The first launch would be at 0000 hours on Day 1, but thereafter the interval between reconnaissance missions will be randomly determined by the values in the distribution. Of course, other periods and times could have been specified and the probabilities might have been equal for all times used, or different for the different cases. As indicated, the time of mission requirement is random, but the requirements are specified. During this period, the simulation will launch 1, 2, or 3 aircraft at the time required.* Again, corresponding make-up policy might cause the requirements to be cancelled if not made on time, or be made up later within some period of time such as 30 minutes, 3 hours, or longer.

Interdiction missions (INT) provide additional examples and include inputs that would generate both variable and specific requirements at variable and specific times during the simulation. On Days 5, 7, and 9, after the first launch at the different hours for each day the requirement would be for a varying number of sorties at varying times. On Day 5 at 1500 hours and repeating every 4 hours thereafter until Day 15, the requirement would be for five sorties. Such a "schedule" could be used to simulate air alert, around-the-clock bombing, fly-overs, etc. On Day 7, at 1800 hours and every two hours thereafter until Day 30, there would be another requirement for four more sorties. Thus, the simulation would attempt to launch five sorties every hour, and four more every other hour on the even hours. Finally, beginning on Day 9 and repeating every 24 hours (each day) thereafter until Day 45, it would attempt to launch two aircraft at 1900 hours each day.

To complete the discussion of Input Illustration 11, it will be noted that the launch service lead times vary for the same mission during different times of the day and for the different missions. The entries have no particular meaning, other than to illustrate that

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*In all cases, the number actually launched will be determined by the capability of the unit in the simulated operations; it might be all, some, or none.

the lead times may differ for different missions and for different time periods.

Alert schedule inputs activate the alert pool routine and priorities, and they may be used to generate operations requirements alone or in combination with other sortie-generation requirements. For example, on-call close support sorties might be met by random launches from an alert pool, with other requirements being flown from the ready or flyable pools.

As indicated in Input Illustration 12, alert schedules are associated with given bases and aircraft types. Thus, every base and aircraft type combination must be identified for which alert is desired.

Each alert schedule begins on the prescribed simulation day, hour, and minute. Any given schedule (C-130) ends (Day 10) when a new schedule supersedes it, or continues until the end of the simulation. Aircraft may be put on or taken off alert at any time.

Quantity on alert is self-explanatory. The quantity specified will be kept on alert so far as possible with the given force size and logistics support capability. The entry also may be zero (B1, F-4C) and thus discontinue any alert schedule set up during a previous period of time.

ALERT SCHEDULE					
BASE NAME	SCHEDULE BEGINS			AIRCRAFT TYPE	QUANTITY ON ALERT
	DAY	HR	MIN		
51–56	57–59	60–61	62–63	64–69	70–72
B1	0	0	0	F4C	4
B2	10	5	0	F101	6
B2	12	0	0	RF101	1
B3	15	9	5	F5A	3
B3	1	0	0	C130	2
B3	10	0	0	C130	3
B1	20			F4C	0

Input Illustration 12
(Form 5)

Because alert schedules are given priority in the model, it is important to understand the interactions among alert schedules, maintenance events, and mission priorities. Aircraft can be removed from the alert pool by the schedule of alert, by an aircraft suffering a standing failure, by a mission being flown from the alert pool, or by a mission requirement with a priority equal to or greater than 5. A schedule change in alert is self-explanatory. Launched alert sorties or aircraft experiencing standing failures cause another aircraft, if available, to be placed on alert to fill the void. Thus, the model attempts to <u>maintain</u> the alert schedule. Although it never preempts aircraft from other sorties, the routine will attempt to keep the required number in the alert pool until the requirement is removed or lowered or a higher-priority mission requirement (Priority 5) is generated that preempts alert aircraft from the pool. Depending upon simulation purposes, these alert pool conditions and constraints may or may not be a desirable model capability.

INPUT FORM 6

Input Form 6 contains maintenance parameters and requirements, resource requirements, and an entry to end the simulation. In some cases, the form is simple and easy to complete; in others it contains a complex set of inputs and must be prepared with considerable care. Simple simulations, involving only maintenance turnaround requirements, require a simple set of maintenance inputs. However, complex simulations usually require many crucial inputs, which should be carefully completed and cross-checked to avoid errors.

<u>Maintenance parameters</u> are identified with bases (both takeoff and landing), and (through the mission association) aircraft types.* They also are identified with aircraft systems. Systems, in turn, may be identified in terms of the work done by the different shops or

---

*This is why the model is programmed to require unique mission/aircraft-type combinations identified on Input Form 2.

work centers, or as conventional Air Force systems* identified in AFM 66-1 data.

Base names will agree with those previously identified in the simulation. Each base at which maintenance is performed must be associated with its related maintenance data combinations.** Launch service requirements will be at takeoff base, other maintenance will be where aircraft land or as directed by the NRTS inputs (Not Reparable This Station).

All missions associated with a given set of maintenance requirements and inputs for a given aircraft type must be identified. In addition, aircraft may receive maintenance unassociated with some mission, as follows:

ALERT -- Upload before going on alert
ABØRT -- Ground abort
PERØD -- Periodic inspection
PØSTFT -- Postflight inspection
STAND -- Standing failures

In other words, the aircraft may receive maintenance after a ground abort, as part of periodic or postflight inspections, or as repairs to correct a standing failure. Each of these kinds of maintenance must be listed in the mission field if maintenance is being described for it. Inspections should also be cross-checked against NRTS entries on later input forms.

All maintenance types should be specifically identified (separately) with each mission. It should be noted that if identical maintenance is to be done at several bases, the bases may be listed down the columns. If identical maintenance is to be done at all bases, the user may write "ALL" in the Base Name field (Cols. 5-7). Similarly, if identical maintenance is to be done for several missions, the missions may be listed down the columns, or if identical maintenance is to be done on all missions, "ALL" may be entered in the Mission field (Cols. 11-13).

---

*Two-digit work unit codes and appropriate aggregations of the support-general codes.

**Maintenance input examples are illustrated later (p. 46), after discussion of maintenance interrelationships and input logic.

The different types of maintenance activity are identified and described below:

Code	Maintenance Type
DC	Debriefing, communications lags, etc.
TS	Trouble-shooting
UM	Unscheduled maintenance
FC	Functional checks
IS	Inspections
FS	Fuel-servicing
LS	Launch service (Upload)
DL	Download
CDTS	Combat damage trouble-shooting
CDUM	Combat damage unscheduled maintenance
CDFS	Combat damage fuel-servicing

Figure 2 illustrates optional "flows" of maintenance activity. Normally, maintenance would be performed in the steps outlined, from debriefing through fuel-servicing. As indicated, some flows begin with a specified activity, such as a standing failure or a sortie schedule. The associated maintenance may begin at a later step, such as unscheduled maintenance for inspections, but not before. Any step may be eliminated from the flow by not providing for it in the inputs. For example, the dashed line shows an alternative for inspection (IS) which would exclude all other maintenance activities.

Each of the maintenance activities not associated with missions (ABØRT, STAND, etc.) also may be subdivided into the different types of maintenance. Thus, ground aborts typically would be associated with unscheduled maintenance (UM) and functional checks (FC). They might or might not generate additional refueling or servicing requirements. As shown by the branching in the figure, periodic (PERØD) and hourly postflight (PØSTFT) inspections, in turn, might be handled as packages under inspections (IS) or be subdivided into the various types of maintenance activity, beginning with troubleshooting (TS). The actual sets and combinations of maintenance used depend upon data availability and simulation requirements.

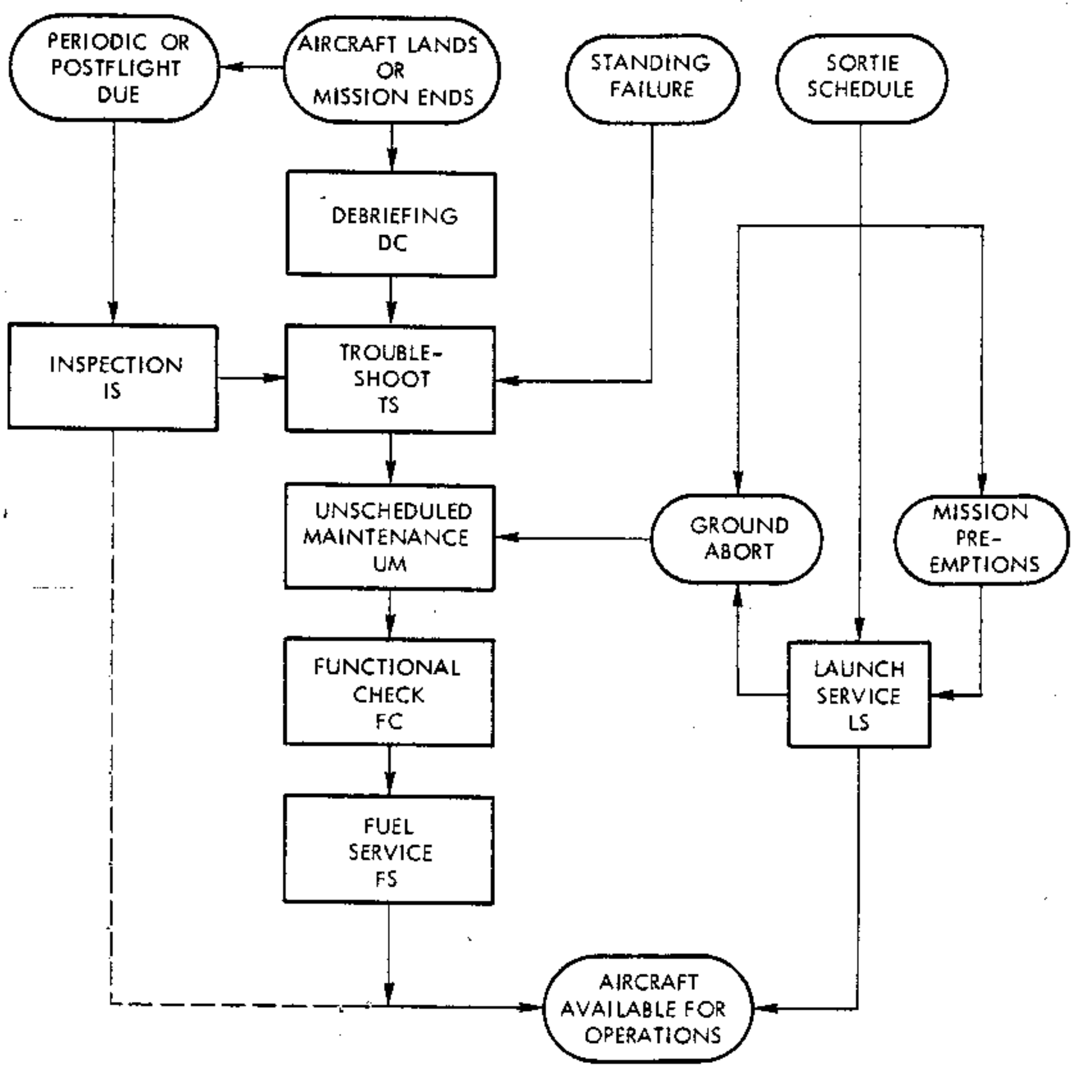

Fig. 2 -- Typical maintenance-activity flows

With certain limitations, selected maintenance activities may be substituted for others or be used to represent different events in a simulation. For example, debriefing activities at an intermediate stop (enroute base) may actually represent offload and onload activity for a cargo aircraft. Associated with different personnel types (which could not work together), offload could be kept separate from onload activities. Such activity could be simulated in other ways. For example, offload could be debriefing maintenance (DC) and onload could be fuel service (FS). At base of origin, but not at intermediate stops,* launch service (LS) might represent cargo loading activities.

The NRTS policy is used to identify maintenance types (UM, TS, etc.) that must be corrected or fixed at another base. An entry in this column causes the aircraft to be flown to another base and all maintenance of this type is done at the other base. NRTS policies are further defined on Input Form 8.

Systems inputs include systems identifications, failure probabilities, and the probability of the failure, if any, being critical.

The systems list may include different parts of the aircraft (radar, power plant, airframe, etc.) or refer to the aircraft as a whole. Systems also may be used (related to shops) to identify the different parts of the aircraft from the point of view of the work centers or shops. If systems are not wanted, "ALL" is used to indicate that the maintenance will be done on the aircraft as a whole. As explained in the discussion on Input Form 8, systems may conflict and prevent concurrent maintenance.

Failure probabilities are used to cause failures and demands for the corresponding resources to perform the necessary maintenance. As previously discussed, they may either refer to specific systems or cover the whole aircraft. If no failure probability is entered, a probability of 1.000 is assumed.

Criticality probability. If desired, all or selected maintenance activities and/or system failures, but not tasks and resource requirements within systems, may be given a probability of being critical. The model attempts to do critical jobs first. Aircraft cannot be preempted from maintenance for priority missions if an outstanding

*Launch Service (LS) activity may be used only at bases of mission origin.

failure is critical, i.e., if critical maintenance is being done or is awaiting resources.

If, within a maintenance type, only noncritical maintenance remains to be done, the aircraft may be preempted. In such cases, all maintenance not yet begun will not be "remembered" and done later. Therefore, noncritical maintenance should be included as part of unscheduled maintenance (UM), which also should be the last maintenance type. If the aircraft is not at the home base (origin of its mission), additional noncritical maintenance will not be started after all critical maintenance has been finished; rather, it will be held to be done concurrently with the next critical maintenance to be done. If the resources required for noncritical maintenance are not available at a base other than the aircraft's home base, it will not be "grounded" for such maintenance. However, unavailability of resources to do noncritical maintenance at the home base sets up a resource "D/NA" condition (resource is demanded but not available) there which will continue until the resource is available or the aircraft is preempted. No entry means that all applicable jobs for the system are noncritical. The probability may be any desirable proportion to fit assumptions or facts.

Maintenance requirements describe the various tasks that must be performed for a given set of maintenance parameters. Each task or maintenance requirement, in turn, is composed of resource requirements. Each maintenance requirement must be associated with one or more resource requirements. Unless prevented by sequencing, conflicting maintenance, and maximum-personnel constraints* discussed later, all resources associated with a given maintenance requirement or task work together. Unless interrupted by shift changes, the resources will work on the task until it has been completed. Maintenance requirements are processed in the order in which they are listed. Unless prevented by constraints, all maintenance requirements for

*Maximum number of people that can work at one time, conflicting systems, and task-sequencing rules.

a given system will be started as soon as possible by processing them "simultaneously."*

Duration of a maintenance requirement or task refers to the elapsed time to repair, inspect, trouble-shoot, etc. -- that is, to how long it takes to complete the job, do the task, or fix the failure. Each duration entry must be associated with at least one resource. It establishes how long the resource(s) will be required. If it is intended for the entry to apply to more than one resource, the first resource listed must have a duration specified. If the duration is omitted for any subsequent resource, it will be used as long as the prime (first) resource is required. Of course, different resources may work different times and any given duration may be obtained from a distribution.

Probability of a maintenance requirement or task is associated with its corresponding duration and may differ from the system failure to which it is related.

The sequence code may be used (a) to require that some tasks be completed before others, or (b) to begin work on some tasks only when work has begun on another task. A "1" punched in the sequence code column indicates that the following tasks on that system and/or maintenance type of activity cannot begin until the current one is completed. A "2" indicates that the following task may not begin until the current one has started to work. No punch or a zero simply means that the next maintenance will be done simultaneously. No task will begin until all of the resources (PT, ET, PA) it requires are available and any time delays (TD) have been accounted for.

Resource requirements refer to the different kinds of resources that may be associated with given maintenance requirements or tasks.

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*It should be noted that nothing is actually done simultaneously on a computer. Jobs can be done one at a time without advancing the "clock"; however, the effect is the same as if they were done simultaneously. Since the computer does them one at a time and in the order listed in inputs, the first one listed will have first call upon any available resources needed.

Resources consist of personnel (PT), equipment (ET), parts (PA), and time delays (TD). The following rules apply to the assignment of resources to a task.

1. If used, TDs are always worked off before any other resource can start to work.

2. PAs and ETs are given similar treatment in the model except that PAs are not returned to stock for reuse as would be a piece of equipment.

3. If there is a possibility of PTs being used for some task, but because of the random draw none are needed, all ET, PA, and TD requirements for that task will be ignored.

4. If ETs and PTs are working together on a task, the ET cannot work longer than the PT. If the distribution for the time the ET must work yields a draw larger than that for the PT, the draw for the ET is truncated to match the draw for the PT.

5. If PTs, ETs, and PAs are all needed in some combination for a task, they must all be available before work can begin (i.e., they will start work together).

The resource <u>type or number</u> may be any combination of alphanumeric characters. All resources used on the maintenance form must have a work shift specified on Input Form 3. The resource-type entry may be omitted for a TD because time delays are not resources; they are devices for delaying an activity or holding aircraft in maintenance. However, if more than one kind of delay is being represented by TDs, they should be given numbers to facilitate identification.

The <u>quantity</u> of resources needed should be specified. If no quantity is given, a quantity of 1 is assumed. The quantity may be obtained from a distribution. In actual simulation practice, quantities may represent some estimated number of men, some average number (average crew or team), or some number drawn from a distribution of available men or team sizes. The quantity is not needed for a TD. As previously explained in connection with Input Form 3, the number of resources required (demanded) at a time should agree with the

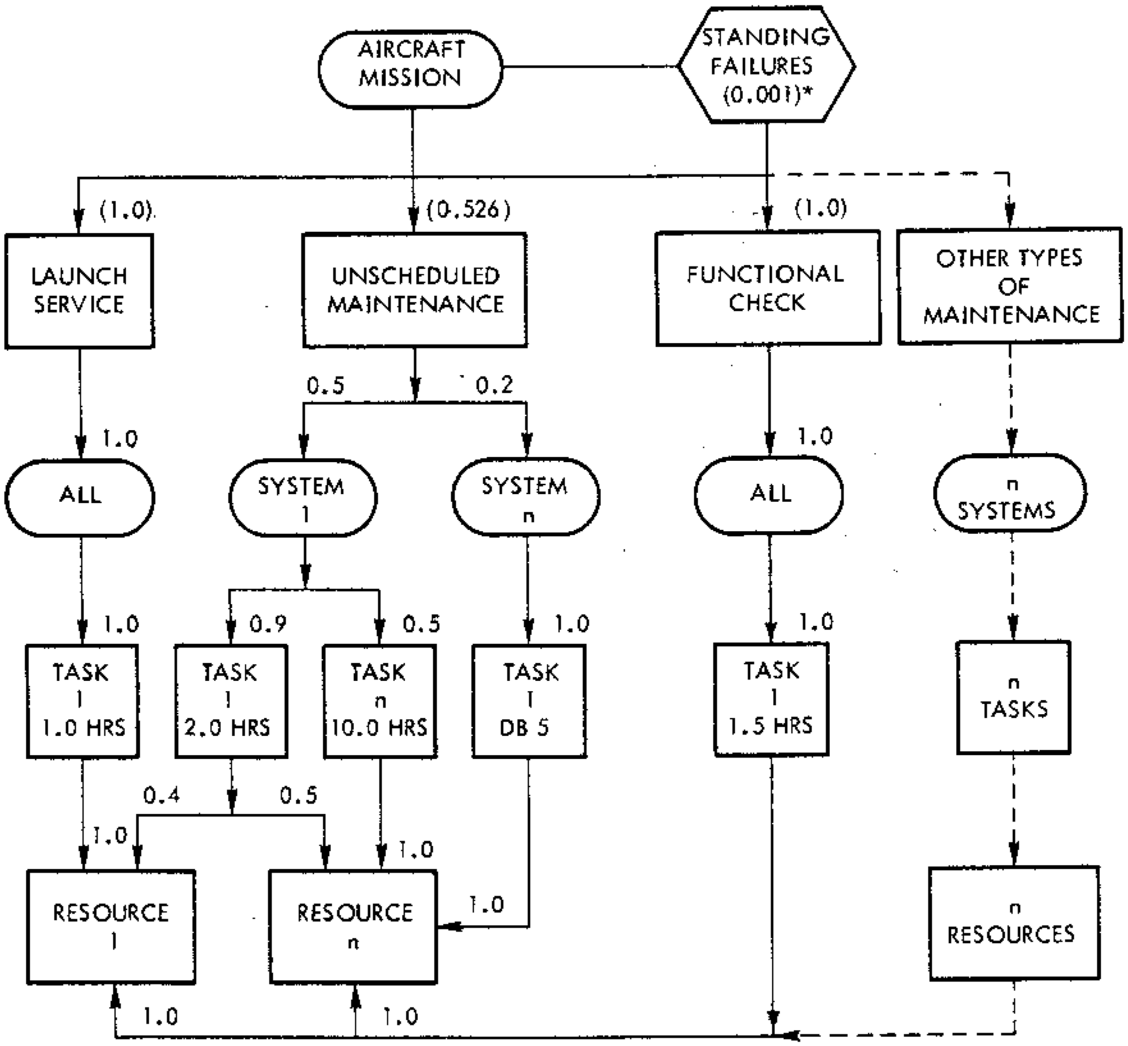
way resource units (teams, crews, or individuals) are made available for simulation and interpreted in the outputs.

Probability of a resource being needed is entered for each resource. Depending upon how the maintenance requirements have been established for the different systems and tasks, this probability determines how often the given resource will be required to do its part of the task. As will be recalled, the duration entry (Cols. 37-43) determines how long the resource will work on the job. Therefore, unless there is some particular reason for grouping resources with a given task (to simulate personnel/equipment relationships), one should be sure that resources and tasks are given unique one-to-one associations. This helps avoid some of the errors that might otherwise be introduced by further elaboration or sets of conditional probabilities.

In fact, in filling out maintenance inputs on Input Form 6, one should be very careful of conditional probabilities. As indicated in the following schematic (Fig. 3), it is possible to use (1) different probabilities for an aircraft needing different types of maintenance, (2) conditional probabilities of individual systems failing, (3) probabilities for the different tasks on the failed systems, and (4) different probabilities for each resource needed to do those tasks that are required.

The schematic shows that launch service is always (probability 1.0) required; unscheduled maintenance occurs 526 times out of 1000; and a standing failure will be generated 1 time out of every 1000 hours of available aircraft time (flyable, ready, and alert time). It also shows that other types of maintenance may be included. In this case, launch service does not involve multiple systems or tasks; so it is described by "ALL" and always results in a Task 1 that is always done by Resource 1 in an hour.

Unscheduled maintenance is more complicated. Two systems, 1 and n, may fail. System 1 will fail half the time and System n will fail 2 times out of 10. Given a failure in System 1, two tasks, 1 and n, may be required. Task 1 will be generated 9 times out of 10 and Task n 5 times out of 10. Given a requirement to do Task 1, two different resources, 1 and n may be needed. Resource 1 will be used 4 times



*The probabilities shown in parentheses on this schematic would not appear on an input form; they are the result of the different probabilities shown. The standing failure rate would be specified on Input Form 2.

Fig. 3 -- Selected maintenance/probability relationships

out of 10 and Resource n 5 times out of 10. If neither resource happens to be drawn, the model treats this as being no failure. If needed, both will work on Task 1 for two hours. Task n, in turn, requires only Resource n and lasts 10 hours. System n, failing 2 times out of 10, generates only one task/resource requirement, Task 1 and Resource n. The time to repair a failure on System n will be determined by a draw from Distribution Number 5.

Standing failures, generated on the basis of 1 out of every 1000 hours of available aircraft time, always result in functional checks.* System "ALL" is used, and the checks, performed by Resources 1 and n, take 1.5 hours. In this case, Resources 1 and n are always used in combination.

The schematic includes other types of maintenance, n systems, n tasks, and n resources to illustrate that many other maintenance parameters and resource inputs might be included in a set of inputs entered on several Input Forms 6.

The relationships shown in the schematic are further demonstrated and explained in Input Illustration 13, which provides a complete set of entries corresponding to the information used in the schematic.

As the schematic and sample inputs show, combinations of conditional probabilities determine the probability that any given kind of maintenance activity will occur. In other words, the input form does

FORM NO.	MAINTENANCE PARAMETERS AND REQUIREMENTS: MAINTENANCE PARAMETERS: BASE NAME	MISSION	MAINT. TYPE	NRTS POLICY*	SYSTEMS: SYSTEM LIST	FAILURE PROBABILITY	CRITICALITY PROBABILITY	MAINTENANCE REQUIREMENTS: DURATION	PROBABILITY	SEQUENCE	PT ET PA TD	RESOURCE REQUIREMENTS: TYPE or No.	QUANTITY	PROBABILITY
6	B	M	LS		ALL	1.000	1.000	1.00	1.000		ET	1	1	1.000
6	B	M	UM		SY1	.500	1.000	2.00	.900	0	ET	1	1	.400
6										0	PT	N	2	.500
6								10.00	.500	0	PT	N	3	1.000
6	B	M	UM		SYN	.200	1.000	-5.00	1.000		PT	N	1	1.000
6	B	STAND	FC		ALL	1.000	1.000	1.50	1.000		PT	N	-6	1.000
6											ET	1	1	1.000

Input Illustration 13
(Form 6)

*They could have been associated with other types of maintenance.

not explicitly contain an entry providing for a 0.526 probability of UM, 1.0 probability of LS, and 1.0 probability of FC. Also note that only one unit (or team) of Resource 1 is used on LS, UM, and FC, but that different numbers of Resource n will be required to accomplish their jobs on LS and UM (Tasks n and 1 on Systems 1 and n, respectively). The number of personnel needed to do FC will be determined by Distribution 6. It also should be noted that Tasks 1 and n on System 1 may be done concurrently (Sequence 0).

Finally, it should be recalled that Input Form 6 does not control the order or sequence in which different kinds of maintenance activity will be accomplished. The order (previously explained on p. 38) <u>for any given aircraft</u> is controlled by the program. The order in which different jobs will be completed among <u>different</u> aircraft, in turn, will be determined by the order in which they are generated and entered on the "work needed" tables, where they are ranked on the basis of first-in, first-out (FIFO) rules.

<u>Simulation ends</u> is a simple input that selects the day, hour and minute the simulation will end. An entry <u>must</u> be made to avoid ambiguous results. Simulation time should be selected for given simulations to permit a reasonable shakedown period to reach a steady state, after which output statistics become more meaningful. As explained in the chapter on outputs, shakedown period statistics need not be collected or printed out in the various output packages.

INPUT FORM 7

Input Form 7 contains a complete description of every distribution identified in the simulation. Not every distribution identified will necessarily be used in a given simulation,* but every distribution must be identified and described on this form. Three types of information are required to describe each distribution.

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*The model prints out an error message (No. 71) identifying all distributions identified but not used. See list of error messages in Appendix A.

The distribution (DBN) numbers must be given and they must be the same as those used on other input forms.* An input edit routine is used to insure compatibility and print out appropriate error messages.**

Entries 1, 2, 3, ... , n contain two kinds of data inputs: probabilities and values associated with each probability. As shown in Input Illustration 14, a distribution may contain only one entry (DBN 4) or entries may be continued on succeeding lines to provide as many points in the distribution (DBNs 1 and 2) as may be required. Distributions containing more than 4 entries will be continued on succeeding lines.

Probability refers to either the individual or cumulative probability that is associated with a given value. Individual probabilities must add to 1.000 in a distribution or it will be rejected.***

FORM NO.	DBN NO.	DISTRIBUTIONS: ENTRY 1 PROBABILITY	ENTRY 1 VALUE	ENTRY 2 PROBABILITY	ENTRY 2 VALUE	ENTRY 3 PROBABILITY	ENTRY 3 VALUE	ENTRY 4 PROBABILITY	ENTRY 4 VALUE
7									
7	1	.3000	2.000	.3000	3.000	.2000	4.000	.1000	5.000
7		.0050	6.000	.0950	7.000				
7	2	.1000	3.000	.5000	4.000	.2000	6.000	.1000	8.000
7		.1000	9.000						
7	3	.5000	9.000	.5500	12.000	.7000	16.000	1.0000	16.000
7	4	1.0000	42.000						
7	5	.6000	0.000	.2000	3.000	.2000	6.000		

Input Illustration 14
(Form 7)

*When setting up simulations requiring many distributions, the user will find that numbering the distributions consecutively will save valuable core storage. At the present time, Entity 77, DBS, must be initialized as high as or higher than the largest number assigned to a distribution. For example, if the five distributions are numbered 2, 4, 6, 7, and 10, then DBS must be initialized at 10 or higher whether or not there are distributions numbered 1, 3, 5, 7, and 9. Therefore, to save space it is more economical to number the five distributions 1, 2, 3, 4, and 5 and initialize DBS at 5.

**See list of error messages in Appendix A.

***If the probabilities do not sum to 1.000, or if the last probability does not equal 1.000, error number 8 will be printed out.

Distribution probabilities represent frequencies or frequency counts converted to percentages and, as indicated in the illustration, they may be written as decimals to four places.

The value associated with a probability may be written as a whole number (to the left of the decimal point) or in decimal fractions. Hours and minutes should be translated into hours to the nearest hundreth for elapsed repair times and similar distributions. Typically, values represent class-interval averages or selected class-interval values.

The distributions (DBN 1, 2, and 3) used to explain random sortie-generation inputs on Input Form 5 have been used as examples to illustrate Input Form 7 entries. DBN 1 and DBN 2 are examples of distributions described by individual probabilities that must add to 1.000. DBN 3 illustrates a distribution using cumulative probabilities for which the last probability must be 1.000. DBN 4 illustrates a single-point distribution. DBN 5 shows that distributions may include a probability for "zero" value.

INPUT FORM 8

Input Form 8 contains maximum-personnel and conflicting-systems constraints, and NRTS policy descriptions. Both types of constraints prevent work from being done simultaneously. The NRTS policy description provides a means for getting maintenance support at another base or rear support area.

Maximum personnel constraints allow the user to specify the maximum number of personnel that can work on a single aircraft at one time while it is undergoing a specific type of maintenance.

The aircraft type to which the maximum applies should agree with the aircraft description given on Input Form 1. Input Illustration 15 includes three aircraft types. Many simulations would include only one type of aircraft.

The maintenance type to which the maximum applies must be one of the following:

DC	CDTS	IS
TS	CDUM	DL
UM	CDFC	LS
FC	FS	

FORM NO.		MAXIMUM PERSONNEL CONSTRAINTS		
		AIRCRAFT TYPE	MAINT. TYPE	MAX NO. PT
01 02 03	04	05 06 07 08 09 10	11 12 13 14	15 16
8				
8		F4C	UM	4
8		C130	IS	20
8		F5A	LS	3

Input Illustration 15
(Form 8)

If any of these types of maintenance are used more than once in a simulation for any given aircraft type, the maximum will apply to all uses. For example, UM might be used for sortie turnarounds and ground aborts, or it might be used for standing failures and as part of an inspection package. Similarly, other maintenance types also might be used more than once.

Maximum number of personnel (PT) refers to the number of people or teams (crews) that may work together simultaneously on a single aircraft of the given type. When the maximum is reached, some personnel may have to wait to begin work until others finish. Personnel can be made to work together on the tasks defined on Input Form 6. Care must be taken that the maximum personnel specified is equal to or greater than the maximum number of personnel that must work together to do a task. Crew or team size distributions or inputs must agree with this constraint. In other words, if resources are assigned on the basis of average teams or crews, the maximum should be stated in team units. Similarly, if they are assigned as individuals the maximum should be stated in terms of individuals. Special inputs are not required, but the user should be aware of how the model interprets the input so he can correctly interpret his set of resource inputs and the effect of the constraint upon them. For example, the maximums specified in the illustration might be interpreted differently as follows.

The maximum of 4 for UM on the F-4C might mean 4 men of any combination of shop personnel or 4 teams from different shops. The entry means 4 units of the personnel resources, however assigned in the

appropriate work-shift-quantity entries on Input Form 3, which work on unscheduled maintenance (Input Form 6).

The maximum shown for the C-130 and F-5A aircraft should also be interpreted in a similar manner. The specific entries take on meaning only when related to the inputs on Input Forms 3 and 6, which establish which personnel (PT) types do the given type of maintenance and whether they are worked as team-units or as individuals.

Conflicting-systems constraints apply to systems only and to all aircraft in the simulation and at all bases.* The constraint prevents work on affected systems from being done at the same time. The constraint can be used to represent safety requirements, power-on, power-off, and similar relationships or maintenance practices.

These constraints may be associated with any or all maintenance types as follows:

DC	CDTS	IS
TS	CDUM	DL
UM	CDFC	LS
FC	FS	

Systems not associated with a type of maintenance identified in this field will not be affected by these constraints. For example, only systems SY1, 2, and 3 shown in Input Illustration 16 are affected by systems constraints. Even though systems SY4, 5, or n may be identified in other inputs, they would never conflict because they are not on Form 8.

CONFLICTING SYSTEM CONSTRAINTS

MAINT. TYPE (18-21)	SYSTEMS 1 (22-24)	SYSTEMS 2 (25-27)	PROBABILITY OF CONFLICT (28-32)
UM	SY1	SY2	1.000
FC	SY2	SY3	0.002

Input Illustration 16
(Form 8)

*The utility of this constraint might be improved if it applied to aircraft types similar to the maximum personnel routine. However, unique choices of systems may be devised to get the same result.

The systems columns identify pairs of systems that conflict. As shown in the illustration, only SY1 and SY2, and SY1 and SY3 conflict. The names of the systems must agree with the system names used on Input Form 6. Any given system (SY1) may conflict with one or more other systems (SY2 and SY3).

The probability of conflict allows one to cause conflict among some portion of simultaneous system failures. Obviously, the proportion may range from total conflict (1.0) for SY1 and SY2, to infrequent conflict (0.002) between some systems (SY1 and SY3).

As soon as work starts on a system, a flag is set against all systems shown as conflicting on Form 8. When two systems are to start at the same time but conflict on Form 8, work on the system listed first on Form 6 will be started and a flag set on its conflicting systems. The flags will not be released nor work started until work on the first system is completed.

NRTS policies used on Input Form 6 must be described on Input Form 8.

The policy numbers must agree with those used on Input Form 6, and they should be consistent for each aircraft type and maintenance combination.

The fix base means the base to which the aircraft must fly for the appropriate maintenance support, i.e., repair, inspection, etc. As shown in Input Illustration 17, this may be some main operating base (MØB1), a home base (HØMBAS), a depot, or a dummy (DUMMY) base.

NRTS POLICIES		
POLICY NO. (34–36)	FIX BASE (37–42)	FLYING TIME (43–49)
1	MØB1	2.00
2	HØMBAS	4.00
3	DEPØT	10.00
4	DUMMY	-7.00

Input Illustration 17
(Form 8)

Flying time means the one-way time in hours. If some dummy base (Policy No. 4) has been established to represent some kind of a variable NRTS repair time, this flying time may be determined by a draw from a distribution (DBN 7). Of course, distributions could have been used for the other bases too.

The primary use for the NRTS routine is to provide for combat-damage repairs at some place (base) other than the base from which the aircraft was launched when it was damaged. It also may be used to send aircraft to some rear support base for major maintenance or inspections, or to simulate other situations involving off-base repairs, in which case the flying time might be interpreted to mean transport time, haul time, etc.

Finally, it is important to recall that the NRTS routine applies to a maintenance type (UM, FC, etc.), not to systems on any given aircraft, and that the aircraft always returns to the base that generated the inspection or requirement. Depending upon specific simulation requirements, this result might not be a desirable attribute.

III. MODEL LOGIC

SAMSOM II consists of three distinct computer programs, each comprising many routines.* The purpose of the first two programs is to simulate and record selected operations and logistics support activities found in typical Air Force aircraft organizations. The third program analyzes the resulting simulated events and produces output reports.

Although a few routines included in the model are simple, straightforward representations of Air Force policies, activities, and events, most are somewhat complex and involve interactions and interrelationships that are difficult to summarize in an orderly manner. One reason for this difficulty is that the model simulates these events and interactions at random and in time sequence while keeping track of such things as mission priorities, maintenance activity sequences, resource location and disposition, bases, and aircraft locations.

Even flow diagrams are inadequate devices for condensing such multiple layers of interacting events into logical sequences of conditional statements. Nevertheless, flow diagrams are useful for our purpose: to isolate and stress the most important routines and relationships from the point of view of the potential user. The following model logic schematics, therefore, are not meant to be complete representations of every model routine and of its relationship with all others. Rather, they should be understood as an aid to the user to help him focus attention upon the primary routines that accept, control, and utilize the inputs described in the previous section. Additional program details will be found in the Programmer's Guide.

Figure 4 grossly aggregates the large number of simulation inputs required to set up operations schedules and requirements, allocate personnel and equipment over shifts and among bases, establish sortie make-up and cancellation policies, and describe maintenance parameters.

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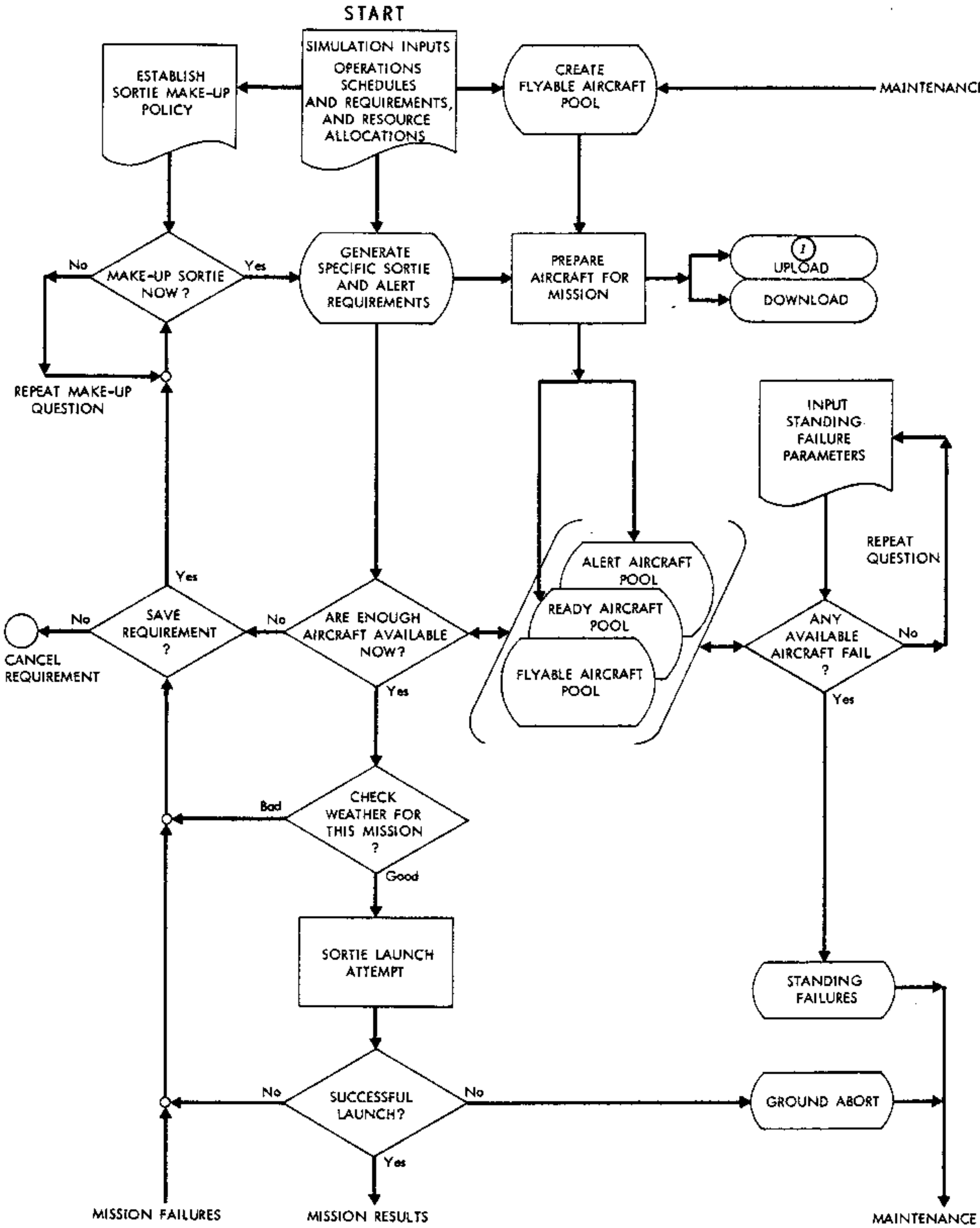
*"Routine" should be interpreted as a general conceptual term approximately synonymous with "module," or "set of procedures." It approximates but does not mean a programming routine or subroutine that would include a set of computer instructions.



(1) Upload and download actions are launch-service activities performed as required to meet specific alert or mission requirements.

Fig. 4 -- Operations routines

This aggregation is intentional in order to focus attention upon the interactions between available aircraft and sortie requirements. Because of their relationship to in-commission aircraft, the figure also shows the origin of standing failures , one of the various sources of maintenance demands that may be included in a simulation.

The first action of the model is to put aircraft in the flyable pool. Then, depending upon the sortie and alert requirements specified in the inputs, suitable numbers of aircraft will be prepared, i.e., uploaded or configured, for their respective missions. After these actions are completed, they are put into the appropriate pools from which they will be launched to meet the operations requirements. Where applicable and time permits, upload will be accomplished ahead of the sortie requirement as specified by the lead-time inputs.

At different times during a simulation, there may not be enough aircraft available to meet the requirements, or weather may prohibit launch. In these cases, the simulator is governed by the sortie make-up policy in effect at the time for the given mission. As shown in the figure, the sortie(s) will be cancelled or made up later as determined by the policy. If ground abort probabilities have been included in the simulation, launch may not be successful, in which case two things will occur: (1) ground abort maintenance will be generated and, (2) depending upon the make-up policy in effect, another aircraft, if available, will be substituted, or the sortie will be saved until later or cancelled. It is obvious that make-up creates a feedback loop which, under some circumstances, alters sortie requirements as time goes by, depending upon the launch capability of the logistic support resources included in the simulation.

Meanwhile, aircraft in the available pools may have experienced standing failures in accordance with the inputs. At periodic intervals, the model will "throw the dice" to determine whether each aircraft in the different pools malfunctions. Given such failures and a maintenance requirement, the aircraft is transferred to maintenance for repairs. Similar action is taken in the case of ground aborts.

As indicated at the top of the flow chart, aircraft are returned from maintenance when repairs are completed, and are put back into the appropriate pools. In this respect, the figure may be somewhat misleading; aircraft always return to the flyable pool first. They are withdrawn and uploaded and transferred to the alert and ready pools as determined by operations requirements and priorities. Therefore, the second flyable pool shown in the figure is the same as that created when the model began simulation.

Mission results are shown on the next figure. Only failing missions return through the make-up and save routine; successes normally generate maintenance support requirements, which are explained in subsequent figures.

Figure 5 begins with the assumption of a successful launch and depicts alternative flows of aircraft and mission requirements involved in simulations including attrition and air aborts. Although several alternatives are included in the model, it should be understood that every successful launch will produce a successful mission unless attrition and air abort inputs have been provided. As shown in the figure, successful missions land at a base after an appropriate period of time has elapsed to represent mission or sortie flying time.

Although many things may degrade a mission in the real world (flak and groundfire hits, navigational errors, target misses, etc.), SAMSOM II will accommodate only three kinds of mission events or degradations: an aircraft may be lost for any reason or set of circumstances the user wishes to assume; it may be damaged in combat by any combination of enemy defenses; or it may abort in the air. Air aborts, in turn, may be interpreted as being caused by any combination of events that suits the user's purpose.

As already indicated in the discussion on inputs, mission successes, air aborts, and combat-damaged and lost aircraft are treated as independent, mutually exclusive events. Only one of the four events will be generated for any given aircraft. If the mission consists of a single sortie (a single aircraft), the mission is lost if the aircraft is lost, damaged, or air aborted. On the other hand, if the mission consists of a sortie element composed of two or more aircraft, the

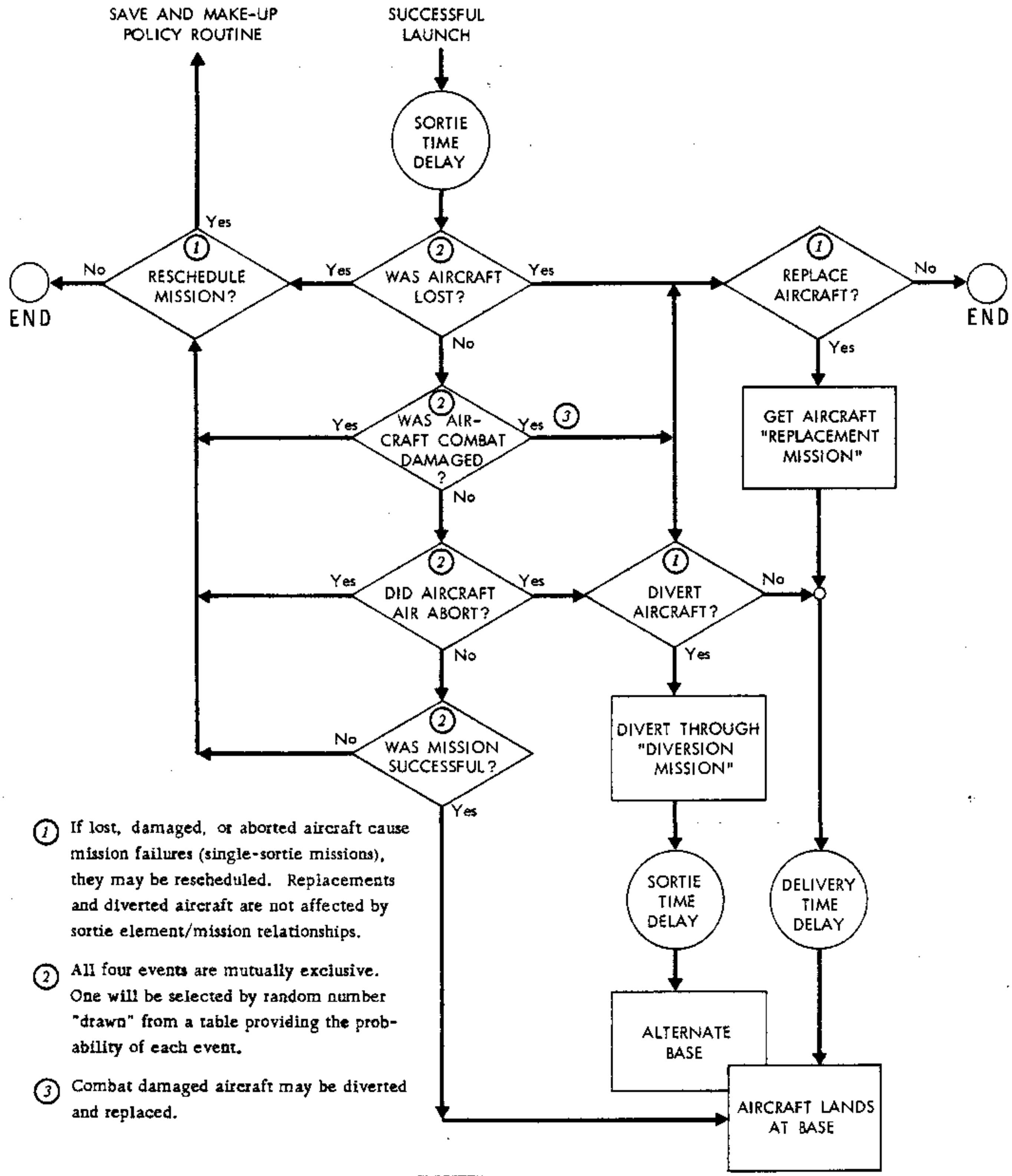


Fig. 5 -- Attrition routines

mission will not be lost unless all of the aircraft are lost, damaged, or air aborted. It should be noted, however, that many missions and schedules of sortie requirements may be provided in inputs as single sorties to take advantage of the rescheduling routine, because the model is programmed so that sortie elements or mission packages with a minimum of one and any number as a maximum are flown one at a time. Hence, individual sortie losses will be rescheduled if desired. The model is not programmed to accept some percentage of aircraft losses as a definition of a mission loss.

Given an unsuccessful mission, several events may be generated by appropriate inputs. As already indicated, some missions may be rescheduled. Aircraft also may be diverted to alternate bases and/or replaced when lost or damaged. As shown in the figure, if a mission is to be rescheduled, it is handled the same as all other schedule fall-outs are handled in the make-up and save procedure already discussed.* If not, the mission and requirement end. Whether or not missions are rescheduled, lost or damaged aircraft may be replaced. Again, if inputs do not provide for replacement, lost aircraft simply disappear from the simulation** and damaged aircraft receive the combat-damage repair provided for in the inputs. The model does not include provisions to replace damaged aircraft according to some rule based upon the extent of damage. It should be noted that the model is selective; both lost and damaged aircraft may be replaced, or either category may be replaced while the other is not. As shown in the figure, air aborts are not replaced.

Given that replacements are required, the model flies an aircraft from a designated "source base" using replacement-mission procedures. Replacement aircraft go to the destination indicated in the inputs for the replacement mission. In other words, replacements will not go to the original destination of the lost mission, unless the destination happens to be the same as that for the replacement mission. It also

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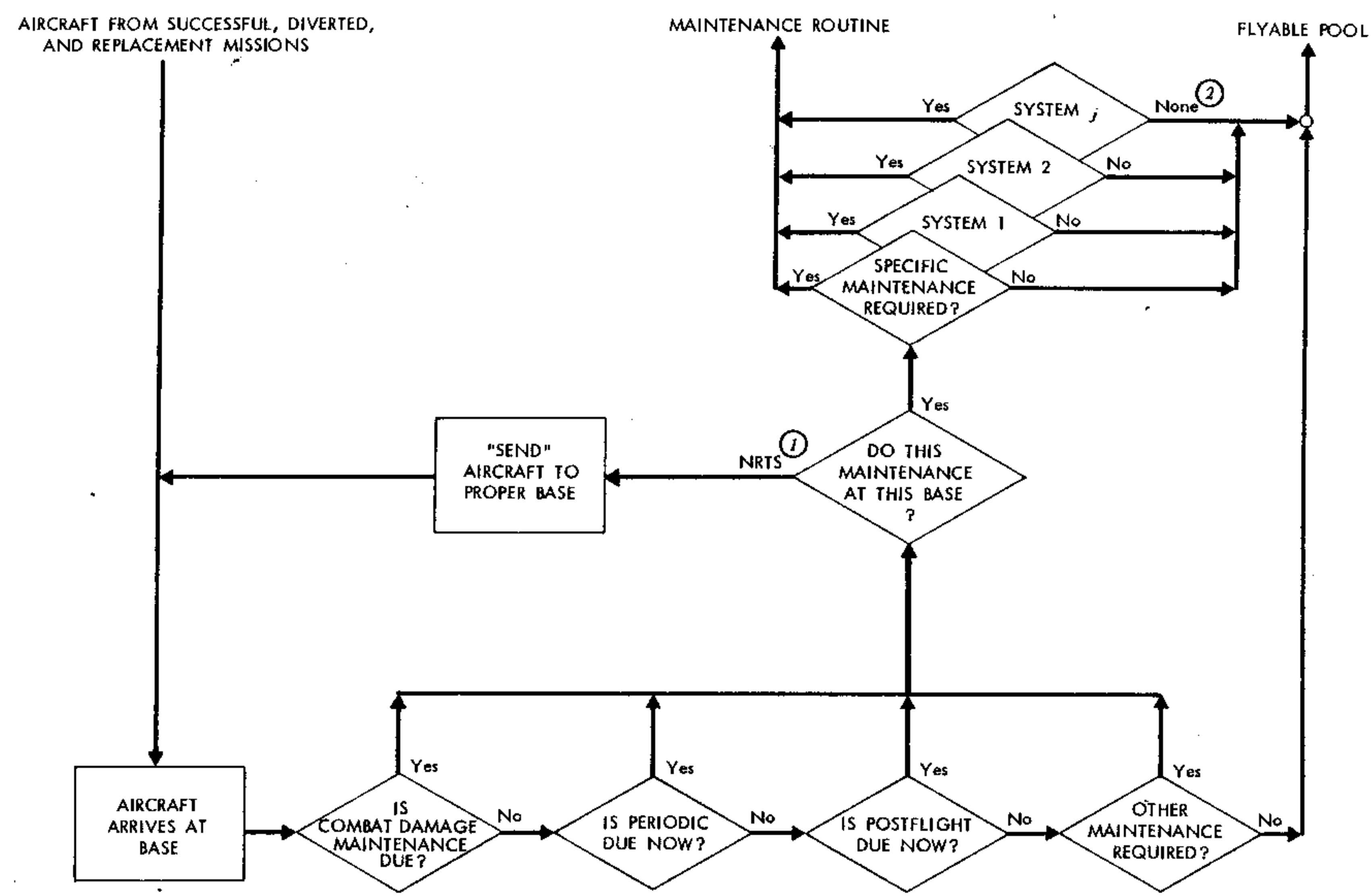
*It is rescheduled even if the make-up routine at the time causes missions not made to be cancelled.

**Their disappearance will be reflected in outputs.

should be noted that the sortie time provided for the replacement mission may represent any kind of delivery-delay time desired. It may depict immediate replacement from another unit or theater replacement pools, flight from the United States, or sailing or rail transport time. In addition, it should be noted that the maintenance, inspection, or other logistic support requirements associated with replacement aircraft and missions may be designed to represent a wide variety of events ranging from normal, routine maintenance to special inspections and/or special assembly requirements. In any event, all of these requirements would be generated after the aircraft lands at its designated base the same way other logistic support requirements are generated and worked off for successful missions.

Finally, the figure shows how air aborts and damaged aircraft may be diverted to alternative bases using the diversion mission. Diverted aircraft may receive combat-damage repairs in a simulation by associating the requirements with the diversion mission and alternate base. As will be discussed in a following section, they also may be accomplished using other model arrangements. As indicated in the figure, combat-damaged aircraft may be both diverted and replaced; air aborts may be diverted but are not involved in the replacement routine, and lost aircraft may be replaced but, obviously, are not diverted. All three events may result in their original mission being rescheduled for a later time.

Figure 6 begins with the arrival of an aircraft at any base from any kind of a mission. If it has been damaged in combat, it is processed through the appropriate maintenance routines to determine what systems were damaged. If an aircraft has not experienced combat damage, its flying time is checked to determine whether a periodic or hourly postflight inspection is due. If not, the aircraft is carried on through the other maintenance routines explained later to determine whether it requires other logistic support. Periodics are usually programmed to occur as some multiple of hourly postflight time. In the event both are required, only the periodic will be done. If they become due one hour (or one sortie) apart, the model will do both one after the other as generated.



(1) NRTS applies to maintenance types (UM, IS, CDTS, FC, etc.) only.

(2) Specific maintenance requirements are determined system by system within each kind and type of maintenance. Even given high failure probabilities, some aircraft may not "break".

Fig. 6 -- Maintenance Requirements routines

Although not accomplished in detail as depicted in summary form in the figure, combat damage, inspections, and other maintenance requirements may be NRTS. If the particular type of maintenance (UM, FC, CDUM, TS, etc.) has been identified as NRTS in the inputs, the aircraft will be sent to the proper base for repairs. As will be recalled, this is the "fix base" identified in Input Form 8. When the NRTS maintenance is completed, the aircraft will be returned to the base from which it was sent, and any additional maintenance will be completed.

The NRTS routine makes it possible to simulate alternative logistic support arrangements for combat damage, inspections, and major maintenance. Thus, inspections may be done at the home base or at some other support location, and combat-damage maintenance may be accomplished where it occurs or at some other base or support center. In fact, it may be directed to the rear support area in two ways: by a diversion mission or by the NRTS routine.

In all of these events, specific maintenance requirements are determined by a series of draws, mission by mission (including PERØD, PØSTFT, ALERT, STAND, and ABØRT), maintenance type by type (UM, FC, etc.), system by system, and requirement by requirement (task by task). As depicted in the figure, if the aircraft was not damaged, inspections are not due, and if other maintenance was not provided for in the inputs, the aircraft will be transferred to the flyable pool and be available for operations. Similarly, if the series of random draws through the several different failure probabilities results in no failures (or requirements, however identified), the aircraft will be transferred to the flyable pool. Given one or more requirements, however, it will be transferred to the appropriate maintenance routines explained in Figs. 7 and 8.

Because it facilitates preparation and understanding of a single flow schematic in Appendix C, interpretation of Fig. 7 begins at the bottom with the notation that aircraft with standing failures and ground abort requirements enter the flow of maintenance at the debriefing routine. Aircraft with routine (regular sorties, inspections, and air aborts) or combat-damage maintenance requirements are sorted to

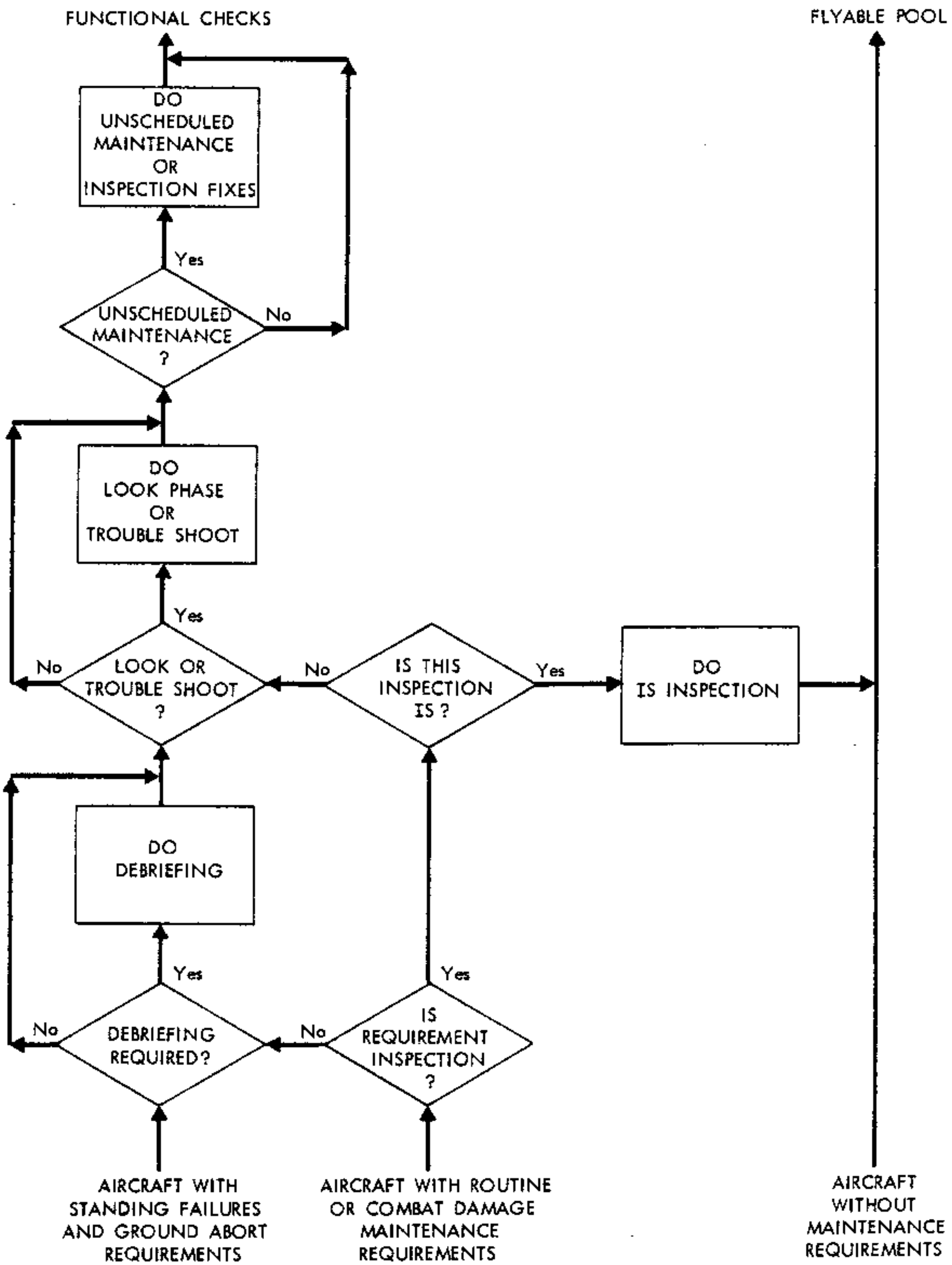


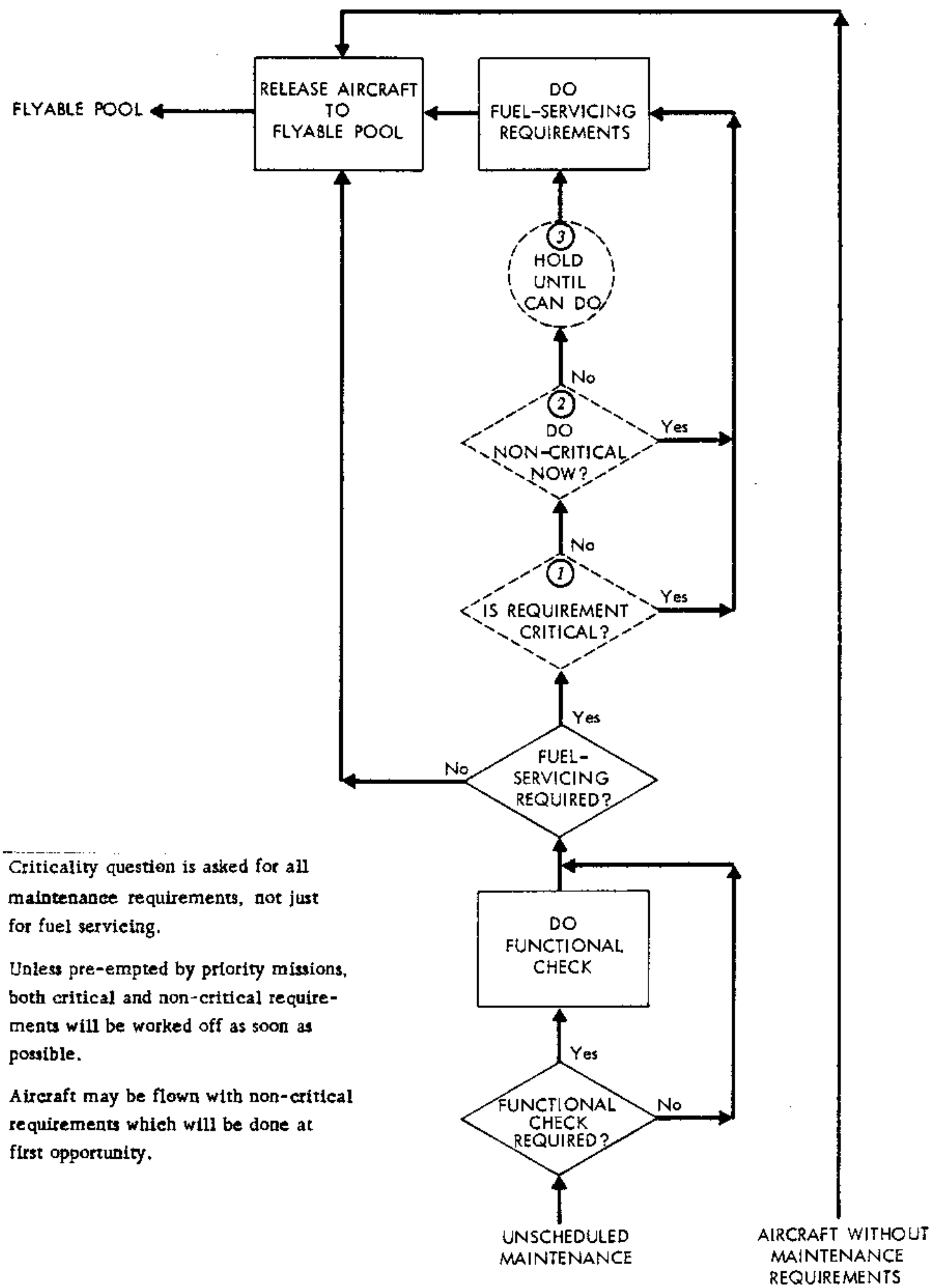
Fig. 7 -- Maintenance routines (1)

identify those with inspections, and aircraft without maintenance requirements continue on their way to the flyable pool.

Aircraft requiring inspections may be handled in the model in two ways. They may be given a general or composite inspection, identified as "IS" in the inputs. Normally, when this routine is used the aircraft will not be routed through other maintenance activities. As shown in the figure, when IS is completed, the aircraft goes immediately to the flyable pool. If the alternative routing is used, the inspection might begin with trouble-shooting as depicted in the figure. An interpretation of trouble-shooting in this case might be that it is equivalent to performing the "look-see" part of the inspection. After this has been accomplished, it may be routed through the other routines the same as for other maintenance requirements. If the proper data have been collected, it might be expedient to separate the look phase of inspections from the fix phase. Thus, unscheduled maintenance (UM) for an inspection (PERØD) is the fix phase. Although the model handles these activities in sequence, the fix phase cannot be made to result from or depend upon the look phase. In other words, the model does not contain a link between look and fix to represent conditional probability relationships between inspection "look-see" and fixes that users might wish to simulate. Of course, proportional relationships can be simulated.

After debriefing, if provided for in the inputs, combat-damage maintenance will be accomplished in the sequences provided for in the inputs; i.e., it may be "researched" or further identified in the trouble-shooting routine, be fixed or repaired, and then be given a functional check as shown in the next figure. Again, none of these activities are linked together even though the requirements, if any, will be accomplished in sequence. Although not indicated in the figure, they will be clearly identified in the outputs as combat damage, if they have been properly identified as CDTS, CDUM, and CDFC in the inputs.

All other maintenance requirements, whether generated by standing failures, ground aborts, or routine failures following successful or air aborted sorties, will be accomplished in the order shown in the



(1) Criticality question is asked for all maintenance requirements, not just for fuel servicing.

(2) Unless pre-empted by priority missions, both critical and non-critical requirements will be worked off as soon as possible.

(3) Aircraft may be flown with non-critical requirements which will be done at first opportunity.

Fig. 8 -- Maintenance routines (2)

figures. First debriefing, if any, will be done; next, troubleshooting, if any; and on through unscheduled maintenance. This process continues, as shown in Fig. 8, through functional check. Fuel-servicing requirements are performed last and the aircraft is released to the flyable pool.

It should be understood that each of these sequences is optional and that each may or may not involve multiple systems, tasks, and resources. If any of them are not provided for in the inputs, the model will skip on to the next type of maintenance and draw to determine what requirements, if any, were generated for that category.

Finally, it is important to understand that for each type of maintenance, however generated, the resulting requirements will be treated as critical or noncritical according to the probabilities provided in the inputs. Rather than repeat the routine for every maintenance activity, we have shown the action of the criticality routine after fuel-servicing. If the requirement is critical, it will be done immediately. If it is noncritical, it may not be done immediately if there is an outstanding priority sortie requirement that preempts the aircraft as soon as all critical work is finished. Given such preemptions, outstanding* noncritical requirements will become a part of the aircraft wherever it goes. They will be worked off at the next opportunity; i.e., when it lands at the next base or returns to its home base.

Model routines and interrelationships shown in Figs. 4 through 8 and described in this section have been combined into one diagram, "SAMSOM II Model Logic Schematic," included in Appendix C. Although this flow diagram does not adequately depict all of the interactions included in the model, it should help the user identify and relate most of the major elements and assist him in the preparation of inputs and interpretation of outputs.

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*"Outstanding" refers to any maintenance identified or in progress at time of preemption. Other maintenance requirements that would be identified later (FS after UM, for example) will <u>not</u> be carried forward. At time of preemption, the model does not know they will occur. Proper identification and sequencing of critical requirements, however, will help overcome this problem. The general rule is to let noncritical maintenance be unscheduled maintenance (UM) <u>and</u> the <u>last</u> kind of activity being done so that other requirements will not be lost.

IV. OUTPUTS

SAMSOM II outputs are recorded on one or two transaction tapes. The output program reads selected transactions on the tape and categorizes, interprets, sums, averages, and prints the various outputs described in this section. These transactions are preselected (they are fixed in the current execution program). The tapes do not contain all of the information that might be generated during a simulation. Technically, the execution program could be revised to incorporate a means for selecting other specific items to record on the tape for subsequent analysis. As will be discussed later, such a procedure should help reduce the computer time required to compile selected outputs. At present, however, addition of other items to the tape is a user's option, and he must make the necessary program changes.

Any or all outputs may be selected at simulation time or later. If output is desired at simulation time, the appropriate output request cards must be included in the running deck. In at least two instances it may be desirable to obtain output later: (1) when available computer time is insufficient to both execute the simulation and provide output at the same time, or (2) when the user is interested in reviewing selected detail outputs only after determining their usefulness from a review of some other selection of summary outputs. When outputs are generated after simulation, a separate output deck must be used. Appendix A explains the procedure for extracting additional output this way along with output deck details. In addition, specific instructions and illustrations applicable to the RAND IBM 7040-7044 installation are contained in Appendix A, which describes the model running deck details and procedures.

SAMSOM II outputs are recorded on eleven different reports. Eight provide detailed and summary records of simulation results; two provide detailed information useful for model and simulation debugging purposes; while the remaining one contains a selected list of transaction tape statistics. As already indicated, additional output may be obtained by amending the execution program to write new data on the transaction

tape or by developing additional output-request programs to obtain the new data or existing data not currently produced by the output program.

All outputs are obtained using appropriate output request cards in the Running Deck. These are described in subsequent sections. The last portion of Sec. IV describes each output report, and both output request cards and their corresponding output reports are conveniently illustrated together on the same or facing pages in Appendix D.

GENERAL RULES AND PROCEDURES

The following general rules and procedures should be observed when preparing output request cards:

1. All cards must contain the report number in Cols. 1 and 2.

2. To minimize computer time, all cards for the same report should be grouped together. Groups of request cards for the same report and the same base should be ordered so that those containing the same start, stop, and increment times appear together.

3. Columns 66-71 identify the simulation. This must be the same identification entered on Input Form 1. Columns 73-80 are blank and may be used for comments, further identification, or other remarks.

Although only three fields of information (report number, simulation identification, and remarks) are standard on all output request cards, cards for several reports are sufficiently similar to warrant coverage now.

1. Output request cards for Reports 1, 2, 3, 4, 7, 8, 10 and 11 contain the same kind of information in Cols. 3-23 as follows:

    a. Columns 3-9 identify the time to begin reporting. This may be any time from the beginning (day 0, hour 0, minute 0) of the simulation until it ends. If the field is left blank, reporting begins at time zero.

b. Columns 10-16 establish the periodicity or interval of time between reports. The period may be any convenient time interval (hourly, daily, weekly, etc.) that fits simulation objectives and the purpose of the specific report. If the field is left blank, the specified output is reported every hour. The request cards for Reports 10 and 11 are blank in Cols. 10 to 16 since this information is not useful for these reports.

c. Columns 17-23 identify the time when reporting ends. If the field is left blank, reporting continues to the end of the simulation. A stop time must be entered when requesting Reports 9, 10 and 11. Obviously, any entry provided should be greater than that used for start time. Unless some specific stop time is desired, a blank entry becomes a useful device for generalizing a set of output request cards to be sure to get a complete set of outputs.

2. Request cards for Reports 1, 2, 3, 4, 7, 8 and 11 also contain similar information in Cols. 24 to 29, which identify the base of interest in the given simulation. If the simulation involves more than one base, the user must either prepare another request card or, in the case of Reports 1 and 2, list the other bases in Cols. 30-65. Care should be taken to use base names listed on Input Form 1.

3. Column 72 on output request cards for Reports 3, 4, 7 and 8 may be used to suppress printing detailed statistics called for at each reporting interval. An "N" punched in this column suppresses details and reports only totals or averages as appropriate. The computer still must compile the records and do the necessary calculations. Therefore, the device saves negligible computer time. The primary saving is in the pages of output that are not printed.

A final general remark on output requests is that all names used on output cards should appear exactly as they do in the inputs. Otherwise, the computer prints out error messages or refuses to process the outputs, as appropriate.

OUTPUT REQUEST CARD FORMATS

Each different output request card is illustrated and discussed in the following subsections.

Report 1 (Operations Summary)

Output request card 1 generates an Operations Summary that provides selected operations statistics for specified bases during selected time periods. As shown in Output Request Illustration 1, the report number must be identified in Cols. 1 and 2. All other fields may vary as shown. The first example calls for reporting to begin at time 0

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	BASE NAME	BASE NAME
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN			
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41
1	0	0	0	0	1	0	30	0	0	HB1	HB2	HB3
1	3	0	5	1	0	0	33	0	0	SH	" "	
1				1	0	0				RAT	KAT	

Output Request Illustration 1

and stop at day 30, hour 0, minute 0. A separate Operations Summary is prepared for HB1, HB2, and HB3. Although such a report would not be very useful, the illustration shows that a summary would be generated every hour for the entire 30-day period. The second example shows the proper entries to get an Operations Summary for a 30-day period beginning on day 3, hour 0, minute 5, and ending on day 33. This would be a very useful report because it summarizes operations on a daily basis. The third example depicts a generalized request that would generate a daily Operations Summary for bases RAT and KAT from the beginning to the end of the simulation. Of course, the simulation identification would be shown in the Cols. 66-71 for each example.

Additional discussion of other variations in the Operations Summary Report and its coverage are discussed later in connection with report contents.

Report 2 (Base Status Report)

Output request card 2 generates a Base Status Report that gives selected status conditions for different aircraft types at the specified bases during selected periods of time. Output Request Illustration 2 provides two examples of the request card for the report. The

first shows the proper entries to get a report each day from day 10 to 50. The second would generate such a report every 12 hours from the start of the simulation until day 10. Bases are identified in both samples to show that the request will generate a report for each base the user selects.

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	BASE NAME
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN		
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35
2	10	0	0	1	0	0	50	0	0	BASE1	BASE2
2	0	0	0	0	12	0	10	0	0	BS	

Output Request Illustration 2

Report 3 (Aircraft Status Report)

Output request card 3 produces an Aircraft Status Report that enables the user to see the base-by-base status of all aircraft types in the simulation. The first example in Output Request Illustration 3 shows a request for a report every 5 minutes from the start of the simulation until day 3. The entry is technically correct to demonstrate the format, but the resulting Aircraft Status Reports for aircraft types 1 and 3 would be very detailed and of doubtful value. The second example demonstrates a more useful reporting interval that provides a snapshot of status every hour of the day, from day 10 to day 50.

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	AIRCRAFT TYPE	AIRCRAFT TYPE
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN			
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41
3	0	0	0	0	0	5	3	0	0	HB1	AC1	AC3
3	10	0	0	1	0	0	50	0	0	PØPE	F-4C	
3				0	0	15	90	0	0	AS	F5A	

Output Request Illustration 3

It should be emphasized that in contrast to the two preceding reports, each card identifies only one base. If other bases are included in the simulation, another card must be prepared to obtain the desired report. Each card, however, may indicate up to six different aircraft types operating from any given base. If more than six types are assigned to a base, another card must be prepared to get a report for the additional aircraft. As a practical matter, one card will probably be sufficient because simulations including as many as six aircraft and their associated maintenance parameters would likely exceed the 32K memory available on current computers which will accept the model.

Because this report provides snapshots of status at the user's discretion, it may produce a considerable volume of paper output. For example, if a report is requested every 5 or 15 minutes as shown in the first and last examples, the output program will produce twelve or four lines of output for every hour of simulated time included in the output period. If the period is short this might not be objectionable, but if it is for 90 days, as in the last example, there would be much paper output. For this and other reasons, the program incorporates the use of the previously discussed "N" option (Col. 72) which suppresses printing and provides only the final set of averages.

Report 4 (Sortie History Report)

Output request card 4 produces a Sortie History Report enabling the user to get a periodic base-by-base tabulation of all sorties that take off and land for each mission in the simulation. Like the previous report, the user may also print only totals (N in Col. 72) if he is not interested in a complete tabulation. In contrast to the format for the Aircraft Status Report, the output request card for this report identifies missions in Cols. 30-65. Again, each card may contain up to six missions for each base. If more than six missions are flown from one base, another card must be prepared to get the appropriate report. A card must be made for each base, or for the bases the user selects.

Output Request Illustration 4 should be interpreted the same as the previous illustrations. Hourly and daily records of sorties launched and flown are the most useful reporting intervals. The other entries are self-explanatory.

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	MISSION NAME	MISSION NAME
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN			
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41
4	0	0	0	0	1	0	30	0	0	HB1	MISS1	MISS2
4	1	0	0	1	0	0	10	0	0	HB2	CA1	CA2

Output Request Illustration 4

Report 5 (Verbal History Dump)

Output request card 5 produces a Verbal History Dump that prints out in words the events that have occurred during the simulation. It should be noted that this report is intended for debugging and tracing purposes. It results in a voluminous amount of output if not used with discretion. Although start and stop times are the same as for other request cards, the field labeled Transactions Number (Output Illustration 5) has a special meaning. It provides a means of selecting the transaction* on the simulation transactions tapes to be printed. If this field is left blank, as shown in the first example in Output Request Illustration 5, all transactions for the specified interval of time will be printed.

The possible entries, labeled A, B and C, may be used as follows:

a. If transaction numbers are entered in A and C, all transactions with numbers A up to and including C will be printed.

b. If a transaction number is entered in B, only the individual transaction numbers entered in A, B and C will be printed.

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*A transaction is an event or series of events that occur during the simulation. They are numbered 1 through 78. For example, the number 54 identifies when an aircraft is removed from the flyable pool. A list of transaction numbers and relevant explanations will be found in Appendix F and in the Programmer's Guide.

The first example shows that for the 10-day period all transaction numbers will be printed. The second example shows that for the 22-hour period, all records from 4 up to and including 7 will be printed. The last example shows that only transaction numbers 21, 39, and 50 for 5 hours on day 10 (from day 10, hour 0, and minute 0 up to day 10, hour 5, minute 0) will be printed.

REPORT NUMBER	START TIME			TRANSACTION NUMBER			STOP TIME		
	DAY	HR	MIN	A	B	C	DAY	HR	MIN
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23
5	1	0	0				10	0	0
5	5	1	0	4		7	5	23	0
5	10	0	0	21	39	50	10	5	0

Output Request Illustration 5

Report 6 (Tape Dump Report)

Output request card 6 generates a Tape Dump Report that dumps selected items from the transactions tape. Like the Verbal History Report, this report has been designed for event-tracing and debugging purposes. The Transaction Number field allows the user to select the transactions from the tape to be printed for review. If this field is left blank, all transactions will be printed.

The different entries on Output Request Illustration 6, A, B and C, may be used as follows:

a. If transaction numbers are entered in A and C, all transactions with numbers A up to and including C will be printed.

b. If a number is placed in B, only the individual transaction numbers entered in A, B and C will be printed.

As already indicated, tape format and the transaction list are explained in Appendix F and in the Programmer's Guide. The first example shows that from day 0, hour 0, minute 5 until day 5, hour 0, minute 0, only

transactions 1 and 2 will be printed. The second example illustrates that transactions 13, 18, and 23 will be printed. The last example shows that all transactions from 60 through 64 will be printed for one day of the simulation.

REPORT NUMBER	START TIME			TRANSACTION NUMBER			STOP TIME		
	DAY	HR	MIN	A	B	C	DAY	HR	MIN
6	0	0	5	1		2	5	0	0
6	6	6	6	13	18	23	10	0	0
6	20	0	0	60		64	21	0	0

Output Request Illustration 6

Report 7 (Resource Report)

Output request card 7 produces a Resource Report that shows the availability and working status, and the associated base-by-base averages for all or selected simulation resources. Although Output Request Illustration 7 shows only one resource field, three different resources may be identified in each card if they are assigned to the same base. If several different bases are represented, a request card must be prepared for each base the user selects.

As indicated in the field headings, resources must be identified by both kind and type (or number). The kind of resource refers to PT (personnel), ET (equipment or facility), PA (parts), and TD (time delays). Resource type refers to the identification numbers used for the different specialties or kinds of equipment included in the simulation. As the illustration shows, numeric entries describing the resource type must be right-adjusted in the field.* In order to avoid possible confusion and mistakes, unused columns have been blanked out on the form.

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*Reorganizing this request format to allow for more than three resources per card seems apparent. Users are cautioned, however, that

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	RESOURCE	
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN		KIND	TYPE
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41
7	20	0	5	0	0	5	25	0	0	BASE2	PA	9
7	0	0	5	0	1	0	2	0	0	BASE1	PT	1
7	60	1	1	0	1	0	100	0	0	HB4	PT	16
7	3	0	0	0	4	0	33	0	0	RAT	ET	123

Output Request Illustration 7

Output Request Illustration 7 contains sample entries. Similar examples for all entries through Col. 29 have been explained previously. The examples show reporting intervals for five minutes, one hour, and four hours. They also identify all three kinds of resources, and the second and third examples illustrate entries that distinguish between PT1 and PT16. Although not shown, TDs also may be requested.

An N punched in Col. 72 on this card suppresses printing and provides averages. As will be explained later in the discussion on report contents, some information the Resource Report provides may also be produced in a different format on Report 9.

Report 8 (Maintenance Report)

Output request card 8 produces a Maintenance Report that shows the aircraft status and associated averages for all or selected types of maintenance activities. As shown in Output Request Illustration 8, this form calls for multiple entries. The user identifies the base, mission names, system and maintenance types on Input Form 6, which facilitates completion of this output request card and reduces the possibility of error. The only entry on the card that does not appear on Input Form 6 is the aircraft type, which is on Input Form 1.

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the output program accepts this general format, and it would have to be changed to realize the gain. Although possible, it is not obvious that the gain would be worth the effort.

REPORT NUMBER	START TIME DAY	START TIME HR	START TIME MIN	REPORT EVERY DAY	REPORT EVERY HR	REPORT EVERY MIN	STOP TIME DAY	STOP TIME HR	STOP TIME MIN	BASE NAME	AIRCRAFT TYPE	MISSION NAME	SYSTEM	MAINTENANCE TYPE
01-02	03-05	06-07	08-09	10-12	13-14	15-16	17-19	20-21	22-23	24-29	30-35	36-41	42-47	48-53
8	0	0	5	0	1	0	30	0	0	B	AC1	M	ALL	LS
8	0	0	5	0	1	0	30	0	0	B	AC1	M	SY1	UM
8	0	0	5	0	1	0	30	0	0	B	AC1	M	SYN	UM
8	0	0	5	0	1	0	30	0	0	B	AC1	STAND	ALL	FC

Output Request Illustration 8

The entries on Output Request Illustration 8 have been taken from Input Illustration 6. The same base and aircraft type appear on each card. On the first three cards the mission is the same. In the first instance, the request is for ALL systems associated with Launch Service (LS). (ALL is entered if the user wishes to associate the maintenance done on all systesm with any maintenance done on the given aircraft type at the given base.) The second and third cards request data on two systems (SY1 and SYN) associated with the same type of maintenance (UM). The last card calls for a different mission (STAND) and all systems associated with functional checks (FC). In general, each time one or more entries change, a new card is completed. The number of cards depends upon the complexity of Input Form 6 entries. If only the final averages are desired, enter an N in Col. 72.

Report 9 (The Matrix Summaries)

Output request card 9 generates a Matrix Summary that shows the number of units of specified output (explained later) associated with the different hours in the day. A Matrix Summary may be generated for sixteen different kinds of output. They are coded in Cols. 32-37 in the following way:

Output Code		Description -- Number of
1.	WØRK	Resources at work
2.	D/NA	Resources demanded but not available
3.	IDLE	Resources idle
4.	LAUNCH	Aircraft launched
5.	LANDED	Aircraft landed
6.	LØST	Aircraft lost
7.	CØMBAT	Aircraft suffering combat damage
8.	ABØRT	Aircraft suffering air abort
9.	ØPERAT	Operational (normal) deficits (sortie schedule fall-out)
10.	WEATHR	Weather deficits (weather fall-out)
11.	TØTAL	Deficits, both operational and weather
12.	FLYABL	Aircraft in the flyable status
13.	ALERT	Aircraft in the alert status
14.	READY	Aircraft in the ready status
15.	MAINT	Aircraft in maintenance
16.	AIR	Aircraft airborne

Associated with each of these sixteen output codes are various output specifications such as aircraft types, mission names, resource names, resource types, and statistics, such as minimum, maximum, average and totals. The user must be careful to associate the desired output specifications with the correct output codes and statistics. Figure 9 shows the proper relationships. When using output codes WORK, D/NA or IDLE (output request card 9, Cols. 32-37) a resource name must appear in Cols. 16-21, and the resource type must appear in Cols. 22-27. ALL might be desirable if one wanted a record of composite manpower, i.e., over all personnel types. If ALL is entered in Cols. 16-21 for any of these three output codes, then the resource name (PT, ET, PA, or TD) must also be entered in Cols. 22-27.

When using output codes LAUNCH, LANDED, LØST, CØMBAT, ABØRT, ØPERAT, WEATHR or TØTAL (output request card 9, Cols. 32-37), a mission name identified in the simulation must appear in Cols. 16-21. ALL may be used in Cols. 16-21 to sum over all missions in the simulation. When using output codes FLYABL, ALERT, READY, MAINT, or AIR (Output Request Form 9, Cols. 32-37) an aircraft identified in the simulation must appear in Cols. 16-21. ALL may be used in Cols. 16-21 to sum over all aircraft types in the simulation.

Output Codes	Output Specification: Aircraft Type	Mission	Resources	Statistics: MIN	MAX	AVG	TØT
1. WØRK			X	X	X	X	
2. D/NA			X	X	X	X	
3. IDLE			X	X	X	X	
4. LAUNCH		X					X
5. LANDED		X					X
6. LØST		X					X
7. CØMBAT		X					X
8. ABØRT		X					X
9. ØPERAT		X		X	X	X	
10. WEATHR		X		X	X	X	
11. TØTAL		X		X	X	X	
12. FLYABL	X			X	X	X	
13. ALERT	X			X	X	X	
14. READY	X			X	X	X	
15. MAINT	X			X	X	X	
16. AIR	X			X	X	X	

Fig. 9 -- Matrix summary codes, specifications, and statistics

Figure 9 also shows that four types of statistics may be specified on output request card 9. For eleven of the output codes, three statistics MIN* (minimum), MAX (maximum), and AVG (average) may be requested. These refer to the number of occurrences, events or status conditions that the output specifications identify for some period of time. For the remaining five output codes (LAUNCH, LANDED, LØST, CØMBAT, ABØRT), only one statistic TØT (total) may be requested. TØT refers to the total number of output specifications that occurred during the specified period.

Output Request Illustration 9 shows several examples of requests for different matrix outputs. The first card provides a LAUNCH matrix for mission MISS1 at base HB1. The second card specifies an output code WØRK for PT1 at HB1, and in this case we request the average.

*This is the only exception to the abbreviation for minimum as "MN" shown in Appendix B.

REPORT NUMBER (01-02)	START DAY (03-05)	STOP DAY (06-08)	(09)	BASE NAME (10-15)	OUTPUT SPECIFICATION (16-21)	RESOURCE TYPE (22-27)	(28)	STATISTIC (29-31)	OUTPUT CODES (32-37)
9									
9	0	10		HB1	MISSI			TØT	LAUNCH
9	0	10		HB1	PT	1		AVG	WØRK
9	0	10		HB1	F-4C			MIN	FLYABL
9	0	10		HB2	ALL			MAX	AIR
9	0	10		HB2	ALL	PT		AVG	IDLE
9	0	10		HB3	ALL	MISSNS		TØT	LØST

Output Request Illustration 9

Either minimum, maximum or average might have been used. The third card requests a Matrix Summary of the minimum number of aircraft (F-4C) flyable (FLYABL) at HB1. The fourth example calls for the maximum number of all aircraft in the air (AIR) at HB2. The fifth card provides a matrix of the average number of all personnel resources idle (IDLE) at HB2. Note that the card calls for ALL in the output specifications and identifies resource type PT. When using ALL as the output specification with output codes WØRK, D/NA and/or IDLE, the resource name (PT, ET, PA) must be entered in the field labeled Resource Type. When requesting ALL as the output specification with any of the other 13 output codes, no entry in Cols. 22-27 is essential; however, these columns may be used for comments to clarify whether the ALL is referring to aircraft type(s) or mission name(s).

In general, the user can avoid errors in completing output request card 9 for the Matrix Summary by referring to Fig. 9 and checking which output specifications and which statistics must be associated with the chosen output codes.

Report 10 (Transaction Summary)

Request card 10 produces a Transactions Summary of selected records on the transactions tape. It provides a count of the different records and gives their relative percentage of the total records generated during the period of interest. The only entries required on this card are start time and stop time. Output Request Illustration 10 shows two requests. The first would generate a Summary for a 98-day period; the second would begin at day 10 and continue until day 40, thereby providing a summary of records for a 30-day period. The resulting output may be easily interpreted using the List of Transactions Records found in Appendix F, which describes the simulation events associated with each transaction record number identified in the model.

REPORT NUMBER	START TIME				STOP TIME		
	DAY	HR	MIN		DAY	HR	MIN
01 02	03 04 05	06 07	08 09	10 11 12 13 14 15 16	17 18 19	20 21	22 23
10	1	0	0		99	0	0
10	10	0	0		40	0	0

Output Request Illustration 10

Report 11 (Distribution Report)

Output request card 11 generates the Distribution Report that provides turnaround, repair and queue-time distributions for selected bases and missions over selected periods of time. As shown in Output Request Illustration 11, the report number must be entered in Cols. 1 and 2. The time to begin reporting is entered in Cols. 3-9, and the time to stop reporting is entered in Cols. 17-23. There is no way to specify a reporting interval, since such an interval is meaningless for this report. Likewise, a stop time must be entered in Cols. 17-23. This entry may be the last day of the simulation or some day prior to the end, but must not be blank.

REPORT NUMBER	START TIME				STOP TIME			BASE NAME	MISSION NAME	NON-LAUNCH SERVICE ONLY	LAUNCH SERVICE ONLY
	DAY	HR	MIN		DAY	HR	MIN				
01 02	03 04 05	06 07	08 09	10 11 12 13 14 15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41	42 43 44 45 46 47
11	3				30			BS1	MS1		
11	0				10			ALL	ALL	X	
11	1	5	0		5	5	0	BS1	ALL		X

Output Request Illustration 11

The first example shows that both Launch Service and Non-Launch Service (blank in Cols. 36-47) distributions for BS1, MS1 will be printed beginning on day 3 and ending on day 30. The second illustration will print Non-Launch Service distributions only for all bases and missions in the simulation from day 0 to day 10. The third illustration begins on day 1, hour 5, and ends on day 5, hour 5, printing Launch Service distributions only for all missions at BS1. ALL means all bases and/or missions in the given simulation aggregated together, not all bases or missions reported separately.

OUTPUT REPORT CONTENTS

The following subsections describe and explain each of the eleven output reports.

Operations Summary Report

Output Report 1 is an Operations Summary. Variations in report contents are illustrated in Fig. 10, Operations Summary Illustrations. As the different headings indicate, this report provides selected operations statistics for the simulation identified on the report. It also provides such statistics for selected periods during the simulation and for the different bases in the simulation. Although the current program distinguishes between bases, it does not consolidate operations over all bases. Neither does it distinguish between different aircraft or missions. The program will be amended to provide for

OPERATIONS SUMMARY

SIMULATION - SIM 9

BASE	TOTAL SORTIES SCHEDULED OR REQUIRED MIN	MAX	SORTIES SCHEDULED AND MADE NO.	PCT.	SORTIES SCHEDULED, NOT MADE AND CANCELED NO.	PCT.	SORTIES SCHEDULED, NOT MADE AND SAVED NO.	PCT.	SORTIES SAVED AND MADE UP LATER NO.	PCT.	SORTIES SAVED, NOT MADE UP LATER AND CANCELED NO.	PCT.	TOTAL SORTIES MADE NO.	PCT.	TOTAL REPLACEMENT SORTIES	TOTAL RESCHEDULED SORTIES
PERIOD COVERED - 000 00 00 TO 999 23 60																
BASE - MOBXYZ -	XXXX	XXXX	XXXX	XX.XX	XXX	XX.XX	XXXX	XX.XX	XXX	XX.XX	XXX	XX.XX	XXXX	XX.XX	XXXX	XXXX
BASE - FOB111 -	800	1000	600	60.00	100	10.00	50	05.00	100	10.00	200	20.00	700	70.00	0	0
PERIOD COVERED - 3 00 00 TO 4 00 00																
BASE - 1	100	100	30	30.00	40	40.00	10	10.00	00	00.00	5	05.00	30	30.00	0	5
PERIOD COVERED - 4 00 00 TO 5 00 00																
BASE - 1	100	100	40	40.00	30	30.00	15	15.00	00	00.00	10	10.00	40	40.00	0	3
PERIOD COVERED - 15 08 00 TO 22 08 00																
BASE - TAR	7	2100	700	33.33	420	20.00	00	00.00	00	00.00	00	00.00	700	33.33	0	0
PERIOD COVERED - 22 08 00 TO 29 08 00																
BASE - TAR	7	1800	900	50.00	360	20.00	00	00.00	00	00.00	00	00.00	900	50.00	0	0
PERIOD COVERED - 5 00 00 TO 45 00 00																
BASE - RAT	450	1350	900	66.67	0	00.00	450	33.33	135	10.00	00	00.00	1035	76.67	3	0
BASE - KAT	900	2700	1400	50.00	0	00.00	1400	50.00	700	25.00	00	00.00	2100	75.00	0	320

Fig. 10 -- Operations Summary illustrations

a selection of all bases and all missions. Aircraft type identification would then be accomplished through mission identifications. Recall that missions are uniquely identified with aircraft types on Input Form 2. Appropriate summing over the different missions provides the operations statistics for any given aircraft.

The period covered may be any useful period of simulated time. For example, it might be for the duration of the simulation as depicted in the period shown in Fig. 10 for bases MOBXYZ and FOB111. The period covered in this case is from the first day 000, hour 00, and minute 00, to day 999, hour 23, minute 60. Actually, this report does not show when the simulation ends, but it may be assumed that day 999 is the end in this case.

The second illustration in Fig. 10 shows that daily periods may also be defined. Base 1 is the only base in the simulation, and we are interested in operations data for every day beginning on day 3. The day might have been defined to include some other 24-hour period, such as day 4, hour 4, minute 13, to day 5, hour 4, minute 13.

Similarly, if the user wants operations statistics on a weekly or biweekly basis, he selects appropriate period beginnings and endings. The third case illustrates a week beginning on day 15 at 0800 hours and ending seven days later. The second week begins and ends at the same time of day. Such weekly summaries could be continued as long as desired.

The last case in Fig. 10 depicts a report covering operations for a 40-day period, beginning on the fifth day of operation. It may be assumed that the last 40 days represent steady-state operations and that the first 5 days do not generate useful information. (It should be understood that all illustrations are descriptive only. How much simulation time would be required to reach a steady state depends upon many considerations, and would differ for different simulations.)

A separate Operations Summary is produced for each period indicated on the output request cards submitted for this report. For example, if the user requests a summary once a day for 10 days (beginning at day 000, hour 00, minute 00, and ending at day 010, hour 00, minute 00),

the output program will produce ten reports, one for each day. In addition, it will produce a separate summary covering the 10-day period as a whole.

The Operations Summary provides nine different sets of statistics concerning sorties scheduled or required, made or cancelled during the simulation. It provides both totals and, where relevant, percentages. The source of the statistics, their meaning, and interpretations of each set of Operations Summary outputs follow.

1. Total sorties scheduled or required includes both minimum and maximum totals. The minimum refers to the minimum number scheduled during the given period. It is the sum of all sorties scheduled in the Minimum Sortie-Element entries recorded on Input Form 5. Similarly, the maximum total scheduled is the sum of the number scheduled in the Maximum Sortie-Element entries on the same input form.

Both "scheduled" and "required" are used to describe these totals in order to avoid the term "schedule," which could be interpreted as some sort of predetermined, cyclical repetition of some number of sorties. Since the totals will include sorties generated on a random basis to represent random requirements, they could include sortie requirements that were not scheduled on a cyclical basis. Of course, when sortie schedule inputs are in a form where minimum and maximum are equal (Base 1 in the second illustration), the two entries will be equal and the minimum total will be redundant. Finally, the totals reported for any period pertain only to the period identified. Schedules and requirements for preceding or following periods are not included in the totals for the given period.

2. Sorties scheduled and made reports both total and percentage data. The total is self-explanatory, referring to the sorties scheduled that were also made on time, i.e., exactly as scheduled. It is derived from transaction 39, Sortie Launched. Depending upon sortie make-up policies included in the simulation, the total should be equal to or less than the total takeoffs reported in the Sortie History Report

discussed later. If no sorties are saved and made up later, and if the simulation does not include rescheduled missions, the two records should be equal. If save and make-up is allowed, or rescheduled missions are flown during the period, the total takeoffs reported in the Sortie History Report may be greater. It should be noted that a sortie may be scheduled in one period and made on schedule during another period. It is therefore possible that for a given period the sorties scheduled and made entry is greater than the total sorties scheduled or required entry.

The percentages shown in all illustrations in Fig. 10 are calculated on the basis of the maximum total sorties discussed immediately above. When sorties are generated on a single basis (one sortie at a time at a specified time) or when minimum and maximum are equal for sortie-element mission packages, the percentages shown on the report may be interpreted in a normal, straightforward manner. When minimums and maximums are not equal in the inputs, however, the percentages should be given special consideration. For example, if the user is interpreting the percentage of a maximum-effort simulation in which the sortie schedule was "launch as many as possible" (Base TAR in the third illustration on Fig. 10), he should be aware that the percentage made would be a function of the specific, and probably "large," number of sorties entered for the maximum on Input Form 5. Therefore, depending upon the maximum used, the percentage may or may not be realistic.

3. Sorties scheduled, not made, and cancelled provides a record of sorties that were not made on time and were cancelled during the period, whether or not scheduled for the period. Recall that this occurs when make-up policy codes 1 and 4 are used. The percentage is computed on the same basis as previously discussed. The total shown is obtained from transaction 27, Sortie Cancelled.

4. Sorties scheduled, not made and saved includes all sorties not made on time but saved for make-up later. They result from make-up codes 2, 3, and 5. Sorties associated with codes 2 and 5, and which

only are saved, may or may not be made up during the period covered, depending upon the make-up codes in effect during that time. The total the report provides is computed from data gleaned from transactions 24 and 26, Sortie Put in Deficit List and Sortie Put in Weather Deficit List, respectively.

5. Sorties saved and made up later includes those sorties saved during the period which are also made up during the period, as well as sorties brought forward from previous periods under make-up codes 2, 3, and 5 and which are made up during the period. The total reported is computed on the basis of information gleaned from transaction 39, Sortie Launched.

6. Sorties saved, not made up later and cancelled includes all sorties saved that are not made up later during the period and that are cancelled before the period ends by make-up codes 4, 5 or 6. Sorties saved may have been brought forward from some previous period. If so, and they get cancelled during the report period, they are included in the total. Obviously, under these circumstances, the percentage takes on special meaning because it still will be computed on the maximum total sorties scheduled during the period. For this reason, it may or may not be a meaningful statistic. The total reported under this category is derived from information on transaction records 27 and 28, Sortie Cancelled and Sortie Cancelled Because of New Make-up Policy, respectively.

7. Total sorties made is the sum of sorties scheduled and made and sorties saved and made up later. Except for replacement and rescheduled sorties explained in the following paragraphs, this total should equal the total takeoffs reported in the Sortie History Report. The percentage is measured against the maximum number scheduled or required and should be interpreted accordingly.

8. Total replacement sorties reports all sorties generated in a simulation that includes attrition and aircraft replacement policies. The total is the sum of transaction 7, Replacement Sortie. Recall that replacement sorties may be generated when aircraft are combat damaged or lost on missions. Since replacements may be flown in from a dummy

base or aircraft pool, the user should call for a report on that base. In the last illustration in Fig. 10, base RAT serves as a replacement base and thus generates three replacement sorties. We do not know where they went, perhaps to base KAT. In any event, the total shown for the base should equal the total number of takeoffs reported in the Sortie History Report for replacement missions.

9. Total rescheduled sorties refers to sorties rescheduled as a result of air aborts and lost or combat-damaged aircraft. Bases 1 and KAT in the illustrations reflect such statistics. Although rescheduled sorties are reflected in the total takeoffs reported in the Sortie History Report, this is the only separate record of them currently available in outputs. The total reported is the sum of transaction 8, Sortie Rescheduled After Mission Failure.

Finally, the output program provides a record of the computer time taken to generate the Operations Summary.* The record includes the time taken to generate all of the different summaries for all of the periods requested. If a user is specifically interested in the time required to generate some part of the total summary, he should submit a separate request for only the part of interest. If Output Request Forms 1 and 2 are processed consecutively (Output Request Form 2 cards immediately follow Output Request Form 1 cards), then the time report includes the time consumed while processing both reports. If the user desires a separate time record for each report, Output Request Forms 1 and 2 should not be processed consecutively. That is to say, another Output Request Form should be inserted between Output Request Forms 1 and 2. However, it is more economical in computer time to process the two forms consecutively.

Base Status Report

The Base Status Report (Output Report 2) summarizes status conditions for all aircraft at all or selected bases for selected periods

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*As is the case with all machine time outputs, this output is available at RAND but may not be available at other installations or on future RAND computer systems.

of time. The user selects the bases and periods to fit his output needs. Figure 11 is an illustration of this report. The examples and numbers were contrived to illustrate different points.

The user is warned that at the present time (July 1967) the Base Status Report is not operating properly. The maintenance statuses described below may give incorrect results. The means of the maintenance statuses are correct, but the other statistics break down under some circumstances. Breakdown occurs when an aircraft enters and leaves a status several times within the same minute of simulated time. Work is currently underway to remedy the situation.

As indicated in the preceding discussion about the output request card for this report, periods may begin and end at any time, and the report for any given simulation may include several periods of interest. Typically, one would be interested in a daily report after the simulation had reached the steady state. This is illustrated by the record for base RAT which shows a period of 30 days beginning at day 3, hour 0, minute 0, and ending at day 33, hour 0, minute 0.

Although the current program distinguishes between bases, it aggregates over all aircraft types at a base. Consequently, in simulations including more than one aircraft type at a base, the report should be interpreted appropriately. The report provides six different kinds of statistics for 8 different aircraft status conditions. The first six are mutually exclusive; the last two, AOCP and NORM, are related and will be explained. The source of all statistics and interpretations of their meanings follow.

1. Flyable aircraft are those available in the flyable pool. They may be flown from this pool or uploaded and transferred to the ready or alert pools for operations. Appendix E and the Programmer's Guide contain a complete list of transaction numbers and appropriate explanations. In addition, Appendix D contains an example of each Output Report showing the specific transaction numbers from which all statistics, totals and averages are derived.

BASE STATUS REPORT

RAT10

PERIOD COVERED 3 0 0 TO 33 0 0

BASE RAT	MEAN	SIGMA	MIN.	MAX.	DURATION	FREQUENCY
FLYABLE	2.22	______	-0.	11.	3.85	416.
READY	2.91	______	0.	12.	2.47	847.
GROUND ALERT	0.	______	0.	0.	0.	0.
AIRBORNE	1.11	______	0.	12.	0.97	818.
AWAITING MAINTENANCE	0.	______	0.	0.	0.	0.
IN MAINTENANCE	5.76	______	-0.	12.	3.29	1260.
TOTAL AOCP	0.	______	0.	0.	0.	0.
TOTAL NORM	5.76	______	-0.	12.	3.29	1260.

MACHINE TIME = 00 HR 03 MIN 24 SEC

Fig. 11 -- Base Status Report Illustration

2. Ready aircraft are those uploaded and carried in the ready pool to accomplish missions flown from this pool. Normally, they will receive some kind of Launch-Service maintenance, i.e., be uploaded to fit different mission configurations.

3. Ground alert aircraft are kept on alert and flown from the alert pool. They may or may not be uploaded, depending upon the specific requirements being simulated.

4. Airborne aircraft are in the air carrying out all missions in the simulation. They may have been flown from any of the three pools. They may be aloft on loiter missions, on airborne alert, or on any leg of any kind of mission established in the simulation. Since the report does not distinguish between missions, the statistics for this status will cover all missions flown by all aircraft on the given base.

5. Awaiting Maintenance includes all aircraft in need of and awaiting maintenance of any kind (inspections, unscheduled maintenance, launch service, etc.). An aircraft undergoing maintenance will not be counted in these statistics, even though one system may be awaiting repairs while another is being worked on. The rule is: given any maintenance work in progress, no amount of other work waiting for equipment or resources will change the status to awaiting maintenance. For this reason, the statistics for this status normally do not reflect all queue situations.

6. In Maintenance includes all aircraft undergoing any kind of maintenance. It is a general term and includes all "maintenance types" and activities as defined in the section on inputs. The current program for compiling this statistic does not distinguish between the different maintenance types or activity such as inspections, repairs and functional checks, etc. It should be noted, however, that reports 8 and 11 provide detailed information by maintenance activity in slightly different format.

7. Total AOCP (Aircraft Out of Commission for Parts) refers to the total time aircraft repairs or other maintenance requirements are delayed for lack of parts (PA) in the simulation. It also includes time delays (TD). In SAMSOM, AOCP may include NORS* (Not Operationally Ready for Supply reasons) and any other supply delays including on-base delivery times, etc. Obviously, users should be careful to interpret any statistics associated with the AOCP status condition according to the particular meaning given "parts" and other simulation inputs. For example, if one uses parts to represent communication delays, travel time, etc., he should interpret the statistics accordingly. In contrast to the distinction between awaiting and in maintenance discussed above, the AOCP status condition may run concurrent with other maintenance.

8. Total NORM (aircraft Not Operationally Ready or out of commission for Maintenance) accounts for all aircraft down for maintenance, and includes those in and awaiting maintenance. In fact, NORM is the sum of the two statistics.

Interpreting the different statistics associated with these status conditions is facilitated if we distinguish between the first four and the last two categories. Mean, sigma,** minimum and maximum refer to the number of aircraft carried in the given status. Average duration and frequency refer to the length of time and number of times all of the different aircraft (counted one by one) are carried in the given status. For maintenance categories, it is important to understand that frequency has a special meaning that will be explained in the discussion of the term.

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*Actually, different kinds of supply delays may be identified with different parameters in the simulation inputs.

**At present, sigma is undefined. It will be defined in the context of report revisions.

Mean refers to the arithmetic mean or average number of aircraft per hour found in the given status. It is computed from the information included in the transactions as follows: M = T/L, where T equals total aircraft hours in the status for the period, and L is the number of hours in the period. Total aircraft hours is the same as total duration, explained in a following paragraph.

Sigma is the standard deviation of all observations identified with reference to the mean. It should be accorded the regular meaning of the square root of the sum of the squares of the deviations from the mean divided by the number of observations.

Minimum refers to the minimum number of aircraft found in the given status during the period of interest provided the aircraft were in the status for more than one minute.

Maximum refers to the maximum number of aircraft found in the given status during the period, provided the aircraft were in the status for more than one minute.

Taken altogether, these four statistics help the user establish the average, range, and variation in the number of aircraft found in the different status conditions for selected periods (days, weeks, months, etc.) or for the entire simulation. For example, the illustrations for the 12 aircraft in Fig. 11 show a mean of 2.22 aircraft were kept in a flyable status during the 30-day period. Similarly, 2.91 were ready, and 1.11 were in the air. None were found waiting for maintenance, but an average of 5.76 aircraft were in maintenance all of the time.

Although the Base Status Report does not reflect percentages, these averages could be interpreted as follows. During the 30-day period, the organization kept 6.24 or 52 percent of its 12 aircraft in commission. The other 5.76 or 48 percent were down for some kind of maintenance. Variations in these data ranged from a minimum of zero in all status conditions at some time or another to maximums of 11 or 12 aircraft in some status. Items reflecting a minus zero should be treated as zero.

Average duration and frequency are more easily explained if total duration* is clearly understood. The total duration of any status condition for an aircraft is the total time it was in the given status during the reporting period. Since the aircraft may change status several times during the period, frequency refers to the total times it entered and left the status. The average duration is the total duration divided by the frequency. Unfortunately, all status conditions in the model may involve fleeting, transitory "statuses" created as the model proceeds with the simulation. Two examples of such simulation artifacts are described.

First, all aircraft coming out of the last** maintenance requirement are put into the flyable pool. If there are no ready or alert requirements, they remain in the pool until flown or removed for some other reason. If an unfilled alert or ready requirement is outstanding, however, they go immediately to the proper status (proper launch service or direct to the ready or alert pool). Even though immediately is a very short period of time in these cases, the aircraft pass through and are recorded as being in the flyable status.

Second, an aircraft is transferred to maintenance when its first maintenance requirement is identified. It remains "in need of maintenance" until the last job or requirement is completed. During this period, however, it may have gone into awaiting maintenance several times as different resources work on it. In other words, when one resource finishes and another begins, the aircraft waits for a fleeting moment during the change from in maintenance back to in need of maintenance, and back to in maintenance. Of course, all such small increments of status time add little to the total duration. They could be ignored

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*Total duration is not included in the report. Since it must be computed to determine this average and the mean previously discussed, it may be added if desired. In any event, it may be computed by multiplying the frequency times the average duration.

**The last maintenance may be any of the different maintenance types; it is determined by the different maintenance activities identified in the inputs for the given mission.

except that they also increase the frequency count. Since they really are only simulation devices, the output program has been designed to exclude all transitory status conditions that last one minute or less in duration.

Although total duration is not affected, another set of circumstances also introduces potential error into the calculation of the average because of frequency. This occurs when a string of maintenance activities such as debriefing, troubleshooting, unscheduled maintenance, etc. is called for and accomplished. As each subsequent maintenance routine is activated, the frequency would increase if the output program did not compensate for the change. Again, it refuses to recognize any change involving one minute or less, and the error is avoided.

Because numerous short periods may be selected, it also should be understood that the output program is designed to accept status conditions that are broken up by the choice of reporting periods. For example, if an aircraft is in flyable status when the period ends, the time will be included in the period and it will be counted in the frequency for computing the average. Similarly, it will be counted in the flyable status in the next reporting period and the time in the status during the period will be included in its total. Again, if either of these times lasts a minute or less, they will not be counted in the total duration or frequency.

Finally, launch-service requirements and standing failures also affect the frequency count. In both cases they are included in the total. Thus, correct interpretation of the average duration requires an understanding of what is included in the statistic. Even though the output program, in effect, adds end to end all maintenance normally included in turnaround concepts, it does not exclude from the frequency count those instances when launch-service comes after some period of flyable status (in excess of one minute) or when the aircraft experiences a standing failure. If the simulation includes the possibility of such events, average maintenance turnaround is underestimated because it includes relatively short launch-service activities (and perhaps standing failure repairs) that really are not part of a turnaround as

normally understood and carried out in the simulation. Report 11 provides additional information in greater detail which may take such considerations into account.

Given the above understandings of average calculations and frequency, the two terms may be defined.

Average Duration is the total amount of aircraft time (total duration) divided by the frequency. It is the average time an aircraft remains in the given status. In terms of the airborne status, it should reflect the average sortie length. In the Fig. 11 sample, this is 0.97. The fraction of an hour could occur for two reasons. It might be the actual average sortie time resulting from draws from a distribution of sortie times; or it might be the result of some sorties being cut into two parts by a particular choice of reporting periods.

Unfortunately, without knowing more about the exact kinds of maintenance activities and circumstances included in a simulation, we are unable to say whether or not the average duration of NORM shown in any given set of outputs is the average turnaround time. Of course, the user may examine the inputs in sufficient detail for proper interpretation, or design inputs to generate an average turnaround time that would agree with his meaning.

Frequency refers to the number of times all aircraft at the base left the given status, provided they were in it for more than a minute. As already discussed, this count may be straightforward and easily interpreted or it may have to be properly interpreted to fit the simulation. In the frequency count for the airborne status, it is a count of the times aircraft took off and remained aloft for more than one minute. In all other cases, it involves consideration of maintenance activity, launch-service requirements, standing failures, aborts, and other events causing status changes that might last for more than one minute.

The source of all frequency counts is as follows:

Status	Transaction Numbers
Flyable	3, 13, 16-18, 35, 44
Ready	14, 17, 19, 29, 30, 34, 40, 44, 45, 61
Ground Alert	19, 31, 37, 60, 68
Airborne	2, 5, 40
Awaiting Maintenance	2, 11, 12, 16, 18, 20, 29-32, 35, 45, 46, 50, 52, 56, 62-64, 68
In Maintenance	50, 52, 56
Total AOCP	50, 52, 56, 57
Total NORM	2, 11, 12, 16, 18, 20, 29-32, 35, 45, 46, 62-64, 68

Finally, it should be noted that the report includes a record of computer time required to produce the total set of reports for all periods in the report. Such information will be useful for estimating computer time required to obtain these statistics for different simulations.

Aircraft Status Report

Output Report 3 is an Aircraft Status Report that provides a periodic snapshot* of the selected status of all aircraft in the simulation at each of the different bases. It also provides an average for each status condition for the period of interest. Figure 12 is a single-page sample of such a report. It shows data for the last two days in a simulation, identifies report headings, and includes averages for the period the report covers. Although this sample does not show when the period began, the first entry on the first page of a complete report of several pages would reveal this information.

It is important to understand that reports may include data for selected periods. For example, a report might show a set of status snapshots and their averages for the first 10 days of a simulation; another set might be for some other period, and a third type or set

*All snapshot reports allow the user to specify the time of the count (on the hour, 5 minutes after the hour, etc.) and the interval between the counts.

AIRCRAFT STATUS FOR BASE RAT

-REPORT- --TIME-- DY HR MN	RATIO FXYZ FYB	ALR	RDY	MNT	AIR	TOT
31 0 5	7	0	-0	5	-0	12
31 1 5	7	0	-0	5	-0	12
31 2 5	4	0	-0	8	-0	12
31 3 5	-0	0	2	10	-0	12
31 4 5	-0	0	7	5	-0	12
31 5 5	-0	0	8	4	-0	12
31 6 5	-0	0	9	3	-0	12
31 7 5	-0	0	9	3	-0	12
31 8 5	-0	0	7	2	3	12
31 9 5	-0	0	1	2	9	12
31 10 5	-0	0	-0	12	-0	12
31 11 5	-0	0	2	10	-0	12
31 12 5	1	0	2	6	3	12
31 13 5	1	0	-0	5	6	12
31 14 5	-0	0	-0	12	-0	12
31 15 5	-0	0	4	8	-0	12
31 16 5	-0	0	6	6	-0	12
31 17 5	-0	0	4	4	4	12
31 18 5	1	0	-0	8	3	12
31 19 5	4	0	-0	8	-0	12
31 20 5	5	0	-0	7	-0	12
31 21 5	5	0	-0	7	-0	12
31 22 5	7	0	-0	5	-0	12
31 23 5	8	0	-0	4	-0	12
32 0 5	9	0	-0	3	-0	12
32 1 5	9	0	-0	3	-0	12
32 2 5	8	0	-0	4	-0	12
32 3 5	-0	0	2	10	-0	12
32 4 5	-0	0	9	3	-0	12
32 5 5	-0	0	11	1	-0	12
32 6 5	-0	0	12	-0	-0	12
32 7 5	-0	0	12	-0	-0	12
32 8 5	-0	0	9	-0	3	12
32 9 5	-0	0	-0	-0	12	12
32 10 5	-0	0	-0	9	3	12
32 11 5	-0	0	2	10	-0	12
32 12 5	3	0	4	3	2	12
32 13 5	4	0	-0	2	6	12
32 14 5	1	0	-0	11	-0	12
32 15 5	-0	0	5	7	-0	12
32 16 5	-0	0	8	4	-0	12
32 17 5	-0	0	8	1	3	12
32 18 5	1	0	-0	4	7	12
32 19 5	2	0	-0	10	-0	12
32 20 5	3	0	-0	9	-0	12
32 21 5	4	0	-0	8	-0	12
32 22 5	7	0	-0	5	-0	12
32 23 5	7	0	-0	5	-0	12
AVERAGES	0.		5.846		12.000	
2.119		2.775		1.260		0.

	FAAA FYB	ALR	RDY	MNT	AIR	TOT	F2A FYB	ALR	RDY	MNT	AIR	TOT	F108 FYB	ALR	RDY	MNT	AIR	TOT	F10 FYB	ALR	RDY	MNT	AIR	TOT
AVERAGES	0.		0.		0.		0.		0.		0.		0.		0.		0.		0.		0.		0.	
		0.		0.		0.		0.		0.		0.		0.		0.		0.		0.		0.		0.

MACHINE TIME = 2.05 MIN.

Fig. 12 -- Aircraft Status Report illustration

might be for the last few days or weeks of operation. Whatever set of snapshots is desired, the statistics printed out on this report, including the averages, will pertain only to the status for the period of interest. It should also be noted that the user may obtain averages for the entire simulation (or for selected periods) in two ways: he may print the entire set of status snapshots quarter-hour by quarter-hour, hour by hour, etc., and the corresponding averages; or, he may choose to get only the averages by using an N entry in Col. 72 on the output request card.

As the sample report heading indicates, a separate report is prepared for each base as requested. The sample is for simulation RAT10 at base RAT. The Report Time field identifies the time (day, hour, minute) of each snapshot taken during the period of interest. Recall that the interval between snapshots is determined by the output request card. Aircraft types included in the report are identified above the (FYB) Flyable column in each set of status records. Although up to five different aircraft types may be identified for each base on a single report, the sample includes data for only one type, the F-XYZ. If more than five aircraft are located on a base, they would be included on another report.

Six kinds of data are reported for each aircraft. The data in the first three columns account for the aircraft carried in the flyable (FYB), alert (ALR), and ready (RDY) statuses. The fourth column shows the number of aircraft in all maintenance categories (MNT). The fifth column is for those in the air (AIR), and the last column accounts for the total (TOT) aircraft of the given type at the base. Averages for each status category are shown at the bottom of the report.

Flyable, ready, and alert aircraft have already been defined and discussed in connection with the Base Status Report and the SAMSOM Model Logic Schematic. The periodic entries shown reflect the number of aircraft in the given category at the point in time shown in the Report Time column. For example, five minutes after the hour on day 31 (day 31, hour 0, minute 5) there were seven aircraft in the flyable pool and none on either alert or ready status. At the same time, five

aircraft were down for some kind of maintenance, and none were flying. The total of twelve accounts for all aircraft in the simulation at the time. The first five columns should total to this number at all times during the simulation. In other words, every aircraft must be in one of the five status conditions at all times. The number of aircraft found in each of the three pools is obtained from the transactions identified on a sample of the report in Appendix D.

The maintenance column reflects all aircraft down for maintenance and unavailable for operations for all reasons. It includes aircraft undergoing all types of maintenance and those waiting for any reason. It should be noted that even though the total number of aircraft is specified in the inputs, the number at any given base may be changed by events. Attrition and replacements may cause changes in the total. In multibase simultations where aircraft are moving about among the bases, the total for any given base may change many times and thus reflect the location of aircraft in the total system being simulated.

The averages are computed from the snapshot entries included in the report for the given period. Their position with reference to the column could be confusing unless it is understood that the last of the three digits in the three-place decimal will always fall under the last digit of all entries for the column. For example, the average for flyable status on the sample is 2.119 aircraft, not 0 as one might read at first glance. The total of 12.000 also looks out of place since the 12 falls under the air column. The reason for this apparent discrepancy is the printing space required to show the averages to three places.

All averages may be compared with similar output on other reports, but the user is cautioned to expect minor* differences for several reasons. For example, the average number of aircraft airborne multiplied

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*In some cases the differences may be substantial and the snapshot averages may be misleading or erroneous. As subsequently explained, the accuracy of this report may be assured by choice of a short reporting cycle or interval.

by the number of snapshots in this report divided by the total sorties launched during the same period (number of sorties would be revealed in the appropriate Base Status Report for the given aircraft or in Report 4) should provide an average sortie time comparable to that shown in the Base Status Report.* The user is cautioned, however, that the data on the two reports are not computed from exactly the same information. The information behind the Base Status Report averages includes all changes in status as previously discussed. The information behind the averages reported in the Aircraft Status Report is based upon snapshots of status and depends on the interval chosen. Thus, short half-hour sorties might not be reflected in snapshots an hour apart. Similarly, aircraft undergoing short maintenance jobs (fuel-servicing, etc.) might not be caught in hourly snapshots. The shorter the interval, the greater the probability that the sample includes all status conditions and more nearly reflects the same averages given in the Base Status Report.**

It might also be noted that the mean number of aircraft airborne according to the Base Status Report (Fig. 11) should agree with the average number in the air shown on this report. In fact, the two samples included here are from the same simulation and the two statistics do compare favorably, even though they are not exactly the same. The mean number in the air on the Base Status Report is 1.11; the average shown on Fig. 12 for this report is 1.26. The other statistics also reflect minor differences. Some are explained by the interval effect discussed above; others may be due to the difference in the computation procedures. In some cases, status truncations due to period cutoffs or changes also may cause slight differences.

As already discussed in connection with previous reports, the computer time to produce the Aircraft Status Report is shown on the report. Note also that the averages shown on the Base Status and

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*Averages for the other columns may be compared in a similar manner.

**Depending upon the simulation inputs, 14-minute or shorter intervals should be sufficient for most purposes. In general, we have found that the hourly intervals provide sufficient data and accuracy.

Aircraft Status Reports are similar in several respects. One or the other might be considered redundant for some purposes. However, the user may choose the one that best serves his purpose or generate both reports if they are useful.

Sortie History Report

Output Report 4 is a Sortie History Report that may be produced for each base in the simulation. Unlike the Aircraft Status Report, which is a series of status snapshots and associated averages, the Sortie History Report provides a series of subtotals and snapshots of selected statistics. The subtotals it provides concern sorties and related attrition events and their associated totals for the period. If subtotals are not useful, an N entry in Col. 72 of the output request card will print out only the totals. The report also provides a series of snapshots of sortie-schedule losses or deficits.

The general format of this report is shown in Fig. 13. Simulation identification and base name are shown in the heading of each separate report generated for the different bases. The illustration identifies base RAT and simulation RAT10. Other headings identify the reporting interval (Report Time) and the different missions included in the given report. Four different missions may be identified on each page of the report. The example shows sortie data for three missions identified as ST1, ST2, and STL. If additional missions are flown from a given base, or if it is desirable to group missions according to aircraft types, additional reports must be requested. Seven different statistics are provided for each mission, including sortie takeoffs and landings, the associated events showing impact of attrition (if any), and sortie-schedule losses.

It is important to understand that the entries for any given report time for schedule losses differ from the entries for the other statistics. As already indicated, statistics on sortie launches and landings and/or attrition reflect subtotals or number of times the event occurred during the interval between the current and the immediately preceding report time. For example, the illustration shows that three aircraft

-REPORT- RATIO SORTIE HISTORY FOR BASE RAT

--TIME--			ST1							ST2							STL													
DY	HR	MN	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH
31	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	8	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	9	5	6	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	10	5	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	11	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	12	5	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	13	5	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	14	5	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0							
31	15	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	16	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	17	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0							
31	18	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0							
31	19	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0							
31	20	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	21	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	22	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
31	23	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	8	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	9	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	10	5	0	8	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	11	5	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	12	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	13	5	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0	0							
32	14	5	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0							
32	15	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	16	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	17	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	2	0							
32	18	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0							
32	19	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0							
32	20	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	21	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	22	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
32	23	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
AVERAGES			321	321	1	2	1			254	254	0	0	0			330	330	0	0	0			0	0	0	0	0		

MACHINE TIME = 1.68 MIN.

Fig. 13 -- Sortie History Report illustration

had taken off (T-O) on mission ST1 between day 31, hour 8, minute 5, and 5 minutes after hour 7 on the same day. On the other hand, sortie losses or deficit (DEF) statistics reflect total deficits as of reporting time, i.e., they are snapshots.

Although not shown in the illustration,* the first entry on the report for sortie launches and landings and attrition data is the total accumulated from the beginning of the simulation. Obviously, if the first line is printed at time zero, then the totals would be zero. If reporting begins after some period of time, perhaps representing a shakedown period, there will be a cumulative subtotal to take into account in determining total sorties launched, attrition losses, etc. For example, a report for the final 30 days in a 33-day simulation would show the cumulative totals for the preceding 3 days of activity on the first line of the Sortie History Report. When output is organized to eliminate such shakedown periods, users should remember that the final total reported is for the final 30 days only and does not include the first 3 days.

A more complete description of each of the seven different statistics that the Sortie History Report provides and an indication of their source in simulation transaction records follows.

Take-offs and landings (LND) are self-explanatory. They are counted as separate events for several reasons. First, they do not necessarily reflect the same data in neat operational patterns or cycles. For example, even though nine (6 plus 3) aircraft took off on day 31 during two hours between 7 and 9, all nine landed between 9 and 10. Of course, the different takeoff times and sortie lengths determine the cycle interval between launches and returns. Although the two columns of data would tend to be equal in the long run, they may differ from day to day, especially when very long sorties, such as airborne alerts, are part of the simulation. Second, when attrition is taken into account and aircraft are lost, the two columns and totals will differ because lost aircraft do not return. Third, the two events

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*It is for the last two days of a longer period of interest.

generate different resource requirements. Takeoffs generate launch-service requirements; turnaround requirements are affected by landings. Therefore, data on both events are useful in analyzing simulation results. Takeoff statistics are derived from transaction-tape record 30, landings are from record number 2.

Since lost and combat-damaged aircraft and air aborts are directly associated with sorties in SAMSOM II, the Sortie History Report provides attrition outputs. As stated in the discussion on inputs, lost aircraft (LST) are destroyed and disappear from the simulation. Combat damage (C/D) is self-explanatory, and air aborts (A/B) refer to mission or operations failures or events. Air aborts should not be confused with ground aborts, which are reported and discussed later in connection with other reports. As indicated in the illustration, one aircraft was lost on day 32 between hours 9 and 10, another was damaged, and a third air aborted.* The statistics are derived from transactions 5, 4 and 6 for lost, combat damaged, and air aborted aircraft, respectively.

Sortie schedule deficits or fall-out have been identified under two categories: normal, operational deficits (DEF), and deficits or losses due to weather (WTH). These must be summed from the output for each snapshot if total deficits are desired. At present, weather deficits are the only outputs available for evaluating how weather affects an organization's sortie-generation capability. The data show when deficits occur during a simulation and whether or not they are eliminated or persist. Since deficit totals in the summary output at the end of the report have no meaning, they are not computed. Operational deficit statistics are derived from transaction records numbered 21, 24, 27, 28 and 42; weather deficits are derived from record numbers 26, 28, and 42.

Verbal History Report

Output Report 5 is the Verbal History Report used for debugging and similar checkout purposes. Its primary use is to trace a series of actions through simulated time to determine if and in what sequence

*It should be remembered that all numbers in the illustrations are contrived to illustrate the format and points under discussion.

the relevant events took place. As indicated in Fig. 14 and the sample report format found in Appendix D, all events called for in the output request are printed out between different points in time during the reporting period.

The first time identified in the illustration is day 0, hour 8, minute 46. Between this time and 0903 hours, "launch will be attempted for ST1 at KAT" and "a sortie is launched from KAT on ST1 with three F-5s." Assuming that the output request calls for all events to be printed out, the report shows that the only significant events during this time are the successful launches of three F-5 aircraft, numbered 7, 8, and 9. The next event occurs at 0903 hours. Three sorties (three F-5s) are scheduled to be flown from KAT on mission ST2. Since none are reported launched, it may be assumed that no aircraft are available at this time. In this connection, the Verbal History Report does not report events which could have but do not happen. Thus, it does not provide a complete tracing of all consequences or sets of interacting events.

At day 0, 4 minutes after hour 9, several events occur. Three F-5s land at base KAT, and resources (PT) are required and go to work on various aircraft. At the same time, another launch is called for and completed at base KAT for three F-5 aircraft.

The best way to understand this report is to use it in connection with an interpretation of any of the other reports. It will provide additional details to explain the more aggregated information shown on all other outputs, except the Tape Dump Report. This report is useful for checking out selected events during selected periods. It also allows one to trace the sequence of events associated with any given aircraft. In fact, it and Report 6 are the only source of tail-number associated events and activities. All other reports ignore tail-number associations and identifications and provide statistics for aircraft types,* missions, and maintenance activities.

---

*It would be possible to set up a simulation with as many aircraft types as number of aircraft and thus permit tail number scheduling and reports. Although feasible, the model has not been programmed to be economical for these kind of simulations.

```
         ON DAY   0  AT 46 MINUTES AFTER HOUR  8  THE FOLLOWING OCCURS
LAUNCH WILL BE ATTEMPTED FOR ST1     AT KAT

A SORTIE IS LAUNCHED FROM KAT     ON ST1     WITH   3 F5    *S
                                                                                                TAIL NUMBER  7
                                                                                                TAIL NUMBER  8
                                                                                                TAIL NUMBER  9

         ON DAY   0  AT  3 MINUTES AFTER HOUR  9  THE FOLLOWING OCCURS
A ST2    SORTIE WITH   3 F5    *S IS SCHEDULED TO BE FLOWN FROM KAT

         ON DAY   0  AT  4 MINUTES AFTER HOUR  9  THE FOLLOWING OCCURS
    3 F5    *S ON ST1    LAND AT KAT
                                                                                                TAIL NUMBER  1
  1 PT     1 WILL BE REQUIRED
                                                                                       SYSTEM ALL
                                                                                                TAIL NUMBER  1
  1 PT     1 ARE SET TO WORK
                                                                                       SYSTEM ALL
                                                                                                TAIL NUMBER  1
                                                                                                TAIL NUMBER  2
  1 PT     1 WILL BE REQUIRED
                                                                                       SYSTEM ALL
                                                                                                TAIL NUMBER  2
  1 PT     1 ARE SET TO WORK
                                                                                       SYSTEM ALL
                                                                                                TAIL NUMBER  2
                                                                                                TAIL NUMBER  3
  1 PT     1 WILL BE REQUIRED
                                                                                       SYSTEM ALL
                                                                                                TAIL NUMBER  3
  1 PT     1 ARE SET TO WORK
                                                                                       SYSTEM ALL
                                                                                                TAIL NUMBER  3

         ON DAY   0  AT  4 MINUTES AFTER HOUR  9  THE FOLLOWING OCCURS
LAUNCH WILL BE ATTEMPTED FOR ST1     AT KAT
```

Fig. 14 -- Verbal History Report illustration

Finally, this report provides voluminous details and soon overwhelms the analyst with paper. It should be used with care for special checking and event-tracing purposes only.

Tape Dump Report

Output Report 6 is a Tape Dump Report that provides abbreviated, coded details on all or selected transactions.* As shown in Fig. 15, it prints out selected coded events, chronologically, in ten columns of information. The first three columns identify the time of the event, shown to the nearest minute.** Column 4 identifies the transaction record number. As explained in connection with the output request card, the user may select any or all transactions. Column 5 contains the base number for all transactions except transaction numbers 36 and 47, in which case it will be blank. Column 6 shows aircraft types (transactions 1-35, 37-46, 54, 60-78) and system numbers (transactions 49-52, 55-58). It will be blank for some transactions (36, 47, 48, 59). It should be emphasized that base and aircraft type numbers reflect the order in which they are entered on Input Form 1 while the system numbers reflect the order in which they are entered on Input Form 6.

Column 7 contains mission numbers (transactions 1, 2, 4-31, 34, 35, 37-47, 49-58, 60-78) or it will be blank for transactions 3, 32, 33, 36, 48, and 59. Mission numbers also reflect the order in which missions are identified on Input Form 2 and the following codes for the "special missions:"

---

*See Appendix F and the Programmer's Guide for a list and explanation of the different transactions.

**Actually, the simulation identifies time in terms of decimal days to the nearest 0.0000001 as it is identified in all SIMSCRIPT programs.

0	2	33	71	1	1	1	6	9	2
0	2	33	50	1	2	1	6	1	1
0	2	34	73	1	1	1	2	9	2
0	2	34	52	1	2	1	2	1	1
0	2	34	75	1	1	1	2	9	2
0	2	34	73	1	1	1	3	9	2
0	2	34	52	1	2	1	3	1	1
0	2	34	75	1	1	1	3	9	2
0	2	45	41	1	1	1	0	0	3
0	2	45	54	1	1	0	7	1	1
0	2	45	18	1	1	1	7	1	1
0	2	45	55	1	1	1	7	1	1
0	2	45	69	1	1	1	7	9	1
0	2	45	55	1	2	1	7	1	1
0	2	45	69	1	1	1	7	9	2
0	2	45	71	1	1	1	7	9	1
0	2	45	50	1	1	1	7	1	1
0	2	45	71	1	1	1	7	9	2
0	2	45	50	1	2	1	7	1	1
0	2	45	54	1	1	0	8	1	1
0	2	45	18	1	1	1	8	1	1
0	2	45	55	1	1	1	8	1	1
0	2	45	69	1	1	1	8	9	1
0	2	45	55	1	2	1	8	1	1
0	2	45	69	1	1	1	8	9	2
0	2	45	71	1	1	1	8	9	1
0	2	45	50	1	1	1	8	1	1
0	2	45	71	1	1	1	8	9	2
0	2	45	50	1	2	1	8	1	1
0	2	45	54	1	1	0	9	1	1
0	2	45	18	1	1	1	9	1	1
0	2	45	55	1	1	1	9	1	1
0	2	45	69	1	1	1	9	9	1
0	2	45	55	1	2	1	9	1	1
0	2	45	69	1	1	1	9	9	2
0	2	45	71	1	1	1	9	9	1
0	2	45	50	1	1	1	9	1	1
0	2	45	71	1	1	1	9	9	2
0	2	45	50	1	2	1	9	1	1
0	2	52	73	1	1	1	1	9	1
0	2	52	52	1	1	1	1	1	1
0	2	52	75	1	1	1	1	9	1
0	2	52	73	1	1	1	1	9	2
0	2	52	52	1	2	1	1	1	1
0	2	52	75	1	1	1	1	9	2
0	2	52	30	1	1	1	1	1	1
0	3	3	41	1	1	1	0	0	3
0	3	3	54	1	1	0	10	1	1
0	3	3	18	1	1	1	10	1	1
0	3	3	55	1	1	1	10	1	1
0	3	3	69	1	1	1	10	9	1
0	3	3	55	1	2	1	10	1	1

Fig. 15 -- Tape Dump Report illustration

Code	Special Mission Name
200	ALERT
201	ABØRT
202	PERØD
203	PØSTFT
204	STAND

In addition to these special mission codes, Col. 7 may reflect a "new" mission number in the case of a Diversion Mission (transaction 9) or an "old" mission number in the case of Preemptions (transactions 61-63). A zero entry in Col. 7 means that the given transaction number covers ALL missions.

Column 8 shows aircraft tail numbers (transactions 2-6, 11-20, 22, 29-35, 37-38, 40, 43-46, 49-58, 60-64, 66-78) which the model arbitrarily assigns when it identifies the number of aircraft assigned to each base. The illustration shows aircraft tail numbers 1-3 and 6-10 associated with the different transactions. During the period (0233-0303 hours on day zero) this illustration covers, other tail numbers are not associated with the given transactions.

Col. 8 also may reflect information other than the aircraft tail number. Transaction 39 reflects the Launch ID code in Col. 8 which may be any of the following:

Code	Event
1	Scheduled sortie
2	Normal deficit
3	Sortie is in the air
4	Sortie is at an intermediate stop
5	Weather deficit
6	End of sortie
7	"Fly to Fix" sortie (NRTS)

Transaction 41 reflects the minimum number of aircraft to launch on the given sortie-element or mission in Col. 8. The zero code for transaction 41 in the illustration means that the inputs reflect a minimum of zero for that particular sortie element or mission. Actually, one or more (as provided for by the maximum) might have been launched. Transaction 59 would reflect the Resource Kind (PT, ET, PA, TD) in Col. 8.

Transaction numbers 1, 7-10, 21, 23-28, 36, 42, 47-48 and 65 are all blank in Col. 8.

Column 9 contains several different kinds of data associated with the different transactions. Transactions 1, 7-8, 17-19, 21, 23-24, 26-28, 54 and 65 reflect the Launch ID associated with the given mission and base. Transaction 9 reflects the old mission number here associated with a diversion sortie. Transaction number 30 shows the cumulative number of aircraft ready for the sortie-element (in the ready pool). The next base at which the aircraft will land is identified by transactions 39 and 40. When work starts or ends on a job (transactions 43, 69, 71, 73 and 75), the entry identifies the maintenance activity involved according to the following codes:

Code	Maintenance Type Activity
1	Debriefing (DC)
2	Troubleshooting (TS)
3	Unscheduled Maintenance (UM)
4	Functional Checks (FC)
5	Combat Damage Troubleshooting (CDTS)
6	Combat Damage Unscheduled Maintenance (CDUM)
7	Combat Damage Functional Checks (CDFC)
8	Fuel Servicing Activities (FS)
9	Launch Service Activities (LS)
10	Download Activities (DL)
11	Inspections (IS)

Column 9 codes for transactions 49-52, 55-59 and 78 show the resource number determined by the order in which they were entered on Input Form 6 as previously explained. Coded data in this column may also reveal a "new" mission number (transactions 61-63) where aircraft are preempted from sorties, maintenance or upload to meet higher priority requirements. Finally, one of the two systems causing a conflict between two maintenance requirements (and consequently a delay in beginning the maintenance on the second system) would be shown for transaction 77, conflicting systems. The system number associated with "system 1" in the inputs would be reflected in Col. 9; Col. 10 would reflect the appropriate number for "system 2." In both cases

the model would determine the number shown for each system. As with resources, the systems will be numbered as they appear on Input Form 6. It might be noted that further analysis of these records could provide additional output reflecting the impact of system conflicts upon operational capability or weapon system turnaround time.

In general, Col. 10 shows the quantity associated with events. For example, the second entry in the illustration shows that one team (or individual) of resource number 1 started work at 0233. For several kinds of transactions, however, this column reflects other data. The first example shows that work started (transaction 71) on system 2 at the given time. Other entries in Col. 10 may reflect the maximum aircraft on a sortie (transactions 21, 23, 24, 26-28, 41, 42, and 65), the minimum aircraft on a sortie (transaction 25), the launch ID (transaction 40), or the number of aircraft on a sortie (transaction 8). Transaction 1 would reflect the number of aircraft landed, while transaction 39 would reflect the number of aircraft ready for a sortie. When a change in make-up policy occurs, the new policy number appears in Col. 10 for transaction 47. Likewise, when there is a weather change, the new weather number (transaction 48) will appear. Transactions 49-52 and 56-59 show the number of resources at work, demanded but not available or completing work. Transactions 69-75 contain the system number on which work is needed, started, stopped or ended. Transaction 78 reflects the maintenance type for which a maximum PT is reached, while transaction 77 reflects system 2 when there are conflicting systems in the inputs. Finally, for many transaction numbers, a 1 appears in Col. 10. For transaction numbers 9 and 10 this 1 is meaningless, but for other transactions (2-7, 11-20, 22, 29-35, 37-38, 43, 46, 54, 60-64 and 66-68) the 1 specifies that one aircraft tail number is involved in the given transaction or event.

As indicated in the discussion of Tape Dump request cards, this report is primarily designed as an aid for program debugging and model checkout purposes. It also is a means for ferreting out details on how the model handles a sequence of activities or set of inputs that the other reports might not reveal. In fact, it provides the user

with an understanding of details that would help him design additional output reports.

Selecting the transactions that reflect the events of interest allows the user to review some particular part of the simulation in terms of details obscured within the other reports. For example, other reports do not reflect the particular aircraft undergoing inspections. Selecting transactions 66 and 67, Periodics and Postflights Due, respectively, allows the user to determine which aircraft tail numbers (shown in Col. 8) were placed in inspections initially, the sequence of periodics and postflights for any given aircraft, and when they occurred. Such analysis also would reveal aircraft not receiving inspections at the expected rate, perhaps due to their random selection to meet flying commitments.

Other details associated with tail-number identifications and other attributes or events could be obtained from this report when they would be useful, or help one understand model logic or follow the events associated with a set of inputs. For example, detailed examinations of the cumulative number of aircraft placed in and held in the ready pool (Col. 9, transaction 30) would allow the user to build a distribution of the number accumulated before the requirement was cancelled for all of the different times this occurred. Such cancellation cycle time, in turn, could be varied for successive simulations to choose some best make-up period for given conditions and resources. Similarly, these details could be examined to derive a distribution of the elapsed times these aircraft were held in ready awaiting sortie-element launch minimums to be equalled or exceeded.

Another example of how analysis of the Tape Dump Report might be useful involves a selection and analysis of system conflict record 77. This record shows both the system conflict situation and the system (Col. 10, system 2) that is delayed because of the conflict. Using a unique identification between systems and resources, the user could make this report show the time of conflict and when work later began (transaction 50) on the delayed system. Thus, he should be able to build a new report (or do a special eyeball analysis of this one) showing the queue (delay) times associated with such situations and

the affected systems (resources). Combined with events showing when other work was in progress, the user might also distinguish between conflicts that "hurt," i.e., occurred alone, and those that overlapped with other maintenance or delay and did not have an impact on turn-around time.

Finally, it should be noted that a similar Dump Report containing additional information (especially a finer division of time to reflect the sequencing of events) is available using a special program described in the Programmer's Guide.

Resource Report

Output Report 7, the Resource Report, provides both detail and summary information on resource availability, utilization and shortages. Detail information is provided in a series of resource status snapshots at selected points in time, as identified in Fig. 16. The details for each resource are categorized four ways: resources at work (WRK), idle (IDL), available (TOT), and demanded not available (DNA). Seven resources may be reported on each page of output. Each page, in turn, shows simulation identification (TEST 3), and base (B1). Snapshot times, such as 5 minutes after the hour shown in the illustration, are selected and identified on the output request card.

The user is cautioned that the quantities recorded in the columns for the different resources should be correctly interpreted to agree with the unit-meaning for each resource established in the inputs. In other words, the correct meaning for personnel types (PTs) 1, 2, 3, 4 6, and 7* in the illustration is unclear. They might refer to either individuals or crews (or teams). The latter terms, in turn, might mean some average number of men. As the reader will recall, these meanings are established when completing Input Form 6 and should be consistent throughout the simulation for any given resource. For example, let us assume that PT1 statistics in the illustration mean individuals. The

*The illustration shows that resources may be reported in any convenient order or grouping.

-REPORT- TEST 3 RESOURCE REPORT FOR BASE 81

--TIME--			PT	1 -----			PT	3 -----			PT	6 -----			PT	7 -----			PT	2 -----			PT	4 -----			ET	5 -----		
DY	HR	MN	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA
28	0	5	7	10	17	0	1	2	3	0	2	3	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	1	5	12	5	17	0	1	2	3	0	3	2	5	0	0	2	2	0	1	0	1	0	1	1	2	0	0	1	1	0
28	2	5	10	7	17	0	1	2	3	0	2	3	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	3	5	13	4	17	0	1	2	3	0	3	2	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	4	5	10	7	17	0	1	2	3	0	3	2	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	5	5	12	5	17	0	1	2	3	0	3	2	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	6	5	10	7	17	0	1	2	3	0	2	3	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	7	5	11	6	17	0	1	2	3	0	2	3	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	8	5	9	8	17	0	1	2	3	0	2	3	5	0	1	1	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	9	5	12	5	17	0	2	1	3	0	1	4	5	0	0	2	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	10	5	11	6	17	0	2	1	3	0	2	3	5	0	1	1	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	11	5	8	9	17	0	1	2	3	0	1	4	5	0	1	1	2	0	0	1	1	0	1	1	2	0	0	1	1	0
28	12	5	9	8	17	0	3	0	3	0	2	3	5	0	2	0	2	0	1	0	1	0	1	1	2	0	1	0	1	0
28	13	5	8	9	17	0	3	0	3	1	3	2	5	0	2	0	2	0	1	0	1	0	1	1	2	0	1	0	1	0
28	14	5	10	7	17	0	3	0	3	2	4	1	5	0	1	1	2	0	1	0	1	1	1	1	2	0	1	0	1	0
28	15	5	12	5	17	0	3	0	3	2	5	0	5	1	2	0	2	0	1	0	1	1	0	2	2	0	1	0	1	0
28	16	5	10	7	17	0	3	0	3	2	5	0	5	1	1	1	2	0	1	0	1	1	0	2	2	0	0	1	1	0
28	17	5	9	8	17	0	3	0	3	0	5	0	5	0	1	1	2	0	1	0	1	1	0	2	2	0	0	1	1	0
28	18	5	11	6	17	0	2	1	3	0	5	0	5	0	0	2	2	0	1	0	1	2	0	2	2	0	0	1	1	0
28	19	5	14	3	17	0	1	2	3	0	4	1	5	0	0	2	2	0	1	0	1	2	0	2	2	0	0	1	1	0
28	20	5	13	4	17	0	1	2	3	0	4	1	5	0	1	1	2	0	1	0	1	2	0	2	2	0	0	1	1	0
28	21	5	11	6	17	0	1	2	3	0	4	1	5	0	1	1	2	0	1	0	1	2	0	2	2	0	0	1	1	0
28	22	5	11	6	17	0	2	1	3	0	3	2	5	0	1	1	2	0	1	0	1	2	0	2	2	0	0	1	1	0
28	23	5	13	4	17	0	1	2	3	0	2	3	5	0	1	1	2	0	1	0	1	1	0	2	2	0	0	1	1	0
29	0	5	15	2	17	0	1	2	3	0	3	2	5	0	1	1	2	0	1	0	1	1	0	2	2	0	0	1	1	0
29	1	5	15	2	17	0	0	3	3	0	2	3	5	0	1	1	2	0	1	0	1	2	0	2	2	0	0	1	1	0
29	2	5	14	3	17	0	0	3	3	0	2	3	5	0	1	1	2	0	1	0	1	1	0	2	2	0	0	1	1	0
29	3	5	13	4	17	0	0	3	3	0	3	2	5	0	1	1	2	0	1	0	1	0	0	2	2	0	0	1	1	0
29	4	5	11	6	17	0	0	3	3	0	3	2	5	0	1	1	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	5	5	10	7	17	0	0	3	3	0	3	2	5	0	1	1	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	6	5	12	5	17	0	1	2	3	0	3	2	5	0	1	1	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	7	5	12	5	17	0	1	2	3	0	1	4	5	0	1	1	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	8	5	11	6	17	0	1	2	3	0	2	3	5	0	1	1	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	9	5	8	9	17	0	1	2	3	0	1	4	5	0	0	2	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	10	5	8	9	17	0	1	2	3	0	1	4	5	0	0	2	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	11	5	8	9	17	0	1	2	3	0	1	4	5	0	0	2	2	0	0	1	1	0	0	2	2	0	0	1	1	0
29	12	5	11	6	17	0	3	0	3	0	3	2	5	0	1	1	2	0	1	0	1	0	0	2	2	0	1	0	1	1
29	13	5	12	5	17	0	3	0	3	0	3	2	5	0	1	1	2	0	1	0	1	0	0	2	2	0	1	0	1	1
29	14	5	10	7	17	0	3	0	3	1	3	2	5	0	1	1	2	0	1	0	1	0	0	2	2	0	1	0	1	0
29	15	5	11	6	17	0	3	0	3	2	5	0	5	0	2	0	2	0	1	0	1	1	1	1	2	0	1	0	1	0
29	16	5	10	7	17	0	3	0	3	1	5	0	5	0	1	1	2	0	1	0	1	1	2	0	2	0	1	0	1	0
29	17	5	9	8	17	0	3	0	3	1	4	1	5	0	1	1	2	0	1	0	1	1	1	1	2	0	0	1	1	0
29	18	5	10	7	17	0	3	0	3	0	5	0	5	1	2	0	2	0	1	0	1	2	2	0	2	0	1	0	1	0
29	19	5	11	6	17	0	3	0	3	0	5	0	5	1	2	0	2	0	1	0	1	0	2	0	2	0	1	0	1	0
29	20	5	12	5	17	0	3	0	3	0	5	0	5	1	1	1	2	0	1	0	1	0	2	0	2	0	0	1	1	0
29	21	5	14	3	17	0	3	0	3	1	5	0	5	2	1	1	2	0	1	0	1	0	2	0	2	0	0	1	1	0
29	22	5	12	5	17	0	3	0	3	1	5	0	5	2	2	0	2	0	1	0	1	0	2	0	2	0	0	1	1	0
29	23	5	14	3	17	0	3	0	3	1	5	0	5	1	2	0	2	0	1	0	1	0	2	0	2	0	0	1	1	0
AVERAGES				5.128		0.187		2.061		0.036		2.817		0.033		1.271		0.075		0.704		0.076		1.685		0.		0.853		0.010
			11.872		17.000		0.939		3.000		2.183		5.000		0.729		2.000		0.296		1.000		0.315		2.000		0.147		1.000	

Fig. 16 -- Resource Report illustration

report shows 17 men available (TOT) throughout the day. Seven or more were always busy (WRK). At various times 3 to 10 were idle (IDL), none were ever demanded but not available (D/NA). Wherever PT1 appears in this simulation it should be interpreted as number of men, not crews.

On the other hand, consistency among the different resources is not required. The statistics for the other PTs may mean number of teams, each of which, in turn, would be composed of some number of men.

Normally, the correct meaning for equipment or facilities would be that each unit was a single piece of equipment, not a group working as a unit. The example in the illustration shows one piece of equipment (ET5) available. It also shows that it was busy some, but not all, of the time. In fact, between 1100 and 1400 hours on day 29, there was a shortage of one piece. One should not conclude from this example that shortages would be only one unit; they could have been any number, even more than was ever available to do the work. For example, the DNA column for PT2 shows that two crews were needed in addition to the one available and busy for several hours on day 28.

The averages at the bottom of the illustration are computed over all snapshots included in the period of interest. In this case it may be assumed that they reflect data for 30 days of operation. As they indicate, every resource shown on the report except PT4 was in short supply some of the time. PT4 reflects a zero D/NA average.*

These averages are computed from the total number of snapshots (observations) included in the report. If resource status is sampled every hour, the averages so reflect. The smaller the interval between snapshots, the more accurate become the averages reflecting resource utilization and idle time. Although utilization percentages may be computed from these statistics, this report does not provide them. In the illustration, PT1 was utilized 70 percent of the time (11.872 ÷ 17.0). ET5 was used only 14.7 percent of the time and was idle 85.3 percent. More accurate utilization data may be obtained from the Matrix Summaries.

Resource status snapshots and averages are not affected by transient states previously discussed. They are derived from the following transaction records.

---

*It is possible, but not likely, that PT4 was demanded but not available between snapshots.

Status	Transaction Numbers
Total Available (TOT)	59
Total at Work (WRK)	50, 52, 56, 59
Total Idle (IDL)	50, 52, 56, 59
Total Demanded Not Available (DNA)	49, 51, 58

Finally, additional resource statistics are available in Report 9, Matrix Reports. These reports, however, consider more than just snapshots. They follow the resources throughout the period and compute accurate statistics. If the reporting interval on the Resource Report is sufficiently small, then the averages computed by the Resource Report should compare favorably with the means printed by the Matrix Reports when AVG is the requested statistic. Further discussion of such comparisons and crosschecks will be found in the explanation of the Matrix Reports.

Maintenance Report

Output Report 8 is the Maintenance Report that provides detailed and summary information on maintenance activities during the simulation. Both the snapshot statistics and averages shown in Fig. 17 are derived and interpreted in a manner similar to that explained for the Resource Report. It is important, however, to understand that Maintenance Report statistics show the number of aircraft in a given maintenance-status category, not the number of resources doing the work. Consequently, appropriate aggregations of these data may be compared with and cross-checked against the maintenance statistics compiled in the Aircraft Status and Distribution Reports.

As reflected in the report headings of Fig. 17, the illustration is for a Base KAT and is from simulation KAT5. It covers F-5 aircraft (top row) and missions ST1, ST2, and STL (second row). The third row shows the systems, and the fourth row shows the maintenance activities. Users may choose any convenient column groupings of these headings to facilitate understanding. Illustration statistics have been grouped

MAINTENANCE REPORT FOR BASE KAT KATS

---TIME---			F5		F5		F5		F5		F5		F5		F5		F5		F5											
----OF----			ST2		STL		ST1		ST1		ST2		STL		ST1		ST2		STL											
--REPORT--			SY ALL		SY ALL		SY SY1		SY SY2		SY SY2		SY SY2		SY ALL		SY ALL		SY ALL		SY									
			UM		UM		LS		LS		LS		LS		FS		FS		FS											
DAY	HR	MIN	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM
31	0	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
31	1	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
31	2	5	0	0	5	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0										
31	3	5	0	0	3	0	4	0	5	0	0	0	0	0	0	0	0	0	2	0										
31	4	5	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0										
31	5	5	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0										
31	6	5	0	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0										
31	7	5	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0										
31	8	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
31	9	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
31	10	5	0	0	2	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0										
31	11	5	0	0	2	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0										
31	12	5	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0										
31	13	5	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0										
31	14	5	5	0	1	0	0	0	0	0	2	0	4	0	0	0	0	0	0	0										
31	15	5	1	0	1	0	0	0	0	0	2	0	4	0	0	0	0	0	0	0										
31	16	5	1	0	1	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0										
31	17	5	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0										
31	18	5	0	0	5	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0										
31	19	5	0	0	7	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0										
31	20	5	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
31	21	5	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0										
31	22	5	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0										
31	23	5	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0										
32	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0										
32	1	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0										
32	2	5	0	0	1	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0										
32	3	5	0	0	1	0	9	0	7	0	0	0	0	0	0	0	0	0	0	0										
32	4	5	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0										
32	5	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0										
32	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
32	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
32	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
32	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
32	10	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0										
32	11	5	0	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0	0										
32	12	5	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0										
32	13	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0										
32	14	5	5	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0										
32	15	5	3	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0										
32	16	5	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0										
32	17	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0										
32	18	5	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0										
32	19	5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
32	20	5	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
32	21	5	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0										
32	22	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
32	23	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
AVERAGES			0.	0.414	0.	2.651	0.	0.626	0.	0.601	0.	0.479	0.	0.614	0.	0.094	0.	0.078	0.	0.246	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

MACHINE TIME = 00 HR 03 MIN 5.4 SEC

Fig. 17 -- Maintenance Report illustration

by maintenance activity, UM, LS, and FS. As shown in the example, up to 14 different sets of statistics may be displayed on each page of the report. Since all outputs are optional, users may request as many sets of these data as may be useful.

Each set of data includes two statistics: number of aircraft in maintenance (IM) and the number of aircraft awaiting maintenance (AM). The data on aircraft both in and awaiting maintenance are derived from transactions 69, 71, 73, 75. The statistics are mutually exclusive for any given aircraft, system, and maintenance type. However, any given aircraft may be in more than one status for the different systems within a given maintenance type. In maintenance means that work is in progress. Awaiting maintenance means that it is not in progress and that it is waiting for resources (either not available or prohibited from working because of conflicting systems or maximum number of personnel constraints) or for parts. Thus, awaiting maintenance reflects both queues and other constraints preventing work from proceeding on the given system and maintenance activity.

Since the model performs the different maintenance types (UM, FS, etc.) sequentially, it is possible to cross-check the sum of selected maintenance report averages against their counterparts in the Base Status and Aircraft Status Reports.* Of course, the reporting interval must be identical when comparing it with the Aircraft Status Report, and sufficiently small when comparing it with the Base Status Report. However, one of the primary uses of these data is to allow the user to redefine in-commission or ready time to suit his purposes. For example, it is common practice to consider any aircraft requiring only fuel-servicing activity to be available and in-commission. Model statistics treat all maintenance as downtime; hence the model tends to understate conventional uptime percentages. Given Maintenance Report statistics, the user may adjust other averages to fit his needs and definitions of downtime

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*The user must be sure to sum mutually independent sets of data. Not all summations would be meaningful. In any given set of maintenance type (UM, FS, etc.) statistics, the different systems may be worked on concurrently.

and ready status. Appropriately categorizing the inputs and system definitions allows the user to establish almost any desired definition of status to fit his needs.

This report also provides information on selected system maintenance parameters. It would be useful for examining the variations in system requirements associated with different operations, break rates, and maintainability assumptions. It should be emphasized, however, that in most cases* separate system statistics would not reflect or measure the impact of improvements or degradations in reliability and maintainability parameters. Impact would be reflected in changes in the overall status statistics or operations output, depending upon how the user chooses to define his measures of capability or output for the analysis.

The Matrix Summaries

Output Report 9 is a set of Matrix Summaries or reports that provides a special form of hourly frequency counts of 16 different kinds of simulation outputs for 24-hour periods. The complete list of outputs will be found in the subsection "Output Request for Report 9." The format used for all output is illustrated in Fig. 18.

The report headings identify the base (SH), aircraft (F-5A), missions included (in this instance all), output code (LAUNCH), desired statistic (TOT), and report start (day 3) and stop (day 32) times covering 30 days of operations. Each cell in the matrix is identified with an hour of the day (across the top), and the number of units are shown on the vertical. Although the hourly identification is fixed (quarter hours, etc., cannot be shown), the number of units may vary to fit the output that the simulation generates. The program allows for 51 lines to be printed per matrix page. If there are more than 50 units, the program automatically sets up an appropriate increment.

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*Unless the inputs were specifically designed to make the particular system requirements mutually exclusive from all other maintenance.

TEST 1 BASE = 'SH ' 'ALL' MISSNS' OUTPUT CODE = 'LAUNCH' STATISTIC = 'TOT' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
25							4																	
24							6																	
23							5																	
22							6																	
21							7																	
20							1																	
19							1																	
18																								
17																								
16																								
15																								
14										1														
13																								
12																								
11										3	1													
10										3							1							
9									2	1			1	1			1			1				
8									1	1	1	1	2	1		2	2		1	3				
7									3	5	3		4	5	1		1	2	1	3				
6									2	6	2	3	6	6	9	5	4	7	6	7				
5									6	3	5	9	5	5	7	5	11	3	5	5				
4									6	3	10	4	5	7	4	7	3	8	5	5				
3									5	4	6	7	4	3	8	7	2	7	7	4				
2								1	4			5	3	2		2	3	2	2	1				
1								4	1		1	1			1	2	2	1	2					
-0	30	30	30	30	30	30		25			1								1	1	30	30	30	30
MEAN	0.		0.		0.		22.6		4.6		4.5		5.1		4.6		4.9		4.1		0.		0.	
MEAN		0.		0.		0.		0.2		6.8		4.0		5.1		4.2		4.3		5.2		0.		0.
SIGMA	0.		0.		0.		1.6		2.1		2.1		1.9		1.4		2.1		1.9		0.		0.	
SIGMA		0.		0.		0.		0.5		2.8		1.6		1.7		1.7		1.5		2.0		0.		0.

Fig. 18 -- Sortie Launch Matrix illustration for base SH

For example, if there are between 50 and 100 units, the scale would be in steps of 1 (50, 51, 52,...,100) or if the number of units is between 100 and 200, the scale would be in steps of 2 (100, 102,...,200).

As will be noted, a frequency count is entered for each hour. The correct interpretation of the example for base SH is that not one (0) aircraft was launched between hours 0-5 and 20-23 during the 30 days covered by the report. The zero-hour entry includes events from 2400 to 0059 hours. Four times out of 30 between 0600 and 0659 hours, a total* of 25 aircraft were launched; 6 times out of 30 the number launched was 24, etc. Thus, the report provides a summary launch profile or histogram for the unit for the period. The sum of the counts in each column should always equal the number of days printed at the top of the report. In this case, the sum of the counts in each column of cells equals 30.

The mean number launched during each hourly period of the day is shown at the bottom, and sigma is computed and shown. The illustration shows that the average number launched from 0600-0659 hours was 22.6; during most of the remainder of the flying day (0600-1959 hours), the average number per hour ranged from 4 to 5. Obviously, the sum of these averages divided by the number of aircraft in the simulation would provide an estimate of the average number of sorties per aircraft day. This average, in turn, should agree with the data shown on the Operations Summary and Sortie History Reports.

Fig. 19 depicts another kind of sortie launch pattern covering all bases and missions in another simulation. It might be noted that the unit count ends at 15, the largest number of launches during any hourly interval in the reporting period. The launch profile shows a cycle of launches that peaks every other hour. No particular significance should be attached to the statistics. The fluctuations probably

---

*It should be noted that this is the sum of all launches during this hour period. These launch statistics differ from those for later matrices.

BASE ='ALL ' 'ALL ' OUTPUT CODE ='LAUNCH' STATISTIC ='TOT' START TIME = -0 STOP TIME = 29 -- 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
15													1				1							
14	1								1				1											
13	1				1														1		1		1	
12	2		3		1		2				1								1		2		1	
11	5		1				2		2		1		3		6		3		2		2		3	
10	2		4		1		4	1	2		2		3		3		6		10		1		3	
9	4		2		6		5	1	7	1	7		5		5		5		3		4		4	2
8	4		7		7		5		4		5	2	11		4		2		8		5		7	
7	7		6	3	6	1	4	1	6	2	9	1	3	2	6		8		4		8	1	7	
6	3	2	4	3	6		3	4	4	2	2	2			5	7	3		1	1	5	4	1	
5		1	2	4	1	1	4	1	2	2	2	3	2	6	1	5	1	2		3	1	3	3	2
4		3		4		9	1	7	2	8		4	1	2		3	1	6		2		9		3
3		7		3	1	5		9		7	1	5		5		7		9		5	1	6		5
2		5		8		7		5		3		7		5		6		9		10		5		9
1		8		4		5		1		4		4		7		2		2		9		2		7
-0	1	4	1	1		2				1		2		3				2						2
MEAN	8.7		7.9		7.7		8.0		7.8		7.8		8.7		8.3		8.4		9.1		8.0		8.3	
MEAN		2.3		3.5		2.7		4.0		3.6		3.3		2.8		3.8		2.7		2.4		3.7		2.7
SIGMA	2.7		2.4		1.9		2.2		2.2		1.8		2.3		1.8		2.2		1.6		2.2		2.0	
SIGMA		1.7		2.0		1.5		2.0		2.0		2.1		2.0		1.6		1.2		1.4		1.5		2.1

Fig. 19 -- Sortie Launch Matrix illustration for all bases

were caused by the schedule of requirements. They may or may not reflect total capabilities.

Figure 20 includes a different kind of statistic. It shows the average* (desired statistic) number of personnel (PT) at work (WORK) at ALL bases for a 30-day period beginning at day zero and ending on day 29. Although examples are not shown, it should be understood that similar kinds of matrices may be generated for resources showing the minimum and maximum number of men at work. In contrast to the average computations previously noted, the minimum is simply the lowest number of men recorded at work <u>at any time</u> during the given hour. Similarly, the maximum is the <u>single</u> highest number of men at work during the hour. Transient states affect these reports: The number of units in a status must remain unchanged for more than one minute or the immediately preceding value will be used.

A similar set of Matrix Summaries may also be generated for PT1 to show the average, minimum and maximum number of men demanded but not available (D/NA) and idle (IDL) for all hours of the day.

All resource matrix means may be compared with their counterpart averages on the Resources Reports. Specifically, the average of the sum of the means on the Matrix Summary should compare favorably with the corresponding average on the Resource Report for the given resource statistic. They may not be equal because the statistics are compiled and computed differently for the two reports and because choice of snapshot interval on the Resource Report may introduce errors into final averages. Matrix Report statistics are the most accurate and are not compromised by sample (snapshot) choices. They take into account all events occurring during the hourly period.

The sources of all Matrix Summary statistics are shown in Fig. 21. Matrix Summaries provide useful information for several purposes. As already indicated, they produce hourly profiles of launches, landings, losses, etc. showing averages and the frequency of occurrences for 24-hour periods. They also provide similar histograms of aircraft status

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*Average is computed by multiplying the number of resources at work by the fraction of the hour during which they worked. For example, if 3 PTs worked for 15 minutes each, the average would be computed as 3 x 15/60.

BASE ='ALL ' 'ALL 'PT' OUTPUT CODE ='WORK ' STATISTIC ='AVG' START TIME = -0 STOP TIME = 29 -- 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
17	2	1	1	4	3	3	2	2	2	3	3	1	3	4	3	3			1	3	2	2	2	3
16	1	1	1		2	3	3	3		1		3	1	2	2	2	1	2	1	3	2	4	1	
15	2	6	2	1	3	2	3	1	3	2	2		1	1	2	3	1	2	2		2	2	2	3
14	6	3	3	1	2		1	3	2	4	2	1	4	2		2	5	5	3	3		2		1
13	5	5	1	10	3	2	6	4	3	4	7	3	2	4	1	2	1	2	5	2	1	4	7	4
12	4	3	7	4	4	5	5	2	5	4	2	6	1	4	7	1	3	4	6	3	6	1	3	8
11	3	3	6	3	3	6	2	6	3	3	5	4	5	1	1	5	3	2	1	4	5	2	2	1
10	4	5	1	1	3	2	1	3	4	3	3	2	4	1	4	5	6	4	2	1	1	7	6	3
9		2	2	3	3	2	2	2	2	2	3	2	3	6	4	4	5	1	3	3	3	3	3	3
8	1		4	1	2	2	3	2	3	1		5	2	2	3		1	2	4	6	1	1	2	2
7	1		1	1		2		1	1	1	1	1	2	1	1	1		3	1	1	6	1	1	2
6					1		1		1	1	1	1	1			1	3	2				1	1	
5										1		1	1	1	1			1	1		1			
4											1					1	1			1				
3					1	1	1							1	1									
2				1				1	1															
1		1	1																					
-0	1																							
MEAN	12.2		11.2		11.9		12.1		11.2		11.8		11.3		11.2		10.6		11.5		10.9		11.5	
MEAN		12.3		12.1		11.7		11.8		12.0		11.0		11.6		11.7		11.0		11.4		12.0		11.9
SIGMA	3.2		3.1		3.3		3.3		3.2		3.0		3.3		3.5		2.9		2.8		3.3		2.8	
SIGMA		3.0		3.2		3.3		3.2		3.1		3.0		3.6		3.3		3.2		3.4		3.0		2.8

Fig. 20 -- Resource working matrix illustration

Output Codes	Associated Transaction Numbers
WØRK	50, 52, 56, 59
D/NA	49, 51, 58
IDLE	50, 52, 56, 59
LAUNCH	39
LANDED	2
LØST	5
CØMBAT	4
ABØRT	6
OPERAT	21, 24, 27, 28, 42
WEATHR	26, 28, 42
TOTAL	3, 5, 39
FLYABL	3, 13, 16-18, 35, 44
ALERT	19, 31, 37, 60, 68
READY	14, 17, 19, 29, 30, 34, 39, 44, 45, 61
MAINT	2, 11, 12, 16, 18, 20, 29-32, 35, 39, 45, 46, 62-64, 68
AIR	2, 5, 39

The transactions specified here are used for the Output Request Form 9 Matrix Output. These transaction numbers are used regardless of whether the desired statistic is MIN (minimum) MAX (maximum), AVG (average) or TOT (total).

Fig. 21 -- Matrix Summary Statistics Sources

conditions and show the user the hourly fluctuations in ready aircraft and the number in maintenance that would be related to the operations profile.

Matrix Summaries also may be used to estimate probabilities and establish confidence limits for statements about launching some number of sorties at different times during the day under the conditions of any given simulation. For example, the data in Fig. 18 indicate that 19 or more aircraft almost always* can be launched each day at six o'clock to meet the given schedule of requirements, given 25 aircraft and the associated support included in the simulation. Similarly, one can say that if the aircraft are used for early morning missions, then there is a very small chance that the given schedule could provide more than 11 aircraft during any hour remaining in the flying day. Such kinds of

*Thirty days of simulated events are substantial, but not enough to be sure that some lower number would never be launched.

statements, based upon the probability distributions for the different hours or periods of the day, may be used as inputs for other models or analyses. However, it is important to remember that they hold only for the particular set of resources, number of aircraft, and operations requirements.

One of the primary uses of Matrix Summaries is to estimate resource requirements and make proper shift assignments to best meet workloads that a given operations schedule generates. The following section on SAMSOM applications and management uses includes a discussion of such use to estimate direct maintenance manpower requirements. The model was used extensively for such purposes in the conduct of the TAC Enhancement Study completed in 1966.

Transaction Summary

Output Report 10 is a Summary of Transaction Tape Statistics that provides a count of different types of records or transactions generated during the simulation. The records reflected in this Summary are identified in Appendix F and further discussed in the Programmer's Guide. The Summary identifies the simulation and period covered. It also provides a total count of all transactions, each transaction category as a percentage of the total, and indicates the time of the final transaction. As shown in Fig. 22, the KAT5-5 simulation generated 24,846 transactions during the simulated period from day 3 0 5 to 33 0 0.

This output provides a brief summary of statistics that are useful for understanding the model and checking out selected statistics in connection with a set of inputs. Many items, such as transaction 2 which is a count of the aircraft launched, may be cross-checked with other reports. However, some transaction statistics are recorded only on this output. For example, ground aborts are random events in all simulations. Transaction 45 is a count of how many actually occurred

TRANSACTION TAPE STATISTICS FROM 3. 0. 5. TO 33. 0. 0. KATS 5

1	259.	1.04	21	337.	1.36	41	330.	1.33	61	0.	0.	81	0.	0.
2	711.	2.86	22	41.	0.17	42	0.	0.	62	0.	0.	82	0.	0.
3	0.	0.	23	78.	0.31	43	0.	0.	63	0.	0.	83	0.	0.
4	0.	0.	24	70.	0.28	44	0.	0.	64	0.	0.	84	0.	0.
5	0.	0.	25	0.	0.	45	66.	0.27	65	259.	1.04	85	0.	0.
6	0.	0.	26	0.	0.	46	0.	0.	66	0.	0.	86	0.	0.
7	0.	0.	27	8.	0.03	47	180.	0.72	67	0.	0.	87	0.	0.
8	0.	0.	28	63.	0.25	48	0.	0.	68	0.	0.	88	0.	0.
9	0.	0.	29	0.	0.	49	0.	0.	69	2536.	10.21	89	0.	0.
10	0.	0.	30	871.	3.51	50	2536.	10.21	70	0.	0.	90	0.	0.
11	0.	0.	31	0.	0.	51	0.	0.	71	2536.	10.21	91	0.	0.
12	525.	2.11	32	861.	3.47	52	2534.	10.20	72	0.	0.	92	0.	0.
13	430.	1.73	33	0.	0.	53	0.	0.	73	2534.	10.20	93	0.	0.
14	113.	0.45	34	19.	0.08	54	432.	1.74	74	0.	0.	94	0.	0.
15	45.	0.18	35	0.	0.	55	2536.	10.21	75	2534.	10.20	95	0.	0.
16	0.	0.	36	0.	0.	56	0.	0.	76	0.	0.	96	0.	0.
17	0.	0.	37	0.	0.	57	0.	0.	77	0.	0.	97	0.	0.
18	432.	1.74	38	0.	0.	58	0.	0.	78	0.	0.	98	0.	0.
19	0.	0.	39	259.	1.04	59	0.	0.	79	0.	0.	99	0.	0.
20	0.	0.	40	711.	2.86	60	0.	0.	80	0.	0.	00	0.	0.

THE FINAL TRANSACTION IN THE PERIOD OCCURRED AT 32.96 TOTAL NUMBER OF TRANSACTIONS IN THE PERIOD = 24846.

MACHINE TIME 00 HR 01 MIN 10 SEC

Fig. 22 -- Transaction Tape Summary illustration

during the given simulation and time period. Similarly, transactions 66 and 67 provide the only record of the number of periodics and post-flights generated during the simulation. Transactions 77 and 78 are the only counts of conflicting systems and the number of times a maximum number of PTs occurred. The latter transaction is the last in the current program. However, the table was set up to accommodate 100 different transactions.

Output Report 10 is similar to the Edit Phase transaction table produced at the time of simulation. The Edit Phase, when used in the program deck, provides a count of all transactions for the entire simulation, while the Transactions Summary provides a count for a specific period of time. For example, the user might want a Transactions Summary (Output Report 10) for ten days of the simulation (day 10 to day 20). He would request this output separately and could use it to check out inputs and cross-check with other reports.

Distribution Report

Output Report 11, the Distribution Report, produces turnaround, repair and queue-time distributions for selected bases, missions, and time periods. Several definitions are important to an understanding of the outputs this report produces.

Input Form 6 allows the user to specify different kinds of maintenance activity such as debriefing (DC), unscheduled maintenance (UM), etc. The model carries an aircraft in NORM or AOCM status for all such activity groups if it is either awaiting maintenance or in maintenance. In the Distribution Report, an aircraft is considered to be in a QUEUE status if it is awaiting maintenance. Likewise, an aircraft is in a REPAIR status if it is undergoing maintenance.

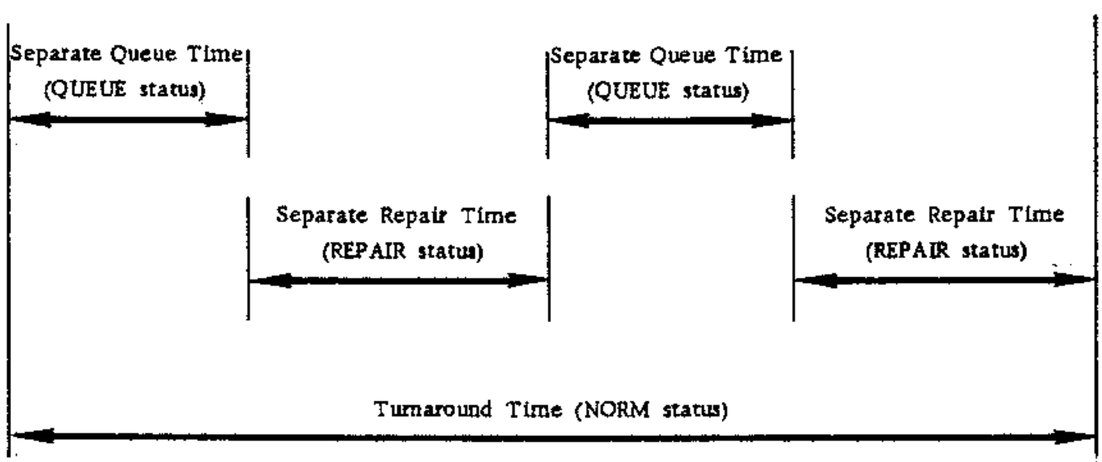
Aircraft enter NORM status when any one of the following transactions occur:

2	Aircraft lands and goes into maintenance	
11	Aircraft scheduled for upload for ALERT pool	(LS)
12	Aircraft scheduled for upload for deficit	(LS)
16	Flyable aircraft suffers a standing failure	
18	Aircraft removed from flyable pool and scheduled for upload	(LS)

20 Aircraft downloaded from preemption (LS)
29 Ready aircraft suffers a standing failure
35 Aircraft scheduled for upload for ALERT (LS)
43 Leftover maintenance started on uploaded aircraft
45 Aircraft has ground abort
46 Aircraft uploaded after preemption (LS)
68 ALERT aircraft suffers a standing failure

When an aircraft enters the NORM status via one of the LS transactions listed above (11, 12, 18, 20, 35, 46), it is said to be in Launch Service maintenance. Hence, for the Distribution Report, maintenance is divided into two parts, Launch Service maintenance and Non-Launch Service maintenance (2, 16, 29, 43, 45, 68). A separate set of Distribution Reports is provided for each part.

Each set of reports, in turn, includes five separate distributions. The first, called the Turnaround Time, is the distribution of times that aircraft are in a NORM status. The second, called the Total Repair Time, is the distribution of the elapsed times that aircraft are in a REPAIR status for each NORM status. For example, suppose that an aircraft is in a NORM status as depicted in the figure below.



As can be seen, the aircraft enters the QUEUE status twice; it also enters the REPAIR status twice. The total repair time for the NORM status is the sum of the two separate repair times. The Total Repair Time is the distribution of total repair times for all NORM status conditions for selected bases and missions. The third distribution, Total Queue Time, is generated in a similar manner. The final two distributions are the Separate Repair Time and Separate Queue Time. They treat

each repair and queue situation as a separate independent event.

Proper interpretation and use of these distribution reports requires an understanding of several rules that govern model manipulation of transient states. As previously discussed in connection with the Base Status Report, aircraft in a status for one minute or less are considered to have been in a transient state while in the given status. The first rule, then, is that an aircraft must remain in a status for more than one minute before it is considered in the status. Thus, if an aircraft enters the NORM status, remains in it for thirty seconds and then leaves, it is considered never to have been in the status. The second rule follows from the first: an aircraft must be out of a status for more than one minute to be considered out of it. The third rule establishes within which set of distributions a given sequence of maintenance activities will be counted. If an aircraft enters Launch Service maintenance within a minute of the time it left Non-Launch Service maintenance, then the aircraft is treated as if it never left the Non-Launch Service maintenance. This implies that if Launch Service maintenance occurs <u>immediately</u> after Non-Launch Service maintenance, then the Non-Launch Service distributions will contain turnaround times* equal to the sum of the Non-Launch Service and the Launch Service elapsed times. The fourth rule follows from the third: the five Launch Service distributions will contain Non-Launch Service maintenance if Non-Launch Service maintenance immediately follows Launch Service activities.

The Distribution Report serves several useful purposes. It is the only source of the statistics behind averages shown on other reports. It provides summary simulation data that may become inputs to other

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*It should be understood that sequences of maintenance activities often could be established to achieve this "total turnaround" concept. For example, Fuel Service (FS), coming last in the activity sequence, could be used to simulate Launch Serivce activities. However, Launch Service (LS) is the <u>only</u> routine associated with a lead time <u>and</u> upload or similar requirements which must <u>precede</u> a launch.

analyses or simulations, including additional SAMSOM iterations, and it provides another means for checking any given simulation (and model) results against a set of inputs for internal consistency.

The Base Status, Aircraft Status, Resource and Maintenance reports provide various averages that reflect or may be used to compute turnaround, repair, and queue times. As already discussed, some of these outputs may be cross-checked against each other. For example, if the reporting interval is sufficiently small, the average number of aircraft in the air (AIR) on the Aircraft Status Report should compare favorably with the average number of aircraft airborne (AIRBORNE) in the Base Status Report. Similarly, the average number NORM on this report should agree with the number in Maintenance (MNT) on the Aircraft Status Report.

The Distribution Report provides additional information that, properly interpreted, should confirm many of these averages. In addition, it provides a frequency distribution of the elapsed times of different events during the simulation that account for the given averages. The Turnaround Time distribution average (or the sum of the Launch Service and Non-Launch Service Turnaround Times) shown in Fig. 23 should agree with its corresponding Total Norm Mean Time for the given base. Similarly, Total Repair Time, and Total Queue Time distributions should agree with In Maintenance and Awaiting Maintenance mean times, respectively. The user should keep in mind, however, that the Base Status Report statistics include aircraft that were in the status at the beginning and/or the end of the period while the Distribution Report permits only those times that are completely within the reporting period.

Figure 23 also shows the detailed information collected for each frequency distribution. The distribution of repair times is derived from a combination of inputs, simulation draws, and model logic. It reflects failure probabilities, repair time draws, and the sums of the sequences of maintenance activities established in the simulation. In a simple case, it should play back as output what was provided in the simulation inputs. Thus, it can be used as a direct check on the model.

MAKE 1   TOTAL TURN AROUND TIME DISTRIBUTION AT BASE 'SAMP ' FOR MISSION 'ALL ' FROM 0 0 0 TO 1 0 0

-----CLASS INTERVALS-----						
DAYS	HOURS	DAYS	HOURS	FREQUENCY	FREQ PROB	CUM. PROB
0	0.20	0	0.30	1	0.0164	0.0164
0	0.60	0	0.70	1	0.0164	0.0328
0	0.70	0	0.80	1	0.0164	0.0492
0	1.00	0	1.10	3	0.0492	0.0984
0	1.20	0	1.30	4	0.0656	0.1639
0	1.30	0	1.40	3	0.0492	0.2131
0	1.50	0	1.60	7	0.1148	0.3279
0	1.70	0	1.80	5	0.0820	0.4098
0	1.80	0	1.90	2	0.0328	0.4426
0	2.00	0	2.10	4	0.0656	0.5082
0	2.20	0	2.30	1	0.0164	0.5246
0	2.30	0	2.40	1	0.0164	0.5410
0	2.40	0	2.50	2	0.0328	0.5738
0	2.50	0	2.60	6	0.0984	0.6721
0	2.70	0	2.80	1	0.0164	0.6885
0	2.80	0	2.90	2	0.0328	0.7213
0	2.90	0	3.00	1	0.0164	0.7377
0	3.00	0	3.10	3	0.0492	0.7869
0	3.20	0	3.30	3	0.0492	0.8361
0	3.50	0	3.60	4	0.0656	0.9016
0	3.80	0	3.90	1	0.0164	0.9180
0	4.00	0	4.10	1	0.0164	0.9344
0	4.30	0	4.40	1	0.0164	0.9508
0	4.40	0	4.50	1	0.0164	0.9672
0	4.80	0	4.90	1	0.0164	0.9836
0	5.50	0	5.60	1	0.0164	1.0000

NUMBER OF REJECTED VALUES = 0   A VALUE IS REJECTED IF IT IS LESS THAN OR EQUAL TO ONE MINUTE

MEAN = 0 DAYS 2.32 HOURS   TOTAL ENTRIES = 61
STANDARD DEVIATION = 0 DAYS 1.08 HOURS

Fig. 23 -- Turnaround time distribution illustration

In the more complicated simulations, however, the output distributions will represent rather complicated sets of inputs, involving several probabilities and distributions. Their combination outside of the model may not be feasible.*

Although Repair Time distributions may be checked and thus further confirmed, SAMSOM II Distribution Report outputs are the only source of frequency details and associated statistical measures for the Queue Time generated in any given simulation. Similarly, except for the non-queue case, Distribution Report outputs are the only source of Total Turnaround Time parameters under given simulation conditions. In this connection, it should be noted that Queue Time includes AOCP or NORS time.

In some cases, the Total Turnaround Time distribution derived from a SAMSOM simulation may provide a very useful input for other analyses. For example, several kinds of airpower or sortie-capability models use aircraft break rates and/or maintenance turnaround times. In most cases, these models might be improved by taking into account more than estimated average turnaround times. Some even might accept empirical distributions (or some number of points and associated values) instead of making assumptions about their shapes and statistical parameters. In these cases, SAMSOM distribution outputs may be used to reflect the simulated turnaround times generated by contingencies and planning assumptions not readily reflected in Air Force data or test results.

In addition to such uses in SAMSOM analyses, simulated turnaround times also may be used to simplify parts of some kinds of SAMSOM simulations and thus expand the model's capability to examine problems beyond its initial capability. For example, a simulation involving very detailed inputs at several bases might exceed computer space

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*For an extended discussion of this problem and partial solutions, see S. H. Miller, N. Kaufman and H. J. Shukiar, The Consolidation of Maintenance Durations with Applications to Aircraft Sorties, The RAND Corporation, RM-5323-PR, July 1967.

capability. Detailed simulation of activity at one base, however, might be very easy. Thus, summary turnaround times derived from previous simulations for each of the different bases might be used in an aggregated version of the total simulation including all bases. This technique also might be useful for aggregating selected parts of a problem at a single base in order to examine other areas in greater detail.*

Although this technique and the distribution details may serve such useful purposes, the user is cautioned that queues usually are the result of the interaction of many events. Thus, projections based upon turnaround times generated by a set of requirements (fly two-at-a-time randomly) and given resources might not be correct for another set of requirements (fly four-at-a-time, half as often as the first case) even though it was based upon the same level of activity and the same resources were made available.

All Distribution Reports follow the same format. The run identification, distribution name, base name, mission name and time period are printed. Figure 23 shows that for run MAKE 1 the Total Turnaround Time Distribution for base SAMP, mission ALL will be printed for Day 0 to day 1. If Launch Service distributions were requested, then Launch Service would have appeared below the top line of the report.

The class interval identifies the intervals within which certain distribution entries fall. This interval is in days and tenths of hours. The frequency is the number of times a value fell in the class interval. The frequency probability of a given class interval is the frequency of that interval divided by the total number of entries in the distribution. The cumulative probability is the sum of the frequencies of all class intervals prior to and including the current one, divided by the total entries in the distribution. The number of rejects is the number of time values that were less than one minute long. In Fig. 23, no rejects were identified. The total number of entries, mean and standard deviation are self-explanatory.

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*Of course the user must be convinced that statistical requirements are not violated when doing this.

V. MODEL APPLICATIONS AND CAPABILITIES

SAMSOM II is especially useful for examining two general kinds of management planning questions. What capability should be expected from any number of aircraft given some set of supporting resources? (The resources may be as many as needed or may be severely constrained.) What resource quantities are required to support some given number of aircraft and operational schedule? Depending upon the simulation objective, then, the model may be operated in a simple or complex mode or level of aggregation, and consequently require different levels of input details.

SIMPLE SIMULATIONS

The model may be used to simulate operations with simple turnaround data. In this case, it provides estimates of sortie-generation, alert, and readiness capability. It also may be used thus to examine alternative operations schedules or sortie requirements. It should be understood that such turnaround data may be gross aggregations of the total time used to do all maintenance, servicing, upload, and other support actions, or different turnaround times depicting separate activities and associated elapsed times. As will be recalled, these actions may be sequenced to fit different purposes and reflect such items as debriefing delays, part delays, troubleshooting times, etc. Thus, a "simple" simulation may include one aggregated turnaround parameter or several related delay estimates, troubleshooting times, and net fix or inspection times.

Figure 24 shows a set of SAMSOM II simulation results* using a combination of simple turnaround data, estimates of failure probabilities, and repair times. It provides an indication of the maximum number of sorties that a squadron of 25 aircraft might generate for the following simulation assumptions or parameters:

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*Again, the results do not reflect capabilities of any known aircraft. They were contrived to illustrate model capabilities.

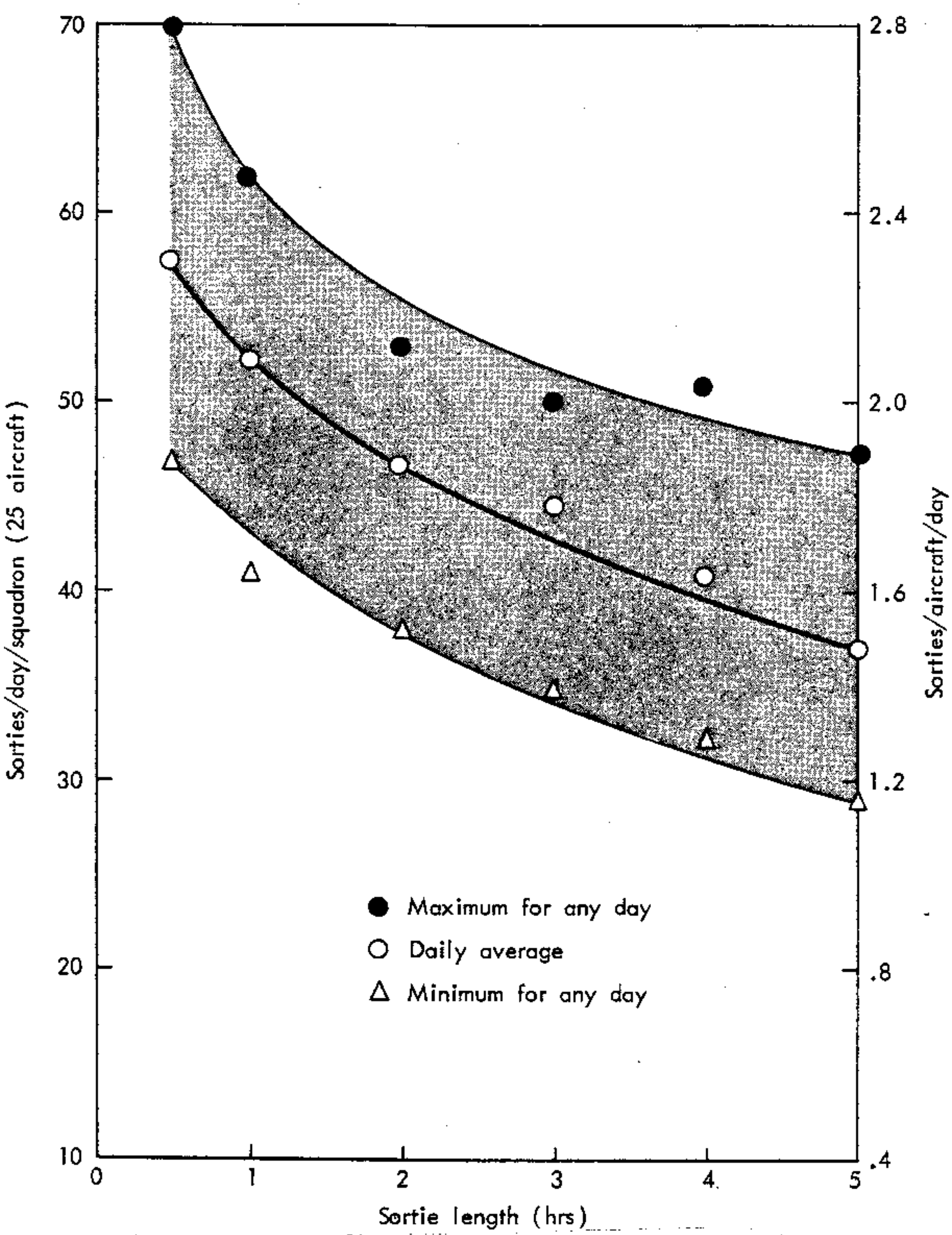

Fig. 24 -- Simulated sortie-generation capability

Flying Day Length: 14 hours + the given sortie length.

Launch Day Length: 14 hours from 0600 to 2000 hours.

Maintenance Requirement Probability: Always or 1.0.

Total Turnaround: Includes repairs, servicing, and basic postflights.

Average Turnaround Time: 8.2 hours, but any given turnaround will be drawn from the appropriate distribution of turnaround times.

Arming (Upload) Times: 1.0 hour.

Excluded Downtime: NORS delays.
Off-shift and similar delays.
Periodic inspections.
Hourly Postflight inspections.

The different points on the Fig. 24 curve were derived from one or more simulations representing 15 to 30 days of operations. Points in the shaded area on either side of the average curve show the maximum and minimum number of sorties launched on any day in the simulations. For example, the range for half-hour sorties was from a low of 47 sorties on one day to a high of 70 on another, for an average of 57.7 sorties. Sortie-generation capability decreases when sortie length increases. At two hours, the squadron should be able to provide an average of 47 sorties. The right-hand scale of the figure shows results in terms of sorties per aircraft per day. Depending upon sortie length, the simulations indicate a range from 2.8 sorties per aircraft per day for half-hour sorties down to 1.2 sorties for five-hour sorties.

Table 1

SIMULATED SORTIE GENERATION CAPABILITY

Sortie Length (Hours)	Sorties per Sqdn per Day			Sorties per Acft per Day		
	Min	Max	Avg	Min	Max	Avg
0.5	47	70	57.7	1.88	2.80	2.31
1.0	41	59	52.2	1.64	2.36	2.01
2.0	38	53	47.2	1.52	2.12	1.89
3.0	35	50	44.9	1.40	2.00	1.80
4.0	32	49	41.0	1.28	1.96	1.64
5.0	29	45	37.7	1.16	1.80	1.51

MAXIMUM SORTIE GENERATION CAPABILITIES

It should be recalled that these results are associated with a specific set of simulation parameters. Since the turnaround times used in the simulation include servicing and basic postflights, the probability of maintenance requirement is 1.0. Table 2 provides detailed information on one of the turnaround time distributions used in the simulations. Other data requirements such as standing failures, Tech Order Compliance requirements, and miscellaneous support activities also included in simulation inputs are not shown in the table.

Table 2

MAINTENANCE TURNAROUND DISTRIBUTION[a]

Time (Hours)	Probability	Cumulative Probability	fx
0.2	0.104	0.104	0.0208
1.0	0.052	0.154	0.0520
1.5	0.075	0.229	0.1125
2.0	0.169	0.398	0.3380
2.5	0.045	0.443	0.1125
3.0	0.084	0.527	0.2520
4.0	0.055	0.582	0.2200
5.0	0.055	0.637	0.2750
6.5	0.025	0.662	0.1625
7.5	0.044	0.706	0.3300
8.3	0.040	0.746	0.3320
9.0	0.025	0.771	0.2250
11.0	0.050	0.821	0.5500
14.0	0.025	0.846	0.3500
16.8	0.020	0.866	0.3360
18.0	0.039	0.905	0.7020
21.0	0.035	0.940	0.7350
24.0	0.035	0.975	0.8400
31.0	0.015	0.990	0.4650
41.3	0.005	0.995	0.2065
78.0	0.005	1.000	0.3900
Mean			7.0068

[a]The distribution does not include standing-failure repair time which is in another report and which would make the total average time previously discussed equal about 8.2 hours.

Simulated upload time was exactly one hour. Obviously, this time would vary for different mission configurations. It also should be understood that these simulations exclude NORS time, major inspections, and off-shift or similar working-policy delays. In other words, they assume adequate manning and equipment and reflect net maintenance requirements. Thus, they only indicate maximum sortie generation capability for the given parameters, which, in turn, might be interpreted more generally to represent the sorties per aircraft per day for an all-out effort of relatively short duration for <u>any</u> number of these kind of aircraft not down for lack of supply support. Simulations including various supply and other degradation factors would reflect lower capability.

Finally, it should be understood that the illustrated maximum capability is based upon a unique "schedule" of sorties that might not be completely useful for meeting operations requirements or commitments. The common characteristics of such "maximum effort" are shown in Fig. 25 (a simplified and adjusted Total Launch Matrix Output), which depicts the daily launch profile, hour-by-hour, for the 25 aircraft when flying two-hour sorties during the 14-hour launch day. The "schedule" of requirements is simple: Launch as many as possible (some large number) for 14 hours a day beginning at 0600 hours. Although the illustration is from a single simulation, the resulting general pattern is typical, even for other maintenance parameters and aircraft. Peak capability occurs during the first hour of the flying day when the largest number of aircraft are in-commission. The bar on the chart representing the hour from 0600 to 0700 hours reflects a minimum of 13 and a maximum of 21 sorties. The average for the hour, shown as a broken line across the bar, is 17.5 sorties. Capability for the remainder of the day varies from zero for some hours on some days to a high of 8 sorties between 1100 to 1200 hours on other days.

The numbers in the bars show the number of days out of the simulated 30 days that the given number of sorties were launched. For example, 2 days out of 30 the squadron launched 13 sorties early in the morning, that is, between 0600 and 0700; on 5 days it launched 16,

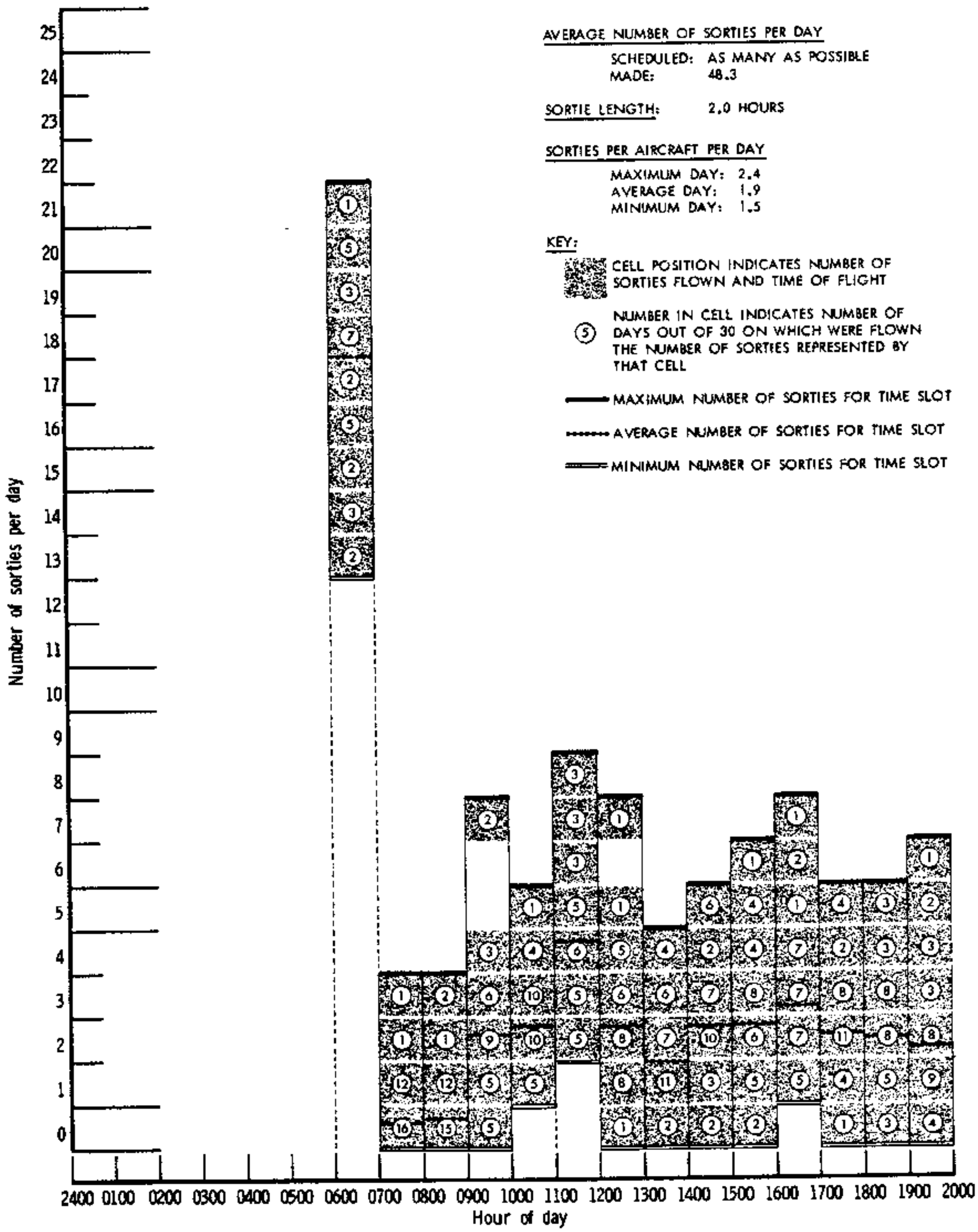

Fig. 25 -- Simulated maximum sortie-generation capability for 25 aircraft

and on one day it launched 21. Similarly, the record from 1900 to 2000 hours was 2 sorties launched on 8 days, 4 sorties on 3 days and 6 sorties on 1 day. These data also provide an estimate of the probability of launching at least "n" sorties during "h" hour of the day for the given flying program and other simulation assumptions. For example, suppose the question is what is the close-support capability of this squadron of 25 aircraft from 1400 to 1500 hours? Or how many sorties should the commander commit the squadron to provide at this time of day? The simulation indicates that the average is almost 3 sorties per day during this period. The squadron should be able to provide the average 50 percent of the time. (The sum of the numbers shown for 3 or more sorties per day is 15, or 50 percent of 30.) On the other hand, if the question is what is the probability of providing at least 2 sorties per day at this time, the answer is about 83 percent of the time (6 + 2 + 7 + 10)/30.

As mentioned, such a 30-day simulation might not provide an accurate estimate of sortie generation capability. It is a limited sample subject to statistical errors. Additional simulations or additional days in another simulation, however, should provide reliable <u>simulation</u> results.

Figure 26 shows the familiar pattern* of early morning sorties when 48 aircraft are included in a similar kind of simulation. The average number of aircraft launched between 0600 and 0700 hours was 32, and the range was from 26 to 40 sorties. The early-morning launch accounts for 33 percent of the total or 97 sorties launched during an average day. The range in the daily total was from 85 to 109 sorties. It also is interesting to note that there may be considerable fluctuation in the number launched for some hours. For example, from 1000 to 1100 hours the minimum was 6 and the maximum was 18.

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*Although the inputs for this simulation were different from those used in the maximum sortie capability simulation for 25 aircraft, the pattern and total are comparable.

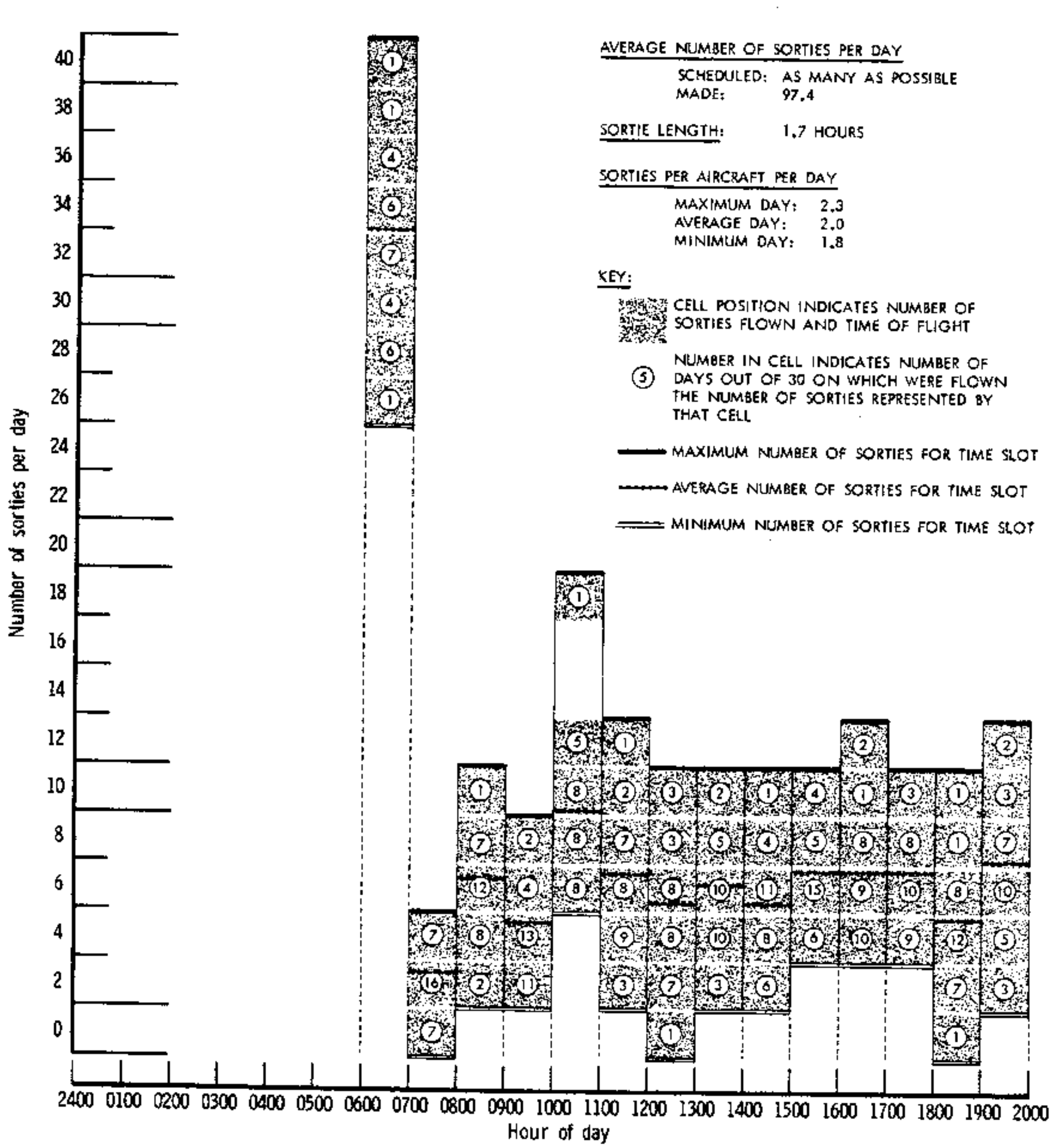

Fig. 26 -- Simulated maximum sortie-generation capability for 48 aircraft

COMPLEX SORTIE SCHEDULES

The information shown in Table 3 is for a schedule which is not as simple as "launch as many as possible." However, the schedule includes a peak requirement early in the morning depicting counterair (CA) missions and early-morning close-air-support (CS) requirements. Requirements for the remainder of the day include both interdiction missions and other close-air-support sorties.

Table 3

SELECTED OPERATIONS INPUTS FOR SAMSOM II
(Schedule repeated every 24 hours)

Mission Name[a]	Sortie Length[b]	Mission Priority	Launch Hour	Sortie Size		Make-up Policy	
				Min	Max	Duration[b]	Code[c]
CA1	1.75	3	0603	24	24	6.00	4
						12.00	3
						6.00	4
CA2	1.75	1	0603	8	8[d]	6.00	4
						12.00	3
						6.00	4
CS1	1.50	3	0603	4	4	6.00	4
						4.00	3
						14.00	4
CS2	1.50	2	1003	4	4	10.00	4
						4.00	3
						10.00	4
CS3	1.50	2	1403	4	4	14.00	4
						4.00	3
						6.00	4

[a]CA means counterair strikes; CS means close-air support.

[b]Hours to nearest hundredth.

[c]Make-up code: 4 = cancel if not made on time, 3 = make-up during specified length of time.

[d]Repeated three times to make 24 sorties taken 8 at a time.

As reflected in Table 3, counterair (CA1) missions begin at 0600 hours and must fly 4 at a time. Other close-support missions (CS2 and CS3) are downgraded to second priority at 1000 hours. Meanwhile, the interdiction (CA2) missions begin at 0600 hours on

the lowest priority (after CA1 and CS1), and fly 8 at a time up to a total of 24 for the day. All together, these requirements total 60 sorties scheduled for 48 aircraft at the simulated base, or an equivalent of 1.25 sorties per aircraft per day.

Simulation results for 30 days of operation are shown in Fig. 27. Since the missions were launched in elements of 4 or 8, it is clear that all CA1 missions were launched by 1300 hours each day. One-third of the time (10 days out of 30) priority 1 and 3 missions were launched most of the time when "scheduled," i.e., at 0600, 1000, and 1400 hours. Similarly, the bunching of 8, 12 and 16 sorties from 1400 through 1800 hours indicates that most CA2 missions, if made at all, were launched during the late afternoon. This reflects their lower priority in the simulation.

SORTIE CAPABILITY AND SCHEDULE INTERACTIONS

A comparison of the data in Figs. 26 and 27 reveals both similarities and differences between the sorties generated to meet "special" requirements" and those that might be obtained when the schedule is "as many as possible." The additional difference of one hour between the flying day for the maximum capability illustration and that for the special requirements schedule does not invalidate the illustrative comparisons discussed in the following paragraphs.

The two schedules are comparable in their demands for early-morning capability; i.e., 24 or more sorties were launched at 0600 hours most of the time in both cases. As indicated by those days when 24 or more were launched after 0700 hours, the 24-aircraft sortie-element rule hurt 6 times out of 30. Some lower number of aircraft, such as 22, 20, 18, etc., probably would increase the probability that more sorties would be launched earlier in the day on the average, and thus, would improve the chances that the aircraft would be available later for another sortie.

The simulated results differ in three ways. First, the average number of sorties launched during the day after the early-morning

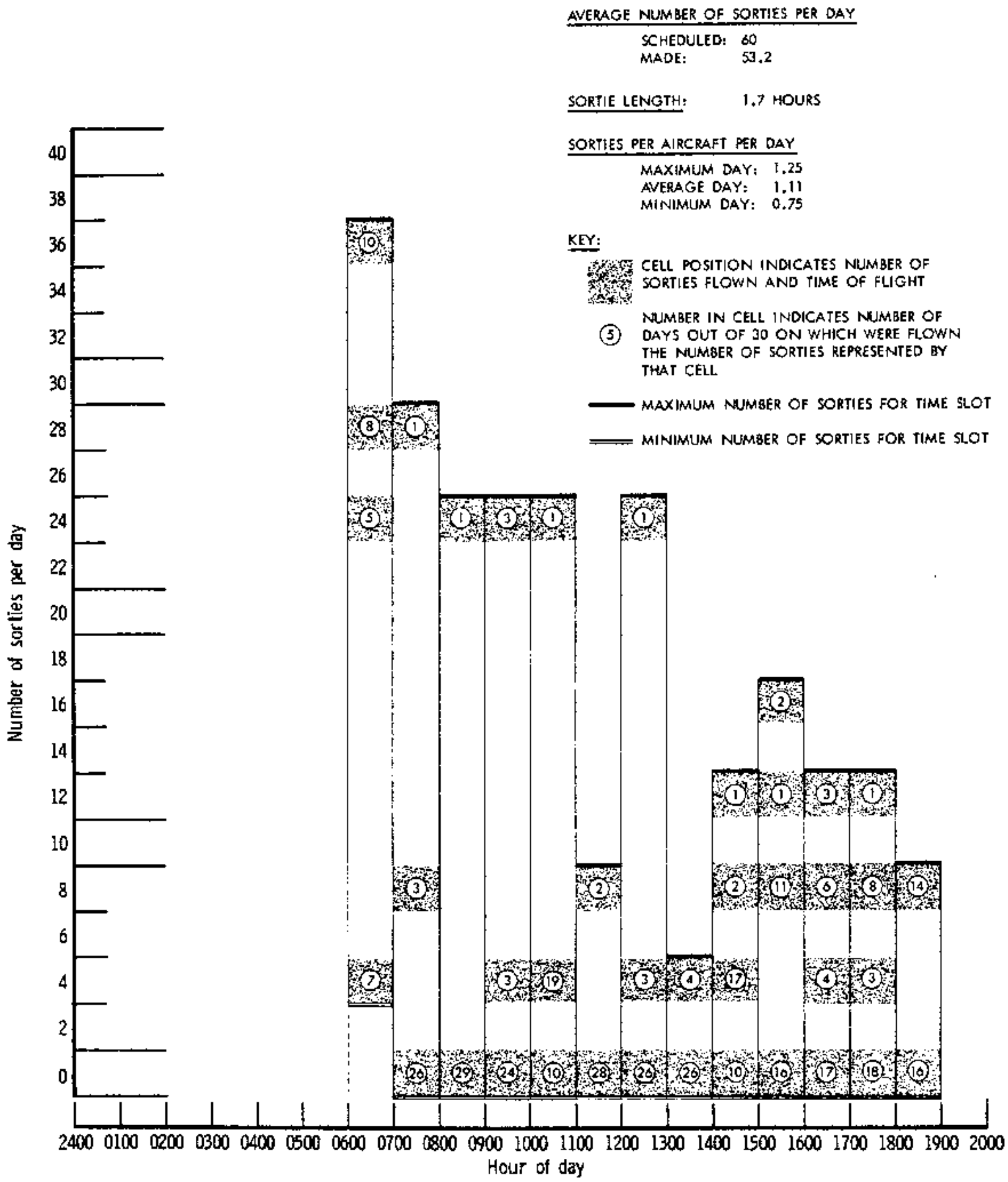

Fig. 27 -- Simulated sortie-generation capability for a selected schedule for 48 aircraft

launch at 0600 hours to meet the special requirements (Fig. 27) was not as great as the average in the all-out case (Fig. 26). The latter provided an average of 5 sorties per hour, while the former provided only 2.4. Second, there was more tendency for a second peak to develop after 1400 hours than was evident in the all-out schedule. Smaller sortie elements for the 8 aircraft called for by the CA2 missions should reduce this peak and spread the launches more evenly over the afternoon. Third, and most important, the special schedule calls for less than two-thirds of the potential of the weapon system indicated in the maximum effort simulations. Not all of this potential is available to operations, but it seems clear that relaxation of operations constraints upon sortie-element size when possible would increase the sortie-generation potential.

In fact, selective relaxation of these massing constraints might produce two kinds of operations improvements. First, the confidence that daily requirements could be met should increase. Even the relatively low requirement of 60 sorties per day was met only 7 times out of 30; the average was 53.2. On one day, only 36 sorties were launched. Both this average and range should be contrasted with the fact that the all-out schedule always provided more than 86 sorties per day. It provided an average of 98 and a maximum of 112. SAMSOM II can be used to examine such situations to search for a sortie-element policy that might improve the daily total number of sorties that could be launched if they could be utilized.

Second, launch timing during the day also might be improved. For example, CS2 and CS3 missions were lost several times because they could not get off 4 at a time even within the rather generous time-frame of 4 hours. Obviously, if this time-frame were reduced, the unit would do even worse, unless a smaller number of sorties could do the job. It also should be noted that the CA2 (lowest priority) missions were flown during the late afternoon about two-thirds of the time. Especially if their timing is of no importance, it would be desirable to launch them sooner in the day, when possible, so that they could return sooner and have a better chance to be turned around and prepared to fly another sortie during the day.

However useful such simple simulations may be to estimate sortie and readiness capabilities and examine alternative schedules using different turnaround estimates, they are inadequate to examine questions concerning resource requirements or to determine the probable impact of resource shortages upon an operation. More complex simulations provide similar outputs. In fact, some of the results previously discussed were from simulations using detailed data behind the simple parameters identified for the first case. An example of model use for more complex simulations is discussed in the following section.

COMPLEX SIMULATIONS

Determining the resources required to support some number of aircraft attempting to meet a given operational schedule is a more complex question than determining operational capability using simple turnaround data. It requires more detailed data and additional analysis of matrix report outputs. In addition, it may take several iterations to find a preferred or balanced mix of resources to support the given requirements in a reasonable manner. The following examples have been developed to illustrate one approach to such a question.

Let the operations requirements be defined as a mixture of sorties averaging 1.8 hours duration from a squadron of 18 aircraft that are to be spread over an 18-hour flying day from first takeoff to last touchdown. Additional constraints are that aircraft seldom fly alone, and that they generally take off in sortie elements including two, three, or four aircraft.* In addition, the simulations exclude weather, NORS, and other degradations and do not include shop (off-equipment) repairs. The illustration covers the direct manning requirements for one shop. Similar analysis could be conducted for all shops and equipment included in the simulation.

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*An exact description of the "schedule of requirements" is not necessary to illustrate the methodology, analysis, and use of model outputs.

Determining Resource Requirements

The first step is to simulate the schedule of requirements given infinite manpower support, and then review the Resource Reports and Matrix Outputs for the given shop. In this case, the Resource Report shows that an average of 5.715 units of personnel type one (PT1) were at work throughout the simulation. The simulation was set up to reflect teams rather than individuals. Assuming that the average team is 2 men, this average utilization implies that 34 men would be adequate around-the-clock manning for this shop. (Average number of teams at work (5.715) x average team size (2) x 3 (8-hour shifts) = 34.29 men.) Since 100 teams were made available, aircraft never waited on specialists from this shop.

This analysis is a beginning, but it is not enough. Obviously, the number of men required will fluctuate through time as sorties and their associated maintenance requirements fluctuate throughout the flying day and overnight. Although a review of the snapshot status records in the Resource Report would show these variations (and aircraft waiting, or DNAs, if any), the best information for present purposes will be found in a Matrix Report for the given shop. The relevant data are shown in Fig. 28, Resource Matrix output for shop PT1 for test MAKE1, base SAMP.

Casual review of this output showing the average number of teams at work throughout the day during the 30-day period reveals that evenly divided shifts of 6 teams would not have filled the requirements. In fact, as many as 14 crews were at work at 0200 hours on 8 of the 30 days. The actual average number of crews required to meet the workload (generated during three 8-hour shifts) was 14 crews from 0200 through 0900 hours, 12 from 1000 through 1700 hours, and 11 from 1800 through 0100 hours. This equals 37 crews or 74 men, more than twice the first estimate based upon Resource Report averages. The hourly averages reported in Fig. 28 ranged from 12.6 to 1.6 crews.

MAKE 1 BASE = 'SAMP -' 'PT 1' OUTPUT CODE = 'WORK ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
14			8																					
13			10	1				2																
12			6	3				2				1												
11			5	3			1						1			1		1				1		
10				4			5	6	1			2	1			2					3	1		
9				5			6	7	1			4	2		1	3	1	3	1	2	4	2	1	
8		10	1	8			7	2	3		1	4	2	1	1	2	3		4	4	3	3	1	
7		8		5	1	1	7	4	1	1	1	11	4	3	4	6	5	4	2	4	5	7	3	
6		12		1	4	1	3	6	3		12	4	8	4	9	7	10	10	7	4	6	6	7	
5					5	3		1	8	4	5	4	4	7	6	6	2	6	11	7	5	6	3	4
4	2				7	5			6	9	8		4	7	7	2	6	3	2	5	2	2	8	6
3	5				10	8	1		5	10	2		4	8	1		1	2	1	3	2	1	4	5
2	9				2	10			2	6	1				1	1	2	1	1			1	3	9
1	7				1	2													1	1				4
-0	7																							2
MEAN	1.6		12.6		4.0		8.0		5.0		5.1		6.0		5.4		5.6		5.5		6.7		4.8	
MEAN		6.9		9.1		3.1		8.6		3.5		7.4		4.7		6.6		5.9		5.6		6.4		2.7
SIGMA	1.2		1.3		1.4		1.6		2.0		1.3		2.1		1.5		1.7		1.7		2.0		1.8	
SIGMA		0.9		1.8		1.4		2.2		1.1		1.6		1.4		2.0		1.9		1.9		1.9		1.4

Fig. 28 -- Resource Matrix output for shop PT1, average number at work

Maximum, Minimum and Average Requirements

Figures 29 and 30, respectively, show the maximum and minimum number of teams at work. Since the average statistic (Fig. 28) reflects the average number of crews at work during the given hour (XX00-XX59), taking into account all maximums and minimums within the hour and properly weighting them by their relative frequencies, it is considered generally accurate enough for present purposes. As a comparison of numbers in the different cells for Figs. 28 and 29 shows, more than 14 teams were at work sometimes. However, the "error" introduced by using the average normally is small and involves very short queues. Although one could not be sure they would be less than an hour long, they often would have been worked off within the given hour.

Seventy-four is the simulated hourly average number of men required from shop PT1 to support the given flying program and number of aircraft. This number of technicians should be enough to meet almost all requirements. In addition to the total required, the matrix output shows that the proper allocation among three 8-hour shifts should be 14, 12, and 11 crews beginning at 0200 hours. Note that the shifts do not begin at conventional hours.*

Iteration Considerations

Finally, it should be noted that one might doubt that 12 crews really were needed at 1100 hours, or that 11 crews would really make a difference at 1500, 1700 and 2100 hours. Questions such as this lead an analyst to conclude that the cost in aircraft downtime might be very little for a considerable reduction in the number of men. Since downtime is a constraint upon sortie production, the analyst also might want to establish the relationship between sortie production and given numbers of PT1. The total men, in turn, would need to be properly allocated among the different shifts.

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*In this case, shifts beginning at 0800 hours would lead to 12, 11 and 14 crews. This is just happenstance; shifts would not generally turn out to be the same.

MAKE 1 BASE = 'SAMP ' 'PT 1' OUTPUT CODE = 'WORK ' STATISTIC = 'MAX' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
18							1	1				2												
17				1			1	1																
16			4	2			2	1				2				2					1			
15			9	6			1	2					1			1		1						
14			7	4			4	3	1			2	2		1	1	2		1	1	1	1		
13			6	7			11	11	2		1	4	1	1	1	2	2	1	1	3	4	2	1	
12			3	5		1	6	4	2		3	3	2		1	2	1	1	1	4	3	3		
11		4		4	1	1	3	2	1	1	5	2	4	4	5	2	3	5	4	1	7	3		
10		7			3	2		4	2	2	4	7	4	3	3	5	4	3	5	6		3	3	
9		11			4	5		1	4	7	8	6	4	4	5	6	8	3	5	6	3	4	2	
8		8	1	1	3	8			3	11	6	2	3	7	6	3	2	6	5	4	7	7	8	
7					8	5			5	4	2		3	3	4	5	1	4	3	4	2	5	5	
6					7	3	1		5	3	1		3	6	3		4	4	2	1	2		4	3
5					2	4			2	1			2	2			1	2	2			1	2	8
4	4				2	1			3	1			1		1	1	2		1			1	4	1
3	7																						1	7
2	7																							7
1	5																							4
-0	7																							
MEAN	1.9		14.0		7.2		13.1		8.1		9.5		9.2		8.9		9.0		8.8		10.1		7.1	
MEAN		9.2		13.3		7.6		12.8		7.9		11.5		8.2		10.0		8.7		9.7		9.2		3.4
SIGMA	1.4		1.6		1.8		2.1		2.8		1.7		2.8		2.2		2.7		2.3		2.5		2.2	
SIGMA		1.0		1.9		1.9		2.0		1.5		2.7		2.0		2.8		2.4		2.1		2.4		1.6

Fig. 29 -- Resource Matrix output for shop PT1, maximum number at work

MAKE I BASE = 'SAMP ' 'PT 1' OUTPUT CODE = 'WORK ' STATISTIC = 'MIN' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
11			1					2																
10			7	4				1				1	1											
9			13	3				2										1			1			
8			8	2			3	4				1	2			2		1	1		2	2		
7				8			3	5	1			1			1		2	1		1	1	3		
6			1	7			4	2	2		2	4	4	1		6	3	2	3	4	5	4	3	
5				4	4		7	7	2	1	3	8	5	5	5	3	6	5	3	5	5	4	8	
4				2	8	2	6	6	7		7	12	5	5	10	7	7	9	9	4	7	9	1	3
3	2	2			4	4	5	1	8	6	8	2	8	6	8	8	6	3	9	8	2	4	7	7
2	7	7			9	6	1		6	11	8	1	1	8	5	2	4	7	2	6	7	2	7	8
1	12	12			5	16			4	8			4	5	1	2	2	1	3	1		2	4	5
-0	9	9				2	1			4	2									1				7
MEAN	1.1		8.9		2.9		4.8		3.2		3.2		4.2		3.6		3.9		3.7		4.5		3.4	
MEAN		1.1		7.0		1.6		6.4		1.8		4.8		3.0		4.2		4.0		3.6		4.5		1.8
SIGMA	0.9		1.0		1.3		1.8		1.5		1.4		2.1		1.2		1.6		1.6		1.9		1.6	
SIGMA		0.9		1.7		1.0		2.2		1.1		1.5		1.4		1.8		1.9		1.7		1.8		1.3

Fig. 30 -- Resource Matrix output for shop PT1, minimum number at work

Since there are many possible combinations of shifts and men, the analyst must use some judgment and knowledge about the operation in setting up iterations. For example, the pile-up of work at 0200 hours (shown in Fig. 28) may result from given lead times for beginning pre-flights and uploads for early morning missions; it is assumed that PT1 performs such work. If the resources cannot be shifted or spaced more evenly, the analyst will be hard pressed to cut back much on that shift. On the other hand, he would be reluctant to reduce the number of men on duty during the daylight hours of the flying day. Reducing the last shift when flights are not required would seem most appropriate. Actually, such reasoning may or may not be appropriate, depending upon the facts. In any event, for illustrative purposes let us assume that such exercises lead to a shift allocation of 14, 11, and 9, or 34 crews and 68 men. Remember that all resources depicted would be evaluated and adjusted at the same time. The Resource Report from a simulation using this mix shows that an average of 11.333 PT1 crews were available -- 5.876 were idle, and 5.457 were at work. An average of 0.049 crews were demanded but not available. Analysis of the corresponding D/NA matrix (Fig. 31) shows that most queues occurred during the night. The largest average number of aircraft waiting for PT1 was 7 at 2100 hours. It happened once in 30 days.

Similar analysis and iterations may continue until the user has determined the relationships between sortie production and different numbers of direct maintenance personnel or equipment, as might be relevant to his problem. The important thing to remember is that the D/NAs or queues should be "balanced" as nearly as possible against the operations requirements. In one case they might be bunched to best advantage. In another they might be spread over the day as nearly as possible so that they would hurt the least. Although such an approach may seem to involve many iterations, two or three often are sufficient, especially when one is thoroughly familiar with the operations requirements, priorities, and associated maintenance parameters and events. In some cases, one may be interested only in the requirements for one or two shops or pieces of equipment given some fixed set of other resources.

MAKE 2 BASE = 'SAMP ' 'PT 1' OUTPUT CODE = 'D/NA ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
7																						1		
6																			1					
5																					1			
4																				1				
3								1										1						
2																			1		1	1	1	
1			2	1							1	4	1					2	1	1	4	2	1	
-0	30	30	28	29	30	30	30	29	30	30	29	26	29	30	30	30	30	27	27	28	24	26	28	30
MEAN	0.0		0.1		0.0		0.0		0.0		0.0		0.0		0.0		C.0		0.3		C.4		0.1	
MEAN		0.0		0.0		0.0		0.1		0.0		0.1		0.0		0.0		0.2		0.2		0.4		0.0
SIGMA	0.0		0.2		0.0		0.0		0.0		0.2		0.2		0.0		0.0		1.1		1.0		0.4	
SIGMA		0.0		0.2		0.0		0.5		0.0		0.3		0.0		0.0		0.6		0.7		1.3		0.0

MACHINE TIME = 3.30 MIN.

Fig. 31 -- Average Queue Matrix for shop PT1

SORTIE CAPABILITY AND RESOURCE REQUIREMENTS

Although the following illustrations focus attention on two shops, they are directed toward use of the model to examine the broader question of the relationship between levels of sortie capability and specific resource requirements. Beginning at some minimum level* of sorties per aircraft per day, how many men should be added to support successive higher levels up to the maximum level the unit can attain for the given conditions? One might begin at either end of the level spectrum, but our previous examples suggest that we have defined both the maximum (unlimited manpower) and one level below it (74 men reduced to 68). These two points are plotted on Fig. 32 as maximum and level 5, respectively. It is assumed that all simulations providing relationships for constructing such curves would be based upon the same assumptions and general schedule of requirements.

As the reader will note, the maximum level extends horizontally to the right. In other words, additional PT1 personnel beyond 74 would not provide more sorties. Of course, simulations based upon other assumptions and conditions might show either more or less maximum sortie capability. The 5-level point shows only a slight reduction in sortie capability. By the time the number of PT1 personnel is reduced to 36 (approximating the average number, 34, reflected in the Resource Report), the curve is beginning to plunge downward almost vertically.

Although these kinds of curves may be developed for all resources, it is important to understand that they also are a function of one another within the complete set of relationships. Shop manning requirements for different levels of capability are not established one-by-one, but rather are determined in combination with other

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*The "minimum" may be a function of several considerations. For present purposes, let it be considered the basic "buy-in" level of resources, i.e., at least one unit of each different kind of specialist, equipment, facility, etc. Levels of sorties per aircraft per day are used to avoid identifying any sortie-capability potentials that are classified planning factors.

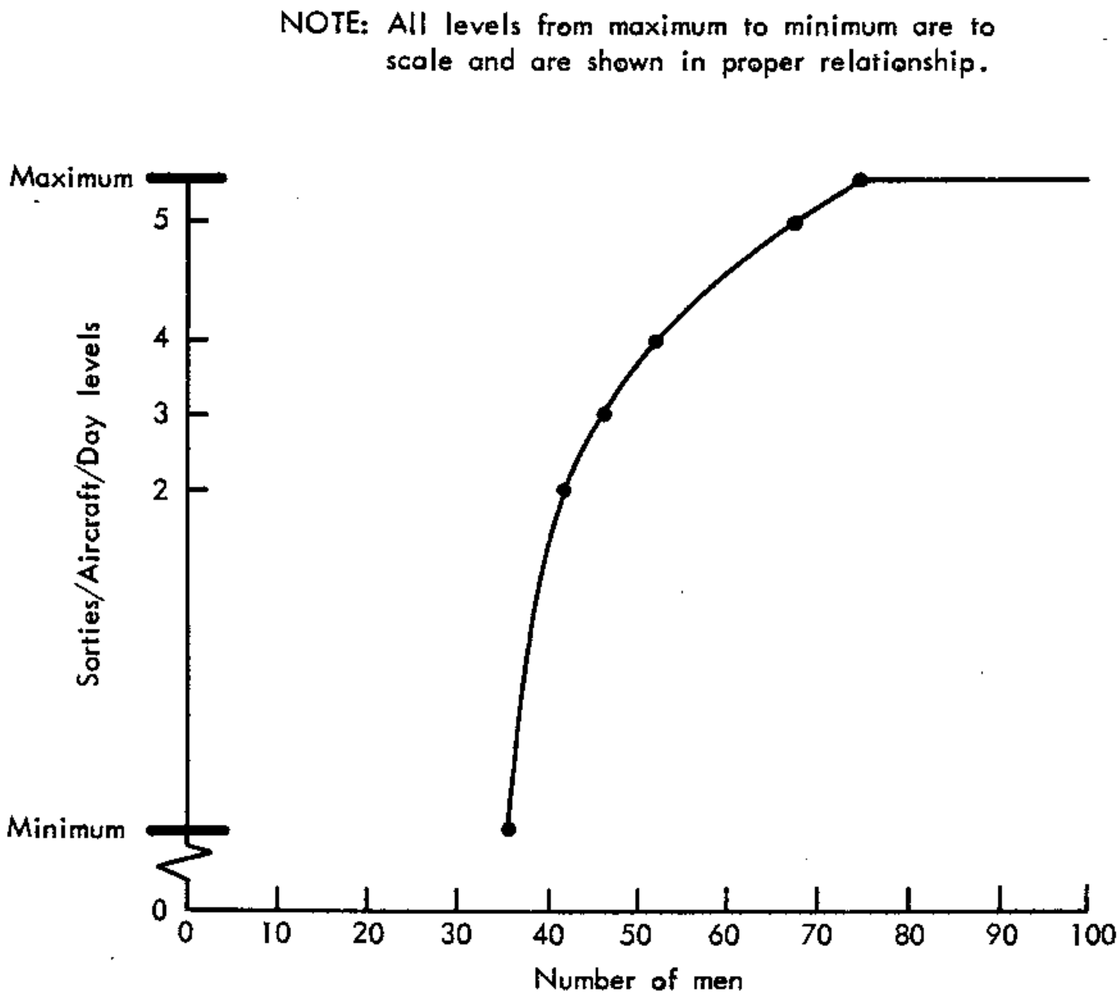

Fig. 32 -- Sortie capability and shop manning relationships (PT1)

resources. Moreover, one should not expect the different curves of requirements for other shops (or equipment) to have similar shapes. Other resources may be subject to other considerations determining the number required to support given operations. Figure 33 illustrates both differences in the curves and such additional considerations.

Resource Requirement Relationships

Observe that the curve for PT2 is considerably different from that for PT1. It shows a sharper break or "knee" at level 4 and the percentage reductions from the fully manned levels are considerably different. For example, the corresponding percentage reductions for level 4 are about 30 percent for PT1 and 72 percent for PT2. At level 5 the comparison is about 8 and 46 percent, respectively. Although sortie levels 2, 3, and 4 show the same manning for PT2, the manning for PT1 is reduced in each case. Even at level 2, however, the percentage reduction for PT2 (73 percent) exceeds that for PT1 (43 percent) by about 30 percentage points. At the minimum level, manning has been reduced significantly for both shops. PT1 now has only 36 men or about half the number required to support the maximum sortie level. On the other hand, the number of men in the PT2 shop has been reduced to 6 or only 18 percent of those required at the maximum sortie level.

Some differences in the two curves are due to differences in demand probabilities and repair times. For example, for some missions PT1 was demanded 44 times to every demand for PT2; on another type of mission the ratio was only 4 to 1. On the other hand, the average repair time for PT1 was one-half as long for one mission and slightly longer than that for PT2 for another mission. Reasons for the differences are the variations in crew sizes and the "best mix" judgments for the different sortie-capability levels.

The crew size for PT1 was 2 men; 3 men are required to do PT2 repairs. At sortie level 4, a review of Resource Reports and D/NA matrix outputs indicates that substantial queues would develop in case of further reductions in PT2 manpower. That is, it seemed

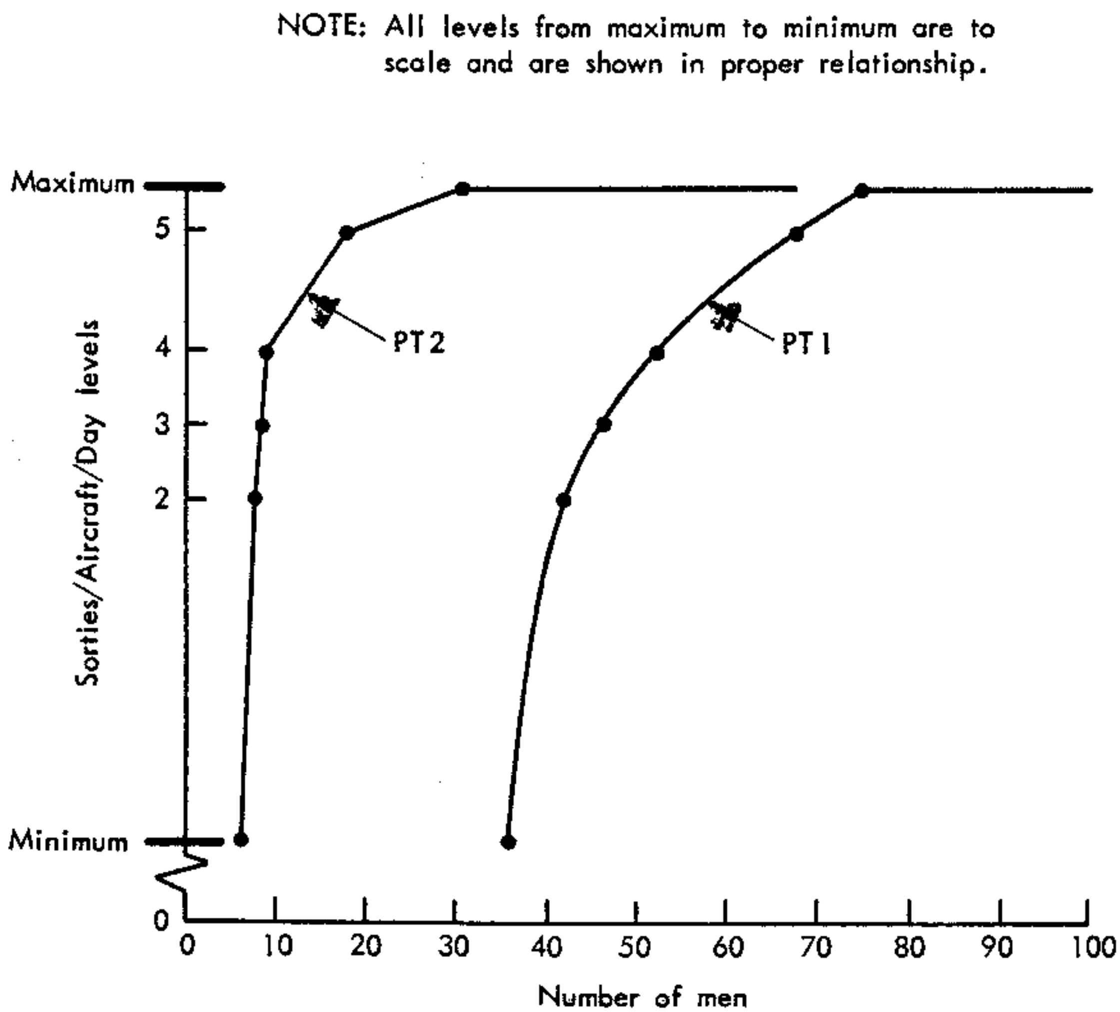

Fig. 33 -- Sortie capability and shop manning relationships (PT1 and 2)

advisable to man each shift with one crew of 3 men. Reducing two crews and 6 men, and accepting queues over an entire shift did not seem appropriate until the minimum sortie level was reached.

Resource Mix Considerations

In fact, the minimum operations level brings into focus other best mix considerations. Prior to this level, the objective for each sortie level was to find the mix of resources that resulted in no shop being either undermanned (worse than others) or overmanned (relative to all others). At the minimum sortie level, additional considerations must be taken into account. PT1 men are crew chiefs and assistants; hence, it is important for aircraft-management reasons that there be at least one crew chief and assistant for each aircraft. Obviously, the different crew-chief pairs will need to help one another when the work requires it, but it would not make sense to reduce the number below the total aircraft the unit possesses. On the other hand, PT2 men are engine mechanics. Although they are not required for engine-management reasons like crew chiefs are for aircraft, they are essential enough to operations so that there should be at least two crews in order to avoid excessive downtimes for lack of support.

It should be obvious at this point that SAMSOM simulations to estimate resource requirements may take into account many factors. Some are straightforward analysis of model outputs; others involve common sense considerations about the total system and the objectives of the analysis; the latter may affect inputs.*

After the user successfully simulates a series of iterations wherein he establishes a satisfactory best mix of resources, he will be able to produce a tradeoff curve between sortie-capability and

*If the user is unhappy with this, let him reflect upon the following: All such models are subject to the same qualifications; analytic "solutions" to these kinds of questions are even less perfect in their ability to handle interactions, interrelationships and complex objectives, i.e., total system considerations.

maintenance manpower similar to that illustrated in Fig. 34. This curve should be interpreted as a composite for all shops, including PT1 and 2, for the given unit (18 aircraft) and the operations schedule of requirements previously reviewed. At the lower levels of sortie production activity, relatively few men add considerably to capability. Beyond level 5, however, more men add very little to sortie capability. As already discussed in connection with PT1, more manpower beyond that associated with the maximum will not improve unit capability; they would be wasted.

Given appropriate data identified in connection with the various inputs, the SAMSOM model can be used to develop such curves for any aircraft, and for various operations requirements and postures.

RESOURCE UTILIZATION ANALYSIS

It should be noted that even though the model provides information on resource utilization, we have not demonstrated its use for projecting utilization rates as a means to determine resource requirements. The reason is simple -- utilization rates are not proper criteria for determining manpower or equipment requirements. Figure 35 illustrates the disparity between utilization rates for the two shops previously examined.

Resource Utilization Percentages Vary Widely

As Fig. 35 shows, utilization rates for corresponding sortie production levels may vary by factors of 2 to 1, depending upon the sortie level.* At the maximum level, crew chief utilization was

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*Since the rate is the ratio of available manpower to that actually used, it theoretically would be possible to "stack the cards" in favor of higher availability to show a "low" rate. At the maximum sortie level, this could not be done because "available" equals the maximum number required to meet all demands. At lower levels of activity the objective is a balanced set of resources; hence "stacking" would cause the shop to be overmanned relative to others.

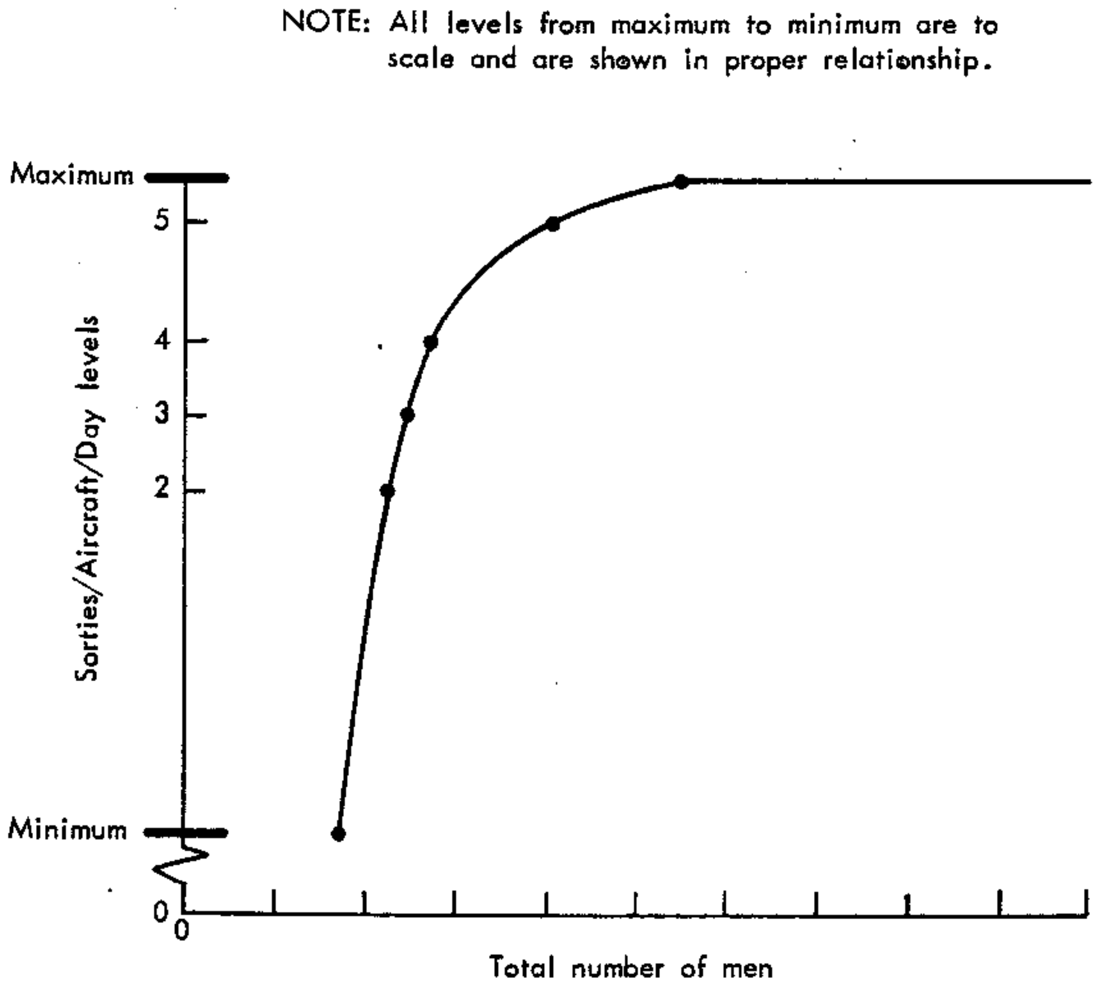

Fig. 34 -- Sortie capability and manpower relationships
(maintenance shops)

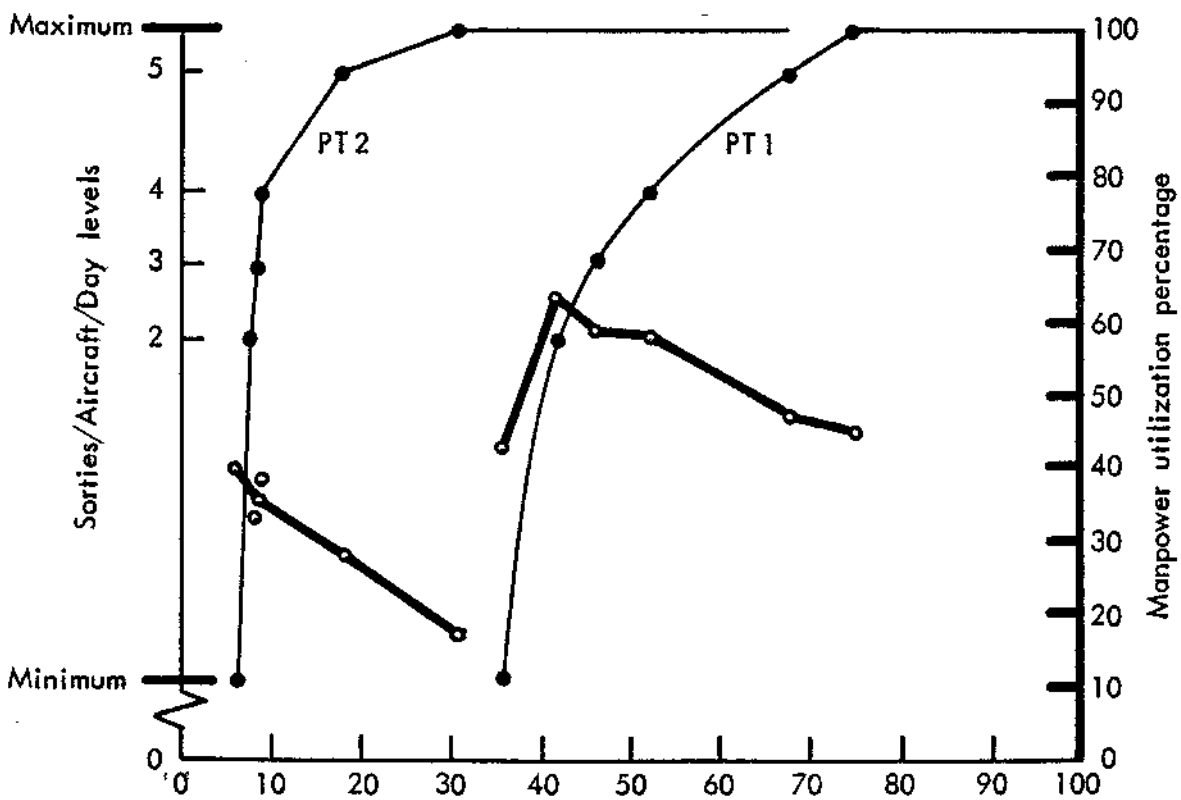

Fig. 35 -- Relationships between sortie production, shop manning, and manpower utilization

46 percent, more than twice the 20 percent shown for the engine mechanics. As one proceeds from sortie level maximum down to level 3, the ratio between utilization narrows somewhat, finally reaching 64 and 36, respectively. At the minimum sortie level, however, their utilization percentages are approximately equal.

This latter turn of events is even more important than the 2 to 1 difference between their utilization rates for the other activity levels. It shows that there may be some peak utilization rate that any given shop may be unable to exceed.* Although such a point was not identified for engine mechanics in this set of simulations, it occurs at about 65 percent for the crew chiefs. At the minimum level of sortie production, the rate for the crew chiefs drops dramatically back to about 44 percent.

Utilization Rollover Phenomenon

Further evidence of this phenomenon is illustrated in the composite utilization rates shown in Fig. 36. Note that the composite or average utilization rate begins at about 23 percent for the maximum sortie level, increases to about 45 percent for levels 2, 3 and 4, and rolls over to about 33 percent at the minimum level. The explanation of this rollover is as follows: Fewer crews create larger queues which cut down availability of aircraft for flying which, in turn, reduces the demand for men to maintain the aircraft, thus causing the men to do less work.

The purpose of this illustration has been to indicate that manpower requirements are not readily reflected by such general utilization factors. Factors may differ significantly among the different shops. Their use also fails in a general sense, because utilization rates are a function of where on its sortie-capability curve a unit is operating. Finally, the percentages found in these simulations

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*Although the example refers only to direct maintenance requirements, the principal holds true for any mix of direct and indirect requirements the same unit generates. In general, the larger the unit (wing versus squadron) the higher the possible utilization rate.

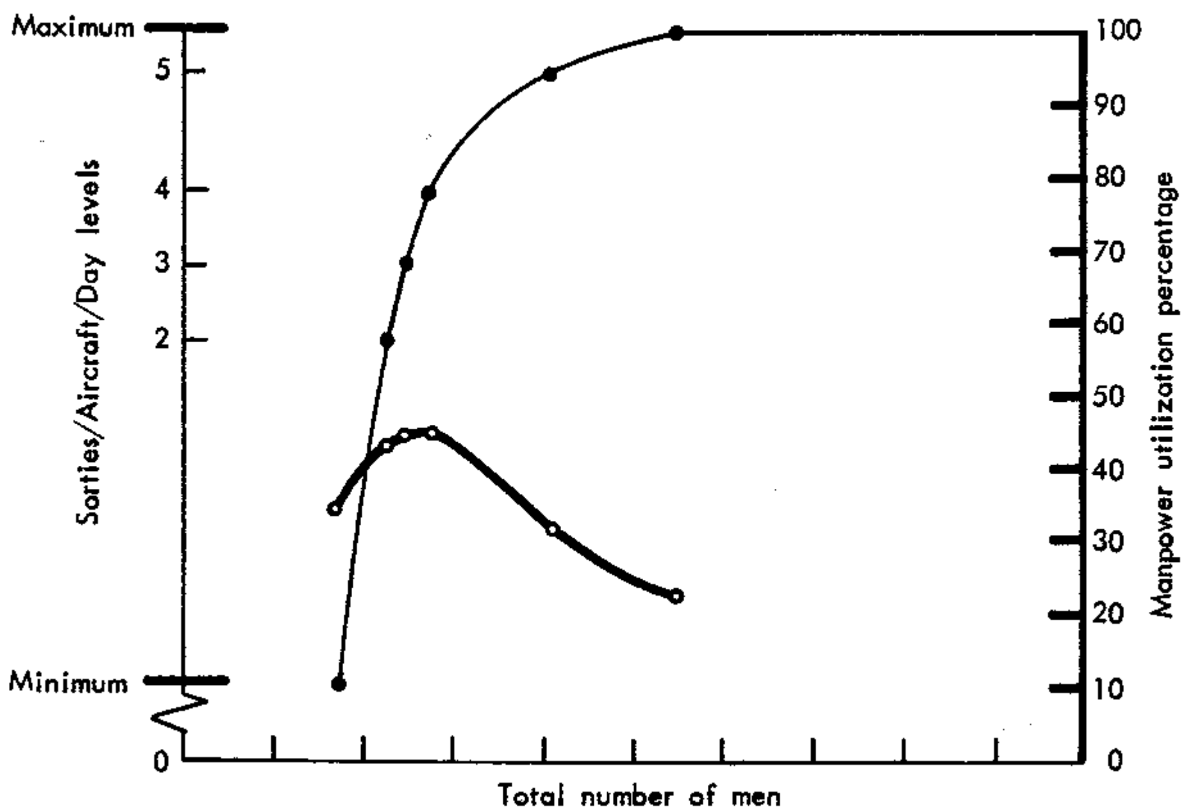

Fig. 36 -- Relationships between sortie production, direct maintenance manpower, and manpower utilization

indicate that a relatively low resource utilization percentage should be expected from small, independent units. Air Force management should not expect these units to show manpower (or equipment) utilization factors much above 50 percent, even when indirect shop-repair workloads are taken into account. In fact, the accurate utilization rates from adequately-manned units flying relatively low flying programs should be expected to be even lower than those indicated in this analysis. Although indirect workloads (off equipment) vary from shop to shop, analyses of AFM 66-1 data by Hq USAF indicate that about 6.5 percent of the maintenance man-hours reported under that system are identified with such shop work, and the data base used for these calculations does not include support-general workload which is a substantial percentage of the total workload for many shops.

SAMSOM SIMULATION CONSTRAINTS

The foregoing discussion has emphasized some of the capabilities and potential usefulness of the SAMSOM model. Like all other management tools, it must be used with care, especially when any given simulation objective may be pressing the state of the art or limitations of the model. Therefore, users are cautioned to recognize the scope of the model and its constraints in setting up their simulation. The following discussion attempts to highlight the more important considerations, including some constraints previously discussed in connection with specific inputs, model logic, and output products.

Computer Constraints

The first consideration is computer limitations. The model runs on the IBM 7040-7044 installation at RAND and on the IBM 7090/7094 installation at Wright-Patterson AFB (Research Technology Division of AFSC) and at Hq USAF in Washington, D.C. The model can be implemented on any computer system with SIMSCRIPT 1 or 1.5 capability and with at least 32K core storage. Many computers accept SIMSCRIPT and have more than 32K, e.g., Univac 1107, CDC 3600.

Core requirements for the SAMSOM program, SIMSCRIPT system, and the computer software system are sufficient to restrict problem size. Additional information is available on these restrictions in the Programmer's Guide; users are cautioned that any combination of several bases, aircraft, routes, and associated maintenance parameters (system break rates and work center repair times) soon adds up to many inputs, so many that the user may want to reexamine the model's initialization parameters that establish the limits upon such items. To date, the largest program successfully simulated on the RAND installation involved 7 bases, 1 aircraft type, 2 routes, and 252 different maintenance parameters.

Because simulation requirements vary so much from problem to problem, it is difficult to estimate computer time. In addition, run time will differ for the same problem at different installations. However, a reasonable spectrum of time ranges from about 10 minutes for short 15-day simulations for about 18 to 20 aircraft, including some operations outputs, to about 10 hours for a multi-base operation involving 70 to 100 aircraft for 30 to 60 days of intensive activity, especially when a complete set of outputs is required involving several resources and missions. In general, useful simulations and outputs may be obtained in about an hour, and even wing-sized, 30-day operations may be simulated in 2 to 3 hours. A complete set of outputs is seldom required for all simulations in a set. In some cases, simple iterations may require only one output report and thus require only the time to simulate the problem. However, output requirements often take more time than actual simulation.

Supply Simulation Constraints

As discussed previously, supply requirements, inventory policy, and related considerations are not provided for in SAMSOM II. At best, the model takes into account assumptions (or actual data) about the probability of not having a part and how long it takes to get it.

Together, these two parameters may be used to represent NORS conditions and rates, but the user is cautioned to remember that such delays (queues for lack of parts) are not generated as a function of supply inventory, reorder, and stockage policy. They only reflect the stock-out probabilities and delivery-time distributions used as simulation inputs. They will reflect random variation about such parameters, but not their relationship to cannibalization, shop repair priorities, depot fill rates, etc., all of which affect maintenance capability and sortie-production.

Shop Repair Workloads

Similarly, SAMSOM does not directly accommodate the interactions between supply policy and direct maintenance requirements and shop repairs. Although shop repair workloads can be represented in the model, they cannot be generated by the sorties and inspections actually achieved* in the simulation. Rather, they must be estimated on the basis of some appropriate ratio of shop repairs to expected direct maintenance workloads. In fact, they should be estimated after the direct maintenance requirements are simulated for some given flying program. Otherwise, the estimate might not be in the correct ratio. Adding such workload to an otherwise stressed unit obviously would affect its total capability. Another alternative is to represent shop repairs as non-critical requirements. In this case, they will tend to be worked off when the required resources are not busy on critical work.

Such repairs might be generated by dummy aircraft, flying dummy sorties or standing failures. In either event, the user could spread the workload out to suit his purposes. When programmed as noncritical inputs, repairs tend to fill out nonproductive time for resources and are thus accorded the kind of priority they generally get in the real world.

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*As the reader will recall, the number of sorties achieved often will be considerably less than the inputs called for. This would be especially true when the inputs are deliberately high in order to "load" the system.

But to repeat, shop repairs cannot be generated directly as a function of the total system operations and <u>achieved</u> flying program, but rather must be generated indirectly by noncritical inputs or some other dummy aircraft, mission, or maintenance-activity arrangement. The final result would not necessarily give a true picture of their impact upon and interactions with the flying program even though they could be handled so as to properly represent the total workload generated for any given set of resources.

<u>Mobile Repair Teams and Aircrew Requirements</u>

Other desirable model attributes have not been incorporated in SAMSOM II. It does not include a complete routine for handling mobile repair teams. It accomplishes only part of the job. The time delay (TD) that might be associated with travel time as the team goes to do the repairs can be provided as a part of the given repair time. Related resources will be tied up and the aircraft will be down for repair the proper time even though part of it would be wait time. But, when repair is completed and the aircraft is available for operations, the team doing the repair <u>also</u> is free. In other words, the model does not include a routine to withhold team availability while it returns from the job. Simply lengthening the job or activating some dummy maintenance requirement last also keeps the aircraft down. Even resort to a noncritical dummy maintenance activity would not solve the problem because there is no way to connect two such activities directly. A fix for the "real" activity cannot be tied to a dummy noncritical requirement representing the "return" of the team. This arrangement would work only if <u>all</u> fix probabilities were 1.0, which does not seem to be a likely circumstance. In any event, the moment the aircraft is launched with noncritical hanging on it, the resources originally tied to the dummy requirement would be free to work on anything else and would <u>not</u> travel back to their origin.

The model does not represent aircrew requirements or in-flight maintenance. Of course, users may estimate aircrew requirements from analyzing the sortie launch report or from matrix outputs, but the

results of such analysis will not be directly accounted for in the simulation. Similarly, one might estimate in-flight requirements outside the model on the basis of achieved sorties. Repairs cannot be done in the model during flight.

Program Constraints

Some constraints are built into the model by the way it has been programmed. For example, the sequence of maintenance activities is fixed (debriefing, troubleshoot, unscheduled, etc.) and cannot be changed to represent other sequences or alternative arrangements. If it is determined that fueling is first, then it must be identified as debriefing; otherwise it will be done last if it is input as FS -- fuel servicing actions. Similarly, if some distinct action such as basic postflight overlaps with unscheduled maintenance, then it should be properly collapsed under unscheduled maintenance along with other inputs for unscheduled maintenance. If included in the FS input, it will be done last, even though in the real world it often overlaps with unscheduled maintenance activities.

Criticality Constraints

The model handles all maintenance requirements on any given aircraft on the following basis of priority: critical first, then noncritical, in the prescribed maintenance-activity sequence, and within each category first in first out (FIFO). Unlike some models, SAMSOM II does not provide the user with options to specify other priority rules such as shortest job first, etc. In addition, the model does not look across aircraft when assigning resources to do work. Thus, given a noncritical requirement on one aircraft and a critical requirement on another (both arrived at the same time), the noncritical job may use the last crew and thus cause a critical job to wait. In other words, SAMSOM neither looks ahead nor preempts work already begun. The exception for preemption is that noncritical work may be interrupted if the aircraft is required to meet some priority mission. In this case, the noncritical will be postponed and completed when the next opportunity arises.

The NRTS routine applies only to maintenance types (UM, FS, etc.) and not to individual systems. The model always returns the aircraft to the origin of the failure after repairs are completed at another base. This may or may not be a desirable outcome for a simulation.

Because the model does not look ahead, it may cut off maintenance that actually would have been generated. This occurs when an aircraft is preempted from completion of noncritical work associated with <u>any but the last maintenance activity</u> included in a simulation. The reason is that once the aircraft moves from one mission (the one generating the requirements) to another, all records associated with the original mission are lost. Thus, when the model has not yet worked its way down to maintenance yet to come and the aircraft is preempted and flown on another sortie, it loses all of the original maintenance not yet begun. At present, the only way to overcome this is to be sure that all noncritical requirements are associated with the <u>last</u> maintenance activity actually used in the given simulation. This may be FS, UM, or any other category, but it should be the last in the sequence activated by inputs for the given simulation.

<u>Program Bugs and Errors</u>

Although hundreds of simulations have been completed with SAMSOM II, it has not been completely debugged. <u>Moreover, it never will be completely checked out</u> because only one form (Input Form 6) contains enough input options to require over 90 million simulations to check out all combinations. Although users might properly conclude that all such combinations need not be checked out, we assure them that those which do need proving from among the 8 input forms provide a requirement for many hundreds of simulations. (Obviously, all routines have been tested, but not always in the context of "real" problems.) Even then, there is some chance that a peculiar set of events will cause the model to print out error messages and/or produce "strange" results.

For this reason users should not be surprised when any <u>new</u> use of the model generates error messages or problems, some of which may be in the program. This statement should not be alarming. Any other

model as general and flexible as SAMSOM II faces the same kind of checkout problems. The larger it is, and the more capability and flexibility it possesses, the more likely is it not to be checked out for all applications.

Needless to say when such events occur, RAND or other experienced users will endeavor to help the new user solve his problem. If it is a result of program errors we will make the necessary corrections and notify all users on the RAND list of their content.

DATA REQUIREMENTS

Data manipulation and inputs are separate and complete subjects themselves. However, a few remarks may help users understand some considerations important to the model. SAMSOM II is driven by sorties, ground aborts, flying, and OR time. Sorties generate most maintenance, standing failures generate some, and flying time generates inspection workloads. Thus, the model is heavily oriented toward sorties as the prime unit of stress. So most data and model inputs must be developed in terms of sorties.

Sortie Orientation

Specifically, system breakrates or failure probabilities and work center (shop) demand probabilities must be related to the sortie, not some function of flying hours. Therefore, all engineering estimates or other data stated in terms of probabilities per 1000 flying hours, MTBF, etc., must be appropriately converted to failures or demands per sortie.*

Our rationale for building the model this way is based upon several studies during the past decade which indicate that the sortie is a better unit of stress and is more nearly the generator of maintenance

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*The user must decide what sortie-length is intended or assumed in the estimates.

requirements than other measures.* Obviously, there are some exceptions, but in the main unscheduled maintenance appears more related to the sortie than to flying time.**

Because the model is programmed this way, supply requirements and inputs, equipment demands, and all related parameters triggered by unscheduled maintenance must be collected or converted to reflect their sortie relationship. Of course, periodic and hourly postflight inspections and standing failures, and their associated supply and equipment requirements must be related to the proper unit of flying or ready time.

Deferred Maintenance

Although sorties generate all unscheduled maintenance in the model, the inputs may be developed to take into account the common practice*** of delaying noncritical requirements until some later time. This may be handled in two ways. First, sorties flown during the early part of the day tend to "cause" fewer failures than the last sortie of the day. Similarly, there is some evidence that transport aircraft tend to break more often at certain bases such as Tachikawa, Honolulu, etc., and on the last leg of missions involving multiple stops.**** Given either kind of phenomenon, users may set up different missions in the

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*R. S. La Vallee and D. S. Stoller, Factors Affecting Malfunction Rates of F-86F and F-86D Aircraft, The RAND Corporation, RM-1790, September 1956.

W. H. McGlothlin and T. S. Donaldson, Trends in Aircraft Maintenance Requirements, The RAND Corporation, RM-4049-PR, June 1964.

**Although we are unaware of any study that proves inspection is a function of accumulated flying hours, we have accepted conventional inspection practice and policy that uses flying time and generates workload accordingly.

***Although common practice in fact, current Air Force data do not provide adequate information to identify and quantify it.

****Unpublished RAND analysis of C-130 TACKDOWN data collected by the Tactical Air Command at Pope AFB in 1965.

desired ratio and let the last sortie generate more maintenance than the first, second, etc. Although this approach is valid, it must be used with care and should be carefully explained if the ratios used in a simulation differ from those that the data reflect.

Second, given the above kind of data identifications, special information on the proper division between critical and noncritical requirements, or estimates thereof, users may exercise the noncritical routine in the model and postpone noncritical requirements until the demanded resources are available to do the work. Even though simulated sorties would generate these requirements, they might be worked off as if they were not related to them.

Elapsed Repair Time

The model does not accept man-hour data. It accounts for manpower in real-life terms of crews and elapsed repair or inspection times. In other words, it is concerned with the rate through time at which manpower is used. Since aircraft downtime is the most important unit of time in the model, it is necessary to model resource requirements using the same basic unit -- elapsed time. For this reason, SAMSOM neither accepts man-hour inputs nor provides man-hour outputs. Users may compute man-hours outside of the model, however, using the averages and appropriate periods of time shown in the Resource and Matrix Reports.

This attribute of the model also means that routine Air Force man-hour data collected and reported under the current AFM 66-1 system are not very useful as a source of model inputs.* The primary reasons are that: (1) the system collects neither elapsed time nor crew sizes to permit one to compute the other parameter, and (2) the data are aggregated on a daily basis thereby making it impossible to relate them to individual sorties. Although several prime contractors have used these data with mixed successes, RAND efforts have not been very successful. We have found that special data collection efforts were

*An Air Force Study Group currently studying the AFM 66-1 Maintenance Management system has indicated that it may be changed in the near future to provide more useful data than now available from it.

the only source of acceptable data on breakrates and repair-time distributions.

Concurrent Maintenance Conflicts

The model provides a means to establish conflicts between systems. The purpose is to represent power-on, power-off, access, button-up, safety, and similar requirements that prohibit concurrent sequential support actions. It also allows the user to limit the total men or, depending upon the way inputs are used and interpreted, crews that can work on any single aircraft at the same time. Both constraints are realistic, but current data do not provide a very solid base for deriving the proper relationships. Some conflicts will be routine practice and reasonably easy to estimate. The only source of information we know of providing data on the maximum number of personnel which do or can work on an aircraft at one time is the data from an augmented AFM 66-1 data system which has been used for several tests and exercises during the past few years.*

Although the model has capability to handle these constraints that prevent concurrent maintenance, its basic procedures cause all maintenance in any given activity (UM, FS, etc.) to proceed simultaneously, unless constrained as above. As the reader will recall, maintenance tasks also may be done sequentially by using the sequence codes. In addition, queue situations may develop that would cause them to be worked off at some later time. On the other hand, the model does not contain a means to force selected maintenance to occur together. This may be a limitation for some simulations, the model is passive in this role. Unless constrained, similar kinds of maintenance occur simultaneously; but there is no way to make maintenance events happen when something else is being done which they normally accompany. Of

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*The reference is the TAC/RAND Maintenance Data Collection and Analysis System begun at Oxnard AFB and further developed at Williams, MacDill and Seymour-Johnson Air Force Bases and used for varying periods of time. This system also was used in the TACKDOWN, SPARROW HAWK, SKOSHI TIGER, and RAPID ROGER tests. A similar, but not identical, system was used at Richards-Gebaur AFB. Another containing most of the essential elements and more on depot support is being used in the LOGGY SORT project. Another version of the system also was used to collect the data during COMBAT SAMPLE.

course, all events that occur every time, i.e., are generated from a probability of 1.0, do occur together (unless prevented by queues or some other constraint).

Failure Model Dependencies

Although the model assumes mutual independence among all failures on an aircraft for any given maintenance activity, some events may be dependent in some way. Besides this possibility there is the chance that data may be manipulated and aggregated for some combination of activities and operations so that it creates apparent dependencies. An example would be a situation where unscheduled maintenance data are combined with basic postflights. The case has been observed where the overall probability of unscheduled maintenance is small (0.25), and the relative occurrence of basic postflight is larger (0.65). Review of the joint occurrence of these two events in an aggregation containing both indicates statistical dependence within the aggregation. Statistically they are "dependent." But, in fact, they just happened that way because postflight requirements were done along with unscheduled maintenance requirements. Neither caused the other.

Unfortunately, the simulation problem does not end with this knowledge.* The model includes no clear and easy solution. If demands for separate shops are used for inputs** as if the demands were mutually independent, the total probability that at least one shop will be demanded causes the aircraft to be down for repairs either more or

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*Users should be aware that other models also may encounter this problem.

**In SAMSOM II, this is a very common and practical way to stimulate many operations. It is the most economical mode for minimizing computer time and provides excellent results in terms of resource support requirements.

less often than might be observed in the original data.* In other words, treating events that are statistically, if not in fact, dependent in a set of data as though they were independent causes their joint occurrence in simulations to differ from what the data might reflect. It should be understood, however, that such treatment does not cause serious error in the total demand for men from the different shops. Personnel will be demanded appropriately and thus accurately reflect resource requirements. But they would not be demanded in the same relationship (pairs, triplets, etc.) one to another as reflected in the original data.

Although the complete impact of this problem upon simulated aircraft downtime is not known because it is intertwined with so many other interrelationships, it is thought to be relatively insignificant. In some instances a dominating shop, such as crew chief, which has a high demand probability, may tend to produce more aircraft downtime than would be expected. On the other hand, the model can accommodate system conflicts when known, and thereby avoid some tendency toward less downtime.

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*If maintenance events that <u>always</u> actually occur together are treated in the simulation as separate, independent events, i.e., as randomly generated single events, their impact would be to cause <u>more</u> simulated aircraft downtime than would be encountered in the real world. On the other hand, if maintenance events that <u>never</u> occur together are treated as separate, independent events, their impact would be to cause <u>less</u> aircraft downtime than would be found in the actual data.

At the present time, we do not have a complete explanation of what happens for different sets of probabilities between these two bounds. We are exploring a way to overcome the problem when using actual data, but the solution requires additional changes in the current SAMSOM II program and the corresponding data processing routines.

In the future it also may be possible to modify the simulation program to use input data that explicitly account for joint breakrates. Theoretically, if there are N work centers, there are = $2^N - 1$ distinct subsets of the N work centers that may be considered (given that at least one center is required). For example, if A indicates work center "A" is in a subset and $\bar{A}$ indicates that "A" is not in the subset then if there are three work centers A, B and C, the $2^3 - 1 = 7$ subsets of work centers are ABC, $AB\bar{C}$, $A\bar{B}C$, $\bar{A}BC$, $A\bar{B}\bar{C}$, $\bar{A}\bar{B}C$ and $\bar{A}B\bar{C}$. If N = 15, there would be 32,767 ($2^{15} - 1$) subsets of work centers to examine. Of course, this would not be feasible. What might be done, however, would be to consider only all pairs of work centers. For N = 15, this amounts to $\binom{15}{2} = \frac{15!}{13!2!} = \frac{15 \times 14}{2} = 105$ pairs.

Just how all of these interrelated events "work out" in our efforts to bridge the gap from the real to the simulated world is not subject to very precise measurements and analysis. Therefore, it is suggested that users carefully examine all hierarchies of maintenance types, tasks, and resources, that events establish on Input Form 6. The way these different kinds of events and relationships are established may, in fact, set up series of conditional probabilities that were neither intended nor actually observed in the data. This general precaution should include a review of the inputs to insure that: (1) the strings of probabilities used agree with their counterparts in the data or estimates, and (2) their total overall impact is that actually intended. In general, identifying breakrates in terms of the shops or work centers rather than systems is less complex and less likely to introduce errors. Users should not shy away from the system orientation, however, if it is important to their simulation objectives. In fact, the model accepts both orientations simultaneously; the actual choice would depend upon the data and objectives. The shop orientation divides the aircraft into "systems" reflecting the demand for each of the different work centers or resources. The system orientation divides the aircraft into conventional AFM 66-1 systems such as airframe, engine, etc., or convenient aggregations thereof, and then associates the different work centers and resource requirements with the separate systems.

SUMMARY OF MODEL CAPABILITIES

In summary, SAMSOM II is a general, flexible Monte Carlo model that simulates single and multiple unit (flights, squadrons, wings, etc.) capabilities for varying numbers of aircraft. It can be used to determine sortie-generation, alert, and readiness combinations for varying operations requirements or schedules. Given a set of support resources, it will simulate operations capability. Or, given a set of operations requirements and policies, it will simulate the resources required to support the operations.

SAMSOM II is activated by sorties, ground aborts, flying hours, and accumulated operational ready time; takes into account specific sortie schedules, make-up policies, maintenance parameters, shift scheduling practices, and queue situations or other work delays; and provides a wide range of outputs depicting operations results for further analysis. The model is written in SIMSCRIPT I and at present runs only on IBM 7044, 7090, or 7094 computer installations. Therefore, it is limited by their 32K core storages. It may be reprogrammed in SIMSCRIPT 1.5 and/or II to run on other computers to gain the advantage of larger memories and thus permit even larger simulations.

It is not a simple model, but it has been used extensively by both RAND and Air Force personnel to successfully simulate several kinds of Air Force operations. Its largest application was to examine about 100 cases of alternative operational postures involving Tactical Air Command fighter operations. It also has been used in RAND to simulate various kinds of operations for several fighters and C-130 transports. Given useful data or reasonable estimates, it may be used to examine a wide range of management questions ranging from a simple determination of an aircraft's sortie-generation capability to a complex determination of the impact of "n" fewer resources or the gains from "n" more resources.

Although the model will accommodate some examination of supply parameters, shop repairs, and other indirect support requirements, it was designed to focus attention upon the more important part of the management problem -- direct support that directly affects operations. Although it will not simulate all kinds of operations, in its own domain, SAMSOM II is a powerful management tool for examining aircraft capabilities and logistic support requirements.

Appendix A

SAMSOM II RUNNING INSTRUCTIONS

The SAMSOM II Running Deck consists of three sets of information: input initialization cards, simulation inputs and output request cards. Some control cards peculiar to the RAND IBM 7040-7044 installation ($ in Col. 1) are included in the Running Deck Listing given in this Appendix. It is assumed a similar deck will be available for other computer installations. Simulation inputs are described in Sec. III and illustrated in Appendix B. Output request cards are discussed in Sec. IV and illustrated in Appendix D. Given a set of inputs and output request cards, the user should be able to simulate his problems by inserting the inputs and output request cards in the appropriate places in the Running Deck and submitting it to the computer along with appropriate SAMSOM II program tapes described in the Programmer's Guide.

The following running instructions are organized to fit the card sequence shown in the SAMSOM Running Deck Listing. Some instructions pertaining to individual cards such as $JØB cards are unique to the RAND computer installations; others are more general and should apply to other installations.

The first card in the Running Deck (See p. 187) is a $JØB card that the user fills out for each simulation he submits to the RAND computer. The next 9 cards are $CLØSE cards closing all units the model uses. The tenth card is a $IBJØB card that calls for the beginning of the Input Program. Card eleven, $RELØAD, immediately follows it and calls the Input Program from the SAMSOM II program tape and loads it into the core. The twelfth card is a System Specification Card that indicates the total arrays (107) the Input Program uses, and the random root. The succeeding input initialization cards are a set of parameter values of the model's various arrays for all simulations accomplished using the Running Deck.

Entries in Cols. 67-80 on all initialization cards identify the parameters for which values have been given. For example, card 36 sets the number of bases in this Running Deck at 5. The different initialization parameters may be changed to fit the user's need as explained in

the initialization procedures in the Programmer's Guide. These parameters may vary with different sets of inputs and should be carefully considered before submitting the simulation to the computer.

Following the initialization cards is a card that reads "1" and PLACE INPUT DATA BEHIND THIS CARD. It shows the user where completed input cards are placed in the Running Deck. The user is cautioned to check the following items.

1. Input form numbers should appear in Col. 3 on all input data cards.
2. All input data cards having the same form number should be grouped together.
3. Each group of input data cards should be preceded by a card identifying the form number in Col. 3 and the simulation in Cols. 66 to 71.
4. The TIME TO END THE SIMULATION should be entered on Input Form 6, Cols. 65 to 72.

Following the input data cards is a card reading 19999. This card is a SIMSCRIPT requirement insuring that the input program runs to completion. The next card, $IBSYS, ends the program's input section.

The card reading $IBJØB SAMSØM NØSØURCE begins the execution program, while the $RELØAD card immediately following it calls the execution program from the SAMSOM II program tape mounted on U07. The next card, which reads "1" in Col. 1, is a SIMSCRIPT initialization card that sets the number of arrays for the execution program at 58.* The "4" on this card indicates that the execution initialization cards are read from FØRTRAN logical unit 4, and the "15" indicates that the exogenous events tape is on logical unit 15. The $IBSYS card ends the execution section of the program.

The card reading $IBJØB EDIT begins the optional edit phase of processing. The $RELØAD control card calls the edit program into core storage. The next card indicates those nondump reports that will be requested during the output phase of processing. If all nondump reports are to be requested, leave Cols. 1-7 blank. If not, then a nonblank character should be punched in the column corresponding to the particular report.

---

*This array number set for the execution section of the program represents permanent entities and attributes and cannot be changed.

Report 1	Col. 1
Report 2	Col. 2
Report 3	Col. 3
Report 4	Col. 4
Report 7	Col. 5
Report 8	Col. 6
Report 9	Col. 7
Report 11	Col. 2

Employing the edit phase can decrease the time the output phase consumes to produce reports. If three or more types of report are requested, or if a large number of reports of the same type are requested, then the edit phase should be employed. Its employment can save as much as 50 percent of computer time. When using the edit program, the output program must be so informed. There is a card in the output program running deck that says, PLACE OUTPUTS BEHIND THIS CARD. If the edit phase is employed, then the first six columns of this card should be nonblank.

The card reading $IBJØB ØUTPUT NØSØURCE begins the execution program, while the $RELØAD card calls the output program from the SAMSOM II program tape mounted on U07. The next card with a "1" in Col. 1 is a SIMSCRIPT initialization card that sets the array for the output program at 144.* The "14" on this card indicates that the output initialization cards are read from logical unit 14. The following card reads PLACE OUTPUT DATA BEHIND THIS CARD.** Output request cards are placed behind this card and in front of the card reading PLACE OUTPUT DATA IN FRONT OF THIS CARD. The user is cautioned to check the following items:

1. The report number should appear in Cols. 1 and 2 on all output request cards.

---

*This array number set for the output section of the program represents permanent entities and attributes and cannot be changed.

**If this card has an entry in Cols. 1-6, it indicates that auxiliary transaction tapes are being used. A discussion of auxiliary tapes and their use is contained in "The Output Program" section of the <u>Programmer's Guide</u>.

2. All output request cards of the same number should be grouped together.
3. If output request card 9 is being used, it must be preceded by a Header card (the form number must appear in Col. 2 and the simulation identification must appear in Cols. 66-71) and followed by a blank (trailer) card.

The $IBSYS card ends the output section of the program, and the two $CLØSE cards rewind the SAMSOM II program tape mounted on U07 and the transactions tape mounted on U06.

The listing on p. 187 is a sample Running Deck currently in use at RAND. Other decks, incorporating different initialization parameters, would be equally useful. A more detailed discussion of alternative parameter values and associated procedures and precautions will be found in the discussion of initialization procedures in the Programmer's Guide.

To generate output as a separate operation after completing a simulation, the user must use: (1) the deck of output initialization* cards produced by that simulation, (2) the desired output request cards, and (3) a SAMSOM II Output Running Deck. As shown below, this Running Deck contains only six cards, not including the request and initialization cards.

The first card is the $JØB. The next card, $IBJØB, begins the output program. The $RELØAD card calls the output program from the SAMSOM II program tape mounted on U07. Following the $RELØAD card is the SIMSCRIPT initialization card that sets the number of arrays

OUTPUT RUNNING DECK LISTING

```
$JOB                3059,OUT-C,M2790,4,0,20,P   TAPE 2283   PAL 106
$IBJOB    OUTPUT    NOSOURCE
$RELOAD             U07,NAME=OUTPUT,SRCH
1         144
                         PLACE OUTPUT INITIALIZATION CARDS BEFORE THIS CARD
                         PLACE OUTPUT DATA IN FRONT OF THIS CARD
```

*Output initialization cards, punched during simulation by the input program, should not be confused with the input initialization cards that are part of the total Running Deck.

for the output program at 144.* As previously discussed, the next card, which reads PLACE OUTPUT INITIALIZATION CARDS BEFORE THIS CARD, may contain optional entries to activate auxiliary transaction tapes** that economize computer time to generate outputs. The deck of output initialization cards is placed before this card, and the output request cards are placed before the last card of the Output Running Deck which reads PLACE OUTPUT DATA IN FRONT OF THIS CARD.

ERROR MESSAGES

The SAMSOM II program includes a system for checking input and other simulation errors. The model not only prints out the error messages but also states the severity of the error and, in some cases, indicates what can be done to correct them. Table 4 (p. 189), SAMSOM II Error Messages, identifies 107 different errors, indicates the subroutine involved for each, and describes the type of error and the program's call argument.

The program recognizes three types of errors. First, it recognizes errors beyond the user's control. For example, he may submit a simulation too big to fit on the computer. This type of error causes the simulation to stop, and SIMSCRIPT prints an error that reads: MACHINE CAPACITY EXCEEDED AT TIME ... . Such errors may not be catastrophic, but they may require the aid of a programmer to delete subroutines not used for the simulation.

A second type of error message may be regarded merely as a warning that input values are not what the model expected. For example, in writing resource work shifts and days, the model expects 24-hour days and 7-day weeks, and the model will print a warning message (error numbers 19 and 22 on the following list) if it does not get what it expects. This type of error does not stop the simulation.

---

*This array number for the program's output section represents permanent entities and attributes and cannot be changed.

**Auxiliary tapes and their uses are discussed in "The Output Program" section of the Programmer's Guide. If auxiliary transaction tapes are used, i.e., if the edit phase is being employed, then the edit phase control cards must be included in the Running Deck and the output program must be so informed.

The third kind of error results from erroneous input data. It must be corrected before the simulation will run. For example, error 101 specifies that there is an unidentified mission in the inputs that must be identified before the simulation will be completed.

Finally, it should be noted that while some errors stop the simulation, none of them stop the input processing. Thus, one pass should reveal all simulation input errors.

INITIALIZATION PROCEDURES

The SAMSOM II program has several built-in error messages which occur when a given parameter for an entity has not been initialized high enough to accommodate a set of inputs. For example, error message 38 says TOO MANY BASES, REDEFINE BASE. The user should then refer to Table 5, Input Program Initialization Variables. BASE has been initialized at 5, and the error message occurred because the given set of inputs defined more than five bases. For illustrative purposes, let us assume that the inputs have defined 10 bases. The user will see from the table that entity (card) 36 must be changed as well as cards 37-39, 41, 44, 65 and 75-76. These cards must be changed to handle the 10 bases. For card 36, a 10 must be punched in Col. 50, left-adjusted (L, Col. 50); for cards 37-39, 41, 44, 65 and 75-76, a 10 must be punched in Col. 18, right-adjusted (R, Col. 18). The same value for any entity must be punched on all cards indicated on the table.

When deciding how high to increase the parameter for entities SYSTM, BASE, TYPAC, MSNSX, MISSN, STØPS, MPØLY, RS, MREQS, RSREQ, WLEVL AND NRTSP, the user need only count the cards beginning with the one immediately preceding the error message and all cards following the message. When defining DBS, the value must be as high or higher than the largest number assigned to a distribution. When defining DBA, the user should count the number of Form 7 (distribution) cards, multiply by 4 (4 points per card, usually), and use that value for initializing DBA.

Running Deck Listing

```
$JOB            3059,SAMSON,M2790,10,100,100,C
$CLOSE          S.SU01
$CLOSE          S.SU02
$CLOSE          S.SU03
$CLOSE          S.SU04
$CLOSE          S.SU06
$CLOSE          S.SU07
$CLOSE          S.SU08
$CLOSE          S.SU11
$CLOSE          S.SU12
$IBJOB INPUT    NOSOURCE,IOOPI
$RELOAD         U07,NAME=INPUT,SRCH
1        107                  11
  1         R                                     15         TAPE1-EXOG
  2         R                                     4          TAPE2-INIT EXE
  3         R                                     14         TAPE3-INIT OUT
  4  22     Z                                                      STORAGE
 23         R                                     (A6)             BLANK
                                                             BLANK CARD
 24         R                                     (A6)             ALL
ALL
 25         R                                     (A6)             END
END
 26         R                                     18               STORAGE
 27       1 Z   18  26                                             STORAGE
 28         R                                     10         SYSTM- NO. OF
 29       1 Z   10  28                                        SYSNO SYSTEMS
 30         R                                     12         STATE-TYPES OF
 31       1 R   12  30                            18(A4)      STATN MAINT.
ALL DC  TS  UM  FC  CDTSCDUMCDFCFS  LS  DL  TS
 32         R                                     4          CLASS-TYPES OF
 33       1 R    4  32                            12(A2)      NAME RESOURCE
PTETPATD
 34         R                                     5          SMISS
 35       1 R    5  34                            12(A6)      SMISN
ALERT ABORT PEROD POSTFTSTAND
 36         R                                     5          BASE-NO. OF
 37  39 1  Z     5  36                                             BASES
 40         R                                     3          TYPAC-NO. OF
 41       1 Z    5  36                                        DEFIN
 42  43 1  Z     3  40                                             A/C TYPES
 44       2 Z    5  36   3  40                               NASGN
 45         R                                     100        MSNSX-MAINT.
 46  48 1  Z   100  45                                          PARAMETERS
 49         R                                     10         MISSN-NO. OF
 50  53 1  Z    10  49                                             MISSIONS
 54         R                                     3          STOPS-NO. OF
 55       2 Z    9  49   9  54  /4                           STOPS ON ROUTE
 56       2 Z    9  49   9  54  /2                           FLYING TIMES
 57       2 Z    9  49   9  54  /4                           ATTRITION PLLC
 58         R                                     10         MPOLY-NO. OF
 59  61 1  Z    10  58                                             POLICIES
 62         R                                     50         RS-NO. OF
 63  64 1  Z    50  62                                            RESOURCES
 65       2 Z    5  36  50  62
 66         R                                     150        MREQS-NO. OF
 67  68 1  Z   150  66                                        MAINT REQ'MTS
 69       2 Z  100  45  10  58                               SREQ
 70         R                                     50         RSREQ-NO. OF
 71  72 1  Z    50  70                                          RES. REQ'MTS
```

```
 73      2  Z  150   66   10   58                                        MREQ
 74         R                                              3             WLEVL-NO. OF
 75      2  Z    7   36    2   74   /4                                   WEATHER LEVELS
 76      2  Z    7   36    2   74   /2                                   PROBABILITIES
 77         R                                              100           OBS-NO. OF
 78      1  Z  100   77                                                   DISTRIBUTIONS
 79         R                                              200           OBA-NO. OF
 80      1  Z  200   79                                                   TOTAL ENTRIES
 81   82    Z
 83         R                                              16
 84      1 R    16   83                                    30(I2)        EXOGS-EXOG.
CCC001CC0002000000003040506070809                                         EVENT NO'S.
 85      1  Z   10   49
 86   88    Z
 89         R                                              1.             PROG. REPORT
 90      1  Z   12   30                                                   FSET7
 91      2  Z    3   40   12   30                                         MAXPT
 92      2  Z   10   49   12   30                                         MNEED
 93         R                                              13            DELTE
 94      1 R    13   93                                    12(A6)         BCONM
ABORT ASSIGNCKATN DIST  MAKEUPMPOLCYPREMT RPOOL SCHEDASTANDGWORKOYWRCHG
CFTSY
 95      1 R    13   93            1/2                     14(I5)         USEDG
  0     0     0     0     0     0     0     0     0     0     0     0     0
 95      1 R    13   93            2/2                     14(I5)         CORUS
 168  335  484  125  307  116  542  144  212  361  281  258  190
 96          Z                                                           NRTS
 97          R                                             2             NRTSP
 98   99 1  Z    2   97                                                   ATTRIBUTES
 100         R                                             7             STORG
 101     1 R     7 100                                     14(I5)         STORH
 6165 487816319    0     0 139832768
 102         R                                             4             OUTP1
 103     1 R     4 102                                     12(A6)         OUTP2
 MIN   MAX   AVG   TOT
 104         R                                             16            OUTP3
 1C5     1 R    16 104                                     12(A6)         OUTP4
 WORK  D/NA  IDLE  LAUNCHLANDEDLOST  COMBATABORT OPERATWEATHRTOTAL FLYABL
 ALERT READY MAINT AIR
 106     2  Z    5   34   12   30
 107     1  Z  100   77                                                  BLANK CARD
  1                      PLACE INPUT DATA BEHIND THIS CARD
                                                                         BLANK CARD
  19999
$IBSYS
$IBJOB SAMSOM   NOSOURCE,IOOP1
$RELOAC         U07,NAME=SAMSOM,SRCH
1          58                   11      4     15
$IBSYS
$IBJOB EDIT
$RELOAD         U07,NAME=EDIT,SRCH
                     AUXILIARY TAPE INPUT CARD
$IBSYS
$IBJOB OUTPUT   NOSOURCE
$RELOAD         U07,NAME=OUTPUT,SRCH
1         144                     14
X                     PLACE OUTPUT REQUESTS BEHIND THIS CARD
                                                                         BLANK CARD
$IBSYS
$CLOSE          S.SU06,REMOVE
$CLOSE          S.SU07,REMOVE
$IBSYS          ENDJOB        TOTAL NUMBER OF CARDS IN YOUR INPUT DECK
```

Table 4

SAMSOM II INPUT PROGRAM ERROR MESSAGES

No.	Sub-routine	Description	Call Argument
1	MASTER	Invalid form number.	(1,Form#,0,0) I3
2	FØRM4	Attrition probability sum greater than 1.	(2,PB,0,0) D1.3
3	FØRM4	Illegal replacement code for attrition policy.	(3,Code,0,0) I3
4		Error number 4 has not been used.	
5	FØRM7	Too many distributions, redefine DBA.	(5,0,0,0)
6	FØRM7	Distribution defined twice.	(6,DB#,0,0) I3
7	FØRM7 FØRM5	Too many distributions. (Repeat time), redefine DBS.	(7,0,0,0)
8	FØRM7	Distribution sum not equal to 1.	(8,DB,Sum,0) I3 D1.3
9	FØRM5	First Launch Service time is less than 0.	(9,0,0,0)
10	FØRM3	Time for week to go into effect left off first card.	(10,0,0,0)
11	FØRM3	Cannot recognize resource kind.	(11,Kind,0,0) A2
12	FØRM3	Resource type omitted.	(12,Kind,0,0) A2
13	FLITE	Distribution for time between sorties equals 0.	(13,Mission,DB,0) A6 I3
14	FØRM3	Hour policy goes into effect left off first card.	(14,0,0,0)
15	FØRM3	There are not 24 hours in the flying day.	(15,0,0,0)
16	FØRM3	Number of times to repeat flying day omitted.	(16,0,0,0)
17	FØRM3	Invalid make-up policy.	(17,Policy,0,0) I3
18	ENDSM	Routing unspecified for a mission.	(18,Mission,0,0) A6
19	FØRM3	There are not 24 hours in the working day.	(19,0,0,0)
20	FØRM3	Times to repeat flying day omitted.	(20,0,0,0)

Table 4 -- Continued

No.	Sub-routine	Description	Call Argument
21	FØRM3	Too many distributions (quantity on shift), redefine DBS.	(21,0,0,0)
22	FØRM3	There are not 7 working days in week.	(22,0,0,0)
23	FØRM2	Attrition policy associated with take-off base.	(23,0,0,0)
24	FØRM3	No base for working week.	(24,0,0,0)
25	FØRM3	No resources for working week.	(25,0,0,0)
26	WRCHG	Distribution for weather duration equals 0.	(26,DB,Base,0) I3 A6
27	FØRM1	Weather levels are not in consecutive order.	(27,0,0,0)
28	FØRM1	Probability of weather level equals 0.	(28,0,0,0)
29	FØRM1	Too many weather levels, must reinitialize WLEVL.	(29,0,0,0)
30	FØRM1	No distribution for weather level.	(30,0,0,0)
31	FØRM1	Too many distributions (weather level), redefine DBS.	(31,0,0,0)
32	FØRM1	Sum of weather probabilities not equal to 1.	(32,Sum,0,0)
33	FØRM1	No base for weather.	(33,0,0,0)
34	FØRM1	No weather levels.	(34,0,0,0)
35	FINDS	Too many missions, redefine MISSN.	(35,0,0,0)
36	FINDS	Too many PTs, redefine RS.	(36,0,0,0)
37	FØRM1	A base defined twice.	(37,Base,0,0) A6
38	FINDS	Too many bases, redefine BASE.	(38,0,0,0)
39		This number unused at time of publication.	
40	ENDSM	Mission not defined.	(40,Mission,0,0) A6
41	FØRM1	No quantity for an aircraft assignment.	(41,0,0,0)
42	FINDS	Too many ETs (equip), redefine RS.	(42,0,0,0)
43	ENDSM	Undefined distribution.	(43,DB,0,0) I3
44	FINDS	Too many PAs (parts), redefine RS.	

Table 4 -- Continued

No.	Sub-routine	Description	Call Argument
45	FØRM3	Not seven days in flying week.	(45,0,0,0)
46		This number unused at time of publication.	
47	FØRM3	No mission for flying week.	(47,0,0,0)
48	FØRM2	More than 1 routing given for a mission.	(48,Mission,0,0) A6
49	FØRM2	Aircraft type omitted for mission description.	(49,0,0,0)
50	FØRM5	Aircraft type omitted for alert.	(50,0,0,0)
51	FØRM1	Aircraft type omitted for aircraft assignment.	(51,0,0,0)
52	ENDSM	Aircraft type not defined.	(52,A/C type,0,0) A6
53		This number unused at time of publication.	
54	FØRM5	Too many distributions (sortie size), redefine DBS.	(54,0,0,0)
55	FØRM5	Maximum sortie size less than minimum sortie size.	(55,0,0,0)
56	FØRM5	Maximum sortie size equals 0.	(56,0,0,0)
57	FØRM2	Illegal code for pool to fly from.	(57,Code,0,0) I3
58	FØRM5	Launch-Service upload time for alert A/C.	(58,0,0,0)
59	FØRM2	No flying time given for a loiter mission.	(59,0,0,0)
60	FØRM2	Too many distributions (flying hours), redefine DBS.	(60,0,0,0)
61	FINDS	Too many aircraft, redefine TYPAC.	(61,0,0,0)
62	FØRM2	No mission for routing.	(62,0,0,0)
63	FØRM2	No bases for routing.	(63,0,0,0)
64	FØRM2	Last base should have no flying time to next base.	(64,0,0,0)
65	FØRM2	Mission defined twice.	(65,Mission,0,0) A6
66	FINDS	Too many attrition policies, redefine MPØLY.	(66,0,0,0)
67	FØRM2	Too many distributions (air speed), redefine DBS.	(67,0,0,0)

Table 4 -- Continued

No.	Sub- routine	Description	Call Argument
68	ENDSM	No aircraft at base for mission.	(68,Base,Mission,0) A6 A6
69	ENDSM	An attrition policy not defined.	(69,Policy,0,0)
70	ENDSM	An attrition policy is not used.	(70,Policy,0,0)
71	ENDSM	A distribution is not used.	(71,DB,0,0) I3
72	FØRM6	Too many distributions (duration), redefine DBS.	(72,0,0,0)
73	FØRM6	Wrong maintenance type.	(73,Type,0,0) A4
74	FØRM6	Probability of system failing equals 0.	(74,0,0,0)
75	FØRM6	Bad sequence code.	(75,Code,0,0) I3
76	FØRM6	Cannot recognize kind of resource.	(76,Kind,0,0) A2
77	FØRM8 FØRM6	Too many distributions (resource quantity), redefine DBS.	(77,0,0,0)
78	FØRM6	Probability of resource requirement equals 0.	(78,0,0,0)
79	FØRM6	No resource requirements for maintenance requirements.	(79,0,0,0)
80	FINDS	Too many systems, redefine SYSTM.	(80,0,0,0)
81	FØRM6	Bad maintenance description parameters.	(81,0,0,0)
82		This number unused at time of publication.	
83	STAND	Time to repeat standing failures equal 0.	(83,0,0,0)
84	FØRM2	No aircraft type for standing failures.	(84,0,0,0)
85	FØRM2	Too many distributions, redefine DBS.	(85,0,0,0)
86	FØRM2	Probability of failure equals 0.	(86,0,0,0)
87	FØRM6	Too many maintenance requirements, redefine MREQS.	(87,0,0,0)
88	FØRM6	Too many missions -- state entries, redefine MSNSX.	(88,0,0,0)
89	FØRM2	Too many stops on route, redefine STØPS.	(89,0,0,0)
90	LIST	Too much maintenance, redefine MPØLY.	(90,0,0,0)
91	FØRM6	No system number.	(91,0,0,0)

Table 4 -- Continued

No.	Sub-routine	Description	Call Argument
92	ENDSM	NRTS policy used but undefined.	(92,0,0,0)
93	ENDSM	NRTS policy defined but unused.	(93,0,0,0)
94	FINDS	Too many NRTS policies, redefine NRTSP.	(94,0,0,0)
95	FØRM8	Bad maximum PT card.	(95,0,0,0)
96	FØRM8	Bad conflicting systems card.	(96,0,0,0)
97	FØRM8	Bad NRTS policy card.	(97,0,0,0)
98	ENDSM	No routing for mission.	(98,Mission,0,0) A6
99	FINDS	Undefined base.	(99,Base,0,0) A6
100	FINDS	Undefined aircraft type.	(100,Aircraft,0,0) A6
101	FINDS	Undefined mission.	(101,Mission,0,0)
102	ENDSM	Resource not where needed.	(102,Kind,Type,Base) A2 A3 A6
103	ENDSM	Divert mission leaves from incorrect base.	(103,Mission,Base,Base) Bad Good A6 A6 A6
104	ENDSM	Maximum PT too small.	(104,A/C,Maint,MaxPT)
105	ENDSM	Mission flies from ready pool since Launch Service given.	(105,Mission,0,0)
106	FØRM6	Too many resource requirements, redefine RSREQ.	(106,#Resources,1,0)
107	FØRM7	Distribution probabilities out of order.	(107,DBN,Value)

Table 5

INPUT PROGRAM INITIALIZATION VARIABLES

Entity Name	Initial Value[a]	Inputs that Entity Limits	Entity No.[b]	If Changed, Also Change These Cards
SYSTM	10	No. of systems	28	29 (R, Col. 18)
BASE	5	No. of bases	36	37-39 (R, Col. 18) 41 (R, Col. 18) 44 (R, Col. 18) 65 (R, Col. 18) 75 (R, Col. 18) 76 (R, Col. 18)
TYPAC	3	No. of A/C types	40	42-43 (R, Col. 18) 44 (R, Col. 26) 91 (R, Col. 18)
MSNSX	100	No. of unique combinations of (BASE/MISSION/MAINT TYPE/ SYSTEM)	45	46-48 (R, Col. 18) 69 (R, Col. 18)
MISSN	10	No. of missions	49	50-53 (R, Col. 18) 55 (R, Col. 18) 56 (R, Col. 18) 57 (R, Col. 18) 85 (R, Col. 18) 92 (R, Col. 18)
STOPS	3	No. of stops/mission	54	55 (R, Col. 26) 56 (R, Col. 26) 57 (R, Col. 26)
MPOLY	10	No. of attrition policies No. of MREQS/MSNSX No. of RESRQ/MREQS	58	59-61 (R, Col. 18) 69 (R, Col. 26) 73 (R, Col. 26)
RS	50	No. of resources	62	63-64 (R, Col. 18) 65 (R, Col. 26)
MREQS	150	No. of maintenance requirements (tasks)	66	67-68 (R, Col. 18) 73 (R, Col. 18)
RSREQ	50	No. of resource requirements (resource kind and type, probability of need, duration, quantity)	70	71-72 (R, Col. 18)
WLEVL	3	No. of weather levels/base	74	75 (R, Col. 26) 76 (R, Col. 26)
DBS	100	No. of distribution tables	77	78 (R, Col. 18) 107 (R, Col. 18)
DBA	200	Total no. of points in all tables	79	80 (R, Col. 18)
NRTSP	1	No. of NRTS policies	97	98-99 (R, Col. 18)

[a]These values are only a suggested initialization. They may be varied to accommodate particular runs.

[b]When changing the values for these entities (cards) the value must be left-punched (left-adjusted) in Col. 50.

Appendix B

SUGGESTED INPUT FORMS AND REQUIRED FORMATS

Appendix B includes a suggested copy of all eight input forms. The forms are suggested but the user may want to use a general card format without headings or substitute his own set of headings. If a general card format is used, all appropriate entries for all columns must be as shown on the forms in this Appendix. In addition, these forms contain summary information and cross-references (Forms and Columns entries) to help the user prepare a complete set of inputs for simulating an operation with SAMSOM II. Note that the inputs on Input Forms 1 through 8 will not provide outputs from the simulation. Outputs are obtained by using the Output Request Forms or comparable output request cards shown in Appendix D.

The following symbols have been given common meanings on all input forms as follows:

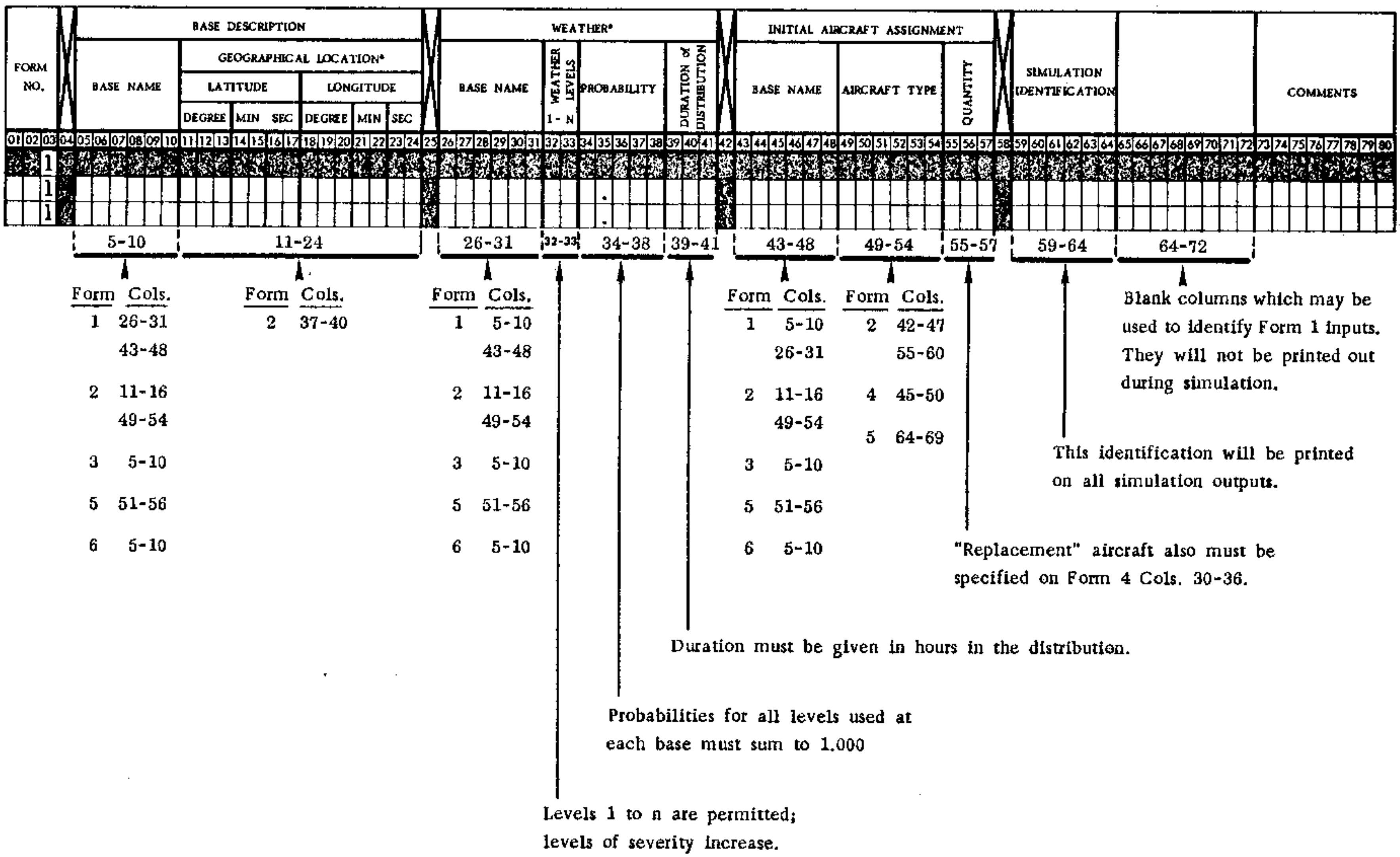
1. An asterisk (*) always denotes that the given column, field, identity, or set of inputs is optional in the model or within the given aggregation of inputs.
2. A minus sign (-) in the lower left-hand corner of a field denotes that a distribution may be used for the entry: (a) if it is given a number and (b) if it is preceded by a minus sign. The program recognizes only this symbol as an instruction to "go-to distribution n" for the appropriate value.

The following abbreviations have been given common meanings on all input forms as follows:

1. NO. means number.
2. MIN means minute.
3. MAX means maximum.
4. PT means personnel.
5. ET means equipment or facilities.
6. PA means parts.
7. TD means time delay.
8. HR means hour.
9. MN means minimum.
10. QTY means quantity.
11. DBN means distribution.

Blanked-out rows (row 1 for each input form) and columns are meaningful. The only entries permitted in these spaces are the input form number for each set of inputs. Columns 73 through 80 contain comments or remarks and are not part of the simulation. They will not be printed on any outputs.

Bases, aircraft types, and missions should be consistently identified and defined in their respective fields and columns on all forms. However, maintenance activities (ABØRT, ALERT, PERØD, PØSTFT and STAND) identified in the mission field on Input Form 6 are not "missions" which have to be identified on other forms.


FORM NO.
BASE DESCRIPTION
BASE NAME
GEOGRAPHICAL LOCATION*
LATITUDE
LONGITUDE
DEGREE MIN SEC
DEGREE MIN SEC
WEATHER*
BASE NAME
WEATHER LEVELS 1 - N
PROBABILITY
DURATION of DISTRIBUTION
INITIAL AIRCRAFT ASSIGNMENT
BASE NAME
AIRCRAFT TYPE
QUANTITY
SIMULATION IDENTIFICATION
COMMENTS
5-10
11-24
26-31
32-33
34-38
39-41
43-48
49-54
55-57
59-64
64-72
Form Cols.
1 26-31
43-48
2 11-16
49-54
3 5-10
5 51-56
6 5-10
Form Cols.
2 37-40
Form Cols.
1 5-10
43-48
2 11-16
49-54
3 5-10
5 51-56
6 5-10
Form Cols.
1 5-10
26-31
2 11-16
49-54
3 5-10
5 51-56
6 5-10
Form Cols.
2 42-47
55-60
4 45-50
5 64-69
Blank columns which may be used to identify Form 1 inputs. They will not be printed out during simulation.
This identification will be printed on all simulation outputs.
"Replacement" aircraft also must be specified on Form 4 Cols. 30-36.
Duration must be given in hours in the distribution.
Probabilities for all levels used at each base must sum to 1.000
Levels 1 to n are permitted; levels of severity increase.

Section	Field	Card columns
FORM NO.		01–03 (2)
MISSION ROUTING	MISSION LIST	05–10
	BASE LIST	11–16
	FLYING TIME	17–23
	ATTRITION POLICY*	24–26
MISSION DESCRIPTION	MISSION NAME	28–33
	PRIORITY*	34
	MAX. Launch weather	35
	AIR SPEED*	37–40
	STATUS POOL*	41
	AIRCRAFT TYPE	42–47
STANDING FAILURE*	BASE NAME	49–54
	AIRCRAFT TYPE	55–60
	FAILURE: CHECK PERIOD	61–67
	FAILURE: PROBABILITY	68–72
COMMENTS		73–80

5-10

Form	Cols.
3	40-45
4	31-36
	38-43
5	5-10
6	11-16

11-16

Form	Cols.
1	5-10
	26-31
	43-48
3	5-10
5	51-56
6	5-10

24-26

Form	Cols.
4	5-14

28-33

Form	Cols.
3	40-45
4	31-36
	38-43
5	5-10
6	11-16

34 — Form 5 Cols. 51-72

35 — Form 1 Cols. 26-41

37-40 — Form 1 Cols. 11-24

41 — Form 5 Cols. 51-72

42-47

Form	Cols.
1	49-54
4	45-50
5	64-69
8	5-10

49-54

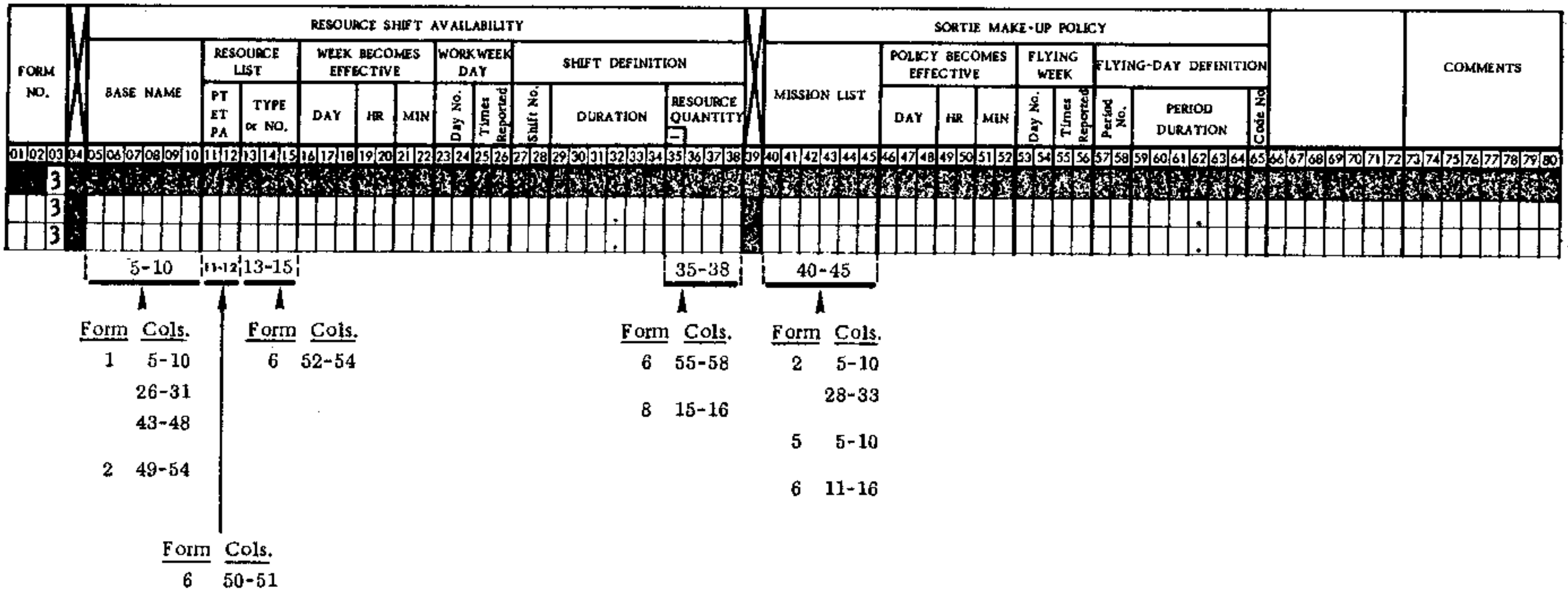
Form	Cols.
1	5-10
	26-31
	43-48
3	5-10
5	51-56
6	5-10

55-60

Form	Cols.
1	49-54
4	45-50
5	64-69
8	5-10

NOTE ON COLUMNS 49-72

If used, care should be taken to provide appropriate maintenance inputs on Form 6.



These inputs should be carefully cross-referenced with the sortie schedules provided on Form 5.

FORM NO.		ATTRITION AND AIR ABORT CONSTRAINTS*										INSPECTION AND GROUND ABORT POLICY*					COMMENTS
		POLICY NO.	POLICY BECOMES EFFECTIVE			ATTRITION AND AIR ABORT PROBABILITIES			REPLACEMENT POLICY		MISSION FAILURE POLICY		AIRCRAFT TYPE	INSPECTIONS		GROUND ABORT RATE		
			DAY	HR	MIN	COMBAT DAMAGE	LOST AIRCRAFT	AIR ABORT	Code No	REPLACEMENT MISSION	Reached Code	DIVERSION MISSION		PERIODIC	POST FLIGHT			
01-03	04	05-07	08-10	11-12	13-14	15-19	20-24	25-29	30	31-36	37	38-43	45-50	51-54	55-58	59-63	64-72	73-80
4						.	.	.								.		
4						.	.	.								.		

Columns	Form	Cols.
5-7	2	24-26
15-19	6	17-20
31-36	1	5-10
		43-57
	2	5-10
		28-33
38-43	2	5-10
		28-33
	6	17-20
45-50	1	49-54
	2	42-47
		55-60
	5	64-69
	8	5-10
51-54	6	11-16, ff. cols.
	8	34-49
55-58	6	11-16, ff. cols.
	8	34-49
59-63	5	5-31
	6	11-16, ff. cols.

FORM NO. (01–03)		SORTIE SCHEDULES AND REQUIREMENTS														ALERT SCHEDULE							COMMENTS (73–80)
		MISSION	LAUNCH TIME			SORTIE CYCLES*				LAUNCH SERVICE LEAD TIME*	SORTIE LAUNCH PROBABILITY	SORTIE ELEMENT SIZE				BASE NAME	SCHEDULE BEGINS			AIRCRAFT TYPE	QUANTITY ON ALERT		
			DAY	HR	MIN	CYCLE INTERVAL	DISCONTINUE CYCLE DAY	DISCONTINUE CYCLE HR	DISCONTINUE CYCLE MIN			MN	–	MAX			DAY	HR	MIN				
01 02 03	04	05–10	11–13	14–15	16–17	18–24 (– at 18)	25–27	28–29	30–31	32–37	38–42	43–45	46	47–49	50	51–56	57–59	60–61	62–63	64–69	70–72		73–80
5																							
5						.				.	.												
5						.				.	.												

5-10

Form	Cols.
2	5-10
	28-33
3	40-45
6	11-16

38-42

Form	Cols.
3	40-65

43-49

Form	Cols.
2	17-23
3	40-64
4	37-43

51-56

Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	41-54
3	5-10
6	5-10

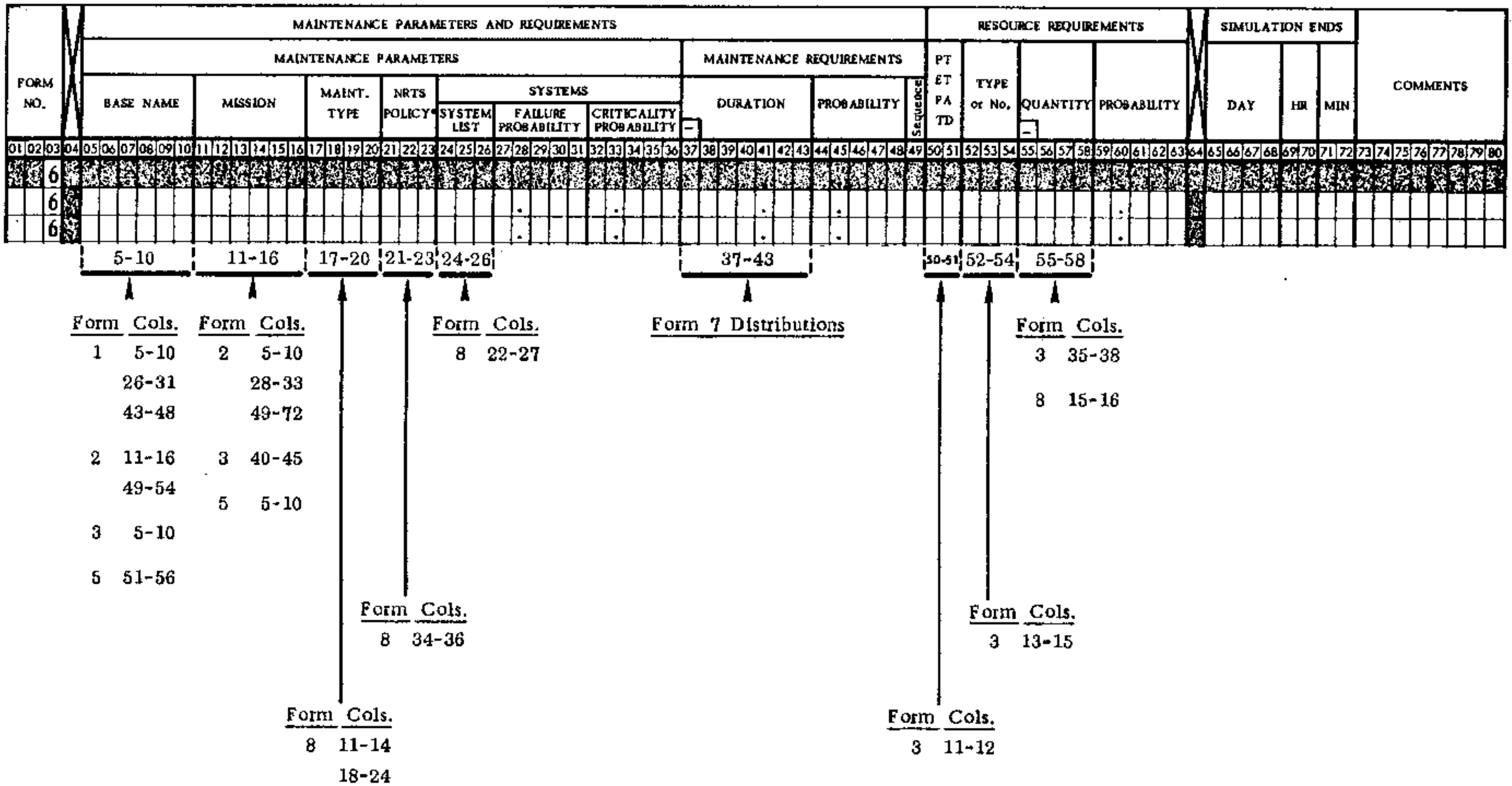
64-69

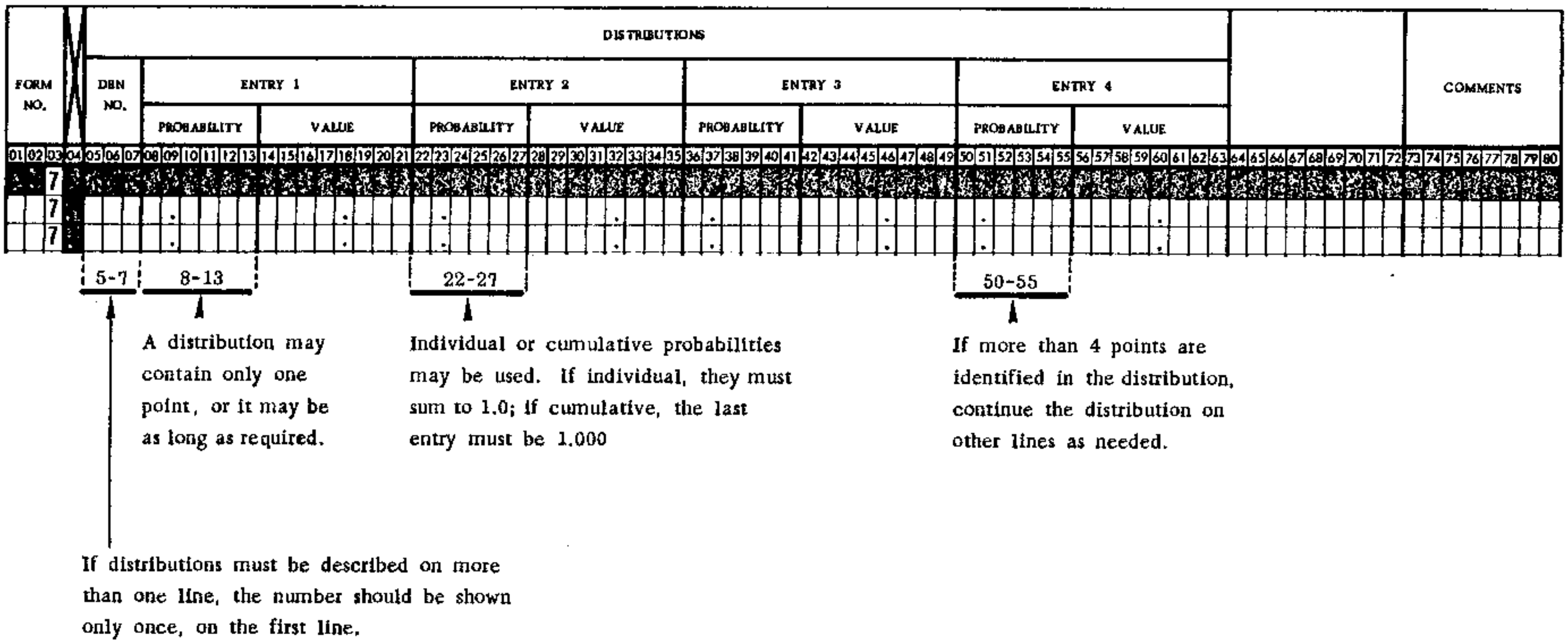
Form	Cols.
1	49-54
2	42-47
	55-60
4	45-50
8	5-10

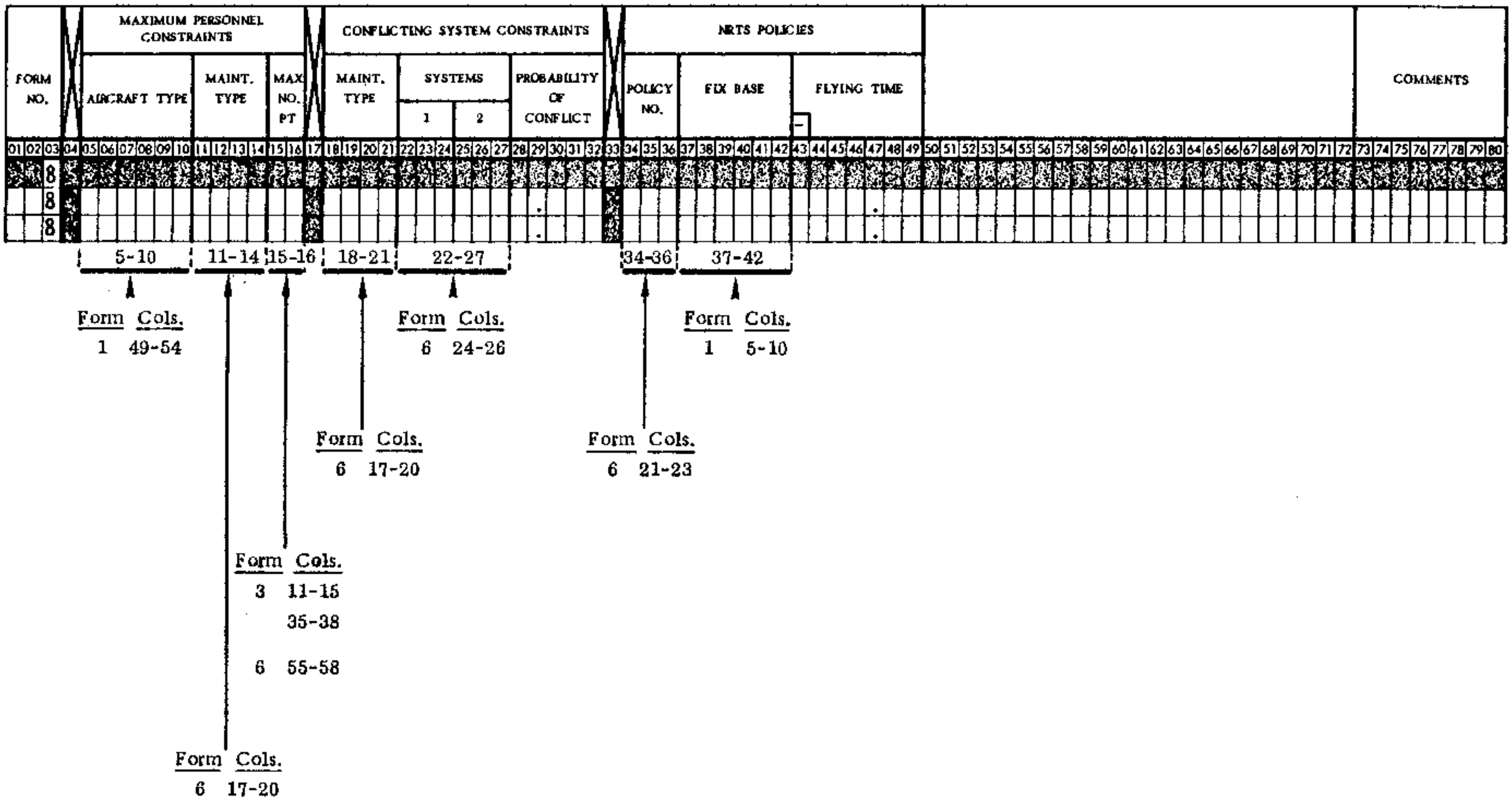
70-72

Form	Cols.
2	34
	41

NOTE: These inputs should be carefully cross-referenced with the sortie make-up policy provided on Input Form 3.


MAINTENANCE PARAMETERS AND REQUIREMENTS
MAINTENANCE PARAMETERS
MAINTENANCE REQUIREMENTS
RESOURCE REQUIREMENTS
SIMULATION ENDS
FORM NO.
BASE NAME
MISSION
MAINT. TYPE
NRTS POLICY*
SYSTEMS
SYSTEM LIST
FAILURE PROBABILITY
CRITICALITY PROBABILITY
DURATION
PROBABILITY
Sequence
PT ET PA TD
TYPE or No.
QUANTITY
PROBABILITY
DAY
HR
MIN
COMMENTS
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
6
6
6
5-10
11-16
17-20
21-23
24-26
37-43
50-51
52-54
55-58
Form Cols.
1 5-10
26-31
43-48
2 11-16
49-54
3 5-10
5 51-56
Form Cols.
2 5-10
28-33
49-72
3 40-45
5 5-10
Form Cols.
8 11-14
18-24
Form Cols.
8 34-36
Form Cols.
8 22-27
Form 7 Distributions
Form Cols.
3 11-12
Form Cols.
3 13-15
Form Cols.
3 35-38
8 15-16

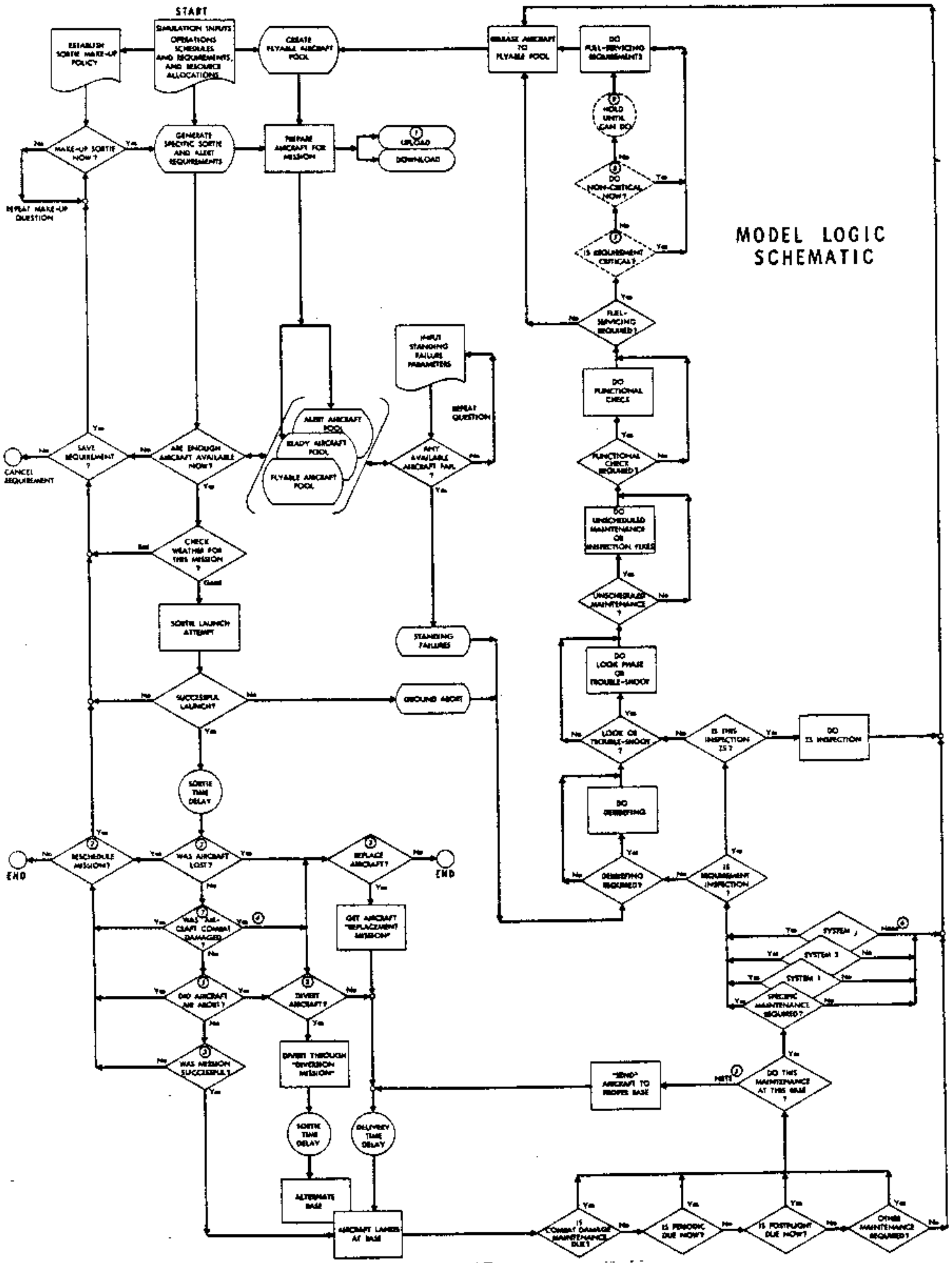

FORM NO.
DISTRIBUTIONS
DBN NO.
ENTRY 1
ENTRY 2
ENTRY 3
ENTRY 4
PROBABILITY
VALUE
COMMENTS
5-7
8-13
22-27
50-55
A distribution may contain only one point, or it may be as long as required.
Individual or cumulative probabilities may be used. If individual, they must sum to 1.0; if cumulative, the last entry must be 1.000
If more than 4 points are identified in the distribution, continue the distribution on other lines as needed.
If distributions must be described on more than one line, the number should be shown only once, on the first line.


FORM NO.
MAXIMUM PERSONNEL CONSTRAINTS
AIRCRAFT TYPE
MAINT. TYPE
MAX NO. PT
CONFLICTING SYSTEM CONSTRAINTS
MAINT. TYPE
SYSTEMS
1
2
PROBABILITY OF CONFLICT
NRTS POLICIES
POLICY NO.
FIX BASE
FLYING TIME
COMMENTS
8
8
8
5-10
11-14
15-16
18-21
22-27
34-36
37-42
Form Cols.
1 49-54
Form Cols.
6 24-26
Form Cols.
1 5-10
Form Cols.
6 17-20
Form Cols.
6 21-23
Form Cols.
3 11-15
35-38
6 55-58
Form Cols.
6 17-20

Appendix C

MODEL LOGIC SCHEMATIC

Appendix C is a summary flow diagram or schematic depicting the model's major elements and interrelationships. It summarizes the basic logic and elements, and should help the user understand the purpose and intent of the major routines. The diagram also shows how specific inputs fit into the overall model logic, and how selected outputs are related to simulation procedures. It should not be interpreted as a complete, unambiguous program flow diagram. See Sec. III for a discussion of appropriate schematic interpretations.



(1) Upload and download actions are launch-service activities performed as required to meet specific alert or mission requirements.
(2) If lost, damaged, or aborted aircraft cause mission failures (single-sortie missions), they may be rescheduled. Replacements and diverted aircraft are not affected by sortie element/mission relationships.
(3) All four events are mutually exclusive. One will be selected by random number "drawn" from a table providing the probability of each event.
(4) Combat damaged aircraft may be diverted and replaced.
(5) NRTS applies to maintenance types (UM, IS, CDTS, FC, etc.) only.
(6) Specific maintenance requirements are determined system by system within each kind and type of maintenance. Even given high failure probabilities, some aircraft may not "break".
(7) Criticality question is asked for all maintenance requirements, not just for fuel servicing.
(8) Unless pre-empted by priority missions, non-critical requirements will be worked off as soon as possible after critical requirements.
(9) Aircraft may be flown with non-critical requirements which will be done at first opportunity.

Appendix D

OUTPUT REQUEST FORMS AND OUTPUT FORMATS

Appendix D includes a suggested copy of output request cards numbered 1 through 11, and the corresponding simulation output or report formats. General precautions concerning format requirements and alternative input forms discussed in Appendix B are appropriate for all output request cards. Symbols and abbreviations are the same for both sets of forms. The format samples contain summary information to help users avoid errors and understand the relationships between the cards and their corresponding reports. The output request cards list the input forms providing the appropriate names or other information for completing the different fields. Sample reports show the transaction-tape record numbers that are the source of the statistics reflected in the report.

All output request cards are optional. Any or all may be used to obtain simulation results from the transaction tape generated during the simulation. Different aggregations of output or additional output may be obtained from the tape if: (1) the data are recorded thereon now, or (2) the user wishes to amend the execution and output programs to create the required statistics. Therefore, neither these output formats nor the sample simulation shown in Appendix E are meant to exhaust output possibilities. They reflect the output currently available from the basic SAMSOM II programs.

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	BASE NAME	BASE NAME	BASE NAME	BASE NAME	BASE NAME	BASE NAME	SIMULATION IDENTIFICATION		COMMENTS
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN										
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41	42 43 44 45 46 47	48 49 50 51 52 53	54 55 56 57 58 59	60 61 62 63 64 65	66 67 68 69 70 71	72	73 74 75 76 77 78 79 80
1																			
1																			
1																			
1																			
1																			
1																			
1																			
1																			
1																			
1																			
1																			
1																			

24-65

Input

Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	49-54
3	5-10
5	51-56
6	5-10

66-71

Input

Form	Cols.
1	59-64

Operations Summary Output Request Card

OPERATIONS SUMMARY

SIMULATION –

	TOTAL SORTIES SCHEDULED OR REQUIRED		SORTIES SCHEDULED AND MADE		SORTIES SCHEDULED, NOT MADE AND CANCELED		SORTIES SCHEDULED, NOT MADE AND SAVED		SORTIES SAVED AND MADE UP LATER		SORTIES SAVED, NOT MADE UP LATER AND CANCELED		TOTAL SORTIES MADE		TOTAL REPLACEMENT SORTIES	TOTAL RESCHEDULED SORTIES
BASE	MIN	MAX	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.		
PERIOD COVERED –		TO														
	Transaction Number 41		Transaction Number 39		Transaction Number 27		Transaction Numbers 24 and 26		Transaction Number 39		Transaction Numbers 27 and 28		Sum of "Sorties Scheduled and Made" and "Sorties Saved and Made Up Later"		Transaction Number 7	Transaction Number 8

MACHINE TIME

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	BASE NAME	BASE NAME	BASE NAME	BASE NAME	BASE NAME	BASE NAME	SIMULATION IDENTIFICATION		COMMENTS
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN										
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41	42 43 44 45 46 47	48 49 50 51 52 53	54 55 56 57 58 59	60 61 62 63 64 65	66 67 68 69 70 71	72	73 74 75 76 77 78 79 80
2																			
2																			
2																			
2																			
2																			
2																			
2																			
2																			
2																			
2																			
2																			
2																			

24-65

Input

Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	49-54
3	5-10
5	51-56
6	5-10

66-71

Input

Form	Cols.
1	59-64

Base Status Report Output Request Card

B A S E   S T A T U S   R E P O R T

PERIOD COVERED TO

BASE	MEAN	SIGMA	MIN	MAX	AVERAGE DURATION	FREQUENCY
FLYABLE						
READY						
GROUND ALERT						
AIRBORNE						
AWAITING MAINT.						
IN MAINT.						
TOTAL ADCP						
TOTAL NORM						

MACHINE TIME

Transaction Numbers used to determine Frequencies are also used to calculate these statistics associated with each of the different statuses and are identified on page 97 of the text.

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	AIRCRAFT TYPE	AIRCRAFT TYPE	AIRCRAFT TYPE	AIRCRAFT TYPE	AIRCRAFT TYPE	AIRCRAFT TYPE	SIMULATION IDENTIFICATION	NO PRINT	COMMENTS
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN										
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41	42 43 44 45 46 47	48 49 50 51 52 53	54 55 56 57 58 59	60 61 62 63 64 65	66 67 68 69 70 71	72	73 74 75 76 77 78 79 80
3																			
3																			
3																			
3																			
3																			
3																			
3																			
3																			
3																			
3																			
3																			
3																			

24-29

Input

Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	49-54
3	5-10
5	51-56
6	5-10

30-65

Input

Form	Cols.
1	49-54
2	42-47
	55-60
4	45-50
5	64-69
8	5-10

66-71

Input

Form	Cols.
1	59-64

Aircraft Status Report Output Request Card

```
-REPORT-                                  AIRCRAFT STATUS FOR BASE
--TIME--
DY HR MN   FYB ALR RDY MNT AIR TOT FYB ALR RDY MNT AIR TOT FYB ALR RDY MNT AIR TOT FYB ALR RDY MNT AIR TOT FYB ALR RDY MNT AIR TOT

AVERAGES

MACHINE TIME
```

FYB: Transaction Numbers 3, 13, 16-18, 35, 44

ALR: Transaction Numbers 19, 31, 37, 60, 68

RDY: Transaction Numbers 14, 17, 19, 29, 30, 34, 39, 44, 45, 61

MNT: Transaction Numbers 2, 11, 12, 16, 18, 20, 29-32, 35, 39, 45, 46, 62-64, 68

AIR: Transaction Numbers 2, 5, 39

TOT: Transaction Numbers 3, 5, 39

REPORT NUMBER	START TIME DAY	START TIME HR	START TIME MIN	REPORT EVERY DAY	REPORT EVERY HR	REPORT EVERY MIN	STOP TIME DAY	STOP TIME HR	STOP TIME MIN	BASE NAME	MISSION NAME	MISSION NAME	MISSION NAME	MISSION NAME	MISSION NAME	MISSION NAME	SIMULATION IDENTIFICATION	NO PRINT	COMMENTS
01-02	03-05	06-07	08-09	10-12	13-14	15-16	17-19	20-21	22-23	24-29	30-35	36-41	42-47	48-53	54-59	60-65	66-71	72	73-80
4																			
4																			
4																			
4																			
4																			
4																			
4																			
4																			
4																			
4																			
4																			
4																			

24-29

Input Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	49-54
3	5-10
5	51-56
6	5-10

30-65

Input Form	Cols.
2	5-10
3	40-45
4	31-36
	38-43
5	5-10
6	11-16

66-71

Input Form	Cols.
1	59-64

Sortie History Report Output Request Card

SORTIE HISTORY FOR BASE

-REPORT- --TIME-- DY HR MN	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH
	Transaction Number 39	Transaction Number 2	Transaction Number 5	Transaction Number 4	Transaction Number 6	Transaction Numbers 21, 24, 27, 28, 42	Transaction Numbers 26, 28, 42																					

TOTALS

MACHINE TIME =

REPORT NUMBER	START TIME			TRANSACTION NUMBER			STOP TIME			COMMENTS	SIMULATION IDENTIFICATION		COMMENTS
	DAY	HR	MIN	A	B	C	DAY	HR	MIN				
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24–65	66 67 68 69 70 71	72	73 74 75 76 77 78 79 80
5													
5													
5													
5													
5													
5													
5													
5													
5													
5													
5													
5													

10-16

Refer to Transaction Record Table
in Appendix G of Users Manual

66-71

Input

Form	Cols.
1	59-64

Verbal History Report Output Request Card

REPORT NUMBER (01–02)	START TIME DAY (03–05)	START TIME HR (06–07)	START TIME MIN (08–09)	TRANSACTION NUMBER A (10–12)	TRANSACTION NUMBER B (13–14)	TRANSACTION NUMBER C (15–16)	STOP TIME DAY (17–19)	STOP TIME HR (20–21)	STOP TIME MIN (22–23)	COMMENTS (24–65)	SIMULATION IDENTIFICATION (66–71)	X (72)	COMMENTS (73–80)
6													
6													
6													
6													
6													
6													
6													
6													
6													
6													
6													
6													

10-16

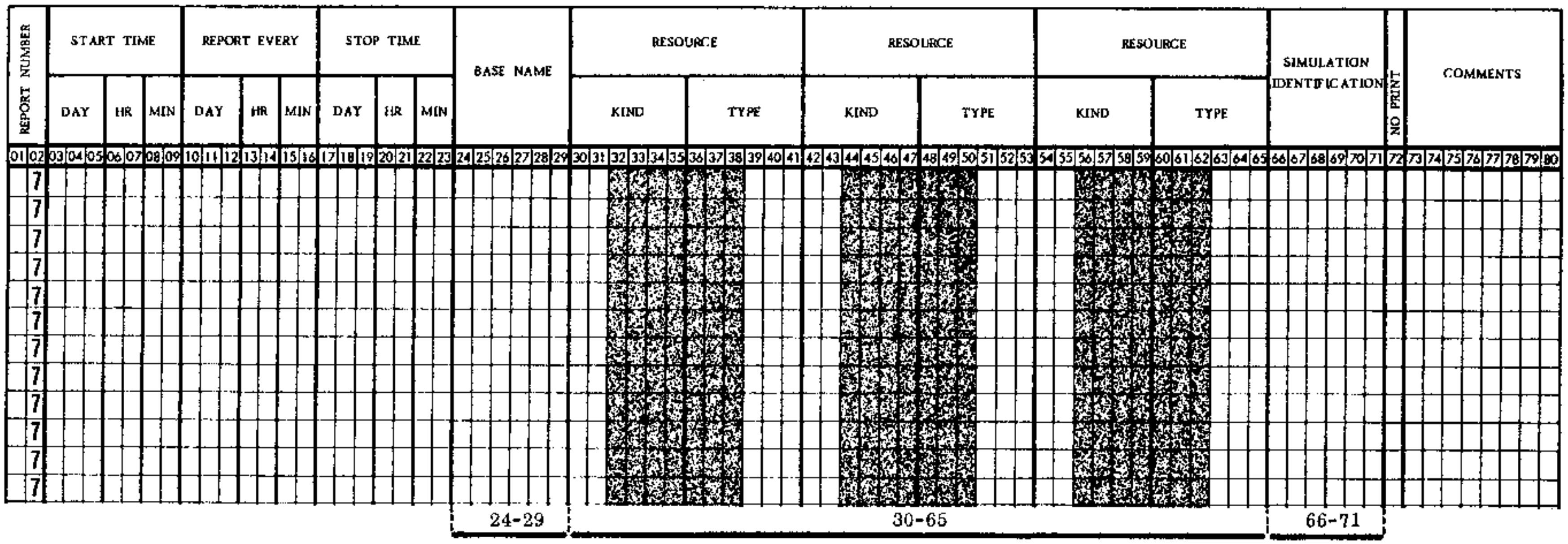
Refer to Transaction Record Table
In Appendix G of Users Manual

66-71

Input

Form	Cols.
1	59-64

Tape Dump Report Output Request Card



Input Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	49-54
3	5-10
5	51-56
6	5-10

Input Form	Cols.
3	11-12
	13-15
6	50-51
	52-54

Input Form	Cols.
1	59-64

Resource Report Output Request Card

```
-REPORT-                       RESOURCE REPORT FOR BASE
--TIME--    PT      1 -----  PT      3 -----  PT      6 -----  PT      7 -----  PT      2 -----  PT      4 -----  PT      5 -----
DY HR MN    WRK IDL TOT DNA  WRK IDL TOT DNA  WRK IDL TOT DNA  WRK IDL TOT DNA  WRK IDL TOT DNA  WRK IDL TOT DNA  WRK IDL TOT DNA
```

WRK: Transaction Numbers 50, 52, 59 ....

IDL: Transaction Numbers 50, 56, 59 ....

TOT: Transaction Number 59 ....

DNA: Transaction Numbers 49, 51, 58 ....

```
AVERAGES

MACHINE TIME =
```

REPORT NUMBER	START TIME			REPORT EVERY			STOP TIME			BASE NAME	AIRCRAFT TYPE	MISSION NAME	SYSTEM	MAINTENANCE TYPE	COMMENTS	SIMULATION IDENTIFICATION	NO PRINT	COMMENTS
	DAY	HR	MIN	DAY	HR	MIN	DAY	HR	MIN									
01 02	03 04 05	06 07	08 09	10 11 12	13 14	15 16	17 18 19	20 21	22 23	24 25 26 27 28 29	30 31 32 33 34 35	36 37 38 39 40 41	42 43 44 45 46 47	48 49 50 51 52 53	54 55 56 57 58 59 60 61 62 63 64 65	66 67 68 69 70 71	72	73 74 75 76 77 78 79 80
8																		
8																		
8																		
8																		
8																		
8																		
8																		
8																		
8																		
8																		
8																		
8																		

24-29		30-35		36-41		42-47		48-53		66-71	
Input Form	Cols.	Input Form	Cols.	Input Form	Cols.	Input Form	Cols.	Input Form	Cols.	Input Form	Cols.
1	5-10	1	49-54	2	5-10	6	24-26	6	17-20	1	59-64
	26-31	2	42-47	3	40-45	8	22-27	8	11-14		
	43-48		55-60	4	31-36				18-27		
2	11-16	4	45-50		38-43						
	49-54	5	64-69	5	5-10						
3	5-10	8	5-10	6	11-16						
5	51-56										
6	5-10										

Maintenance Report Output Request Card

MAINTENANCE REPORT FOR BASE

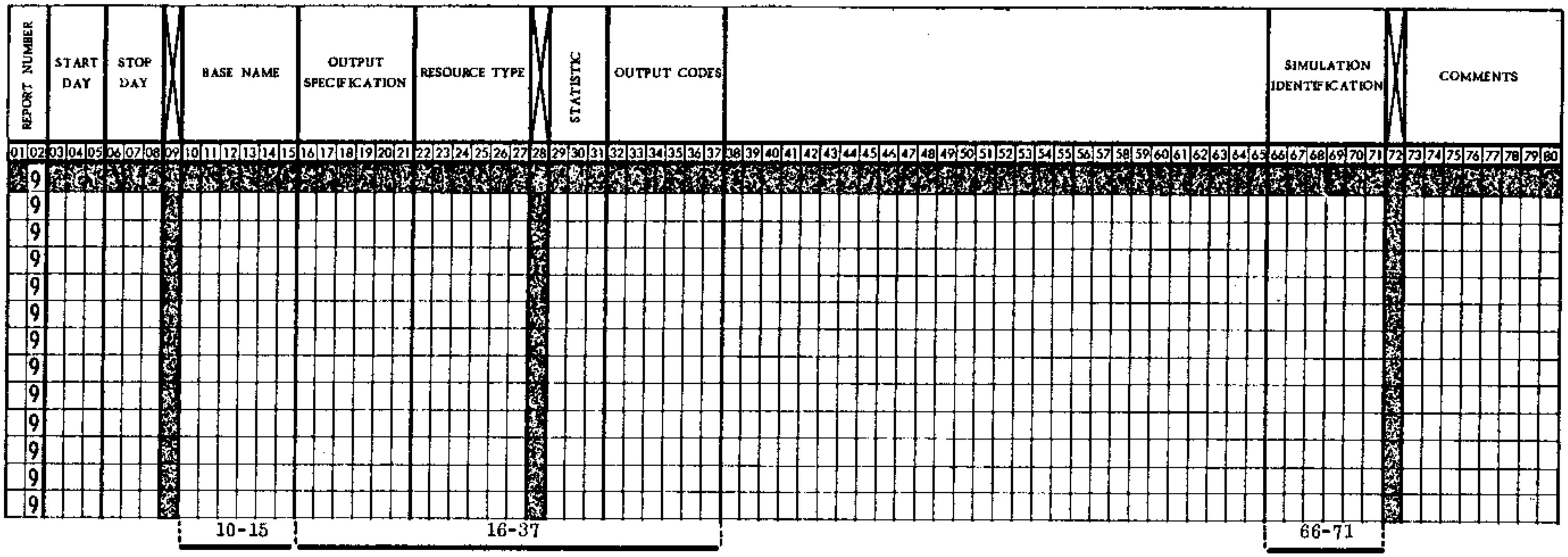
---TIME---	F5	F5	F5	F5	F5	F5	F5	F5	F5					
----OF----	ST2	STL	ST1	STL	ST2	STL	ST1	ST2	STL					
--REPORT--	SY ALL	SY ALL	SY SY1	SY SY2	SY SY2	SY SY2	SY ALL	SY ALL	SY ALL	SY				
	UM	UM	LS	LS	LS	LS	FS	FS	FS					
DAY HR MIN	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM	IN AM

Transaction Numbers 71, 73 ....

Transaction Numbers 69, 71, 73, 75 ....

AVERAGES

MACHINE TIME =



Input Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	49-54
3	5-10
5	51-56
6	5-10

Figure 9 -- Matrix Summary Codes, Specifications and Statistics, Section IV of the Users Manual.

Input Form	Cols.
1	59-64

Matrix Summary Output Request Card

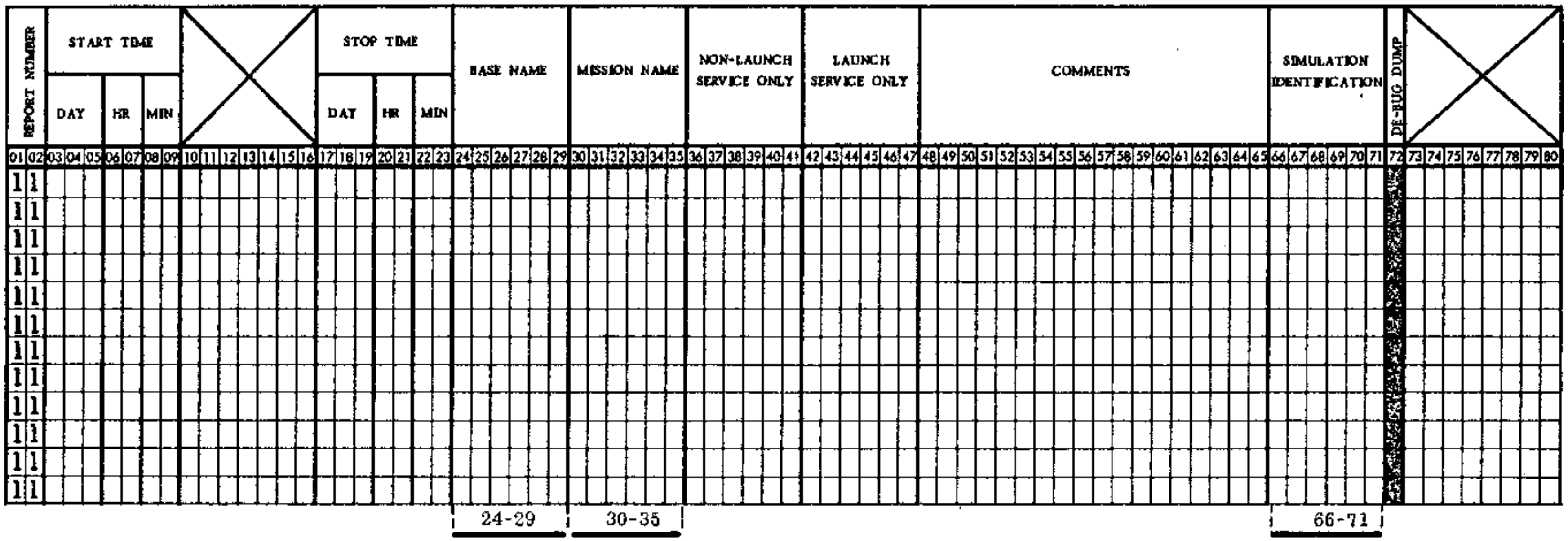
REPORT NUMBER	START TIME			(blocked)	STOP TIME			COMMENTS	SIMULATION IDENTIFICATION	(blocked)	COMMENTS
	DAY	HR	MIN		DAY	HR	MIN				
01-02	03-05	06-07	08-09	10-16	17-19	20-21	22-23	24-65	66-71	72	73-80
10											
10											
10											
10											
10											
10											
10											
10											
10											
10											
10											
10											

66-71

Input

Form	Cols.
1	59-64

Transactions Summary Output Request Card



Base Name (24-29):

Input Form	Cols.
1	5-10
	26-31
	43-48
2	11-16
	49-54
3	5-10
5	51-56
6	5-10

Mission Name (30-35):

Input Form	Cols.
2	5-10
3	40-45
4	31-36
	38-43
5	5-10
6	11-16

Simulation Identification (66-71):

Input Form	Cols.
1	59-64

Distribution Report Ouptut Request Card

```
MAKE 1     TOTAL TURN AROUND TIME DISTRIBUTION AT BASE  *SAMP  *  FOR MISSION  *ALL   *  FROM   0  0  0 TO   1  0  0

                    -----CLASS INTERVALS-----                      FREQ    CUM
                    DAYS  HOURS   DAYS  HOURS      FREQUENCY       PROB    PROB
```

THE DISTRIBUTION REPORT USES TRANSACTION NUMBERS:

2	30	50
11*	31	52
12*	32	56
16	35*	62
18*	40	63
20*	43	64
29	45	66
	46*	67
		68

*These transaction numbers put an aircraft into the NORM status for Launch Service Maintenance.

```
NUMBER OF REJECTED VALUES =            A VALUE IS REJECTED IF IT IS LESS THAN OR EQUAL TO ONE MINUTE

MEAN =                                      TOTAL ENTRIES =
STANDARD DEVIATION =
```

Appendix E

SAMSOM II SIMULATION ILLUSTRATION

The following listing of SAMSOM II simulation outputs is from a simple, but contrived, simulation designed to identify the most-used inputs and outputs. Some parts of the normal printout have been truncated to avoid redundancy.

Users may obtain a complete listing of the inputs and outputs using the input and output request cards included in the illustration. In fact, it is suggested that users employ the inputs in this illustration as an initial familiarization experiment. Other inputs for more complex simulations also should be available from RAND and Air Force users.

FORM	BASE DESCRIPTION BASE	BASE LOCATION LATITUDE DEG	LATITUDE MIN	LATITUDE SEC	LONGITUDE DEG	LONGITUDE MIN	LONGITUDE SEC	WEATHER BASES	WEATH LEVEL	PROB.	DISTRIBN FOR DURATION	A/C ASSIGNMENT BASE	A/C TYPE	QUANTITY TO ASSIGN	RUN IDENT
1	FORT1	0	0	0	0	0	0		0	0.000	0	FORT1	C130	48	OF1325

FORM	MISSION ROUTING MISSION	LAUNCH /LAND-BASES	HOURS TO NEXT-BASE	ATTRIT POLICY	MISSION DESCRIPTION MISSION	MISSION-PRIORITY	MAXIMUM LAUNCH WEATHER	AIR-SPEED	POOL TO FLY FROM	A/C TYPE	STANDING FAILURES BASE	A/C TYPE	HOURS BETWEEN CHECKS	PROBABILITY OF SINGLE AC FAILURE
2	DON1	FORT1	1.00	0	DON1	0	0	0	2	C130			0.00	0.000
2		FORT1	0.00	0		0	0	0	0				0.00	0.000

FORM	BASES	RESOURCES KIND	TYPE	RESOURCE SHIFTS: TIME WEEK BECOMES EFFECTIVE DAY	HR	MIN	DAYS: DAY NO.	TIMES TO REPEAT	SHIFTS: SHIFT NO.	DURATION (HOURS) OF SHIFT	QUANTITY ON SHIFT	MISSION	MAKE UP POLICIES: TIME WEEK BECOMES EFFECTIVE DAY	HR	MIN	DAYS: DAY NO.	TIMES TO REPEAT	PERIODS: PERIOD NO.	DURATION (HOURS) OF PERIOD	MAKE UP CODE
3	FORT1	PT	1	0	0	0	1	7	1	24.00	99	DON1	0	0	0	1	7	1	23.90	3
3	FORT1	PT	2	0	0	0	1	7	1	24.00	99		0	0	0	0	0	2	0.10	4
3	FORT1	PT	3	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	4	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	5	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	6	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	7	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	8	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	9	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	10	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	11	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	12	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	13	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	14	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	15	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	16	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	17	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	18	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0
3	FORT1	PT	19	0	0	0	1	7	1	24.00	99		0	0	0	0	0	0	0.00	0

FORM	POLICY —NO.—	—TIME— EFFECTIVE DY	HR	MIN	-PROBABILITY- —OF— COMBAT DAMAGE	PROBABILITY- OF A/C BEING —LOST—	PROBABILITY —OF— -AIR ABORT-	REPLACE —CODE-	REPLACE MISSION	RESCHED. —CODE—	DIVERT- MISSION	-A/C- -TYPE-	—HOURS— -BETWEEN PERIODICS	—HOURS— —BETWEEN— POSTFLIGHTS	GROUND -ABORT -RATE-
4	0	0	0	0	0.000	0.000	0.000	0		0		C130	150	0	0.000

(Columns FORM through DIVERT- MISSION: ATTRITION AND AIR ABORT POLICY; columns -A/C- -TYPE- through GROUND -ABORT -RATE-: A/C TYPE DESCRIPTION)

FORM	MISSION	—SORTIE— -LAUNCHED- —AT— DAY	HR	MIN	REPEAT -EVERY	—UNTIL— DAY	HR	MIN	DELAY -FOR- -L.S.	-PROB. —OF— SORTIE	-SORTIE —SIZE- MIN	MAX
5	DON1	0	7	0	1.00	50	0	0	3.00	0.000	0	100

(Columns FORM through MAX: SCHEDULE OF SORTIES)

BASE	-SCHEDULED —AT— DAY	HR	MIN	-A/C TYPE	QUANTITY
	0	0	0		0

(Columns BASE through QUANTITY: SCHEDULE OF ALERT)

	MAINTENCE SYSTEM						INPUTS MAINTENANCE REQUIREMENTS			RESOURCE REQUIREMENTS				TIME FOR END OF RUN		
FORM	BASES	MISSIONS	TYPE OF MAINT.	NRTS POLICY	SYSTEMS	PROB. OF NEED.	PROB. OF BEING CRITICAL	DURATION	PROB. OF NEED	SEQUENCE	RESOURCE KIND	RESOURCE TYPE	QUAN.	PROB. OF NEED	DAY	HR	MIN
6	FORT1	DON1	UM	0	SY1	0.001	1.000	-110.00	1.000	0	PT	1	1	1.000	33	0	0
6	FORT1	DON1	UM	0	SY2	0.414	1.000	-111.00	1.000	0	PT	2	1	1.000	0	0	0
6	FORT1	DON1	UM	0	SY3	0.002	1.000	-112.00	1.000	0	PT	3	1	1.000	0	0	0
6	FORT1	DON1	UM	0	SY4	0.009	1.000	-113.00	1.000	0	PT	4	1	1.000	0	0	0
6	FORT1	DON1	UM	0	SY5	0.017	1.000	-114.00	1.000	0	PT	5	1	1.000	0	0	0
6	FORT1	DON1	UM	0	SY6	0.002	1.000	-115.00	1.000	0	PT	6	1	1.000	0	0	0
6	FORT1	DON1	UM	0	SY7	0.004	1.000	-116.00	1.000	0	PT	7	1	1.000	0	0	0
6	FORT1	DON1	UM	0	SY8	0.066	1.000	-117.00	1.000	0	PT	8	1	1.000	0	0	0
6	FORT1	DON1	UM	0	SY9	0.063	1.000	-118.00	1.000	0	PT	9	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S10	0.027	1.000	-119.00	1.000	0	PT	10	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S11	0.011	1.000	-120.00	1.000	0	PT	11	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S12	0.095	1.000	-121.00	1.000	0	PT	12	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S13	0.068	1.000	-122.00	1.000	0	PT	13	1	1.000	0	0	0

6	FORT1	DON1	UM	0	S14	0.069	1.000	-123.00	1.000	0	PT	14	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S15	0.050	1.000	-124.00	1.000	0	PT	15	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S16	0.058	1.000	-125.00	1.000	0	PT	16	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S17	0.090	1.000	-126.00	1.000	0	PT	17	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S18	0.088	1.000	-127.00	1.000	0	PT	18	1	1.000	0	0	0
6	FORT1	DON1	UM	0	S19	0.031	1.000	-128.00	1.000	0	PT	19	1	1.000	0	0	0
6	FORT1	DON1	LS	0	SY1	0.333	1.000	-129.00	1.000	0	PT	2	1	1.000	0	0	0
6	FORT1	DON1	FS	0	SY1	1.000	1.000	-130.00	1.000	0	PT	2	1	1.000	0	0	0
6	FORT1	DON1	FS	0	ALL	1.000	1.000	0.50	1.000	0	PT	3	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY1	0.800	1.000	-81.00	1.000	0	PT	1	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY2	1.000	1.000	-82.00	1.000	0	PT	2	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY3	1.000	1.000	-83.00	1.000	0	PT	3	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY4	1.000	1.000	-84.00	1.000	0	PT	4	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY5	1.000	1.000	-85.00	1.000	0	PT	5	1	1.000	0	0	0

6	FORT1	PEROD	IS	0	SY7	0.900	1.000	-87.00	1.000	0	PT	7	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY8	1.000	1.000	-89.00	1.000	0	PT	8	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY9	1.000	1.000	-88.00	1.000	0	PT	9	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S10	1.000	1.000	-90.00	1.000	0	PT	10	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S11	0.900	1.000	-91.00	1.000	0	PT	11	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S12	1.000	1.000	-92.00	1.000	0	PT	12	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S13	1.000	1.000	-93.00	1.000	0	PT	13	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S14	1.000	1.000	-94.00	1.000	0	PT	14	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S15	1.000	1.000	-95.00	1.000	0	PT	15	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S16	1.000	1.000	-96.00	1.000	0	PT	16	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S17	1.000	1.000	-97.00	1.000	0	PT	17	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S18	0.900	1.000	-98.00	1.000	0	PT	18	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	S19	1.000	1.000	-99.00	1.000	0	PT	19	1	1.000	0	0	0
6	FORT1	PEROD	IS	0	SY6	1.000	1.000	-86.00	1.000	0	PT	6	1	1.000	0	0	0

FORM	DB-NO.	DISTRIBUTIONS ENTRY 1 -PROB-	ENTRY 1 -VALUE-	ENTRY 2 -PROB-	ENTRY 2 -VALUE-	ENTRY 3 -PROB-	ENTRY 3 -VALUE-	ENTRY 4 -PROB-	ENTRY 4 -VALUE-
7	110	0.5000	2.700	1.0000	4.000	0.0000	0.000	0.0000	0.000
7	111	0.1000	0.300	0.2040	0.500	0.2730	0.800	0.3480	1.000
7	0	0.4620	1.500	0.5660	2.000	0.6490	2.500	0.7140	3.000
7	0	0.7550	3.500	0.7910	4.000	0.8240	4.500	0.8500	5.000
7	0	0.8960	6.000	0.9150	7.000	0.9300	8.000	0.9420	9.000
7	0	0.9600	10.300	0.9710	13.100	0.9820	14.600	0.9900	18.200
7	0	0.9940	20.300	0.9980	23.200	1.0000	31.000	0.0000	0.000
7	112	0.2500	0.500	0.5000	0.900	0.7500	1.300	1.0000	3.100
7	113	0.1420	0.300	0.2850	0.500	0.5710	1.000	0.7140	1.200
7	0	0.9520	2.000	1.0000	6.000	0.0000	0.000	0.0000	0.000
7	114	0.1790	0.500	0.4100	1.000	0.5640	1.500	0.7430	2.000
7	0	0.8200	2.500	0.8970	5.200	0.9480	6.500	0.9740	9.400
7	0	1.0000	20.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
7	115	0.2500	0.200	0.5000	0.500	0.7500	0.900	1.0000	1.300
7	116	0.5000	0.300	0.7000	0.500	0.8000	0.800	1.0000	1.000
7	117	0.1680	0.500	0.4520	1.000	0.5470	1.500	0.6750	2.000
7	0	0.7500	2.500	0.7970	3.000	0.8780	4.000	0.9320	5.300
7	0	0.9590	7.300	0.9930	9.300	1.0000	17.800	0.0000	0.000
7	118	0.1840	0.500	0.5460	1.000	0.6950	1.300	0.7870	1.900
7	0	0.8430	2.500	0.8930	4.000	0.9070	6.100	0.9500	8.700
7	0	0.9780	12.000	0.9920	14.500	1.0000	24.100	0.0000	0.000
7	119	0.0830	0.500	0.4660	1.000	0.6660	2.000	0.7500	3.000
7	0	0.8830	4.000	0.9330	5.500	0.9500	8.500	0.9830	13.000
7	0	1.0000	16.500	0.0000	0.000	0.0000	0.000	0.0000	0.000
7	120	0.2910	1.000	0.4580	2.000	0.5410	6.000	0.7510	9.000
7	0	0.7910	13.500	0.8750	16.000	0.9580	19.500	1.0000	26.000

7	121	0.2680	0.500	0.5510	1.000	0.6830	1.500	0.7780	2.000
7	0	0.8300	2.500	0.8910	3.000	0.9430	4.000	0.9760	6.000
7	0	0.9950	7.500	1.0000	10.200	0.0000	0.000	0.0000	0.000
7	122	0.0860	0.500	0.3570	1.000	0.5820	2.000	0.6420	2.500
7	0	0.7410	3.000	0.8600	4.000	0.8940	5.000	0.9470	6.500
7	0	0.9800	8.000	0.9860	10.000	1.0000	15.000	0.0000	0.000
7	123	0.1670	0.500	0.5030	1.000	0.6190	1.500	0.7410	2.000
7	0	0.8900	3.000	0.9350	4.000	0.9740	5.700	0.9870	9.000
7	0	0.9930	11.200	1.0000	24.000	0.0000	0.000	0.0000	0.000
7	124	0.0980	0.500	0.2760	1.000	0.5000	1.500	0.7410	2.000
7	0	0.8390	3.000	0.9100	4.000	0.9640	5.500	0.9820	7.000
7	0	0.9910	10.300	1.0000	20.600	0.0000	0.000	0.0000	0.000
7	125	0.1930	0.500	0.4340	1.000	0.5890	1.500	0.7200	2.000
7	0	0.8990	3.000	0.9450	3.800	0.9840	5.000	0.9920	7.300
7	0	1.0000	11.800	0.0000	0.000	0.0000	0.000	0.0000	0.000
7	126	0.1430	0.500	0.4700	1.000	0.6130	1.500	0.7570	2.000
7	0	0.8710	3.000	0.9300	4.000	0.9550	5.200	0.9850	7.500
7	0	1.0000	10.000	0.0000	0.000	0.0000	0.000	0.0000	0.000
7	127	0.1770	0.500	0.4870	1.000	0.6540	1.500	0.8120	2.000
7	0	0.9230	3.000	0.9690	5.000	0.9890	8.000	1.0000	13.000
7	128	0.4570	1.000	0.5710	1.500	0.8280	2.000	0.9000	3.000
7	0	0.9420	3.800	0.9570	4.200	0.9850	5.900	1.0000	36.200
7	130	0.0770	0.300	0.3790	0.500	0.5030	0.800	0.8140	1.000
7	0	0.8550	1.300	0.9230	1.500	0.9570	1.800	1.0000	2.000
7	129	0.0520	0.500	0.1800	1.000	0.3610	1.500	0.4280	1.800
7	0	0.6490	2.000	0.7830	2.500	0.8400	2.800	1.0000	3.000
7	81	0.1250	5.500	0.5000	6.000	0.6250	6.500	0.8750	7.000
7	0	1.0000	11.000	0.0000	0.000	0.0000	0.000	0.0000	0.000

7	82	0.1000	23.500	0.2000	46.700	0.3000	51.900	0.4000	54.700
7	0	0.5000	69.700	0.6000	72.000	0.7000	75.600	0.9000	78.900
7	0	1.0000	107.300	0.0000	0.000	0.0000	0.000	0.0000	0.000
7	83	0.1000	58.100	0.2000	64.000	0.4000	75.900	0.5000	79.900
7	0	0.7000	85.100	0.8000	86.800	0.9000	88.600	1.0000	93.700
7	84	0.1000	0.400	0.4000	2.500	0.5000	6.300	0.7000	7.500
7	0	0.8000	7.800	0.9000	9.100	1.0000	12.800	0.0000	0.000
7	85	0.3000	7.700	0.4000	8.700	0.5000	12.100	0.6000	14.100
7	0	0.7000	16.700	0.8000	20.200	0.9000	27.300	1.0000	28.300
7	86	0.1000	4.300	0.2000	8.500	0.3000	9.300	0.4000	10.800
7	0	0.5000	11.300	0.7000	13.500	0.8000	14.500	1.0000	18.400
7	87	0.2220	1.500	0.4440	1.900	0.6660	2.500	0.7770	3.300
7	0	1.0000	6.100	0.0000	0.000	0.0000	0.000	0.0000	0.000
7	88	0.1000	3.700	0.2000	5.800	0.3000	10.900	0.4000	13.800
7	0	0.6000	18.500	0.7000	23.300	0.9000	30.900	1.0000	35.600
7	89	0.1000	13.600	0.3000	20.200	0.4000	23.200	0.5000	28.500
7	0	0.7000	35.200	0.9000	39.700	1.0000	49.800	0.0000	0.000
7	90	0.3000	2.000	0.4000	6.500	0.6000	8.000	0.7000	12.200
7	0	0.8000	13.000	0.9000	17.000	1.0000	19.800	0.0000	0.000
7	91	0.2220	0.500	0.4440	1.000	0.5550	5.500	0.6660	10.000
7	0	0.7770	13.700	0.8880	19.500	1.0000	20.000	0.0000	0.000
7	92	0.1000	2.500	0.3000	4.100	0.4000	4.500	0.5000	5.400
7	0	0.8000	7.300	0.9000	14.800	1.0000	18.400	0.0000	0.000
7	93	0.1000	7.000	0.2000	8.800	0.3000	9.600	0.5000	11.100
7	0	0.7000	13.500	0.8000	14.800	0.9000	24.300	1.0000	30.300
7	94	0.1000	1.000	0.2000	1.800	0.3000	2.700	0.5000	4.500
7	0	0.6000	6.000	0.8000	7.500	0.9000	10.300	1.0000	13.500
7	95	0.1000	8.200	0.2000	10.800	0.3000	12.500	0.5000	13.000

```
   7     0   0.7000   24.000  0.8000   24.500  0.9000   26.200  1.0000   27.000

   7    96   0.3000    6.100  0.4000    8.000  0.5000   10.800  0.6000   12.000

   7     0   0.8000   13.000  0.9000   14.900  1.0000   18.400  0.0000    0.000

   7    97   0.1000    1.000  0.3000    1.500  0.4000    2.000  0.6000    2.500

   7     0   0.7000    4.500  0.8000    5.000  1.0000    8.300  0.0000    0.000

   7    98   0.2220    1.000  0.3330    2.400  0.4440    3.300  0.6660    4.000

   7     0   0.7770    4.600  0.8880    7.800  1.0000    8.400  0.0000    0.000

   7    99   0.1000    0.500  0.3000    1.500  0.5000    2.000  0.6000    2.500

   7     0   0.8000    3.000  0.9000    4.700  1.0000    9.500  0.0000    0.000
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  1= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  2= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  3= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  4= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  5= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  6= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  7= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  8= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT  9= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 10= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 11= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 12= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 13= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 14= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 15= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 16= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 17= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 18= 99
AT TIME  0  0  0, A SHIFT CHANGE HAS OCCURRED AT FORT1  FOR THE FOLLOWING PT
PT 19= 99
```

```
AT TIME  0  0  0 THE MAKE UP CODE FOR DON1   WILL BE SET TO 3
AT TIME  0  4  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0  7  0
AT TIME  0  5  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0  8  0
AT TIME  0  6  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0  9  0
AT TIME  0  7  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 10  0
AT TIME  0  8  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 11  0
AT TIME  0  9  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 12  0
AT TIME  0 10  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 13  0
AT TIME  0 11  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 14  0
AT TIME  0 12  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 15  0
AT TIME  0 13  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 16  0
AT TIME  0 14  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 17  0
AT TIME  0 15  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 18  0
AT TIME  0 16  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 19  0
AT TIME  0 17  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 20  0
AT TIME  0 18  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 21  0
AT TIME  0 19  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 22  0
AT TIME  0 20  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 23  0
AT TIME  0 21  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  0 24  0
AT TIME  0 22  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  1  0
AT TIME  0 23  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  2  0
AT TIME  0 23 54 THE MAKE UP CODE FOR DON1   WILL BE SET TO 4
AT TIME  0 24  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  3  0
AT TIME  1  0  0 THE MAKE UP CODE FOR DON1   WILL BE SET TO 3
AT TIME  1  1  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  4  0
AT TIME  1  2  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  5  0
AT TIME  1  3  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  6  0
AT TIME  1  4  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  7  0
AT TIME  1  5  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  8  0
AT TIME  1  6  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1  9  0
AT TIME  1  7  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 10  0
AT TIME  1  8  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 11  0
AT TIME  1  9  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 12  0
AT TIME  1 10  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 13  0
AT TIME  1 11  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 14  0
AT TIME  1 12  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 15  0
AT TIME  1 13  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 16  0
AT TIME  1 14  0, A DON1    SORTIF WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 17  0
AT TIME  1 15  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 18  0
AT TIME  1 16  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 19  0
AT TIME  1 17  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 20  0
AT TIME  1 18  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 21  0
AT TIME  1 19  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 22  0
AT TIME  1 20  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 23  0
AT TIME  1 21  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  1 24  0
AT TIME  1 22  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  1  0
AT TIME  1 23  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  2  0
AT TIME  1 23 54 THE MAKE UP CODE FOR DON1   WILL BE SET TO 4
AT TIME  1 24  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  3  0
AT TIME  2  0  0 THE MAKE UP CODE FOR DON1   WILL BE SET TO 3
AT TIME  2  1  0, A DON1    SORTIE WILL BF SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  4  0
AT TIME  2  2  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  5  0
AT TIME  2  3  0, A DON1    SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  6  0
AT TIME  2  4  0, A DON1    SORTIE WILL BF SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  7  0
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AT TIME  2  5   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  8  0
AT TIME  2  6   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2  9  0
AT TIME  2  7   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 10  0
AT TIME  2  8   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 11  0
AT TIME  2  9   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 12  0
AT TIME  2 10   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 13  0
AT TIME  2 11   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 14  0
AT TIME  2 12   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 15  0
AT TIME  2 13   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 16  0
AT TIME  2 14   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 17  0
AT TIME  2 15   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 18  0
AT TIME  2 16   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 19  0
AT TIME  2 17   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 20  0
AT TIME  2 18   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 21  0
AT TIME  2 19   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 22  0
AT TIME  2 20   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 23  0
AT TIME  2 21   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  2 24  0
AT TIME  2 22   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  3  1  0
AT TIME  2 23   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  3  2  0
AT TIME  2 23 54 THE MAKE UP CODE FOR DONI   WILL BE SET TO 4
AT TIME  2 24   0, A DONI   SORTIE WILL BE SCHEDULED WITH A MIN OF  1, AND A MAX OF 100 A/C,  LAUNCH WILL BE AT  3  3  0
AT TIME 33  0   0, THE RUN WILL BE STOPPED
```

```
EXECUTION INITIALIZATION CARDS
  1        R                                           200
  2        R                                             1
  3   4 1  Z      1    2
  5     1 R       1    2           1/2                 (U6.6)
   1.570801
  5     1 R       1    2           2/2                 (U6.6)
   0.000000
  6     1 R       1    2                                (A6)
FORT1
  7        R                                             1
  8     1 R       1    7           1/2                 (U6.6)
   6.250000
  8     1 R       1    7           2/2                 (U6.6)
   0.000000
  9     1 R       1    7           1/1                 (U6.6)
   0.000000
 10     1 R       1    7                                (A6)
C130
 11  14 2  Z      1    2    1    7
 15        R                                            41
 16     1 R      41   15           1/4                  (I6)
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
    1
  202
  202
  202
  202
  202
  202
  202
  202
  202
  202
```

NOTE: THIS MODEL AUTOMATICALLY PRINTS SEVERAL PAGES OF EXECUTION INITIALIZATION CARD IMAGES. TO CONSERVE SPACE ONLY THE FIRST PAGE IS SHOWN.

```
OUTPUT INITIALIZATION CARDS
   1        R                                                 19
   2    5 1  Z    19    1
   6        R                                                (A6)

   7        R                                                 30
   8    9 1  Z    30    7
  10        R                                                  1
  11   84 1  Z     1   10
  85      1 R      1   10                                    (A6)
FORT1
  86        R                                                  1
  87      1 R      1   86                                    (A6)
C130
  88   94 2  Z     1   10    1   86
  95        R                                                  1
  96      1 R      1   95                                    (A6)
DGN1
  97  104 2  Z     1   10    1   95
 105        R                                                 48
 106  112 1  Z    48  105
 113        R                                                 19
 114      1 R     19  113                                    (A6)
      1
      2
      3
      4
      5
      6
      7
      8
      9
     10
     11
     12
     13
     14
     15
     16
     17
     18
     19
 115      1 R     19  113                                    (A6)
PT
PT
PT
PT
PT
PT
PT
PT
PT
PT
PT
```

```
PT
PT
PT
PT
PT
PT
PT
PT
116 120 2  Z    1  10  19 113
121         R                                     19
122      1 R    19 121                          (A6)
SY1
SY2
SY3
SY4
SY5
SY6
SY7
SY8
SY9
S10
S11
S12
S13
S14
S15
S16
S17
S18
S19
123         R                                     11
124      1 R    11 123                          (A6)
DC
TS
UM
FC
CDTS
CDUM
CDFC
FS
LS
OL
IS
125         R                                   (A6)
ALL
126         R                                     14
127   0 1  Z    14 126
128         R                                      8
129   0 2  Z     8 128  14 126
130         R                                   (A6)
DF1325
131         R                                   (A6)
PT
132         R                                   (A6)
```

```
ET
133        R                                  (A6)
PA
134        R                                  (A6)
TD
135        R                                    4
136      1 R      4 135                       (A6)
MIN
MAX
AVG
TOT
137        R                                   16
138      1 R     16 137                       (A6)
WORK
C/NA
IDLE
LAUNCH
LANDED
LOST
COMBAT
ABORT
OPERAT
WEATHR
TOTAL
FLYABL
ALERT,
READY
MAINT
AIR
139        R                                    5
140      1 R      5 139                       (A6)
ALERT
ABORT
PEROD
POSTFT
STAND
141 144 1  Z     48 105
```

```
Q U I C K   L O O K   A T   M A I N T E N A N C E

MISSIONS    TYPES OF MAINTENANCE WHICH HAVE BEEN ACTIVATED BY INPUT DATA

 ALERT
 ABORT
 PEROD      IS
 POSTFT
 STAND
 DONI       UM     FS     LS
```

```
C O R E   S T O R A G E   A L L O C A T I O N

     IBSYS SYSTEM          =  7752      (STORAGE IS FIXED)

     SIMSCRIPT SYSTEM      =  5019      (STORAGE IS FIXED)

     EXECUTION PROGRAM     = 10821      (STORAGE OCCUPIED BY THE SIMULATION PROGRAM ITSELF)

     TEMPORARY STORAGE     =  6613      (AMOUNT OF STORAGE AVAILABLE FOR QUEUES, ETC.  AMOUNT NEEDED DEPENDS ON ACTIVITY)

     PERMANENT STORAGE     =  1190      (AMOUNT OF STORAGE REQUIRED TO STORE INPUT DATA)

     INPUT-OUTPUT BUFFERS  =  1373      (STORAGE IS FIXED)

                             -----
                   TOTAL  =  32768      (FIXED BY SIZE OF COMPUTER--DAMNIT)
                             -----
                             -----

MACHINE TIME =   1.32 MIN.

DAY    0 HOUR  0 MINUTE  0 SUCCESSFULLY COMPLETED
DAY    1 HOUR  0 MINUTE  0 SUCCESSFULLY COMPLETED
     .
     .
     .
DAY   32 HOUR  0 MINUTE  0 SUCCESSFULLY COMPLETED


THE RUN WAS SUCCESSFULLY COMPLETED AT DAY    33    HOUR     0    MINUTE     0
TOTAL EVENTS = 49317

MACHINE TIME =  60.31 MIN.
```

BEGIN EDIT PHASE

1	6627.	2.80	21	4716.	2.00	41	789.	0.33	61	0.	0.C0	81	0.	0.00
2	6627.	2.80	22	0.	0.00	42	0.	0.00	62	0.	0.00	82	0.	0.00
3	48.	0.02	23	4716.	2.00	43	0.	0.00	63	0.	0.00	83	0.	0.00
4	0.	0.00	24	4716.	2.00	44	0.	0.00	64	0.	0.00	84	0.	0.00
5	0.	0.00	25	0.	0.00	45	0.	0.00	65	6627.	2.80	85	0.	0.00
6	0.	0.00	26	0.	0.00	46	0.	0.00	66	48.	0.02	86	0.	0.00
7	0.	0.00	27	0.	0.00	47	67.	0.03	67	0.	0.00	87	0.	0.00
8	0.	0.00	28	785.	0.33	48	0.	0.00	68	0.	0.00	88	0.	0.00
9	0.	0.00	29	0.	0.00	49	0.	0.00	69	23911.	10.12	89	0.	0.00
10	0.	0.00	30	6636.	2.81	50	23911.	10.12	70	0.	0.00	90	0.	0.00
11	0.	0.00	31	0.	0.00	51	0.	0.00	71	23911.	10.12	91	0.	0.00
12	6592.	2.79	32	6593.	2.79	52	23852.	10.09	72	0.	0.00	92	0.	0.00
13	0.	0.00	33	0.	0.00	53	0.	0.00	73	23852.	10.09	93	0.	0.00
14	0.	0.00	34	1.	0.00	54	48.	0.02	74	0.	0.00	94	0.	0.00
15	158.	0.07	35	0.	0.00	55	23911.	10.12	75	23852.	10.09	95	0.	0.00
16	0.	0.00	36	1.	0.00	56	0.	0.00	76	0.	0.00	96	0.	0.00
17	0.	0.00	37	0.	0.00	57	0.	0.00	77	0.	0.00	97	0.	0.00
18	48.	0.02	38	0.	0.00	58	0.	0.00	78	0.	0.00	98	0.	0.00
19	0.	0.00	39	6636.	2.81	59	19.	0.01	79	0.	0.00	99	0.	0.00
20	0.	0.00	40	6636.	2.81	60	0.	0.00	80	0.	0.00	100	0.	0.00

TOTAL NUMBER OF TRANSACTIONS = 236334.

MACHINE TIME = 19.33 MIN.

AUXILIARY TRANSACTION TAPES ARE BEING USED.

SIMULATION – DF1325

O P E R A T I O N S   S U M M A R Y

	TOTAL SORTIES SCHEDULED OR REQUIRED		SORTIES SCHEDULED AND MADE		SORTIES SCHEDULED, NOT MADE AND CANCELED		SORTIES SCHEDULED, NOT MADE AND SAVED		SORTIES SAVED AND MADE UP LATER		SORTIES SAVED, NOT MADE UP LATER AND CANCELED		TOTAL SORTIES MADE		TOTAL REPLACEMENT SORTIES	TOTAL RESCHEDULED SORTIES
	MIN	MAX	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.		
PERIOD COVERED – 3 0 0 TO 4 0 0																
BASE FORT1	24	2400	75	3.13	0	0.00	2325	96.88	131	5.46	2194	91.42	206	8.58	0	0
PERIOD COVERED – 4 0 0 TO 5 0 0																
BASE FORT1	24	2400	81	3.37	0	0.00	2319	96.62	113	4.71	2206	91.92	194	8.08	0	0
.																
.																
.																
PERIOD COVERED – 31 0 0 TO 32 0 0																
BASE FORT1	24	2400	96	4.00	0	0.00	2304	96.00	119	4.96	2185	91.04	215	8.96	0	0
PERIOD COVERED – 32 0 0 TO 33 0 0																
BASE FORT1	24	2400	79	3.29	0	0.00	2321	96.71	125	5.21	2196	91.50	204	8.50	0	0

SIMULATION – DF1325

O P E R A T I O N S   S U M M A R Y

	TOTAL SORTIES SCHEDULED OR REQUIRED		SORTIES SCHEDULED AND MADE		SORTIES SCHEDULED, NOT MADE AND CANCELED		SORTIES SCHEDULED, NOT MADE AND SAVED		SORTIES SAVED AND MADE UP LATER		SORTIES SAVED, NOT MADE UP LATER AND CANCELED		TOTAL SORTIES MADE		TOTAL REPLACEMENT SORTIES	TOTAL RESCHEDULED SORTIES
	MIN	MAX	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.	NO.	PCT.		
PERIOD COVERED – 3 0 0 TO 33 0 0																
BASE FORT1	720	72000	2340	3.25	0	0.00	69660	96.75	3666	5.09	65994	91.66	6006	8.34	0	0

MACHINE TIME = 4.32 MIN.

B A S E   S T A T U S   R E P O R T

DF1325

PERIOD COVERED 3 0 0 TO 33 0 0

BASE FORT1	MEAN	SIGMA	MIN	MAX	AVERAGE DURATION	FREQUENCY
FLYABLE	0.00	0.00	0.	0.	0.00	0.
READY	1.84	0.00	0.	20.	0.59	2229.
GROUND ALERT	0.00	0.00	0.	0.	0.00	0.
AIRBORNE	8.35	0.00	0.	21.	1.00	6016.
AWAITING MAINT.	0.00	0.00	0.	0.	0.00	0.
IN MAINT.	37.81	0.00	0.	47.	4.51	6039.
TOTAL AOCP	0.00	0.00	0.	0.	0.00	0.
TOTAL AOCM	37.81	0.00	0.	47.	4.51	6041.

MACHINE TIME = 28.85 MIN.

AIRCRAFT STATUS FOR BASE FORT1

-REPORT- --TIME-- DY	HR	MN	C130 FYB	DF1325 ALR	RDY	MNT	AIR	TOT	FYB	ALR	RDY	MNT	AIR	TOT	FYB	ALR	RDY	MNT	AIR	TOT	FYB	ALR	RDY	MNT	AIR	TOT	FYB	ALR	RDY	MNT	AIR	TOT
3	0	0	-0	0	-0	35	13	48																								
3	1	0	-0	0	9	38	1	48																								
3	2	0	-0	0	6	31	11	48																								
3	3	0	-0	0	9	31	8	48																								
3	4	0	-0	0	5	30	13	48																								
3	5	0	-0	0	3	38	7	48																								
3	6	0	-0	0	9	33	6	48																								
3	7	0	-0	0	2	31	15	48																								
3	8	0	-0	0	6	38	4	48																								
3	9	0	-0	0	1	39	8	48																								
3	10	0	-0	0	-0	41	7	48																								
3	11	0	-0	0	7	37	4	48																								
3	12	0	-0	0	4	35	9	48																								
3	13	0	-0	0	-0	40	8	48																								
3	14	0	-0	0	-0	39	9	48																								
3	15	0	-0	0	8	32	8	48																								
3	16	0	-0	0	3	31	14	48																								
3	17	0	-0	0	-0	36	12	48																								
3	18	0	-0	0	-0	40	8	48																								
3	19	0	-0	0	-0	43	5	48																								
3	20	0	-0	0	-0	37	11	48																								
3	21	0	-0	0	-0	42	6	48																								
3	22	0	-0	0	1	35	12	48																								
3	23	0	-0	0	-0	34	14	48																								
3	24	0	-0	0	-0	42	6	48																								
4	1	0	-0	0	8	40	-0	48																								
4	2	0	-0	0	11	30	7	48																								
4	3	0	-0	0	9	29	10	48																								
4	4	0	-0	0	2	34	12	48																								
4	5	0	-0	0	7	38	3	48																								
4	6	0	-0	0	9	30	9	48																								
4	7	0	-0	0	-0	34	14	48																								
4	8	0	-0	0	2	41	5	48																								
4	9	0	-0	0	7	39	2	48																								
4	10	0	-0	0	1	32	15	48																								
4	11	0	-0	0	2	37	9	48																								
4	12	0	-0	0	3	41	4	48																								
4	13	0	-0	0	4	35	9	48																								
4	14	0	-0	0	1	34	13	48																								
4	15	0	-0	0	9	34	5	48																								
4	16	0	-0	0	-0	31	17	48																								
4	17	0	-0	0	1	38	9	48																								
4	18	0	-0	0	-0	42	6	48																								
4	19	0	-0	0	1	37	10	48																								
4	20	0	-0	0	-0	40	8	48																								
4	21	0	-0	0	6	38	4	48																								
4	22	0	-0	0	-0	35	13	48																								
4	23	0	-0	0	-0	43	5	48																								

-REPORT- DF1325 AIRCRAFT STATUS FOR BASE FORT1

--TIME-- DY HR MN	C130 FYB	ALR	RDY	MNT	AIR	TOT
30 24 0	-0	0	-0	42	6	48
31 1 0	-0	0	11	37	-0	48
31 2 0	-0	0	14	27	7	48
31 3 0	-0	0	10	27	11	48
31 4 0	-0	0	6	31	11	48
31 5 0	-0	0	8	32	8	48
31 6 0	-0	0	4	29	15	48
31 7 0	-0	0	1	41	6	48
31 8 0	-0	0	7	36	5	48
31 9 0	-0	0	3	35	10	48
31 10 0	-0	0	4	33	11	48
31 11 0	-0	0	7	33	8	48
31 12 0	-0	0	7	30	11	48
31 13 0	-0	0	-0	38	10	48
31 14 0	-0	0	1	39	8	48
31 15 0	-0	0	2	38	8	48
31 16 0	-0	0	3	39	6	48
31 17 0	-0	0	-0	37	11	48
31 18 0	-0	0	3	34	11	48
31 19 0	-0	0	7	33	8	48
31 20 0	-0	0	4	31	13	48
31 21 0	-0	0	-0	37	11	48
31 22 0	-0	0	-0	37	11	48
31 23 0	-0	0	-0	39	9	48
31 24 0	-0	0	1	41	6	48
32 1 0	-0	0	10	37	1	48
32 2 0	-0	0	12	31	5	48
32 3 0	-0	0	10	28	10	48
32 4 0	-0	0	6	30	12	48
32 5 0	-0	0	5	34	9	48
32 6 0	-0	0	2	38	8	48
32 7 0	-0	0	7	34	7	48
32 8 0	-0	0	4	31	13	48
32 9 0	-0	0	6	36	6	48
32 10 0	-0	0	8	31	9	48
32 11 0	-0	0	-0	33	15	48
32 12 0	-0	0	4	40	4	48
32 13 0	-0	0	2	39	7	48
32 14 0	-0	0	1	35	12	48
32 15 0	-0	0	2	38	8	48
32 16 0	-0	0	3	39	6	48
32 17 0	-0	0	-0	38	10	48
32 18 0	-0	0	-0	38	10	48
32 19 0	-0	0	2	37	9	48
32 20 0	-0	0	1	38	9	48
32 21 0	-0	0	-0	39	9	48
32 22 0	-0	0	-0	37	11	48
32 23 0	-0	0	-0	43	5	48
32 24 0	-0	0	1	38	9	48
AVERAGES	-0.000	0.000	3.361	36.291	8.348	48.000

--TIME-- DY HR MN	FYB	ALR	RDY	MNT	AIR	TOT	FYB	ALR	RDY	MNT	AIR	TOT	FYB	ALR	RDY	MNT	AIR	TOT	FYB	ALR	RDY	MNT	AIR	TOT
AVERAGES	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

MACHINE TIME = 2.13 MIN.

-REPORT- DF1325 SORTIE HISTORY FOR BASE FORT1

--TIME--			DON1						
DY	HR	MN	T-O	LND	LST	C/D	A/B	DEF	WTH
3	0	0	630	617	0	0	0	-0	0
3	1	0	1	13	0	0	0	99	0
3	2	0	11	1	0	0	0	188	0
3	3	0	8	11	0	0	0	280	0
3	4	0	13	8	0	0	0	367	0
3	5	0	7	13	0	0	0	460	0
3	6	0	6	7	0	0	0	554	0
3	7	0	15	6	0	0	0	639	0
3	8	0	4	15	0	0	0	735	0
3	9	0	8	4	0	0	0	827	0
3	10	0	7	8	0	0	0	920	0
3	11	0	4	7	0	0	0	1016	0
3	12	0	9	4	0	0	0	1107	0
3	13	0	8	9	0	0	0	1199	0
3	14	0	9	8	0	0	0	1290	0
3	15	0	8	9	0	0	0	1382	0
3	16	0	14	8	0	0	0	1468	0
3	17	0	12	14	0	0	0	1556	0
3	18	0	8	12	0	0	0	1648	0
3	19	0	5	8	0	0	0	1743	0
3	20	0	11	5	0	0	0	1832	0
3	21	0	6	11	0	0	0	1926	0
3	22	0	12	6	0	0	0	2014	0
3	23	0	14	12	0	0	0	2100	0
3	24	0	6	14	0	0	0	-0	0
4	1	0	0	6	0	0	0	100	0
4	2	0	7	0	0	0	0	193	0
4	3	0	10	7	0	0	0	283	0
4	4	0	12	10	0	0	0	371	0
4	5	0	3	12	0	0	0	468	0
4	6	0	9	3	0	0	0	559	0
4	7	0	14	9	0	0	0	645	0
4	8	0	5	14	0	0	0	740	0
4	9	0	2	5	0	0	0	838	0
4	10	0	15	2	0	0	0	923	0
4	11	0	9	15	0	0	0	1014	0
4	12	0	4	9	0	0	0	1110	0
4	13	0	9	4	0	0	0	1201	0
4	14	0	13	9	0	0	0	1288	0
4	15	0	5	13	0	0	0	1383	0
4	16	0	17	5	0	0	0	1466	0
4	17	0	9	17	0	0	0	1557	0
4	18	0	6	9	0	0	0	1651	0
4	19	0	10	6	0	0	0	1741	0
4	20	0	8	10	0	0	0	1833	0
4	21	0	4	8	0	0	0	1929	0
4	22	0	13	4	0	0	0	2016	0
4	23	0	5	13	0	0	0	2111	0

T-O LND LST C/D A/B DEF WTH T-O LND LST C/D A/B DEF WTH T-O LND LST C/D A/B DEF WTH

-REPORT- DF1325 SORTIE HISTORY FOR BASE FORT1

--TIME--			DON1						
DY	HR	MN	T-O	LND	LST	C/D	A/B	DEF	WTH
30	24	0	6	10	0	0	0	-0	0
31	1	0	0	6	0	0	0	100	0
31	2	0	7	0	0	0	0	193	0
31	3	0	11	7	0	0	0	282	0
31	4	0	11	11	0	0	0	371	0
31	5	0	8	11	0	0	0	463	0
31	6	0	15	8	0	0	0	548	0
31	7	0	6	15	0	0	0	642	0
31	8	0	5	6	0	0	0	737	0
31	9	0	10	5	0	0	0	827	0
31	10	0	11	10	0	0	0	916	0
31	11	0	8	11	0	0	0	1008	0
31	12	0	11	8	0	0	0	1097	0
31	13	0	10	11	0	0	0	1187	0
31	14	0	8	10	0	0	0	1279	0
31	15	0	8	8	0	0	0	1371	0
31	16	0	6	8	0	0	0	1465	0
31	17	0	11	6	0	0	0	1554	0
31	18	0	11	11	0	0	0	1643	0
31	19	0	8	11	0	0	0	1735	0
31	20	0	13	8	0	0	0	1822	0
31	21	0	11	13	0	0	0	1911	0
31	22	0	11	11	0	0	0	2000	0
31	23	0	9	11	0	0	0	2091	0
31	24	0	6	9	0	0	0	-0	0
32	1	0	1	6	0	0	0	99	0
32	2	0	5	1	0	0	0	194	0
32	3	0	10	5	0	0	0	284	0
32	4	0	12	10	0	0	0	372	0
32	5	0	9	12	0	0	0	463	0
32	6	0	8	9	0	0	0	555	0
32	7	0	7	8	0	0	0	648	0
32	8	0	13	7	0	0	0	735	0
32	9	0	6	13	0	0	0	829	0
32	10	0	9	6	0	0	0	920	0
32	11	0	15	9	0	0	0	1005	0
32	12	0	4	15	0	0	0	1101	0
32	13	0	7	4	0	0	0	1194	0
32	14	0	12	7	0	0	0	1282	0
32	15	0	8	12	0	0	0	1374	0
32	16	0	6	8	0	0	0	1468	0
32	17	0	10	6	0	0	0	1558	0
32	18	0	10	10	0	0	0	1648	0
32	19	0	9	10	0	0	0	1739	0
32	20	0	9	9	0	0	0	1830	0
32	21	0	9	9	0	0	0	1921	0
32	22	0	11	9	0	0	0	2010	0
32	23	0	5	11	0	0	0	2105	0
32	24	0	9	5	0	0	0	-0	0
TOTALS			6006	6010	0	0	0		

	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH	T-O	LND	LST	C/D	A/B	DEF	WTH
TOTALS	0	0	0	0	0			0	0	0	0	0			0	0	0	0	0		

MACHINE TIME = 2.71 MIN.

-REPORT- DF1325 RESOURCE REPORT FOR BASE FORT1

--TIME--			PT	1 -----			PT	2 -----			PT	3 -----			PT	4 -----			PT	5 -----			PT	6 -----			PT	7 -----		
DY	HR	MN	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA
3	0	0	1	98	99	0	28	71	99	0	8	91	99	0	1	98	99	0	2	97	99	0	2	97	99	0	1	98	99	0
3	1	0	1	98	99	0	27	72	99	0	4	95	99	0	1	98	99	0	2	97	99	0	2	97	99	0	1	98	99	0
3	2	0	1	98	99	0	24	75	99	0	6	93	99	0	1	98	99	0	2	97	99	0	2	97	99	0	1	98	99	0
3	3	0	1	98	99	0	23	76	99	0	6	93	99	0	0	99	99	0	2	97	99	0	2	97	99	0	0	99	99	0
3	4	0	1	98	99	0	21	78	99	0	4	95	99	0	0	99	99	0	2	97	99	0	2	97	99	0	0	99	99	0
3	5	0	1	98	99	0	28	71	99	0	9	90	99	0	1	98	99	0	2	97	99	0	2	97	99	0	0	99	99	0
3	6	0	1	98	99	0	23	76	99	0	6	93	99	0	0	99	99	0	2	97	99	0	2	97	99	0	0	99	99	0
3	7	0	1	98	99	0	21	78	99	0	5	94	99	0	1	98	99	0	2	97	99	0	2	97	99	0	0	99	99	0
3	8	0	2	97	99	0	26	73	99	0	8	91	99	0	1	98	99	0	4	95	99	0	3	96	99	0	1	98	99	0
3	9	0	2	97	99	0	25	74	99	0	5	94	99	0	1	98	99	0	5	94	99	0	3	96	99	0	1	98	99	0
3	10	0	2	97	99	0	31	68	99	0	7	92	99	0	2	97	99	0	4	95	99	0	3	96	99	0	1	98	99	0
3	11	0	1	98	99	0	27	72	99	0	7	92	99	0	2	97	99	0	4	95	99	0	2	97	99	0	0	99	99	0
3	12	0	1	98	99	0	27	72	99	0	5	94	99	0	1	98	99	0	4	95	99	0	2	97	99	0	0	99	99	0
3	13	0	1	98	99	0	30	69	99	0	10	89	99	0	1	98	99	0	4	95	99	0	2	97	99	0	0	99	99	0
3	14	0	0	99	99	0	30	69	99	0	8	91	99	0	1	98	99	0	5	94	99	0	2	97	99	0	0	99	99	0
3	15	0	0	99	99	0	26	73	99	0	8	91	99	0	1	98	99	0	4	95	99	0	2	97	99	0	0	99	99	0
3	16	0	0	99	99	0	25	74	99	0	8	91	99	0	1	98	99	0	4	95	99	0	2	97	99	0	0	99	99	0
3	17	0	0	99	99	0	27	72	99	0	8	91	99	0	0	99	99	0	4	95	99	0	2	97	99	0	0	99	99	0
3	18	0	0	99	99	0	30	69	99	0	7	92	99	0	0	99	99	0	4	95	99	0	2	97	99	0	0	99	99	0
3	19	0	0	99	99	0	32	67	99	0	10	89	99	0	0	99	99	0	4	95	99	0	1	98	99	0	0	99	99	0
3	20	0	0	99	99	0	27	72	99	0	9	90	99	0	0	99	99	0	2	97	99	0	1	98	99	0	0	99	99	0
3	21	0	1	98	99	0	34	65	99	0	11	88	99	0	1	98	99	0	3	96	99	0	1	98	99	0	1	98	99	0
3	22	0	1	98	99	0	29	70	99	0	9	90	99	0	1	98	99	0	3	96	99	0	1	98	99	0	1	98	99	0
3	23	0	1	98	99	0	28	71	99	0	8	91	99	0	0	99	99	0	3	96	99	0	1	98	99	0	1	98	99	0
3	24	0	1	98	99	0	33	66	99	0	8	91	99	0	0	99	99	0	3	96	99	0	1	98	99	0	0	99	99	0
4	1	0	1	98	99	0	33	66	99	0	11	88	99	0	0	99	99	0	3	96	99	0	1	98	99	0	0	99	99	0
4	2	0	1	98	99	0	24	75	99	0	7	92	99	0	0	99	99	0	3	96	99	0	1	98	99	0	0	99	99	0
4	3	0	1	98	99	0	22	77	99	0	8	91	99	0	0	99	99	0	3	96	99	0	1	98	99	0	0	99	99	0
4	4	0	0	99	99	0	24	75	99	0	7	92	99	0	0	99	99	0	2	97	99	0	1	98	99	0	0	99	99	0
4	5	0	0	99	99	0	26	73	99	0	10	89	99	0	0	99	99	0	3	96	99	0	1	98	99	0	0	99	99	0
4	6	0	0	99	99	0	22	77	99	0	8	91	99	0	0	99	99	0	2	97	99	0	0	99	99	0	0	99	99	0
4	7	0	0	99	99	0	23	76	99	0	9	90	99	0	0	99	99	0	3	96	99	0	0	99	99	0	0	99	99	0
4	8	0	0	99	99	0	26	73	99	0	10	89	99	0	0	99	99	0	3	96	99	0	0	99	99	0	0	99	99	0
4	9	0	0	99	99	0	29	70	99	0	8	91	99	0	0	99	99	0	3	96	99	0	0	99	99	0	0	99	99	0
4	10	0	0	99	99	0	26	73	99	0	7	92	99	0	0	99	99	0	2	97	99	0	0	99	99	0	0	99	99	0
4	11	0	0	99	99	0	25	74	99	0	10	89	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	12	0	0	99	99	0	31	68	99	0	10	89	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	13	0	0	99	99	0	27	72	99	0	8	91	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	14	0	0	99	99	0	27	72	99	0	6	93	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	15	0	0	99	99	0	23	76	99	0	11	88	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	16	0	0	99	99	0	22	77	99	0	7	92	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	17	0	0	99	99	0	29	70	99	0	8	91	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	18	0	0	99	99	0	34	65	99	0	10	89	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	19	0	0	99	99	0	29	70	99	0	8	91	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	20	0	0	99	99	0	30	69	99	0	13	86	99	0	0	99	99	0	2	97	99	0	0	99	99	0	0	99	99	0
4	21	0	0	99	99	0	23	76	99	0	7	92	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	22	0	0	99	99	0	19	80	99	0	8	91	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
4	23	0	0	99	99	0	28	71	99	0	13	86	99	0	1	98	99	0	2	97	99	0	1	98	99	0	0	99	99	0

-REPORT- DF1325 RESOURCE REPORT FOR BASE FORT1

--TIME--			PT	1 -----			PT	2 -----			PT	3 -----			PT	4 -----			PT	5 -----			PT	6 -----			PT	7 -----		
DY	HR	MN	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA	WRK	IDL	TOT	DNA
30	24	0	1	98	99	0	32	67	99	0	9	90	99	0	2	97	99	0	2	97	99	0	2	97	99	0	1	98	99	0
31	1	0	1	98	99	0	27	72	99	0	10	89	99	0	2	97	99	0	2	97	99	0	2	97	99	0	1	98	99	0
31	2	0	1	98	99	0	20	79	99	0	7	92	99	0	1	98	99	0	2	97	99	0	2	97	99	0	1	98	99	0
31	3	0	1	98	99	0	15	84	99	0	5	94	99	0	1	98	99	0	2	97	99	0	2	97	99	0	0	99	99	0
31	4	0	1	98	99	0	25	74	99	0	10	89	99	0	0	99	99	0	2	97	99	0	2	97	99	0	0	99	99	0
31	5	0	0	99	99	0	23	76	99	0	4	95	99	0	0	99	99	0	2	97	99	0	2	97	99	0	0	99	99	0
31	6	0	0	99	99	0	20	79	99	0	7	92	99	0	0	99	99	0	2	97	99	0	2	97	99	0	0	99	99	0
31	7	0	0	99	99	0	30	69	99	0	3	96	99	0	0	99	99	0	2	97	99	0	2	97	99	0	0	99	99	0
31	8	0	0	99	99	0	29	70	99	0	6	93	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
31	9	0	0	99	99	0	30	69	99	0	6	93	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
31	10	0	0	99	99	0	27	72	99	0	8	91	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
31	11	0	0	99	99	0	20	79	99	0	7	92	99	0	1	98	99	0	3	96	99	0	0	99	99	0	0	99	99	0
31	12	0	0	99	99	0	17	82	99	0	5	94	99	0	1	98	99	0	2	97	99	0	0	99	99	0	0	99	99	0
31	13	0	0	99	99	0	25	74	99	0	7	92	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
31	14	0	0	99	99	0	29	70	99	0	7	92	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
31	15	0	0	99	99	0	29	70	99	0	8	91	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
31	16	0	0	99	99	0	34	65	99	0	5	94	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
31	17	0	1	98	99	0	30	69	99	0	6	93	99	0	1	98	99	0	2	97	99	0	1	98	99	0	1	98	99	0
31	18	0	1	98	99	0	27	72	99	0	11	88	99	0	1	98	99	0	2	97	99	0	1	98	99	0	1	98	99	0
31	19	0	1	98	99	0	26	73	99	0	6	93	99	0	0	99	99	0	2	97	99	0	1	98	99	0	1	98	99	0
31	20	0	1	98	99	0	27	72	99	0	8	91	99	0	0	99	99	0	2	97	99	0	1	98	99	0	0	99	99	0
31	21	0	2	97	99	0	32	67	99	0	8	91	99	0	1	98	99	0	3	96	99	0	2	97	99	0	1	98	99	0
31	22	0	2	97	99	0	31	68	99	0	9	90	99	0	1	98	99	0	3	96	99	0	2	97	99	0	0	99	99	0
31	23	0	1	98	99	0	30	69	99	0	6	93	99	0	2	97	99	0	4	95	99	0	3	96	99	0	2	97	99	0
31	24	0	1	98	99	0	34	65	99	0	8	91	99	0	1	98	99	0	3	96	99	0	3	96	99	0	1	98	99	0
32	1	0	1	98	99	0	31	68	99	0	9	90	99	0	1	98	99	0	2	97	99	0	3	96	99	0	1	98	99	0
32	2	0	1	98	99	0	26	73	99	0	8	91	99	0	1	98	99	0	2	97	99	0	3	96	99	0	0	99	99	0
32	3	0	1	98	99	0	21	78	99	0	9	90	99	0	1	98	99	0	2	97	99	0	3	96	99	0	0	99	99	0
32	4	0	0	99	99	0	20	79	99	0	9	90	99	0	1	98	99	0	1	98	99	0	3	96	99	0	0	99	99	0
32	5	0	0	99	99	0	22	77	99	0	7	92	99	0	1	98	99	0	1	98	99	0	3	96	99	0	0	99	99	0
32	6	0	0	99	99	0	28	71	99	0	13	86	99	0	1	98	99	0	1	98	99	0	3	96	99	0	0	99	99	0
32	7	0	0	99	99	0	24	75	99	0	11	88	99	0	1	98	99	0	1	98	99	0	3	96	99	0	0	99	99	0
32	8	0	0	99	99	0	23	76	99	0	10	89	99	0	1	98	99	0	1	98	99	0	2	97	99	0	0	99	99	0
32	9	0	0	99	99	0	30	69	99	0	7	92	99	0	0	99	99	0	1	98	99	0	2	97	99	0	0	99	99	0
32	10	0	0	99	99	0	25	74	99	0	6	93	99	0	0	99	99	0	1	98	99	0	2	97	99	0	0	99	99	0
32	11	0	0	99	99	0	24	75	99	0	11	88	99	0	0	99	99	0	1	98	99	0	1	98	99	0	0	99	99	0
32	12	0	0	99	99	0	28	71	99	0	9	90	99	0	0	99	99	0	1	98	99	0	1	98	99	0	0	99	99	0
32	13	0	0	99	99	0	32	67	99	0	9	90	99	0	0	99	99	0	1	98	99	0	1	98	99	0	0	99	99	0
32	14	0	0	99	99	0	27	72	99	0	9	90	99	0	0	99	99	0	1	98	99	0	1	98	99	0	0	99	99	0
32	15	0	0	99	99	0	31	68	99	0	9	90	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
32	16	0	0	99	99	0	34	65	99	0	11	88	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
32	17	0	0	99	99	0	32	67	99	0	12	87	99	0	0	99	99	0	0	99	99	0	0	99	99	0	0	99	99	0
32	18	0	0	99	99	0	32	67	99	0	7	92	99	0	0	99	99	0	0	99	99	0	0	99	99	0	0	99	99	0
32	19	0	0	99	99	0	29	70	99	0	11	88	99	0	0	99	99	0	0	99	99	0	0	99	99	0	0	99	99	0
32	20	0	0	99	99	0	28	71	99	0	6	93	99	0	0	99	99	0	0	99	99	0	0	99	99	0	0	99	99	0
32	21	0	0	99	99	0	29	70	99	0	10	89	99	0	1	98	99	0	0	99	99	0	0	99	99	0	0	99	99	0
32	22	0	0	99	99	0	29	70	99	0	10	89	99	0	0	99	99	0	0	99	99	0	0	99	99	0	0	99	99	0
32	23	0	0	99	99	0	32	67	99	0	8	91	99	0	0	99	99	0	2	97	99	0	0	99	99	0	0	99	99	0
32	24	0	0	99	99	0	31	68	99	0	12	87	99	0	0	99	99	0	1	98	99	0	0	99	99	0	0	99	99	0
AVERAGES				98.577		0.000		72.736		0.000		90.811		0.000		98.603		0.000		97.632		0.000		98.143		0.000		98.799		0.000
			0.423		99.000		26.264		99.000		8.189		99.000		0.397		99.000		1.368		99.000		0.857		99.000		0.201		99.000	

MAINTENANCE REPORT FOR BASE FORT1 OF1325

---TIME---	----OF----	--REPORT--	C130 DON1 SY ALL UM		C130 DON1 SY ALL LS		C130 DON1 SY ALL FS		C130 PEROD SY ALL IS		SY																	
DAY	HR	MIN	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM
3	0	0	15	0	2	0	15	0	3	0																				
3	1	0	23	0	8	0	4	0	3	0																				
3	2	0	17	0	6	0	5	0	3	0																				
3	3	0	17	0	5	0	6	0	3	0																				
3	4	0	20	0	4	0	3	0	3	0																				
3	5	0	21	0	6	0	8	0	3	0																				
3	6	0	19	0	3	0	8	0	3	0																				
3	7	0	18	0	2	0	8	0	3	0																				
3	8	0	26	0	3	0	5	0	4	0																				
3	9	0	28	0	5	0	2	0	4	0																				
3	10	0	23	0	4	0	10	0	4	0																				
3	11	0	23	0	5	0	5	0	4	0																				
3	12	0	20	0	5	0	6	0	4	0																				
3	13	0	19	0	8	0	9	0	4	0																				
3	14	0	17	0	8	0	10	0	4	0																				
3	15	0	17	0	3	0	8	0	4	0																				
3	16	0	19	0	3	0	5	0	4	0																				
3	17	0	17	0	3	0	12	0	4	0																				
3	18	0	22	0	6	0	8	0	4	0																				
3	19	0	20	0	11	0	8	0	4	0																				
3	20	0	18	0	6	0	9	0	4	0																				
3	21	0	15	0	10	0	12	0	5	0																				
3	22	0	13	0	11	0	6	0	5	0																				
3	23	0	16	0	3	0	10	0	5	0																				
3	24	0	23	0	4	0	10	0	5	0																				
4	1	0	20	0	6	0	9	0	5	0																				
4	2	0	17	0	5	0	3	0	5	0																				
4	3	0	17	0	2	0	5	0	5	0																				
4	4	0	19	0	4	0	6	0	5	0																				
4	5	0	23	0	5	0	5	0	5	0																				
4	6	0	16	0	6	0	3	0	5	0																				
4	7	0	20	0	3	0	6	0	5	0																				
4	8	0	23	0	2	0	11	0	5	0																				
4	9	0	20	0	7	0	7	0	5	0																				
4	10	0	15	0	5	0	7	0	5	0																				
4	11	0	23	0	1	0	8	0	5	0																				
4	12	0	25	0	3	0	8	0	5	0																				
4	13	0	20	0	3	0	7	0	5	0																				
4	14	0	14	0	3	0	12	0	5	0																				
4	15	0	17	0	3	0	9	0	5	0																				
4	16	0	15	0	6	0	5	0	5	0																				
4	17	0	22	0	7	0	4	0	5	0																				
4	18	0	23	0	7	0	7	0	5	0																				
4	19	0	21	0	5	0	6	0	5	0																				
4	20	0	20	0	5	0	10	0	5	0																				
4	21	0	25	0	5	0	3	0	5	0																				
4	22	0	24	0	3	0	3	0	5	0																				
4	23	0	25	0	1	0	11	0	6	0																				

MAINTENANCE REPORT FOR BASE FORT1 DF1325

---TIME--- -----OF----- --REPORT--			C130 DON1 SY ALL UN		C130 DON1 SY ALL LS		C130 DON1 SY ALL FS		C130 PEROD SY ALL IS	
DAY	HR	MIN	IM	AM	IM	AM	IM	AM	IM	AM
30	24	0	23	0	7	0	7	0	5	0
31	1	0	19	0	5	0	8	0	5	0
31	2	0	15	0	5	0	2	0	5	0
31	3	0	19	0	2	0	1	0	5	0
31	4	0	15	0	2	0	10	0	4	0
31	5	0	19	0	3	0	7	0	3	0
31	6	0	17	0	3	0	6	0	3	0
31	7	0	23	0	8	0	7	0	3	0
31	8	0	19	0	6	0	8	0	3	0
31	9	0	17	0	7	0	8	0	3	0
31	10	0	17	0	2	0	11	0	3	0
31	11	0	23	0	2	0	5	0	3	0
31	12	0	21	0	2	0	4	0	3	0
31	13	0	24	0	4	0	7	0	3	0
31	14	0	21	0	4	0	11	0	3	0
31	15	0	19	0	7	0	9	0	3	0
31	16	0	19	0	9	0	8	0	3	0
31	17	0	20	0	9	0	4	0	4	0
31	18	0	16	0	3	0	11	0	4	0
31	19	0	18	0	5	0	6	0	4	0
31	20	0	13	0	7	0	7	0	4	0
31	21	0	17	0	8	0	7	0	5	0
31	22	0	19	0	6	0	7	0	5	0
31	23	0	25	0	5	0	3	0	6	0
31	24	0	22	0	6	0	7	0	6	0
32	1	0	19	0	2	0	10	0	6	0
32	2	0	15	0	6	0	4	0	6	0
32	3	0	14	0	3	0	5	0	6	0
32	4	0	17	0	3	0	4	0	6	0
32	5	0	20	0	4	0	4	0	6	0
32	6	0	17	0	5	0	10	0	6	0
32	7	0	16	0	3	0	9	0	6	0
32	8	0	14	0	3	0	8	0	6	0
32	9	0	16	0	5	0	9	0	6	0
32	10	0	17	0	5	0	3	0	6	0
32	11	0	19	0	2	0	6	0	6	0
32	12	0	20	0	1	0	13	0	6	0
32	13	0	16	0	9	0	8	0	6	0
32	14	0	17	0	6	0	6	0	6	0
32	15	0	19	0	7	0	6	0	6	0
32	16	0	18	0	6	0	9	0	6	0
32	17	0	15	0	8	0	9	0	6	0
32	18	0	17	0	10	0	5	0	6	0
32	19	0	15	0	6	0	10	0	6	0
32	20	0	21	0	9	0	2	0	6	0
32	21	0	21	0	6	0	6	0	6	0
32	22	0	19	0	4	0	8	0	6	0
32	23	0	25	0	3	0	9	0	6	0
32	24	0	20	0	3	0	9	0	6	0
AVERAGES			19.168	0.000	5.293	0.000	6.717	0.000	5.114	0.000

	SV																			
	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM	IM	AM
AVERAGES	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.CCO	0.000	C.COO	0.000	0.000	0.000	0.000	0.000	0.000	0.000

MACHINE TIME = 8.50 MIN.

FORM NINE INPUTS AND RELEVANT ERROR MESSAGES

FORM NUMBER	START TIME (DAY)	STOP TIME (DAY)	BASE NAME	AC, MISSION, OR RESOURCE TYPE		DESIRED STATISTIC	OUTPUT CODE	RUN IDENTIFIER
9	3	33	FORT1	PT	1	AVG	WORK	DF1325
9	3	33	FORT1	PT	2	AVG	WORK	DF1325
9	3	33	FORT1	PT	3	AVG	WORK	DF1325
9	3	33	FORT1	PT	4	AVG	WORK	DF1325
9	3	33	FORT1	PT	5	AVG	WORK	DF1325
9	3	33	FORT1	PT	6	AVG	WORK	DF1325
9	3	33	FORT1	PT	7	AVG	WORK	DF1325
9	3	33	FORT1	PT	8	AVG	WORK	DF1325
9	3	33	FORT1	PT	9	AVG	WORK	DF1325
9	3	33	FORT1	PT	10	AVG	WORK	DF1325
9	3	33	FORT1	PT	11	AVG	WORK	DF1325
9	3	33	FORT1	PT	12	AVG	WORK	DF1325
9	3	33	FORT1	PT	13	AVG	WORK	DF1325
9	3	33	FORT1	PT	14	AVG	WORK	DF1325
9	3	33	FORT1	PT	15	AVG	WORK	DF1325
9	3	33	FORT1	PT	16	AVG	WORK	DF1325
9	3	33	FORT1	PT	17	AVG	WORK	DF1325
9	3	33	FORT1	PT	18	AVG	WORK	DF1325
9	3	33	FORT1	PT	19	AVG	WORK	DF1325
9	3	33	FORT1	ALL		TOT	LAUNCH	DF1325

BEGIN BINARY TAPE SCAN
DAY 3 HAS BEEN SUCCESSFULLY COMPLETED

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DAY 31 HAS BEEN SUCCESSFULLY COMPLETED

THE FINAL EVENT OF THE SIMULATION OCCURS ON DAY 32 WHICH LIES WITHIN THE SCAN INTERVAL (3, 33).
OUTPUT FOR THE 32TH DAY WILL BE PRODUCED.

DF1325 BASE = 'FORTI ' 'PT 2' OUTPUT CODE = 'WORK ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 30 DAYS

NO. UNITS \ HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
37															1									
36																							1	1
35						1	1	1				1		1		1			1					1
34	3									1		2			1	2	2	1				2		
33	1				1	1	1	3	2	2	2	2	3			1	1	3	1		3		2	
32	3				1		2	1	3	3	2	2	4		2	1	3	3	5	1	4		2	3
31	2		1		4	1	2	1	2	2	1	2	2	2	2	2	3	5	4	4	4	5		4
30		1			2	4	1	3	1	1	4	2	1	6	6	3	7	2	2	3	2	1	6	4
29	5	2			2	4	5		3	2	3	8	2	2	2	1	1	4	3	7	1	7	3	3
28	2	6	5	3	5	4	2	6	3	6	5	3	4	5	2	7	1	3	4	5	5	6	3	3
27	4	4	2	2	4	2	5	4	5	3	4	1	3	5	2	3	4	2	1	4	3	2	4	2
26	3	4	2	4	6	4	3	4	3	2	2	2	3	3	2	2	4	4	5	3	4	3	2	2
25	5	2	5	5	3		2	4	4	3	1	1	2	1	2	3		2	2	2		2	2	3
24		5	2	2	1	2	3	1	1	3	1	1	4	2	2	2	1	1	2			1	1	1
23	1	2	5	8		3	2		3	1	1	1	2	1	3	1	2				2		1	1
22		3	1	2		2		2			4	2		1	3		1				1		3	1
21	1		3	2		2								1		1				1	1	1		1
20				1	1		1			1														
19			2																					
18		1	2	1																				
17																								
16																								
15																								
14																								
13																								
12																								
11																								
10																								
9																								
8																								
7																								
6																								
5																								
4																								
3																								
2																								
1																								
-0																								
MEAN	28.3		24.1		27.7		27.5		27.7		27.6		28.0		27.7		28.7		28.9		28.5		28.0	
MEAN		25.6		24.1		26.9		27.8		27.9		28.9		27.6		28.2		29.2		28.2		28.4		28.4
SIGMA	3.3		3.3		2.7		3.3		3.0		3.2		3.2		3.8		3.2		2.9		3.3		3.4	
SIGMA		2.6		2.4		3.5		3.2		3.3		3.4		2.9		3.3		2.7		2.3		2.7		3.5

DF1325 BASE = 'FORT1 ' 'PT 3' OUTPUT CODE = 'WORK ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
14	1								1			1					1	1						1
13	1	1	1	1	2		2	1		1	2	2	1	3	1		2		3		1	1	1	1
12	1			1	2	2	1	2	2	2		2	1	1	1	3	1	4		3		3	2	2
11	1	3	4	6	3	4	3	7	3	3	3	3	4	5	5	6	7	2	4	4	8	6	3	4
10	11	2	3	2	4	5	3	5	4	3	3	3	7	1	8	2	2	3	6	3	7	3	7	5
9	6	7	9	6	5	5	8	6	6	14	11	7	9	12	6	8	4	6	10	6	5	6	5	12
8	4	7	3	5	11	6	6	5	3	4	5	6	4	5	6	4	6	9	4	6	5	8	6	3
7	3	5	7	2	3	5	3	2	9	2	4	5	4	2	2	4	4	4	2	4	2	1	4	1
6	2	4	1	4		3		2	2			1		1		3	2	1		4	2	2		
5		1	1	3			3			1	2						1						2	1
4							1								1				1					
3																								
2			1																					
1																								
-0																								
MEAN	9.3		8.5		9.2		8.7		8.8		8.9		9.3		9.3		9.3		9.4		9.4		9.0	
MEAN		8.3		8.6		8.8		9.5		9.2		9.3		9.5		9.1		9.1		8.8		9.4		9.6
SIGMA	1.8		2.1		1.7		2.2		2.0		1.8		1.5		1.7		2.2		1.8		1.6		1.9	
SIGMA		1.8		2.2		1.7		1.7		1.6		2.0		1.8		1.8		1.9		1.9		1.8		1.7

DF1325 BASE = 'FORT1 ' 'PT 7' OUTPUT CODE = 'WORK ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
2									1			1	1			1								
1	9	7	2	2	4	3	4	8	6	8	7	6	6	8	8	4	5	3	3	3	5	7	7	11
-0	21	23	28	28	26	27	26	22	23	22	23	23	23	22	22	25	25	27	27	27	25	23	23	19
MEAN	0.3		0.1		0.1		0.1		0.3		0.2		0.3		0.3		0.2		0.1		0.2		0.2	
MEAN		0.2		0.1		0.1		0.3		0.3		0.3		0.3		0.2		0.1		0.1		0.2		0.4
SIGMA	0.5		0.2		0.3		0.3		0.5		0.4		0.5		0.4		0.4		0.3		0.4		0.4	
SIGMA		0.4		0.2		0.3		0.4		0.4		0.5		0.4		0.5		0.3		0.3		0.4		0.5

DF1325 BASE = 'FORT1 ' 'ALL ' OUTPUT CODE = 'LAUNCH' STATISTIC = 'TOT' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
21											1													
20																								
19				1			1																	
18				2																				
17				1							1			1		1								
16			1	1			1								1			1		1			1	
15				1		1	2			1	2			1	1	1					1			1
14				2		1	1		2		1		1	1	1	1		1	1			1	2	1
13			3	5	1			2	1	2		1	1	2	1	3	1	1	2	2	2	1	1	1
12			1	6		1	2	1		2	2	2	2	5	3	2	3	3	1	2		3	1	2
11		2	4	4	1	4		2	3	4	4	2	3	1		3	4	2	3	3	5	3	5	2
10		2	5	2	1		5	3	4	1	3		3	3	2	1	4	3	3	3	2	4	6	3
9		3	1	3	4	6	3	3	6	5	2	7	8	2	5	3	4	6	4	6	5	3	3	5
8		1	3	1	3	3	4	3	4	2	9	4	3	6	6	7	1	3	6	6	1	3	3	3
7	1	9	3	1	6	4	3	5	3	6		2	4	3	2		3	2	4	4	4	2	2	1
6		4	5		3	5	4	2	5	2	3	3	2	3	4	4	4	4	4	2	4	4	2	8
5		5	2		4	1	1	2	1	5	1	2	1	2	3	2	5	2	1	1	2	2	3	2
4	1	1			4	2	1	6			1	4	2		1	2	1	2	1		3	3		
3	1	2	2		3	2	2					2									1	1	1	1
2	3							1	1			1												
1	8	1																						
-0	16																							
MEAN	0.9	6.7	8.7	12.5	6.6	8.0	9.1	7.5	8.6	8.6	9.9	7.3	8.8	9.6	8.8	9.2	8.4	8.8	8.7	9.2	8.2	8.3	9.3	8.5
SIGMA	1.5	2.3	3.1	2.9	2.4	2.9	3.8	2.9	2.6	2.7	3.6	2.9	2.4	3.0	3.0	3.3	2.6	2.9	2.4	2.4	3.0	2.9	2.9	2.9

MACHINE TIME = 17.18 MIN.

DF1325 BASE = 'FORTL ' 'ALL ' OUTPUT CODE = 'LANDED' STATISTIC = 'TOT' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
21												1												
20																								
19					1			1																
18					2																			
17					1							1			1		1							
16				1	1			1								1			1		1			1
15	1				1		1	2			1	2			1	1	1					1		
14	1				2		1	1		2		1		1	1	1	1		1	1			1	2
13	2			3	5	1			2	1	2		1	1	2	1	3	1	1	2	2	2	1	1
12	2			1	6		1	2	1		2	2	2	2	5	3	2	3	3	1	2		3	1
11	2		2	4	4	1	4		2	3	4	4	2	3	1		3	4	2	3	3	5	3	5
10	3		2	5	2	1		5	3	4	1	3		3	3	2	1	4	3	3	3	2	4	6
9	4		3	1	3	4	6	3	3	6	5	2	7	8	2	5	3	4	6	4	6	5	3	3
8	3		1	3	1	3	3	4	3	4	2	9	4	3	6	6	7	1	3	6	6	1	3	3
7	1	1	9	3	1	6	4	3	5	3	6		2	4	3	2		3	2	4	4	4	2	2
6	8		4	5		3	5	4	2	5	2	3	3	2	3	4	4	4	4	4	2	4	4	2
5	2		5	2		4	1	1	2	1	5	1	2	1	2	3	2	5	2	1	1	2	2	3
4		1	1			4	2	1	6			1	4	2		1	2	1	2	1		3	3	
3	1	1	2	2		3	2	2					2									1	1	1
2		3							1	1			1											
1		8	1																					
-0		16																						
MEAN	8.6		6.7		12.5		8.0		7.5		8.6		7.3		9.6		9.2		8.8		9.2		8.3	
MEAN		0.9		8.7		6.6		9.1		8.6		9.9		8.8		8.8		8.4		8.7		8.2		9.3
SIGMA	3.0		2.3		2.9		2.9		2.9		2.7		2.9		3.0		3.3		2.9		2.4		2.9	
SIGMA		1.5		3.1		2.4		3.8		2.6		3.6		2.4		3.0		2.6		2.4		3.0		2.9

DF1325 BASE = 'FORT1 ' 'ALL ' OUTPUT CODE = 'READY ' STATISTIC = 'MIN' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
9			1																					
8		1																						
7			1																					
6			3																					
5		4	6																					
4		4	7																					
3		5	7																					
2		6	4																					
1		8	1																					
-0	30	2		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN	-0.0		4.1		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0	
MEAN		2.6		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0		-0.0
SIGMA	0.0		1.7		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
SIGMA		1.8		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0

DF1325 BASE = 'FORTI ' 'ALL ' OUTPUT CODE = 'READY ' STATISTIC = 'MAX' START TIME = 3 STOP TIME = 32 - 30 DAYS

NO. UNITS \ HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
21			1																					
20		1																						
19																								
18																								
17		1	1																					
16																								
15		1	1																					
14		1	3	2			1																	
13	1	3	3	1		1																		
12	4	6	5	2																				
11	3	3	5	2																				
10	3	4	3	5	1	2	1									1								
9	3	7	5	6		3	2		1	3	2		1	1	1	1				1	1			
8	5	2	2	4	3	1	1	5	4	7	4		2	4	3		1	2						
7	2			6	4	5	6	2	5	1	4	5	3	1	1		1	1	1	1		1	1	
6	5	1		1	8	7	3	8	9	4	3	3	4	3	2	4	1	1	2		1	1		1
5	2		1	1	4	3	3	6	3	6	5	4	7	6	4	1	2	3	2	3	2		1	2
4	1				8	6	9	3	4	3	4	4	7	6	4	6	3	2	3	3	4	2		
3	1				2	2	4	2	3	5	3	7	1	5	6	6	8	4	3	3	1	2	3	3
2								4	1		3	3	4	2	4	3	6	6	8	5	5	3	4	3
1										1	2	3		1	1	4	4	5	4	6	7	5	2	8
-0												1	1	1	4	4	4	6	7	8	9	16	19	13
MEAN	8.4		11.5		5.6		5.8		5.7		5.1		4.8		3.8		2.8		2.3		2.0		1.0	
MEAN		11.2		9.2		6.3		5.3		5.7		4.0		4.7		3.3		2.7		2.3		1.3		1.3
SIGMA	2.6		3.0		1.6		2.5		1.7		2.3		2.0		2.5		2.0		2.0		2.2		1.7	
SIGMA		2.8		2.2		2.3		1.9		2.2		2.0		2.2		2.5		2.4		2.2		1.9		1.7

OF1325 BASE = 'FORT1 ' 'ALL ' OUTPUT CODE = 'READY ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
16		1																						
15																								
14																								
13																								
12			1																					
11		2																						
10		1	3																					
9		2				1																		
8	3	7	5																					
7	3	3	10																					
6	5	6	2						1	1					1									
5	6	4	7	1	2	5	1	3	1	2			1	1										
4	7	2	1	3	5	2	2	4	1	3	3	2	2	1			2			1				
3	3	1	1	5	11	6	4	4	7	4	2	5	3		1			1	1			1		
2	2	1		9	8	4	5	10	9	8	3	5	7	5	6	2	3	3	1	3	2	1	2	1
1				11	4	11	11	7	7	5	10	8	10	9	10	14	7	4	8	3	1	3	3	1
-0	1			1		1	7	2	4	7	12	10	7	14	12	14	18	22	20	23	27	25	25	28
MEAN	4.9		6.9		2.8		1.5		2.0		1.1		1.5		1.0		0.7		0.4		0.2		0.2	
MEAN		7.1		2.0		2.6		2.3		2.0		1.4		0.9		0.6		0.4		0.4		0.3		0.1
SIGMA	1.9		1.9		1.1		1.3		1.4		1.3		1.3		1.3		1.1		0.7		0.5		0.6	
SIGMA		2.7		1.2		1.9		1.4		1.7		1.3		1.2		0.6		0.8		0.9		0.7		0.4

DF1325 BASE = 'FORTI ' 'ALL ' OUTPUT CODE = 'MAINT ' STATISTIC = 'MIN' START TIME = 3 STOP TIME = 32 - 30 DAYS

NO. UNITS \ HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
43																								2
42															1		1						1	
41	1					1								1			1			1			1	
40	2					1			1							1		3	1				1	1
39	3	1				2	1	1	2	2		1	2	1	1	1	3	4	5	4	5	5		1
38	3	1			1	3	3	1	1	1			2	1	1	5	2	3	1	2	7	3	3	5
37	2	1				1	2		1	2	3	4	1	4	5	3	3	3	6	5	4	7	5	4
36	5				1	2	1	5	2	2	6	5	3	2	3	2	2	3	3	4	1	5	6	3
35	5		1	1	2	1	3	2	6	2	4	6	7	3	3	3	6	4	1	2	7	4	4	2
34	4	2		1	4	2	4	4	3	4	2	5	4	3	3	5	5	6	4	4	1	4	4	6
33	1	2	2	2	1	5	2	6	4	5	4	1	2	4	4	4	3	2	5	4	2	1	1	3
32	3	7	3	1	3	4	8	4	3	5	1	2	3	3	4	2	1	1	3	1		1	2	
31	1	5	6	2	4	3	1	4	4	3	5	1	3	5	2	2	3		1	2	1			1
30		3	2	5	7	2	3	2	1	4	2	2	1	3	2			1		1	2		1	
29		1	2	5	3	2	1		2		1		1			1								1
28		1	4	3	2						1	2	1											
27		2	4	5		1	1	1			1	1											1	1
26		1	2	1	1										1	1								
25		2	2	2																				
24		1	1	1																				
23					1																			
22																								
21			1	1																				
20																								
19																								
18																								
17																								
16																								
15																								
14																								
13																								
12																								
11																								
10																								
9																								
8																								
7																								
6																								
5																								
4																								
3																								
2																								
1																								
-0																								
MEAN	35.9		28.9		31.2		33.4		33.9		33.3		34.1		34.2		35.4		35.5		36.0		35.6	
MEAN		30.9		28.8		33.9		33.3		33.5		33.9		33.9		34.7		36.0		35.5		36.3		35.7
SIGMA	2.6		3.1		3.0		2.9		2.8		2.8		2.8		3.1		2.8		2.6		2.6		3.0	
SIGMA		1.5		3.0		3.6		2.5		2.6		2.9		2.9		3.1		2.6		2.7		1.9		3.4

OF1325 BASE = 'FORT1 ' 'ALL ' OUTPUT CODE = 'MAINT ' STATISTIC = 'MAX' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
48		1																						
47					1	1			1		1	1			2									
46						1					1	1		1	2	1					1		4	
45	4	1			2		3	3	2	1	2	1	2	1	1	2	5	3	3		2	6	1	4
44	5				4	1	3	2	1	2	3	5	8	4		3	2	3	5	4	4	3	6	7
43	7	2	2		1	6	4	5	1	4	2	4	6	4	5	6	3	6	8	8	7	7	4	3
42	3	3	1		5	7	6	7	5	3	3	4	2	3	2	6	5	5	4	5	3	6	4	3
41	5	4	2	1	7	4	4	1	4	5	3	4	3	2	6	4	7	5	2	5	6	7	6	5
40	3	4		3	8	1	3	4	7	7	3	4	2	5	3	1	2	4	1	4	3		2	4
39	2	3	3	5		5	3	4	5	4	3	5	3	2	6	2	6	4	2	4	3	1	2	2
38	1	4	2	2	1	1	1	2	2	2	4	1	3	4	2	3			2		1		1	1
37		3	6	4		1	1		1	1	3		1	2		1			1					1
36		4	6	6	1	1	1	2			1			1					1					
35		1	1	3		1				1	1			1	1				1					
34			3	3					1							1								
33			1	2																				
32			1	1			1																	
31			1																					
30																								
29																								
28																								
27			1																					
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2																								
1																								
-0																								
MEAN	42.3	39.6	36.7	36.7	41.6	41.1	41.2	41.2	40.7	40.7	40.7	41.8	41.8	40.7	41.4	41.5	41.8	41.9	41.7	41.7	42.0	42.7	42.5	42.0
SIGMA	1.9	2.9	3.4	2.3	2.2	2.6	2.8	2.4	2.5	2.2	3.1	2.3	2.4	2.8	2.8	2.6	2.0	1.8	2.7	1.6	2.0	1.6	2.2	2.2

DF1325 BASE = 'FORT1 ' 'ALL ' OUTPUT CODE = 'MAINT ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
45												1			1									
44						1					1	1			1								1	1
43	2				1		2	2	1	1			1	1	2	1	2	1	1		2	2	2	2
42	5	1			4	1	1	2			2		3	2	1	3	1	5	5	2	1	3	1	6
41	3	1			2	3	4	2	2	3	4	4	2		2	2	4	4	5	4	8	6	6	1
40	5		1		4	3		2	5	1	2	4	3	5	3	5	5	6	2	3	3	4	2	1
39	2			1	5	4	7		3	2	2	7	3	2	4	6	5	3	4	7	5	5	5	8
38	2	3	2	1	4	2	4	10	4	5	2	5	3	5	2	3	4	1	5	4	4	2	4	4
37	7	3	2	3	5	3	3	3	2	6	7	3	3	4	5	3	4	7	1	2	3	6	4	2
36	2	4	1	2	1	2	4	3	7	7	3	4	7	5	3	4	4	2	3	4	3	2	2	3
35	1	3	3	3	2	3	2	4	4	3	3		4	3	3	1	1	1	3	4	1		2	1
34	1	4	4	3	2	4				1	1		1	1	2									1
33		5	4	6		2	1	1	1		1	1		1		1			1					
32		1	5	6		1	1	1		1				1	1								1	
31		1	2	1		1			1							1								
30		3	1	2			1				2													
29			3	2																				
28		1																						
27			1																					
26																								
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24			1																					
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4																								
3																								
2																								
1																								
-0																								
MEAN	39.1		33.0		38.6		37.9		37.5		37.5		38.0		38.3		38.9		38.9		39.2		38.9	
MEAN		34.6		33.5		37.1		37.9		37.3		38.8		37.6		38.4		39.3		38.4		39.4		39.3
SIGMA	2.5		3.4		2.4		3.0		2.6		3.3		2.5		3.1		2.1		2.6		2.1		2.7	
SIGMA		3.1		2.5		3.2		2.7		2.3		2.4		2.6		2.7		2.2		2.1		2.0		2.5

DF1325 BASE = 'FORT1 ' 'ALL ' OUTPUT CODE = 'AIR ' STATISTIC = 'MIN' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
13				1																				
12				1																				
11				3									1											
10				5									1		1	2			1				1	1
9				3			1			2			1		1	1	2		2	1	2		1	3
8				4		2	2		2	3	2		2	2	1	1	1	3	4	4	2		1	3
7				4		2	3		1	7		1	2	2	4	3	2	4	2	6	4	4	4	5
6	1		3	5	1	1	10	4	2	6	3	5	5	6	6	4	5	6	3	5	3	6	4	4
5			3	2	4	4	3	7	3	8	7	5	4	11	6	9	7	8	9	7	10	8	6	3
4	1		2		7	6	5	5	11	2	8	9	9	5	4	6	8	5	6	7	5	6	7	7
3	1		3	2	8	4	4	6	7	1	3	6	3	2	3	3	5	4	3		3	6	2	4
2	3		5		6	4	2	A	3	1	3	3	2	2	2	1					1		4	
1	7	2	6		4	4			1		3	1			2									
-0	17	28	8			3					1													
MEAN	0.9		2.2		3.1		5.2		4.1		4.0		5.3		5.1		5.1		5.7		5.4		5.0	
MEAN		0.1		8.0		3.5		3.8		6.0		4.1		5.0		5.4		5.3		5.9		4.9		5.8
SIGMA	1.4		2.0		1.3		1.8		1.6		1.9		2.2		2.1		1.7		1.9		1.7		2.0	
SIGMA		0.2		2.5		2.3		1.4		1.6		1.4		1.4		1.9		1.5		1.5		1.3		2.1

DF1325 BASE = 'FORT1 ' 'ALL ' OUTPUT CODE = 'AIR ' STATISTIC = 'MAX' START TIME = 3 STOP TIME = 32 - 30 DAYS

HOURS / NO. UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
21											1	1												
20				1																				
19				1	1		1	1																
18				1	2				1					1	1	1					2			
17				2	1		1				1	1		1		1	1							2
16	1		1	3	1		2	1		1	1				2	1		1	3	2		1	2	1
15	1			3	1	2	1	5	1	1	4	2		3	3	3	1		2		1	1		3
14			1	6	2	1	2	1	1	2	2	3	3	4	4	1	3	5	4	3		3	5	5
13	5		2	7	7	2		1	2	3	4	2	5	5	4	8	4	3	2	7	6	3	5	2
12	3	1	2		6	3	4	8	2	4	3	4	5	5	4	2	8	5	2	5	1	6	6	1
11	2	1	6	4	3	2	5		11	6	4	8	2	4	4	3	4	5	6	4	7	8	6	7
10	2	2	5	1	4	4	5	3	4	4	4	6	3	2	5	5	3	3	5	3	6	3	3	2
9	2	3	6		2	5	5	3	4	7	2	1	9	2	2	2	3	3	5	5	6	4		4
8	3	1	1	1		6	2	4		2	3	2	3			3	1	2			1		1	
7	3	9	4			3	2	1						3			1	3	1	1		1	1	1
6	6	4	2			1		2	4		1				1		1						1	
5	1	5				1																		2
4		2																						
3	1	2																						
2																								
1																								
-0																								
MEAN	9.4		9.9		12.8		11.3		10.6		12.1		10.8		12.3		11.5		11.7		11.3		11.9	
MEAN		6.8		14.0		9.8		11.4		11.0		11.9		12.1		12.1		11.1		11.7		11.5		11.8
SIGMA	3.3		2.3		2.6		2.9		2.6		3.1		2.0		2.5		2.3		2.4		2.4		2.2	
SIGMA		2.2		2.6		2.5		3.2		2.0		2.7		2.7		2.6		2.4		2.1		1.9		3.1

DF1325 BASF = 'FORTI ' 'ALL ' OUTPUT CODE = 'AIR ' STATISTIC = 'AVG' START TIME = 3 STOP TIME = 32 - 33 DAYS

HOURS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NO. UNITS																								
18				1			1																	
17				1							1													
16			1	1					1															
15				4		1	1			1	1			2		2								
14				2			1								1								1	1
13				4		1		2	1		2				3			1	2		1		1	1
12		1	3	8		3	1	1	1	2	3	2	3	5	2	2	1	1	3	3	2	1	2	3
11			2	2	2	3	3	3		1	3	1	4	4	2	4	3	3	2	6	4	5	3	1
10		1	4	4	1	1	3	3	8	8	3	3	4	3	5	3	6	5	2	4	3	2	5	4
9	1	4	3	2	3	2	3	1	4	5	4	5	1	3	3	4	4	3	4	7	3	5	5	8
8	2		4	1	5	5	6	4	4	1	3	4	6	5	4	5	7	3	6	3	4	6	3	2
7	1	9	2		5	5	4	7	4	6	4	8	6	4	2	3	3	6	5	4	9	4	6	
6	1	5	5		4	4	1	3	3	4	4	5	4	2	2	6	3	6	5	3	2	5	1	7
5	5	3	2		5	2	4	4	2	2			1	2	4	1	3	2	1		2	2	2	2
4	7	4	1		3	1	1	2	1		2	1	1		1								1	1
3	7	2	3		2	2	1		1			1			1									
2	4																							
1	2	1																						
-0																								
MEAN	4.1		8.0		6.7		8.6		8.4		9.2		8.4		8.7		8.4		8.6		8.5		8.8	
MEAN		6.3		12.5		8.1		7.9		8.6		7.8		9.4		8.9		8.2		9.2		8.3		6.6
SIGMA	2.0		3.1		2.1		3.3		2.7		3.0		2.2		2.9		1.9		2.2		2.1		2.4	
SIGMA		2.3		2.4		2.9		2.5		2.3		2.1		2.6		2.6		2.1		1.8		1.9		2.5

MACHINE TIME = 18.33 MIN.

0 0 0 0 0 0 0 0 0 0 PLACE OUTPUT REQUE ST CAR DS IN FRONT O
ERROR NO. 11 HAS OCCURED
RUN ID FRONT ON CARD DOES NOT AGREE WITH DF1325 FOR TAPE

Appendix F

TRANSACTION TAPE CONTENTS

The transaction tape(s) contains 78 selected records or transactions and their associated arguments or identities. As many as seven coded arguments may be shown for each transaction. In some cases, some arguments will be blank. A table of Transaction Tape argument codes is included here to aid the user in reading the Output Form 6 Dump Report. Additional information on transaction tape records, codes, and uses will be found in the Programmer's Guide.

Table 6

TRANSACTION TAPE CONTENTS

Transaction No./Definition	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10
1 Sortie lands at a base	Base no.	Acft type	Mission no.	Blank	Launch ID	No. landed
2 Acft arrives and goes to maintenance	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
3 Acft assigned to a base	Base no.	Acft type	Blank	Acft tail no.	Blank	1
4 Acft receives combat damage	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
5 Acft is lost	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
6 Acft air aborts	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
7 Sortie scheduled to fly acft in to replace lost or damaged acft	Base no.	Acft type	Mission no.	Blank	Launch ID	1
8 Sortie scheduled after mission failure	Base no.	Acft type	Mission no.	Blank	Launch ID	1
9 Sortie diverted after mission failure	Base no.	Acft type	New mission no.	Blank	Old mission no.	1
10 Sortie destroyed because all acft lost	Base no.	Acft type	Mission no.	Blank	Blank	1
11 Acft scheduled for upload for ALERT pool	Base no.	Acft type	Alert (200)	Acft tail no.	Blank	1
12 Acft scheduled for upload for deficit	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
13 Acft put into flyable pool	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
14 Acft removed from ready pool	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
15 Acft in maintenance release from sortie	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
16 Acft in flyable has standing failure	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
17 Acft removed from flyable and assigned to sortie	Base no.	Acft type	Mission no.	Acft tail no.	Launch ID	1
18 Acft removed from flyable and scheduled for upload	Base no.	Acft type	Mission no.	Acft tail no.	Launch ID	1
19 Acft removed from ALERT and assigned to sortie	Base no.	Acft type	Mission no.	Acft tail no.	Launch ID	1
20 Acft downloaded from pre-emption	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
21 Launch attempted on sortie	Base no.	Acft type	Mission no.	Blank	Launch ID	Max. acft on sortie
22 Sortie launch with min.--acft continues upload	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
23 Sortie not launched because acft not available	Base no.	Acft type	Mission no.	Blank	Launch ID	Max. acft on sortie
24 Sortie put in deficit list (saved)	Base no.	Acft type	Mission no.	Blank	Launch ID	Max. acft on sortie
25 Acft not launched because of bad weather	Base no.	Acft type	Mission no.	Blank	Blank	Min. acft on sortie
26 Sortie put in weather deficit list (saved)	Base no.	Acft type	Mission no.	Blank	Launch ID	Max. acft on sortie
27 Sortie cancelled	Base no.	Acft type	Mission no.	Blank	Launch ID	Max. acft on sortie
28 Sortie cancelled because of new makeup policy	Base no.	Acft type	Mission no.	Blank	Launch ID	Max. acft on sortie
29 Acft in ready has standing failure	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
30 End of maintenance--acft put in ready pool	Base no.	Acft type	Mission no.	Acft tail no.	No. ready for sortie	1
31 End of ALERT upload-acft put on ALERT	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
32 End of download or failure maintenance	Base no.	Acft type	Blank	Acft tail no.	Blank	1
33 This transaction number has not been used						
34 Acft previously uploaded is assigned to sortie	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
35 Acft scheduled for upload for ALERT	Base no.	Acft type	Alert (200)	Acft tail no.	Blank	1
36 End of run	Blank	Blank	Blank	Blank	Blank	Blank
37 Acft released from ALERT because of ALERT schedule	Base no.	Acft type	Alert (200)	Acft tail no.	Blank	1
38 Acft released from upload for ALERT because of schedule for ALERT	Base no.	Acft type	Alert (200)	Acft tail no.	Blank	1
39 Sortie launched	Base no.	Acft type	Mission no.	Launch ID	Next base	No. ready for sortie

Table 6 -- Continued

Transaction No./Definition	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10
40 Acft belonging to a sortie is launched	Base no.	Acft type	Mission no.	Acft tail no.	Next base	Launch ID
41 Upload for sortie scheduled to begin	Base no.	Acft type	Mission no.	Min. acft on sortie	Blank	Max. acft on sortie
42 Weather clears for sortie	Base no.	Acft type	Mission no.	Blank	Blank	Max. acft on sortie
43 Leftover maintenance started on uploaded acft	Base no.	Acft type	Mission no.	Acft tail no.	Maint. type	1
44 Previously uploaded acft is assigned to sortie	Base no.	Acft type	Mission no.	Acft tail no.	Launch ID	1
45 Acft has ground abort	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
46 Acft uploaded after pre-emption	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
47 Makeup period change	Blank	Blank	Mission no.	Blank	Old policy	New policy
48 Weather change	Base no.	Blank	Blank	Blank	Old weather	New weather
49 D/NA removed	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Quantity
50 Resource set to work	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Quantity
51 D/NA set up	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Quantity
52 End of resource requirement	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Quantity
53 This transaction number has not been used						
54 Acft removed from flyable pool	Base no.	Acft type	Mission no.	Acft tail no.	Launch ID	1
55 Resource requirement formed	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Blank
56 Work stopped on resource requirement	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Quantity
57 Resource won't work without PT	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Quantity
58 D/NA removed	Base no.	System no.	Mission no.	Acft tail no.	Resource no.	Quantity
59 Resource shift change	Base no.	Blank	Blank	Resource kind	Resource no.	Quantity
60 Acft pre-empted from ALERT pool	Base no.	Acft type	Alert (200)	Acft tail no.	Mission no.	1
61 Acft on ready pre-empted from sortie	Base no.	Acft type	Old mission no.	Acft tail no.	New mission no.	1
62 Acft pre-empted from upload for sortie	Base no.	Acft type	Old mission no.	Acft tail no.	New mission no.	1
63 Acft pre-empted from maintenance	Base no.	Acft type	Old mission no.	Acft tail no.	New mission no.	1
64 Acft pre-empted from upload for ALERT	Base no.	Acft type	Alert (200)	Acft tail no.	Mission no.	1
65 Sortie destroyed--end of sortie	Base no.	Acft type	Mission no.	Blank	Launch ID	Max. acft on sortie
66 Periodics due	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
67 Postflights due	Base no.	Acft type	Mission no.	Acft tail no.	Blank	1
68 ALERT acft has standing failure	Base no.	Acft type	Alert (200)	Acft tail no.	Blank	1
69 Work needed on a system	Base no.	Acft type	Mission no.	Acft tail no.	Maint. type	System no.
70 This transaction number has not been used						
71 Work started on a system	Base no.	Acft type	Mission no.	Acft tail no.	Maint. type	System no.
72 This transaction number has not been used						
73 Work stopped on a system	Base no.	Acft type	Mission no.	Acft tail no.	Maint. type	System no.
74 This transaction number has not been used						
75 Work ended on a system	Base no.	Acft type	Mission no.	Acft tail no.	Maint. type	System no.
76 This transaction number has not been used						
77 Conflicting systems	Base no.	Acft type	Mission no.	Acft tail no.	System 1	System 2
78 Maximum PT reached	Base no.	Acft type	Mission no.	Acft tail no.	Resource no.	Maint. type

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