Summary Report

SHUTTLE OPERATIONS
SIMULATION MODEL
PROGRAMMERS'/USERS' MANUAL

June 1972

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SHUTTLE OPERATIONS SIMULATION MODEL
PROGRAMMERS'/USERS' MANUAL

By
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ABSTRACT

The prospective user of the Shuttle Operations Simulation (SOS) Model is given sufficient information by this document to enable him to perform simulation studies of the Space Shuttle launch-to-launch operations cycle. The procedures used for modifying the SOS Model to meet user requirements are described. The various control card sequences required to execute the SOS Model are given in the text of the report. The report is written for users with varying computer simulation experience.

A description of the components of the SOS Model is included that presents both an explanation of the logic involved in the simulation of the Shuttle operations cycle and a description of the routines used to support the actual simulation.

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DEFINITION OF SYMBOLS

CA   Cards added
CD   Cards deleted
CPU  Central Processing Unit
GPSS General Purpose Systems Simulator
LUT  Launch Umbilical Tower
MSFC Marshall Space Flight Center
SOS  Shuttle Operations Simulation

Control Card Sequence--A sequence of UNIVAC 1108 instructions that represents the information required to execute a computer program.

Insert Card--A specific card type used to indicate the addition to or the deletion of the statements contained in the computer program.

Location Number--The UNIVAC 1108 computer assigned number to each statement of the computer program.

Mnemonic Inserts--The GPSS II language commonly uses numeric block identification numbers. The language can accept alphanumerics as block numbers by using specific control card sequences. The alphanumeric block identification numbers are referred to as mnemonic inserts.

Model--A representation of a process or concept that permits the manipulation of its parameters as a means of determining how the concept or process behaves in various situations.

Operational Cycle--Those functions performed on each Shuttle element after its previous launch in preparation for its succeeding launch.

Simulation--Represents the behavior of a physical system by means of a computer and a program. The computer and program serves to demonstrate system behavior under the influence of stimuli and permits system performance analysis.

Subprogram--A routine designed to solve a particular problem that becomes applicable to the problem only when appropriate parametric values are supplied.
DEFINITION OF SYMBOLS (Concluded)

Supplemental Fortran Instructions--A collection of Fortran routines, both user written and GPSS II language supplied, that implement and support the simulation of the Shuttle turnaround cycle.

System Model Description--A sequence of GPSS II language instructions that, upon implementation, simulate the Space Shuttle launch-to-launch operations cycle.

Turnaround Cycle--Starting with a Shuttle vehicle at launch, represents those operations performed to prepare the vehicle to the same state of preparedness for its next launch.
SECTION I. INTRODUCTION

A. Purpose

A model has been developed that analyzes the major events of the Space Shuttle launch-to-launch operations cycle. The formulation of a model describing the Shuttle operations cycle was initiated by isolating the operational characteristics of the elements involved in the operations cycle. Next, the logical rules governing the interaction of those operational characteristics were identified and formulated into a model describing the entire Shuttle launch-to-launch operations cycle. To further analyze the system, a simulation technique was employed as an effective method of testing and evaluating the proposed real system. The simulation technique employed allows statistical estimates of the operational parameters in the real system. Using the results of the simulation technique only allows comparison of the alternatives to the real system, and does not necessarily generate an optimal solution. The resulting model has been named the Shuttle Operations Simulation (SOS) Model and, as developed, is activity oriented and designed to simulate the major events of the Space Shuttle launch-to-launch operations cycle. The SOS Model serves as a tool for conducting operations and logistical analysis relevant to the definition and design phase of the Space Shuttle program.

The Space Shuttle operational cycle is described by the General Purpose Systems Simulator (GPSS) II computer language which is supported by special purpose Fortran subprograms. As written, the SOS Model is capable of projecting real life activities and functions which will probably occur during the operational phase of the Space Shuttle program. From the results of parametric studies, real life projection and logistical and operational requirements can be determined for the Space Shuttle system.

This document is written to describe the use and operations of the SOS Model. Sufficient data and instructions are given to the potential user of the SOS Model to enable him to modify the model to meet his particular needs. A complete description of the components of the SOS Model is also given within the text of this document.
B. Scope

This report provides instructions for the use and operation of the SOS Model. Supplemental information is given to allow user modifications to the program enabling the user to meet his particular requirements. Section II of this document contains general information relating to the SOS Model operations and a description of the necessary input data required for implementing the SOS Model. Section III describes the two basic components of the SOS Model, the System Model Description, and the Supplemental Fortran Instructions. Included in Section IV are the control card sequences used to execute the SOS Model along with a description of each control card sequence. The Appendices contain data to support the sections of this document.
SECTION II. SOS MODEL OPERATING INSTRUCTIONS

A. General Information

The SOS Model is designed for execution by the Marshall Space Flight Center (MSFC) UNIVAC 1108 EXEC VIII Computer System and requires approximately 32,800 words of core storage. The SOS Model consists of two major components: the System Model Description and the Supplemental Fortran Instructions. The System Model Description component consists of a sequence of GPSS II language instructions that describe the launch-to-launch operation cycle of the Space Shuttle flight elements and support hardware. The Supplemental Fortran Instructions are a combination of user-written Fortran subprograms and the standard subprograms supplied as part of the GPSS II language. The GPSS II supplied subprograms are responsible for implementing the instructions contained in the System Model Description.

The SOS Model is maintained as a catalogued drum file by the UNIVAC 1108 computer located at MSFC. The catalogued file contains both the Supplemental Fortran Instructions and the System Model Description which defines a baseline configuration of the operational elements and their time distribution parameters. The System Model Description, as catalogued, defines a specific operational concept for the Space Shuttle launch-to-launch operations cycle. Using the basic configuration, a number of Shuttle flight elements and support facility arrangements are capable of being studied. Therefore, the user must decide the type of analysis to be performed and select the parameters to be varied.

B. Temporary System Model Modification Procedure

If the catalogued version of the System Model Description of the SOS Model is not entirely satisfactory to the user, temporary modifications to the System Model Description can be accomplished by utilizing the procedure described below. In making temporary model modifications, it will be useful to refer to Appendix A which contains a printout of the System Model Description. This printout is fully documented with each of the GPSS II language system variables used in the System Model Description defined prior to the first GENERATE block. Section IV shows the appropriate placement of the Model modification cards in the control card sequences required to execute the SOS Model.
Each statement of the System Model Description is computer numbered with the number positioned to the extreme left of each statement. Appendix A contains a computer printout of the System Model Description showing the GPSS II statements, block numbers, and computer assigned location numbers. To temporarily modify the System Model Description, such as to change the Booster and Orbiter storage capacities or to change the number of launch pads, the insert card method is used.

The insert card method requires an insert card which contains any of the following: the location number of the statement to be replaced (Example 1), the sequential location numbers of the statements to be modified (Example 2), or the location number of the statement which modifications are to follow (Example 3). All insert cards are punched beginning with a minus sign in column one. The inserted statements must conform with GPSS II block type formats (Reference 2). The following examples illustrate the use of the insert card method for implementing temporary model modifications. The format for these examples is: original GPSS II statements from the System Model Description, solid line, insert cards and new GPSS II statements. A brief discussion follows each example.

Example 1:

```
U00051 2  CAPACITY  2
U00052 3  CAPACITY  2
U00053 4  CAPACITY  9

-51,51
  2  CAPACITY  1
-53,53
  4  CAPACITY  1
```

In Example 1 the storage capacities of both Booster maintenance and Booster storage, identified as location Nos. 51 and 53, respectively, were modified. The storage capacity of Booster maintenance was changed from two to one, and the Booster storage capacity was changed from nine to seven. Notice on each insert card that the location number is listed twice. This example illustrates a one for one replacement of the statement whose location was 53. It should be noted that all statements between the insert card and the succeeding insert card, if any, will replace the statement at location 53. Thus, it is possible to delete the statement at location 53 or to insert a finite number of statements in place of the statement at location 53.
Example 2:

```
000000  11  CAPACITY  2
000001  12  CAPACITY  2
000002  13  CAPACITY  9
```

Example 2 illustrates the modification procedure required when replacing all statements between and including two statement location numbers. The storage capacities of Orbiter maintenance, Orbiter test, and Orbiter storage were changed from two, two, and nine, respectively, to three, one and eight, respectively. The insert card contains the two numbers, inclusive, that identify the program segment to be modified. Using the above example and the discussion at the conclusion of Example 1, it is possible to delete all statements between and including two location numbers or to insert a finite number of statements in place of the statements between and including the indicated location numbers.

Example 3:

```
000000  31  CAPACITY  1
```

Example 3 illustrates how a number of statements can be inserted to follow a particular statement. It should be noted that only one location number is required on the insert card with this number preceeded by a minus sign.
Example 4:

Example 4 changes the System Model Description from the use of two launch pads to the use of three launch pads. By using the following QUEUE card, instead of the QUEUE card shown previously in this example, the System Model Description can be modified to limit the number of launch pads to one.

It should be noted that the maximum number of available launch pads is three.

C. Temporary Supplemental Fortran Instructions
Modification Procedure

Temporary modifications to the subprograms contained in the Supplemental Fortran Instructions can be accomplished by utilizing the insert card method outlined in the preceding discussion. Appendix B contains a printout of the Supplemental Fortran Instructions. Like the System Model Description, each statement of the Supplemental Fortran Instructions has a computer assigned location number. These location numbers are used in conjunction with the insert card method previously outlined to perform the temporary modifications required by the user of the SOS Model.

Mention of the modification procedure to the Supplemental Fortran Instructions has been made only for completeness. Thus, no effort has been made to include examples of modifications. Modifications to the Supplemental Fortran Instructions should be attempted by only the most experienced user. Section IV shows the control card sequence required when modifications are made.

D. Input Data Description

The data input requirements for the execution of the SOS Model consist of the two card types described below.
Card type one, which is commonly referred to as the comment card, is used by the SOS Model to place a desired comment or heading on the output summary tables resulting from the execution of the SOS Model. All 80 columns of the card may be used to obtain the heading for the output summary tables.

Card type two, which is commonly referred to as the data card, defines the traffic density to be scheduled, the number of Booster and Orbiter elements to be used, the number of active Launch Umbilical Towers (LUT's), the level of significance for the statistics collected by the Confidence Interval Option (Reference 3), and the random number generator seeds for both the Traffic Model Simulator and the Shuttle Operations Simulator. The user has the option of choosing any of the 5 available traffic densities, numbered consecutively from 1 to 5 which represent 20, 35, 45, 55, and 75 launches per year, respectively. The required format for the type two data card is:

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Traffic Density Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columns 2 through 5</td>
<td>Number of Boosters (right justified)</td>
</tr>
<tr>
<td>Columns 6 through 10</td>
<td>Number of Orbiters (right justified)</td>
</tr>
<tr>
<td>Columns 11 through 15</td>
<td>Number of LUT's (right justified)</td>
</tr>
<tr>
<td>Columns 16 through 20</td>
<td>Level of Significance for Confidence Interval Option (right justified)</td>
</tr>
<tr>
<td>Columns 61 through 70</td>
<td>Random Number Seed for the Traffic Model Simulator</td>
</tr>
<tr>
<td>Columns 71 through 80</td>
<td>Random Number Seed for the Shuttle Operations Simulator</td>
</tr>
</tbody>
</table>

Sample data cards can be seen in Section IV which contains the control card sequences used to execute the SOS Model.

The Fortran format associated with data card type two in SUBROUTINE HELP is:

```
FORMAT (I1, I4, 3I5, 40X, 2I10)
```

Following the second data card type, it is necessary to place a card which terminates the computer's execution of the current set of data. This is accomplished by placing (after the data card) a card that has the word END punched in columns seven through nine.
SECTION III. SOS MODEL DESCRIPTION

A. SOS Model Components

The SOS Model consists of two major components: the System Model Description and the Supplemental Fortran Instructions (Figure 1). The model, formed by analyzing the operational elements of the Space Shuttle turnaround cycle, was translated into the GPSS II language. The resulting set of instructions that describe the model are known as the System Model Description. When the System Model Description is implemented, the launch-to-launch operations cycle of the Space Shuttle vehicle and support hardware is simulated. The Supplemental Fortran Instructions of the SOS Model contain the routines which implement the instructions contained in the System Model Description. The routines contained in the Supplemental Fortran Instructions are mostly user written Fortran routines. However, there are several routines supplied by the GPSS II language that are included in the Supplemental Fortran Instructions.

Reference 1 describes the SOS Model. Sections III B and III C give more detailed data relating to the two major components of the SOS Model.

B. SOS Model System Description

The System Model Description component of the SOS Model is a sequence of GPSS II language instructions that allows the simulation of the operational facts concerning individual Shuttle processing facilities, LUT's, Orbiters, and Boosters. The necessary instructions are included to simulate the operations involved in the complete launch-to-launch cycle of the Space Shuttle. The operations in the launch-to-launch cycle are expected to have time distributions associated with their performance. In order to reflect this, frequency distribution functions have been estimated that approximate the expected real life time distributions for the performance of each operation. The estimated frequency distribution functions are used in conjunction with the Monte Carlo technique to provide a stochastic simulation of the launch-to-launch operations for the Space Shuttle.

The following is a brief description of the overall logic in the System Model Description. Figure 2 is a detailed flowchart depicting
FIGURE 2. SYSTEM MODEL DESCRIPTION FLOWCHART
the functional logic of the Shuttle turnaround cycle. In the ensuing
discussion, references are made to GPSS II system variables through
the use of parentheses. A brief definition of the commonly used system
variables is contained in Table I.

Using a GPSS II HELP block and Fortran SUBROUTINE HELP,
a data card is read which contains the number of Boosters, Orbiters,
and LUT's. Each of these values is placed in a separate storage
location (SAVEX) for use during the simulation.

The simulation proceeds by using a HELP block to determine
both a realistic first launch date and the parameters associated with
the mission scheduled for that date. The HELP block, through
Fortran SUBROUTINE MISSION, also establishes the time between
launches. Throughout the simulation, the launch intervals and the
parameters for both the current and the succeeding missions are
always known.

The earliest feasible storage exit time prior to launch is the
maximum processing time required to prepare the vehicle for launch.
The request for vehicle elements for the current mission is not made
until this time. The ready storage time prior to storage exit is
determined by subtracting both the current simulated clock time (C1)
and the maximum time required to process the vehicle from mate and
hookup initiation to launch (V5) from the launch date of the current
mission (XZ1). At the maximum processing time prior to the scheduled
mission, a request is made to determine if there is a Booster, Orbiter,
and LUT available in their respective storages. If all three elements
are available, their storage departure time is recorded and they are
placed in a queue for the mate and hookup operation (Q20).

The time a request may be delayed (V11) because of vehicle
element unavailability is the difference between the maximum and
minimum time to process the vehicle from mate and hookup initiation
to launch. If this time is exceeded, the mission is cancelled and a
record of the unavailable elements is kept. When all vehicle elements
are available and the maximum time delay has not occurred, the pad
availability is checked. The vehicle elements are removed from
storage, sent to the mate and hookup waiting line (Q2), and this
information is recorded. If a pad will not be available, the mission
is cancelled and the pad unavailability is recorded.

When the vehicle elements complete mate and hookup (S20),
the vehicle goes to the launch pad waiting line (Q21) where it is
# Table I. Definition of Commonly Used System Variables*

<table>
<thead>
<tr>
<th>Scope</th>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>Fn</td>
<td>Facility status, facility n</td>
</tr>
<tr>
<td></td>
<td>Sn</td>
<td>Storage occupancy, storage n</td>
</tr>
<tr>
<td>Queue</td>
<td>Qn</td>
<td>Queue length, queue n</td>
</tr>
<tr>
<td>System</td>
<td>Vn</td>
<td>Defined variable, numbered n</td>
</tr>
<tr>
<td></td>
<td>Xn</td>
<td>Stored value, cell n</td>
</tr>
<tr>
<td></td>
<td>Kn</td>
<td>Constant n</td>
</tr>
</tbody>
</table>

*A more complete description of the available GPSS II system variables can be found in Reference 2.*
assigned to the first available pad after the pads have been checked in sequential order. (After a vehicle has been assigned a pad, the pad is unavailable until either the vehicle has been launched and the pad refurbished or until the vehicle is removed from the pad.)

Once a pad has been assigned to a vehicle and a LUT, they are transferred to the pad from the launch pad waiting line (Q21). The vehicle is installed on the pad and precountdown preparations are performed (S22). The countdown time (V6) is compared to the time left to launch (V2) to determine if sufficient time remains to complete countdown. If excess time exists to launch, a built-in variable length hold (V3) is utilized. When insufficient time remains to meet the first launch window, the second launch window is tried.

Should a failure occur while the vehicle is in countdown, a check is made to determine if the failure can be corrected on the pad. If the failure cannot be corrected on the pad, the vehicle and LUT are removed from the pad (S25) and the pad is released for the use of another mission. The Orbiter is separated from the Booster and LUT (S30) and sent to maintenance (S11). The Booster is separated from the LUT (S19) and they are sent to their respective maintenances (S2, S18). If no failure occurs, the vehicle is launched. The LUT is removed from the pad (S17) and sent to maintenance (S18) and the launch pad is refurbished (S27) and released for future launches. The lift-off time, time between lift-off and separation, Booster flight time, and Orbiter flight time are recorded.

After the Booster flies back and lands, it enters the waiting line for Booster safing (Q1) and enters the safing facility (S1) when it becomes available. Upon completion of safing, the Booster enters the maintenance waiting line (Q2) and maintenance is performed. When maintenance is completed, the Booster enters storage and becomes available for future launch requests.

After the Orbiter has performed its mission, flown back to landing site and landed, it enters the waiting line for Orbiter safing (Q10). When the safing facility (S10) becomes available, the Orbiter is safed and transported to the Orbiter maintenance waiting line (Q11). After maintenance is completed on the Orbiter, it is transported to storage for future use.

When the above Shuttle operations cycle logic is simulated, three computer outputs that describe the simulation results are available to the user of the SOS Model. Sample computer outputs resulting from executing the SOS Model can be found in Appendices C, D, and E.
C. SOS Model Supplemental Fortran Instructions

The Supplemental Fortran Instructions component of the SOS Model is composed of user written Fortran routines and the GPSS II supplied routines. The instructions necessary to simulate the System Model Description of the SOS Model are supplied by the Supplemental Fortran Instructions. Figure 1 denotes the manner in which the System Model Description interfaces with the Supplemental Fortran Instructions.

The GPSSZ routine, as supplied by the GPSS II language, is the nucleus of the SOS Model and, as such, actually performs the operations required to execute the System Model Description which in turn simulates launch-to-launch operations cycle of the Space Shuttle. All of the GPSS II supplied routines are in binary format and cannot be changed, with the exception of the GPSSZ routine. Consequently, the GPSSZ routine is the only GPSS II supplied routine discussed within this document. At the discretion of the user, this routine may be altered through the use of Fortran parameter statements to increase or decrease the size limitations of the System Model Description. However, this should be attempted by only the most experienced of users.

Upon request, the GPSSZ routine calls either of two user written Fortran subroutines: TABLE1 and STAT. Both subroutines are used to read the System Model Description of the SOS Model as data. Both subroutines are described below.

TABLE1 is used to output a table of time distribution parameters for each of the operations simulated by the System Model Description. The output of the time distribution parameters is accomplished by reading each statement of the System Model Description until a comment card is located that has the key symbol IDST in columns 68 through 71, with columns 67 and 72 containing a blank. The program continues reading cards until a HELP card is found which is used to supply the desired information for the time distribution parameters. The program prints the title of the activity found on the comment card and the time distribution parameters found on the HELP card. Appendix C contains an example listing of the TABLE1 output. It should be noted that TABLE1 and its support routines of OUTPUT and REALN are not active during the dynamic simulation of the Space Shuttle operations cycle. Section IV gives the control card sequences required to obtain the TABLE1 output.
STAT is used to read and store headings to be in the output of confidence interval statistics. A detailed description of the use of the Confidence Interval Option is contained in Reference 3. Each statement of the System Model Description is read until a statement with the key symbol CONF in columns 67 through 70 is found. At such time, the heading contained on that statement is stored to be used during the output of the confidence interval statistics. Appendix E contains an example output from the Confidence Interval Options. STAT, like TABLEI, is not active during the dynamic simulation of the operations cycle of the Space Shuttle. A complete description of the use of SUBROUTINE STAT and of the Confidence Interval Option can be found in Reference 3.

The primary user written routine of the Supplemental Fortran Instructions is the HELP routine. The HELP routine enables the GPSS II user to perform operations that are not easily obtainable from using the GPSS II block types. Upon completion of the operations in the HELP routine, the calculated values are transmitted back to the System Model through a specified SAVEX (system variable Xn), which is a core storage location. The user employing the GPSS II HELP block must supply a Fortran subroutine called HELP which has five or less fixed point variables as arguments. These arguments are specified on the GPSS II HELP card in the X, Y, Z, Mean, and Mod field locations.

The launch requirements for the Space Shuttle and the Orbiter on-orbit mission requirements are supplied by SUBROUTINE MISSON which is supported by subprograms UNFRM, DICRET, TRIAG, and DRAND. To gain access to SUBROUTINE MISSON, one must use the HELP block in the GPSS II model as illustrated in the following example:

* CALL HELP TO GENERATE ATTRIBUTES OF NEXT LAUNCH
24 HELP K1 A11 A12 BOTH 10 25 X13 X10

Upon entering the HELP block, the program calls for SUBROUTINE HELP with its five fixed point variables. The proper form of SUBROUTINE HELP is shown below:

SUBROUTINE HELP(A1,K2,K3,K4,K5)

The first variable in the call statement, K1, is used by a Fortran computed GO TO statement within SUBROUTINE HELP to determine which Fortran user written routine is to be used to assist the operations of the GPSS II block types. In the above example, the value of K1 is used to call SUBROUTINE MISSON from SUBROUTINE HELP.
SUBROUTINE MISSION calculates the length of the next Orbiter mission, determines the mission type, computes the time until the next launch, and the time between launch opportunities. These values are calculated as different variables in SUBROUTINE MISSION and reset equal to K2, K3, K4, and K5 by SUBROUTINE HELP. The calculated values are then stored in the SAVEX locations of X11, X12, X13, and X15 for use by the GPSS II program.
SECTION IV. UNIVAC 1108 CONTROL CARD SEQUENCES USED IN THE EXECUTION OF THE SOS MODEL

A. General Discussion

Execution of the SOS Model can be accomplished by choosing the appropriate control card sequence of those described in this section. Multiple executions of the SOS Model can be accomplished by using the Systems Model Description as catalogued on the UNIVAC 1108 drum files. Two executions, both with and without the Confidence Interval Option and each simulating 500 Shuttle launch requests, can be obtained from one computer run with a resulting Central Processing Unit (CPU) time of approximately 3 minutes.

In selecting the appropriate control card sequence, it is assumed that the user has acquainted himself with the material and techniques presented in this document, and that he has defined his objectives sufficiently to enable an intelligent decision in the choice of control card sequences. The control card deck setups which follow are used in conjunction with the execution of the SOS Model. No effort has been made to enumerate all the possible control card sequences. Instead, only the most commonly used sequences are presented. A description of each individual control card is provided in Appendix F.

B. Multiple Executions of the SOS Model

The basic control card sequence used for executing the SOS Model, when no modification or additions are made to either the System Model Description or the Supplemental Fortran Instructions, is shown in Figure 3. The sequence (Figure 3) includes two of the options available to the user of the SOS Model. Both options are for the convenience of the user and the inclusion or deletion of either option has no effect on the results of the simulation.

The @SETC 4 control card placed before the @XQT control card generates the TABLEI output as described previously in this document. In order to produce the output table, it was necessary to place the System Model Description in the execution run stream. This was accomplished by the addition of the one extra @ADD MODEL control card placed immediately after the first @XQT control card.
FIGURE 3. MULTIPLE EXECUTION OF THE SOS MODEL WITHOUT MODIFICATIONS
The @SETC 3 control card placed before the second @XQT control card eliminates the printout of the model listing but allows the output of the summary results and the standard GPSS II output.

C. Modifications to the System Model Description

If the catalogued version of the System Model Description is not completely satisfactory to the user of the SOS Model, temporary model changes can be made through the use of the control card sequence shown in Figure 4.

The control card sequence shown in Figure 4 is used for multiple executions of the SOS Model. The sequence also encompasses the use of the TABLE1 output and the use of the @SETC 3 command. If only one execution is desired, the two @FIN cards should follow the first END card.

D. Modifications to the Supplemental Fortran Instructions

The user written routines of the Supplemental Fortran Instructions can be added to or modified in order to meet the user's requirements by utilizing the control card sequence shown in Figure 5. The use of this control card sequence enables the user to test both a modified user written routine and a newly developed user written routine by utilizing the catalogued drum files. The control card sequence (Figure 5) is an example of only one execution of the SOS Model; but, multiple executions are possible by utilizing the information previously supplied in this section. The procedure for modifying the user written routines entails the use of the insert card method described previously in conjunction with modifications to the System Model Description. More detailed information concerning the user written routines can be found in Appendix B.

E. Creation of an Update Tape

The control card sequence (Figure 6) is used to create a tape that includes all updates to both the Supplemental Fortran Instructions and the System Model Description. The created tape, which includes all updates, can then be used to update the catalogued drum file of the SOS Model. Great care should be taken when creating a tape to be used for updating the SOS Model. To ensure the proper operation of the updated tape, Figure 7 gives the control card sequence used to test the newly created tape.
FIGURE 4. MULTIPLE EXECUTION OF THE SOS MODEL WITH SYSTEM MODEL DESCRIPTION MODIFICATIONS
FIGURE 5. EXECUTION OF THE SOS MODEL WITH SUPPLEMENTAL FORTRAN INSTRUCTIONS MODIFICATIONS
**FIGURE 6. CREATION OF A TAPE FOR UPDATING THE SOS MODEL**

```plaintext
*RUN* /T SAMPLE 999999 PORTERB IN 25,3,200/5000
*ASG 1 TAPENAME IN SAVEU2
*ASG 1 GPSSE8 F2
*ASG 1 DUMMY9 F2
*ASG 1 MODEL F2
*COPY HSA MASTER GPSSE8, GPSSE8
*HUGP <<<PROGRAM FILE UPDATE NUMBER AAA>>>
***INSERT ALL SUBPROGRAM UPDATES AND INSERTIONS HERE***
*HUGP GPSSE8
*MAPXS GPSSE8, MAP, GPSSE8, MAPGPS
*HUGP <<<SOS MODEL UPDATE MSFC VERSION III-BBB>>> DATAFL DUMMY,MODEL
-1:1

ASSEMBLER JOB
***INSERT ALL MODEL MODIFICATIONS HERE***
-XXX
END
*SETC 2
*BRKPT PUNCH, DUMMY
*XUT GPSSE8, MAPGPS
*AUD MODEL
*BRKPT PUNCH
*DATAFL DUMMY, MODEL
-YY,YY

START 501
END
*REWIND TAPENAME
*COPOUT GPSSE8, TAPENAME
*COPY XM MODEL, TAPENAME
*ERS GPSSE8
*REWIND TAPENAME
*COPIN TAPENAME, IPF$,
*FREE TAPENAME
*HUGP <REVISION NUMBER CCC TO THE SYSTEM FILE>
*PRTT
*xutla SYSTEM MSFC5, LIST II
*FIN
```
A few words of explanation are needed before the user attempts to create a tape containing the inserts and additions to either of the major components of the SOS Model. In the control card sequence (Figure 6), it should be noted that there are two insert cards, one with a location number of XXX and one with a location number of YYY. Before attempting to create the tape, location number XXX needs to be replaced by the location number of the GPSS II START card. At this time in the control card sequence, the System Model Description is assembled with all the statements reassigned new location numbers. The START card has been temporarily replaced by an END card which prohibits the execution of the model and prevents an error occurring during the assembly process. Location number YYY needs to be the new location number of the inserted END card and is determined by knowing the total number of new cards added (CA) and the number of cards deleted (CD) from the current version of the model. The new insert number of the END statement is found by:

\[ YYY = XXX + CA - CD \]

At this time in the control card sequence, the START card permanently replaces the END card prior to storing the System Model Description on tape.

The sample control card sequence (Figure 7) is an example of one execution of the SOS Model. Multiple executions are possible by following the procedures outlined previously in this section. The numbers XXXXX on the @ASG, T TAPENAME card should be replaced by the number of the tape to be tested.

F. Mnemonic Inserts to the System Model Description

The control card sequence (Figure 8) is used when the modifications to the System Model Description contain mnemonic location references in the GPSS block types. Mnemonic references are helpful during the development of major modifications to the SOS Model when block location numbers are in a constant state of change. The presence of an insert card containing location number XXX should be noted in Figure 8. The number XXX should be changed to the location number of the START card before an attempt is made to execute this control card sequence. This will place an end card immediately after the START card as is required by mnemonic decks.
FIGURE 7. TEST OF AN UPDATE TAPE

**RUN** //T SAMPLE:999999,PORTERBIN225,3,150
**ASG** S TAPENAME:1,XXXX
**ASG** T GPSSE8,F2
**ASG** T FILE2,F2
**ASG** T MODEL,F2
**REWIND** TAPENAME
**COPY** IN TAPENAME:GIPSSE8.
**COPY** G TAPENAME:FILE2
**FREE** TAPENAME
**DATA** FILE2,MODEL
**END
**XUT** GPSSE8:MAPGPS
**ADD** MODEL.
**********COMMENT CARD********
**********DATA CARD**********
**END
**FIN
**FIN

FIGURE 8. EXECUTION OF THE SOS MODEL WITH MNEMONIC INSERTS TO THE SYSTEM MODEL DESCRIPTION

**RUN** //T SAMPLE:999999,PORTERBIN225,3,150
**ASG** S T GPSSE8,F2
**COPY** IN TAPENAME:GIPSSE8.
**ASG** S T MODEL,F2
*** INSERT ALL SUBPROGRAM UPDATES OR INSERTIONS HERE ***
**DATA** FILE2,MODEL
-1,1
**ASSEMBLER**
**JOB
***INSERT ALL MODEL MODIFICATIONS HERE***
-XXX
**END
**XUT** GPSSE8:MAPGPS
**ADD** MODEL.
**********COMMENT CARD********
**********DATA CARD********
**FIN
**FIN

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G. Example Production Deck and Explanation

Figure 9 is an example of an SOS Model production deck with temporary System Model Description modifications. The System Model portion was modified to change the statements at locations 51, 489, and 513. The modification at location 51 altered the capacity of the Booster maintenance facility and the modification at location 489 changed the number of available launch pads to 3. The modification at location 513 resulted in a mean time for countdown preparations of 2.0 days being associated with block number 80.

Two executions of the SOS Model are required to complete the case study. The @SETC 4 command is used to obtain a listing of the time distribution parameters contained in the Systems Model Description. The @SETC 3 command is used to prevent a listing of the System Model Description for the last execution of the program. An example of the TABLE1 output from the above run is found in Appendix C.

The first requested execution of the SOS Model uses traffic density four with the number of LUT's and launch pads fixed at three and three, respectively. The number of active Boosters and Orbiters for the first study are four and five, respectively. The random number seeds for the entire case study are constant. The random number seed for the Traffic Model Simulator is 3154267131 and the random number seed for the Shuttle Operations Simulator is 4339968911. (Note: Any ten digit odd number with the last digit not ending in five may serve as a random number seed.) The second execution uses the same study conditions as the first execution with the exception of the number of Orbiters being changed to four. Sample output of the summary table and the GPSS II output resulting from the above case study can be found in Appendix D.
FIGURE 9. EXAMPLE PRODUCTION DECK FOR THE EXECUTION OF THE SOS MODEL
REFERENCES


APPENDIX A. SYSTEM MODEL DESCRIPTION LISTING
| 000055 | *6 | IIIA 340 |
| 000056 | *7 | IIIA 350 |
| 000057 | *8 | IIIA 360 |
| 000058 | *9 | IIIA 370 |
| 000059 | 10. CAPACITY 1 | IIIA 380 |
| 000060 | 11. CAPACITY 2 | IIIA 390 |
| 000061 | 12. CAPACITY 3 | IIIA 400 |
| 000062 | 13. CAPACITY 4 | IIIA 410 |
| 000063 | 14. CAPACITY 5 | IIIA 420 |
| 000064 | *15. CAPACITY 10 | IIIA 430 |
| 000065 | 16. CAPACITY 2 | IIIA 440 |
| 000066 | 17. CAPACITY 2 | IIIA 450 |
| 000067 | 18. CAPACITY 2 | IIIA 460 |
| 000068 | 19. CAPACITY 1 | IIIA 470 |
| 000069 | 20. CAPACITY 1 | IIIA 480 |
| 000070 | *21. CAPACITY 2 | IIIA 490 |
| 000071 | *22. CAPACITY 7 | IIIA 500 |
| 000072 | *23. CAPACITY 2 | IIIA 510 |
| 000073 | *24. CAPACITY 2 | IIIA 520 |
| 000074 | *25. CAPACITY 2 | IIIA 530 |
| 000075 | *26. CAPACITY 2 | IIIA 540 |
| 000076 | *27. CAPACITY 2 | IIIA 550 |
| 000077 | *28. CAPACITY 2 | IIIA 560 |
| 000078 | *29. CAPACITY 1 | IIIA 570 |
| 000079 | *30. CAPACITY 1 | IIIA 580 |
| 000080 | *31. CAPACITY 1 | IIIA 590 |
| 000081 | *32. CAPACITY 1 | IIIA 600 |
| 000082 | * | IIIA 610 |
| 000083 | * | IIIA 620 |
| 000084 | * | IIIA 630 |
| 000085 | * | IIIA 640 |
| 000086 | * | IIIA 650 |
| 000087 | * | IIIA 660 |
| 000088 | * | IIIA 670 |
| 000089 | * | IIIA 680 |
| 000090 | * | IIIA 690 |
| 000091 | * | IIIA 700 |
| 000092 | * | IIIA 710 |
| 000093 | * | IIIA 720 |
| 000094 | * | IIIA 730 |
| 000095 | * | IIIA 740 |
| 000096 | * | IIIA 750 |
| 000097 | * | IIIA 760 |
| 000098 | * | IIIA 770 |
| 000099 | * | IIIA 780 |
| 001000 | * | IIIA 790 |
| 001010 | *10. ORBITER SAFING (O) | IIIB 280 |
| 001012 | *11. ORBITER MAINTENANCE (O) | IIIB 290 |
| 001013 | *12. ORBITER TO SYSTEMS TEST, TEST, TRANSPORT TO STORAGE (O) | IIIB 300 |
| 001014 | *13. ORBITER STORAGE | IIIB 310 |
| 001015 | *14. ORBITER BOOST TO ORBIT, PERFORM MISSION RETURN | IIIB 320 |
| 001016 | *15. LAUNCH UMBILICAL TOWER (ULT) STORAGE | IIIB 330 |
| 001017 | *16. REMOVE POST LAUNCH LUT FROM PAD | IIIB 340 |
| 001018 | *17. TRANSPORT LUT TO MAINT + REFURBISH/TEST, TRANSPORT TO STORAGE (O) | IIIB 350 |
| 001019 | *18. SEPARATE BOOSTER FROM LUT TRANSPORT BOOSTER TO MAINTENANCE | IIIB 360 |

**Note:** The definitions which are followed by the notation (O) refer to a queue which immediately precedes the storage. The definitions which are not followed by the notation (O) have no queue associated with them.
FUNCTION DEFINITIONS

I100140

I11100

I11120

I11130

SAXEY DEFINITIONS

I11140

I11150

I11160

NOTE A - UNLESS OTHERWISE STATED THE FOLLOWING DEFINITIONS

NOTE B - SAVESYS 10-11 AND 12 ARE FIRST USED TO INITIALIZE

THE NUMBER OF BOOSTERS, ORBITERS, AND LUTS RESPECTIVELY.

THEY ARE THEN USED AS DEFINED BELOW.

1 - BOOSTER AND ORBITER ARE AVAILABLE

2 - BOOSTER AND ORBITER ARE NOT AVAILABLE

3 - BOOSTER IS NOT AVAILABLE

4 - ORBITER IS NOT AVAILABLE

5 - BOOSTER AND/OR ORBITER AND/OR LUT NOT AVAILABLE

6 - TOTAL GENERATED LAUNCH REQUESTS

7 - ORBITER AND/OR LUT NOT AVAILABLE

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.000157  8  LUT NOT AVAILABLE WHEN BOOSTER AND ORBITER ARE AVAILABLE  IIIb 630
.000160  9  IIb 640
.000161  10  THE INPUT VARIABLE TO FUNCTION 1 (SEE NOTE B ABOVE)  IIIb 550
.000170  11  THE LENGTH OF THE NEXT GREATER MISSION (SEE NOTE B ABOVE)  IIIb 660
.000171  12  MISSION TYPE FOR NEXT MISSION (SEE NOTE B ABOVE)  IIIb 670
.000172  13  TIME UNTIL NEXT LAUNCH  IIIb 680
.000173  14  IIIb 690
.000174  15  TIME BETWEEN LAUNCH OPPORTUNITIES FOR NEXT MISSION  IIIb 700
.000175  16  LENGTH OF GREATER MISSION FOR NEXT MISSION  IIIC 30
.000176  17  MISSION TYPE OF CURRENT MISSION  IIIb 710
.000177  18  TIME UNTIL CURRENT LAUNCH  IIIb 720
.000178  19  TIME BETWEEN LAUNCH OPPORTUNITIES FOR CURRENT MISSION  IIIb 730
.000180  21  TIME OF FIRST LAUNCH OPPORTUNITY FOR CURRENT MISSION  IIIb 740
.000181  22  VEHICLES REMOVED FROM PAD (FAILURE ON PAD)  IIIb 750
.000182  23  VEHICLES REMOVED FROM PAD (CONTRAINTS NEXT LAUNCH)  IIIb 760
.000183  24  VEHICLES REMOVED FROM PAD (NO SECOND LAUNCH WINDOW)  IIIb 770
.000184  25  LAUNCHES MISSED DUE TO PAD UNAVAILABILITY  IIIb 780
.000185  26  THE NUMBER OF VEHICLES LAUNCHED AT AN ALTERNATE LAUNCH WINDOW  IIIb 790
.000186  27  LAUNCH WINDOW INDICATOR  IIIC 800
.000187  28  NUMBER OF LAUNCHES AT PRIMARY WINDOW  IIIC 810
.000188  29  NUMBER OF TIMES A VEHICLE WAS REPAIRED ON THE PAD  IIIC 820
.000189  30  TOTAL SUCCESSFULLY ACCOMPLISHED LAUNCHES  IIIb 830
.000190  31  IIIb 840
.000191  32  IIIC 61
.000192  33  IIIC 62
.000193  34  IIIC 63
.000194  35  AMOUNT OF TIME AFTER PRIMARY WINDOW AT WHICH LAUNCH OCCURS  IIIC 64
.000195  36  IIIA1500
.000196  37  IIIA1510
.000197  38  IIIA1520
.000198  39  IIIA1530
.000199  40  IIIA1540
.000200  41  IIIA1550
.000201  42  IIIA1560
.000202  43  IIIA1570
.000203  44  IIIB 860
.000204  45  IIIB 870
.000205  46  IIIB 880
.000206  47  IIIB 890
.000207  48  IIIB 900
.000208  49  IIIB 910
.000209  50  IIIB 920
.000210  51  IIIB 930
.000211  52  IIIB 940
.000212  53  IIIB 950
.000213  54  IIIB 960
.000214  55  IIIB 970
.000215  56  IIIB 980
.000216  57  IIIB 990
.000217  58  IIIB 1000
.000218  59  IIIB 1010
.000219  60  IIIB 1020
.000220  61  IIIB 1030
.000221  62  IIIB 1040
.000222  63  IIIB 1050
.000223  64  IIIB 1060

VARIABLE DEFINITIONS

1  - GROUND PROCESSING TIME FOR EACH ROOSTER  IIIB 860
2  - TIME OUT OF STORAGE-TIME IN STORAGE  IIIB 870
3  - TIME LEFT BEFORE LAUNCH (TO DETERMINE IF SUFFICIENT TIME  IIIB 880
4  - REMAINS BEFORE LAUNCH TO INITIATE AND COMPLETE COUNTDOWN)  IIIB 890
5  - TIME TO LAUNCH FROM EARLIEST POSSIBLE STORAGE EXIT-ELAPSED  IIIB 900
6  - TIME FROM EARLIEST POSSIBLE STORAGE EXIT  IIIB 910
7  - NOTE- IF FIRST LAUNCH WINDOW IS MISSED V2 WILL BE NEGATIVE.  IIIB 920
8  - THIS IS TAKEN INTO ACCOUNT IN LATER VARIABLES.  IIIB 930
9  - IIIB 940
10  - BEGINS COUNTDOWN WHEN ORBITER READY  IIIB 950
11  - FIRST LAUNCH OPPORTUNITY  IIIB 960
12  - TIME LEFT BEFORE LAUNCH-COUNTDOWN TIME)  IIIB 970
13  - TIME TO SECOND LAUNCH WINDOW  IIIB 980
14  - TIME BETWEEN FIRST AND  IIIB 990
15  - SECOND WINDOW  IIIB 1000
16  - MAXIMUM TIME TO PROCESS VEHICLE FROM MATE AND HOOKUP INITIATION  IIIB 1010
17  - TO LAUNCH. THIS ALSO REPRESENTS THE EARLIEST POSSIBLE STORAGE  IIIB 1020
000223 - EXIT FOR THE VEHICLE ELEMENTS.
000224 - (ASSIGN CONSTANT = SUM OF MAXIMUM TIMES IN EACH
000225 - PRELAUNCH OPERATION)
000226 - 6 - LENGTH OF COUNDTOWN
000227 - (PREASSIGNED CONSTANT)
000228 - 7 - GROUND PROCESSING TIME FOR EACH ORBITER
000229 - (TIME OUT OF STORAGE)-(FLIGHT TIME)+TIME IN STORAGE)
000230 - 8 - MINIMUM TIME TO PROCESS VEHICLE FROM MATE AND HOOKUP INITIATION
000231 - TO LAUNCH. THIS ALSO REPRESENTS THE LATEST POSSIBLE STORAGE
000232 - EXIT FOR THE VEHICLE ELEMENTS IF THE FIRST LAUNCH WINDOW IS
000233 - TO BE MET.
000234 - 9 - TIME VEHICLES ARE HELD IN READY STORAGE PRIOR TO EARLIEST
000235 - POSSIBLE INITIATION OF MATE AND HOOKUP RELATIVE TO THEIR MISSION
000236 - (LAUNCH TIME)-(CURRENT TIME)-(VARIABLE 5)
000237 - 10 - THE NUMBER OF SIMULATIONS FOR WHICH STATISTICS ARE COLLECTED
000238 - (ASSIGN CONSTANT = ONE LESS THAN NUMBER OF SIMULATIONS
000239 - SPECIFIED ON THE START CARD)
000240 - 11 - MAXIMUM TIME A REQUEST MAY WAIT FOR ANY VEHICLE ELEMENT
000241 - AFTER THE EARLIEST POSSIBLE MATE AND HOOKUP INITIATION.
000242 - (MAXIMUM TIME TO LAUNCH(V rises)+(MINIMUM TIME TO LAUNCH(V8)))
000243 - 12 - TIME TO BEGINNING OF FINAL COUNDTOWN FOR THE SECOND WINDOW
000244 - (TIME TO SECOND LAUNCH WINDOW)-(LENGTH OF COUNDTOWN)
000245 - 13 - LENGTH OF TIME BETWEEN EVEN AND ODD WINDOWS
000246 - (23.5 HOURS)-(TIME BETWEEN FIRST AND SECOND WINDOW)
000247 - 14 - TIME LEFT TO BEGINNING OF FINAL COUNDTOWN FOR LAUNCH AT THE
000248 - (LENGTH OF TIME BETWEEN FIRST WINDOW AND CURRENT WINDOW)+TIME
000249 - THE FIRST WINDOW WAS MISSED BY)-(LENGTH OF COUNDTOWN)
000250 - 15 - DIVIDE WINDOW NUMBER BY 2 DISCARD QUOTIENT AND RETAIN REMAINDER
000251 - IF VIS=0 THE WINDOW IS EVEN. IF VIS=1 THE WINDOW IS ODD
000252 - 1 VARIABLE MP11-P1+P2
000253 - 2 VARIABLE V5-M1
000254 - 3 VARIABLE V2-V6
000255 - 4 VARIABLE P7+P2
000256 - 5 VARIABLE X525
000257 - 6 VARIABLE K83
000258 - 7 VARIABLE MP11-P1+P4
000259 - 8 VARIABLE X3025
000260 - 9 VARIABLE V21-C1-V5
000261 - 10 VARIABLE K500
000262 - 11 VARIABLE V5-V8
000263 - 12 VARIABLE V4-V6
000264 - 13 VARIABLE K379-P7
...<<SQS MODEL UPDATE MSEC VERSION III-D>>

002279  14 VARIABLE X15+Y2+V6.
002280  15 VARIABLE X27+K2.
002281  
002282  
002283  
002284  
002285  
002286  
002287  
002288  1 - INDEPENDENT TOTAL FLIGHT TIME OF EACH BOOSTER AND ORBITER
002289  2 - TIME IN STORAGE FOR THE BOOSTER OF THE CURRENT MISSION
002290  3 - LENGTH OF CURRENT ORBITER MISSION
002291  4 - MISSION TYPE UNTIL REDEFINED AS TIME IN STORAGE FOR THE ORBITER
002292  5 - TIME TO THE CURRENT LAUNCH
002293  6 -
002294  7 - TIME BETWEEN LAUNCH OPPORTUNITIES FOR CURRENT LAUNCH
002295  8 - TIME FROM LANDING TO STORAGE ENTRY
002296  9 - DEFINES PAD TO BE SEIZED FOR CURRENT MISSION
002297  10 - INITIALIZATION OF THE NUMBER OF Boosters+Orbiters AND LUTs
002298  11 - IS MARKED SUCH THAT THE LEAVE STORAGE TO LAUNCH TIME CAN BE
002299  12 - IS MARKED SUCH THAT THE LEAVE STORAGE TO LAUNCH TIME CAN BE
002300  
002301  
002302  
002303  
002304  
002305  
002306  
002307  
002308  1 GENERATE 0 1 2
002309  2 HELP K7 X11 X10 3 X12
002310  
002311  
002312  
002313  
002314  3 ASSIGN 10 X10 4
002315  4 ENTER 17 P10 5
002316  
002317  
002318  
002319  
002320  
002321  
002322  
002323  7 ASSIGN 10 X12 8
002324  8 ENTER 16 P10 15
002325  
002326  
002327  
002328  
002329  
002330  
002331  
002332  
002333  
002334  

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000335
39 SAVEX 16 X11 10 IIIA2230
000336
10 SAVEX 17 X12 11 IIIA2240
000337
11 SAVEX 19 X13 12 IIIA2250
000338
12 SAVEX 20 X15 13 IIIA2260
000339
* INITIALIZE TIME TO LAUNCH CUMMULATOR WITH SIMULATION START TIME IIIA2270
000340
13 SAVEX 21 C1 BOTH 14 15 IIIA2280
000341
* DETERMINE IF FIRST LAUNCH REQ HAS ENOUGH TIME TO MEET ITS LAUNCH IIIA2290
000342
* COMPARE X18 GE V5 .16 IIIA2300
000343
* CALL HELP & DETERMINE A MORE REALISTIC FIRST LAUNCH REQ. IIIA2310
000344
* HELP K1 X11 X12 9 X13 X15 IIIA2320
000345
* RETURN AND REINITIALIZE SAVEX 16 THROUGH 21 IIIA2330
000346
* 16 LOGIC R3 17 IIIA2340
000347
* 17 TERMINATE IIIA2350
000348
* THE SIMULATION TRANSACTIONS ARE GENERATED FOLLOWING THIS POINT IIIA2360
000349
* GENERATE LAUNCHES BASED ON PROJECTED TRAFFIC REQUIREMENT IIIA2370
000350
* 18 GENERATE 19 IIIA2380
000351
* 19 GATE LR3 20 IIIA2390
000352
* 20 LOGIC 5? 21 IIIA2400
000353
* COUNT THE NUMBER OF LAUNCH REQUESTS IIIA2410
000354
* CALL HELP TO GENERATE ATTRIBUTES OF NEXT LAUNCH IIIA2420
000355
* 21 SAVEX G+ K1 22 IIIA2430
000356
* 22 HELP K1 X11 X12 23 X13 X15 IIIA2440
000357
* 23
000391  ---------------
000392  *
000393  *
000394  ---------------
000395  * ASSIGN ATTRIBUTES OF CURRENT LAUNCH TO TRANSACTION
000396  * 3 - LENGTH OF THE ORBITER MISSION
000397  * 4 - MISSION TYPE
000398  * 5 - TIME UNTIL NEXT LAUNCH
000399  * 7 - TIME BETWEEN LAUNCH OPPORTUNITIES
000400  *
000401  23 ASSIGN  3 X16  24
000402  24 ASSIGN  4 X17  25
000403  25 ASSIGN  5 X18  25
000404  26 ASSIGN  7 X20  27
000405  27 SAVEX  16 X11  28
000406  28 SAVEX  17 X12  29
000407  29 SAVEX  18 X13  30
000408  30 SAVEX  20 X15  31
000409  31 SAVEX  21+ X18  32
000410  32 SPLIT  33  37
000411  37 SAVEX  10 X13  34
000412  34 ADVANCE  10 X13  35  1 FN1
000413  35 LOGIC  R3  36
000414  36 TERMINATE
000415  *
000416  *
000417  *
000418  *
000419  * READY STORAGE QUEUE TIME INCLUDED IN TABLE 2 AND TABLE 22
000420  37 QUEUE  29  38
000421  *
000422  * ADVANCE UNTIL TIME TO MATE THE VEHICLES
000423  *
000424  38 ENTER  29  39
000425  39 SAVEX  10 V9  40
000426  40 ADVANCE  10 V9  41  1 FN1
000427  41 LEAVE  29  42
000428  42 QUEUE  31  43
000429  43 ENTER  31  44
000430  *
000431  44 MARK  BOTH 45  47
000432  *
000433  *
000434  *
000435  * CHECK IF TOO MUCH DELAY HAS OCCURRED TO MEET THE LAUNCH
000436  *
000437  45 COMPARE  M1 G V11  46
000438  46 LEAVE  31  25C
000439  47 DATE  SNE  BOTH 45  47
000440  48 DATE  SNE13  BOTH 45  47
000441  49 DATE  SNE16  BOTH 51  50
000442  *
000443  * CHECK TO SEE IF PAD IS AVAILABLE FOR THIS MISSION.
000444  * IF NOT GO TO MISSED LAUNCH STATISTICS SECTION
000445  *
000446  50 LEAVE  31  259
<table>
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**Notes:**
- IIC: Instructional Control Code
- A-11: Document Reference
- Page 78: Page Number
- Date 03/21/77: Document Date

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<CS5505 MODEL UPDATE MSFC VERSION III-0>  

000615  • THERE IS NOT ANOTHER LAUNCH OPPORTUNITY  
000616  • COUNT NUMBER OF VEHICLES REMOVED DUE TO NO FURTHER  
000617  • LAUNCH WINDOW THEN GO TO VEHICLE REMOVAL PATH  
000618  104 SAVEK 24+ K1  210  
000619  • THERE IS ANOTHER LAUNCH OPPORTUNITY  
000620  • SET SECOND LAUNCH WINDOW INDICATOR  
000621  • SECTION  
000622  • THIS THE SECONDARY PATH THROUGH THE LAUNCH LOGIC. ONLY VEHICLES  
000623  • WHICH CANNOT LAUNCH ON THE PRIMARY WINDOW FLOW THROUGH THIS  
000624  •  
000625  •  
000626  •  
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000629  •  
000630  105 SAVEK 27 K2  106  
000631  • TABULATE AMOUNT OF TIME LEFT TO FIRST WINDOW (MAY BE NEGATIVE)  
000632  • TABULATE 7 BOTH 107 111  
000633  • IS THERE TIME TO LAUNCH AT THE SECOND WINDOW  
000634  • TABULATE V9 GE V6  108  
000635  • THERE IS TIME TO LAUNCH AT THE SECOND WINDOW  
000636  • ESTABLISH LENGTH OF HOLD TO BEGINNING OF FINAL COUNTDOWN  
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000638  • FOR THE SECOND WINDOW  
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000646  • THERE IS NOT TIME TO LAUNCH AT THE SECOND WINDOW  
000647  • ESTABLISH LENGTH OF TIME BETWEEN FIRST AND SECOND WINDOW  
000648  • TABULATE 35 P7  
000649  • INCREMENT WINDOW INDICATOR TO NEXT WINDOW  
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000651  • DETERMINE IF THE WINDOW BEING TRIED IS EVEN OR ODD  
000652  • COMPAR V15 G KD  114  
000653  • THE WINDOW IS ODD.  
000654  • ESTABLISH LENGTH OF TIME BETWEEN FIRST AND SUBSEQUENT  
000655  • ODD WINDOWS  
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000659  • THE WINDOW IS EVEN  
000660  • ESTABLISH LENGTH OF TIME BETWEEN FIRST AND SUBSEQUENT  
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**SOS MODE UPDATE MSFC VERSION III-D**

*FAILURE HAS NOT OCCURRED DURING TIME ON PAD. INITIATE LAUNCH OF SHUTTLE***

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<tr>
<td>001048</td>
<td>* INSERT HELP CARDS IN THIS BLOCK TO REQUEST CONFIDENCE INTERVALS</td>
<td>1110 60</td>
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<tr>
<td>001049</td>
<td>* THESE ARE THE FIVE DUMMY ADVANCE CARDS USED AS PLACE HOLDERS AND</td>
<td>1110 70</td>
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<tr>
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<td>* ARE REPLACED BY HELP CARDS WHEN REQUESTING CONFIDENCE INTERVALS</td>
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<td>1110 190</td>
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**Notes:**
- Lines marked with an asterisk (*) indicate optional or conditional commands.
- Comments are denoted by `|` and provide additional context or explanations for the code sequence.
- The table structure is designed to facilitate quick navigation and understanding of the flowchart's logic.
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<th>Line</th>
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<td>1 - TIME FROM LANDING TO STORAGE ENTRY (BOOSTER)</td>
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<td>001078</td>
<td>2 - STORAGE TIME (BOOSTER)</td>
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<td>001081</td>
<td>3 - GROUND PROCESSING TIME (BOOSTER)</td>
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<td>4 - FLOATING HOLD TIME BETWEEN COMPLETION OF ALL PRECOUNTO</td>
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<td>OPERATIONS AND THE INITIATION OF FINAL COUNTDOWN FOR THE FIRST WINDOW</td>
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<td>5 - FLOATING HOLD TIME BETWEEN COMPLETION OF ALL PRECOUNTO</td>
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</tr>
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<td>FOLLOW TO THE FIRST WINDOW</td>
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<td>THE AMOUNT OF TIME A SUCCESSFUL REQUEST SPENT WAITING FOR</td>
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<td>VEHICLE ELEMENTS</td>
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<td>VALUES IN THE TABLE INDICATE THE AMOUNT OF TIME PAST THE WINDOW</td>
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<td>AMOUNT OF TIME AFTER PRIMARY WINDOW LAUNCH OCCURED AT</td>
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<td>INDICATES THE NUMBER OF LAUNCHES AT EACH WINDOW</td>
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**Number of Simulations to be Performed**

IIIIB1960

**Note - See Variable 10**

IIIIB1980

**Start**

IIIIB1990
APPENDIX B. SUPPLEMENTAL FORTRAN INSTRUCTIONS
DESCRIPTION AND LISTING

As the SOS Model evolved, it became apparent that additional Fortran subprograms were required to supplement the basic instructions provided by the standard GPSS II language. These subprograms, which are referred to as the user written routines, are utilized during the dynamic simulation of the Shuttle operations cycle by means of the GPSS II HELP block. The subprograms utilized in the SOS Model are listed after the descriptions in this Appendix. The function of the Fortran subprogram HELP is described below:

- HELP serves as the interfacing routine between the GPSS II instructions and the user written subprograms. The HELP subprogram is accessed by a GPSS II HELP block containing a control variable located in the X field. The HELP subprogram serves four general functions in support of the SOS Model: 1. generating random deviates from the available probability distribution; 2. collecting statistics on the time of stage storage; 3. transferring control to other special purpose subprograms; 4. providing scheduling data for each launch. A description of each segment of subprogram HELP is shown in Table B-I. Transfer to the segments from within the HELP subprogram is accomplished by utilizing the control variable in a Fortran computed GO TO statement and selecting the proper HELP segment.

The subprograms described below are responsible for the generation of the random numbers used in the user written subprograms.

- DRAND and DRAND1 serve as two independent random number generators. The random number generation is accomplished by modulo division. The random number seeds for these two subprograms are defined by variables ISEED and ISEED1, respectively. (No support routines called.)

The following subprograms are used in determining deviates from various statistical distributions to be used by the GPSS II instructions to accurately simulate the Shuttle operations cycle.
**TABLE B-I. SUBPROGRAM HELP SEGMENT DESCRIPTION**

<table>
<thead>
<tr>
<th>Segment</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Generates the attributes of the next launch including mission type, time between launches, Orbiter mission length, and the time between the first and second launch opportunity. (Support routine called: MISSON.)</td>
</tr>
<tr>
<td>2</td>
<td>Calls a special purpose subprogram that prepares information obtained from GPSS II system variables for use in the Confidence Interval Option. (Support routine called: DUMMY.)</td>
</tr>
<tr>
<td>3</td>
<td>Generates the deviates from a triangular distribution. (Support routine called: TRIAG1.)</td>
</tr>
<tr>
<td>4</td>
<td>Generates the deviates from a normal distribution. (Support routine called: RNORM.)</td>
</tr>
<tr>
<td>5</td>
<td>Saves the clock time when a stage has completed processing and has entered storage. (No support routine called.)</td>
</tr>
<tr>
<td>6</td>
<td>Computes the elapsed time a stage has spent in storage based on a first in first out basis. (No support routines called.)</td>
</tr>
<tr>
<td>7</td>
<td>Prepares the model for a new case study by reading the input variables and the comment card title. (No support routines called.)</td>
</tr>
<tr>
<td>8</td>
<td>Generates the deviates for a two-parameter exponential distribution. (Support routine called: EXPO.)</td>
</tr>
<tr>
<td>9</td>
<td>Generates the deviates for a lognormal distribution. (Support routine called: RLOGN.)</td>
</tr>
<tr>
<td>10</td>
<td>Outputs the summary table. Repeated calls are required to complete the entire table. (Support routine called: PRINT.)</td>
</tr>
<tr>
<td>11</td>
<td>Generates the deviates for a constant distribution. (No support routines called.)</td>
</tr>
<tr>
<td>12</td>
<td>Generates the deviates for a uniform distribution. (Support routine called: UNFRM1.)</td>
</tr>
<tr>
<td>13</td>
<td>Generates the deviates for a beta distribution. (Support routines called: BETADP and PERTXF.)</td>
</tr>
</tbody>
</table>
• BETA DP generates the deviates for a beta distribution. (Support routines called: GAM and PERTXF.)

• DICRET produces deviates from a discrete probability distribution. This subprogram permits the model to generate random values from data that has either a 1/3 or 1/2 probability of selection. (Support routine called: DRAND.)

• EXPO generates the deviates for a two parameter exponential distribution. (Support routine called: DRAND1.)

• GAM generates the deviates for a gamma distribution. (Support routine called: DRAND1.)

• PERTXF converts three input parameters, namely the minimum expected time, the most likely expected time and the maximum expected time to the mean and standard deviation of a beta distribution. (No support routines called.)

• RLOGN calculates the deviates for a lognormal distribution by exponentiating the normal deviate. The mean and standard deviation of the lognormal distribution are obtained from the calling subprogram. (Support routine called: RNORM.)

• RNORM calculates the deviates for a normal distribution. The mean and standard deviation of the routine are obtained from the calling subprogram. (Support routine called: DRAND1.)

• TRIAG and TRIAG1 produce the random deviates for a triangular distribution function. These two routines are identical and independent. (Support routines called: DRAND and DRAND1, respectively.)

• UNFRM and UNFRM1 produce random deviates from a uniform distribution. The two routines are identical and independent. (Support routines called: DRAND and DRAND1, respectively.)

It should be noted that subprograms DRAND, TRIAG, and UNFRM are used exclusively by the MISSION subprogram to provide a separate and unique sequence of random numbers.

The subprogram described below is responsible for scheduling the Shuttle launches.

• MISSION is responsible for determining the parameters associated with each Shuttle launch. MISSION is used to
determine a realistic time between launches for the Shuttle system. For each launch, the mission type is defined with the possible types including Shuttle payload placement, space station logistics, tug placement and fuel supplies, Department of Defense, and others, including space rescue. The MISSION subprogram also determines the Orbiter mission length which depends on mission type, the date of the next launch, and the time between the first and second launch opportunity. (Support routines called: DICRET, TRIAG, UNFRM.)

The following subprograms are not active during the dynamic simulation of the Shuttle operations cycle, but were developed for the convenience of the user. These subprograms are used to produce the TABLE1 output which summarizes the activity time distributions defined in the System Model Description of the SOS Model.

- OUTPUT determines the type of distribution for each Shuttle processing event and outputs this information in tabular form. (Support routine called: REALN).
- REALN converts alphanumeric data into the real data used by the OUTPUT routine. (No support routines called.)
- TABLE1 scans the System Model Description for the titles of the various processing operations and for their associated time distributional parameters. (Support routine called: OUTPUT.)

The following subprograms are used when confidence intervals are requested for specific statistics generated during the dynamic simulation of the Shuttle operations cycle. Reference 3 gives detailed information on the Confidence Interval Option.

- DUMMY controls the sampling rate used in obtaining statistical observations for those statistics specified by the Confidence Interval Option. The subprogram also assures the proper collection of the statistics specified by the user. (Support routine called: SAMPLE.)
- SAMPLE makes statistical observations during the simulation on the statistics specified by the user to have confidence intervals calculated for them. At the conclusion of the simulation, a summary table is outputted that contains a descriptive heading and a corresponding confidence interval for each of the statistics specified by the user to be collected. (Support routine called: STDV.)
- **STAT** is used to read and store descriptive headings to be used in the output of confidence interval statistics. Each card of the System Model Description is scanned for the appropriate headings. This subprogram is not active during the actual simulation. (No support routines called.)

- **STDV** calculates the sample standard deviation for the statistics specified for confidence interval calculations. (No support routines called.)

The subprogram described below is responsible for a summary output of the statistics collected during the simulation of the Shuttle operations cycle.

- **PRINT** is a collection of various write statements which print out a summary table of various simulation parameters at the end of each computer run. The values of these parameters are transmitted to the routine through two different transfer methods. The first method transfers the values of certain GPSS II system variables (table means, facility utilization and queue times) to PRINT as arguments of the subroutine. These arguments are defined on the HELP blocks at the end of the model. The other method permits the user to retrieve the output parameters through the values stored in the GPSS II common block variables. These tables are subscripted arrays and are defined in the GPSS II reference manual. The routine is executed by a series of call statements that subsequently execute each statement of the subprogram. (Support routine called: SAMPLE.)

The GPSS II Mainline (GPSS2) routine is the only GPSS II symbolic element deck available for modification by the SOS Model user. It serves as the mainline master control for the complete GPSS II program. The GPSS2 routine is a software package available upon request from the operators of the UNIVAC 1108 EXEC VIII System. The routine is described as follows:

- **GPSS2** contains the option to specify the size of the network and its associated variables by means of the Fortran parameter statements contained within the routine. The total program core size is determined by the limits of the model description as defined by the values assigned to the Fortran parameter statements. Complete instructions and other information on making changes is contained in the comments of the routine listing. (Major GPSS II routines USES, BLOCKD, SETERR, INPROC, EXECUT, PUTOFF,
ASSEMB; other support routines called: RCONWN, CSFREQ, LETTER, STAT, and TABLE1.)
FUNCTION DCRET(JP)

1 COMMON /HEPL/PARAM(7,3),LL,ISEED,ISEED1,ISTONE(2,10),IS(2)
2 RNUM,DRAUS(1,ISEED)
3 IF (PARAM(JP,2)*EQ.0.5) GO TO Z0
4 IF (PARAM(JP,1)*EQ.0.333160 TO 10
5 DCRET=PARAM(JP,1)
6 RETURN
7 10 DCRET=PARAM(JP,2)
8 RETURN
9 15 DCRET=PARAM(JP,3)
10 RETURN
11 20 IF (RNUM*LE.0.5) GO TO 30
12 DCRET=PARAM(JP,1)
13 RETURN
14 30 DCRET=PARAM(JP,1)
15 RETURN
16 END
FUNCTION GRAND(NR)

IF(NR<15,.A)

IF(NR<3,16231)

IF(NR>34359738367)

RETURN

END

GRAND1
56  K4=JEKS(26)
57  CALL SAMPLE(K1,K2,K3,K4,K5)
58  C
59  K2=K
60  K4=JEKS(31)
61  CALL SAMPLE(K1,K2,K3,K4,K5)
62  C
63  K2=K
64  K4=JEKS(4)
65  CALL SAMPLE(K1,K2,K3,K4,K5)
66  C
67  K2=K
68  K4=JEKS(2)
69  CALL SAMPLE(K1,K2,K3,K4,K5)
70  C
71  K2=K
72  K4=JEKS(8)
73  CALL SAMPLE(K1,K2,K3,K4,K5)
74  C
75  K2=K
76  K4=JEKS(25)
77  CALL SAMPLE(K1,K2,K3,K4,K5)
78  C
79  K2=K
80  K4=JEKS(22)+JEKS(23)+JEKS(24)
81  CALL SAMPLE(K1,K2,K3,K4,K5)
82  C
83  IF OPTION 1 HAS BEEN REQUESTED, RETURN
84  IFIX2+EQ+DJ RETURN
85  C
86  IF OPTION 2 HAS BEEN REQUESTED, COLLECT STATISTICS FOR REQUEST 1
87  K2=K10
88  K3=K7
89  K4=K7
90  KS=K5
91  CALL SAMPLE(K1,K2,K3,K4,K5)
92  RETURN
93  C
94  IF OPTION 2 HAS BEEN REQUESTED, COLLECT STATISTICS FOR THE
95  REMAINING REQUESTS
96  I
97  K2=K2+9
98  CALL SAMPLE(K1,K2,K3,K4,K5)
99  RETURN
END

FILE E
EXPO

FILE T
EXPO

FURFUR HAIB-06/30-13:31
FUNCTION EXP0(J)
    COMMON /HEPL/PARAM(17,3),LL,ISEED,ISEED1,ISTOMEZ,(0),IS(2)
    RNUM=DRAND1(ISEED1)
    EXP0=PARAM(J,1)+PARAM(J,2)*ALGIRUM
    RETURN
END

RNGS.P GAM

"FUPUR MA 18-06/30-13:13"
 FUNCTION GAM(ALPHA) GAMA 19
   K = ALPHA GAMA 20
   FX = K GAMA 21
   GAM = 0. GAMA 22
   IF (K LT 2) GAMA 23
     6 IF (K LT 20) GO TO 30 GAMA 24
     7 PROD = 1.0 GAMA 25
     8 DO 10 I = 1, K GAMA 26
     9 10 PROD = PROD * RAND(1,ISEED1) GAMA 27
    10 GAM = -ALOG(PROD) GAMA 28
    11 7 D = ALPHA * FX GAMA 29
    12 IF (D EQ 0) GAMA 30
    13 11 IF (D EQ 1) GAMA 31
    14 20 X = 1.9 GAMA 32
    15 20 Y = 1.9 GAMA 33
    16 13 A = 1.0/9 GAMA 34
    17 B = 1.0/(1.0 - D) GAMA 35
    18 X = RAND(1,ISEED1) GAMA 36
    19 Y = RAND(1,ISEED1) GAMA 37
    20 IF (I EQ 1) GAMA 38
    21 15 W = X/Y GAMA 39
    22 22 Y = -ALOG10(RAND(1,ISEED1)) GAMA 40
    23 GAMA = GAMA + W GAMA 41
    24 12 RETURN GAMA 42
    25 30 GAM = ALPHA GAMA 43
    26 RETURN GAMA 44
    27 END GAMA 45

GPDG, P GPSS2
GPRM, S GPSS2
FURMUR 1A 18=06/30=13:31
**GPSS II VERSION F LEVEL 3**

1. THE GENERAL PURPOSE SYSTEM SIMULATOR II FINAL USER'S MANUAL IS UP-1429, AND THE FINAL GPSS II CODING FORM IS UP-1431, BOTH OBTAINABLE FROM MILYSENG ASSY., VIA A SALES HELP REQUEST.

2. THROUGH THE LOCAL UNIVAC MANAGER.

3. THE FOLLOWING NOTES ARE INTENDED TO SUPPLEMENT THE

4. UPDATE INFORMATION PRESENTED IN THE GPSS USER MANUAL....

5. 1. EACH TIME AN ERROR OCCURS A WARNING TO THIS EFFECT

6. IS PRINTED, BUT EXECUTION IS NOT Halted.

7. 2. IF JOBTAPE AND LOAD ARE USED THE NUMBER OF TRAN- 

8. ACTIONS ON TAPE MUST BE AT LEAST ONE GREATER THAN 

9. THE NUMBER REQUIRED FOR THE EXECUTION OF THE JOB

10. 3. EXECUTION USING NON-TEMP RESULTS IN A SEGMENTATION

11. OF GPSS II.

12. 4. THE STANDARD UPPER LIMITS OF FIELDS GIVEN IN APPENDIX 3 

13. OF THE GPSS USER MANUAL MAY BE CHANGED. THE METHOD FOR 

14. MAKING SUCH CHANGES HAS BEEN REVISED. SEE NOTE 7 FOR AN

15. EXPLANATION.

16. 5. THE EXECUTIVE COMMAND, NSEG 2, WILL CAUSE AN 

17. EXECUTION TO BE PUNCHED OUT. 

18. 6. UPON DETECTION OF AN ERROR COMMAND, ALL JOBTAPES WHICH WERE 

19. REFERENCED BY A WRITE BLOCK WILL HAVE AN END-OF-FILE PLACED 

20. ON THEM. WRITING OF THESE TAPES WILL NOT OCCUR.

21. 7. THE METHOD USED TO CHANGE TABLE SIZES FOR THIS 

22. VERSION IS TO CHANGE THE VALUES GIVEN IN THE 

23. ***FURTHER PARAMETER STATEMENTS WHICH FOLLOW THE 

24. ***TABLE TYPE REFERRED TO BY A FORTRAN PARAMETER 

25. ***STATEMENT IS GIVEN IN THE LINE PRECEDING THAT

26. ***STATEMENT.

27. C**H LUCKS

28. PARAMETER NHMAX = 400

29. C**FACILITIES

30. PARAMETER NFMAX = 15

31. C**STORAGES

32. PARAMETER NSMAX = 50

33. C**QUEUES

34. PARAMETER NQMAX = 50

35. C**USER CHAINS

36. PARAMETER NHMAX = 1

37. C**LOGIC SWITCHES

38. PARAMETER NLMAX = 25

39. C**SAVEX LOCATIONS

40. PARAMETER NLSMAX = 50
**FUNCTIONS**

PARAMETER NFMX = 10

**TABLES AND QABLES (COMBINED TOTAL)**

PARAMETER NMAX = 30

**COMMON CORE AREA**

PARAMETER NCMAX = 1000

**TRANSACTIONS (MAXIMUM ALLOWED IN SYSTEM AT ANY GIVEN TIME)**

PARAMETER NMAX = 100

**PARAMETERS PER TRANSACTION (MUST BE LESS THAN OR EQUAL TO 30)**

PARAMETER NPRMAX = 20

*******THE FOLLOWING CARDS ARE NOT TO BE DELETED, NOR CHANGED UNLESS SO NOTED IN COMMENT CARDS*******

PARAMETER NPRM = (NPRM + 1) / 2

A  NPX2 = NPRM / 2 * NPRM / 2

B  -NPRM / 2 -NPRM / 2

C  +NPRM / 2 +NPRM / 2

D  NPX4 = NPRM / 2 * NPRM / 2

E  -NPRM / 2 -NPRM / 2

F  NPX8 = NPRM / 2 * NPRM / 2

G  +NPRM / 2 +NPRM / 2

H  NP2 = NPX2 + NMX + 1 = NPX2

J  NPX8 = NPX4 + NMX + 1 = NPX6

I  NPX6 = NPX4 + NMX + 1 = NPX6

K  NP10 = NPX10 + NMX + 1 = NP10

L  NP20 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

M  NP30 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

N  NP40 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

O  NP50 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

P  NP60 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

Q  NP70 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

R  NP80 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

S  NP90 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

T  NP100 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

U  NP300 = (NPRM / 2) * NMX + 1 = (NPRM / 2)

V  COMMON/NODE1/J1 (NBMX)

W  COMMON/NODE2/J2 (NBMX)

X  COMMON/NODE3/J3 (NBMX)

Y  COMMON/NODE4/J4 (NBMX)

Z  COMMON/NODE5/J5 (NBMX)
COMMON LPRI(128), LPRI*CT(128)
COMMON ICARR(70), NTYPES(43), KGATE(12), KCONTY(7), KSY(50),
1 KCMP(6), KESEL(7), LKX(6)
COMMON/STATS/ISN
COMMON/STATS/ISN
COMMON/STATS/NHEAD
DIMENSION HEAD(IHEAD)
DIMENSION FORD(S(1))
EQUIVALENCE(JMORD(1), JORD(1))
EQUIVALENCE(K(1), KSY(1)), (K(2), KSY(2)), (K(3), KSY(3)), (K(4), KEQ(4)),
1 (K(5), KSTORS(1), K(6), KJUS(1), K(7), KVAR(1), K(9), KLOGIX(1)),
1 (K(9), KESES(1), K(11), KFNST(1), K(12), KTRANS(1), K(13), KTRANS(1)),
3 (K(17), KTRANS(1), K(18), KTRANS(1), K(19), KTRANS(1), K(20), KTRANS(1)),
4 (K(1), KTRANS(1), K(2), KTRANS(1))
EQUIVALENCE(K(79), KPRKAM), (K(171), INDFLO), (K(172), INDEND),
1 (K(151), IFATAL)

C C***THE FOLLOWING NOTES PROVIDES TO THE USER OF THE MFSC-SOS MODEL
C THE NECESSARY INFORMATION CONCERNING WSETC COMMAND CONTROL OPTIONS.
1 A WSETC 3 COMMAND PLACED BEFORE THE WENT CONTROL CARD WILL
2 ELIMINATE THE PRINTOUT OF THE MODEL LISTING ONLY SUMMARY
1 RESULTS AND STANDARD GSS OUTPUT WILL BE PRINTED.
1 A WSETC S COMMAND PLACED BEFORE THE WENT CONTROL CARD WILL
2 GENERATE THE LAYOUT CONTAINING THE DISTRIBUTION TIME PARAMETERS
3 FOR THE DIFFERENT PROCESSING OPERATIONS.
1 NOTE THAT THE MODEL MUST BE ADDED TO THE RUN STREAM IN ORDER
2 TO PRODUCE THIS OUTPUT.
EXAMPLE DECK SET-UP:
WSETC 4
WSETC 5
WSETC 6
WSETC 7
EXAMPLE DECK SET-UP:
WSETC 5
WSETC 6
WSETC 7
DATA CARD 1
DATA CARD 1
DATA CARD 1
END
DIMENSIONICL(14), JCLCD(14), ICCLCD(14)
DATA ICLCD/MAS(1), DUMMY, F * /,
1 JCLCD/FRKPRT PRINT/DUMMY * /,
2 KCLCD/FRKPRT PRINT * /
CALL KCMPD(INPRT)
CALL KCMPD(INPRT)
CALL KCMPD(INPRT)
IF(NPRINT.EQ.5) CALL STAT
IF(NPRINT.EQ.3) GO TO 5
CALL "CSFR1(ECTLC)"
CALL "CSF01(ECTLC)"
9 CALL USES
KPARAM = 0PRH
KIT = 5
KOT = 6
KRAND = 122070312
KNODES = 0HMAX
KEGS = 0FMAX
KSTORS = 0SMAK
KGUES = 0HMAX
KVARS = 0YMAL
KLOGIX = 0LSMAX
KEKSES = 0SSLMAX
KFNS = 0FMAX
KTABLES = 0TMAX
KDORDS = 0CCMAX
KTRANS = 0IMAX
KUSER = 0UNMAX
USCH
CALL SETERR
10. CALL INPROC(120,420).
20 IF (INFLPO *NE. 0) CALL FLOX
C TO PERMIT EXECUTION OF A JOB WITH ILLEGAL INPUT CARDS, OR TO
C PERMIT EXECUTION FOLLOWING A RESET OR CLEAR CARD WHERE A GPSS II
C ERROR HAS ALREADY OCCURRED, REMOVE THE FOLLOWING CARD
250 IF (IFATAL *NE. 0) GO TO 10
251 IF (INPATH *NE. 0) GO TO 10
252 IF (INPATH *NE. 310) GO TO 25
C CALL CSFR3(ECTLC)  
254 CALL LETTER
255 25 CALL EXECUT.
256 CALL PUTOUT
257 GO TO 10
258 CALL ASSEMB
259 GO TO 10
END
HELP
HELP
FURPUR MA18-06/30-13131
SUBROUTINE HELP(K1,K2,K3,K4,K5)
COMMON /HELP/PARAM(1,1),LL,ISEED,ISTORE(120),IS(12)
COMMON /HELP/MK/MK2,MK3,MK4,MK5
25 CONTINUE
C****GENERATE REQUIREMENTS FOR NEXT LAUNCH
C****CONTINUE
CALL MISSON(NP1,NP2,NP3,NP4,NP5,MODEL)
K2=NP1
K3=NP2
K4=NP3
K5=NP5
RETURN
C****COLLECT STATISTICAL DATA FOR CONFIDENCE INTERVALS
CALL DUMMY(K1,K2,K3,K4,K5)
RETURN
C****GENERATE DEVIATE FOR TRIANGULAR DISTRIBUTION
PARAM(1,1)=K2
PARAM(1,2)=K3
K5=TRIAG(1)
RETURN
C****GENERATE DEVIATE FOR NORMAL DISTRIBUTION
PARAM(1,1)=K2
PARAM(1,2)=K3
K5=RNORM(1)
K5=K4
RETURN
C****STORE THE TIME THAT THE BOOSTER (K2=1) OR ORBITER (K2=2) WAS
C****PUT IN STORAGE.
C****COMPUTE THE TIME THAT THE BOOSTER OR ORBITER WAS PUT IN STORAGE
C****BASED ON FIRST-IN-FIRST-OUT.
5 IS(K2)=IS(K2)+1
K=IS(K2)
ISTORE(K2,K)=K
RETURN
C****CONTINUE
ISTORE(K2,1)=ISTORE(K2,1)+1
RETURN
...
HELP

56 7 CONTINUE HELP 580
57 C HELP 590
58 C*****INITIALIZE MISSION SUBROUTINE AND PREPARE FOR NEW CASE HELP 600
59 C HELP 610
60 LL=0 HELP 620
61 C HELP 630
62 C*****READ CASE STUDY COMMENT CARD HELP 640
63 C HELP 650
64 READ(1,0)(TITILE(1),I=1,20) HELP 660
65 ) 101 FORMAT(I20A1) HELP 670
66 C HELP 680
67 C*****READ THE VERSION CODE OF THE TRAFFIC MODEL TO BE SIMULATED HELP 690
68 C*****READ IN THE NUMBER OF BOOSTERS, ORBITERS & LUTS HELP 700
69 C*****READ IN THE LEVEL OF SIGNIFICANCE HELP 710
70 C*****READ IN THE RANDOM NUMBER SEED FOR MISSION MODEL PROGRAM(ISEED) HELP 740
71 C*****READ IN THE RANDOM NUMBER SEED FOR DISTRIBUTION GENERATORS(ISEED) HELP 750
72 C READ(1,0)(MODEL,NB00S,NORB1,NLUTS,NCONF,ISEED,ISEED1) HELP 760
73 103 FORMAT(11,14,315,40X,2(I10) HELP 770
74 IS(11)NB00S HELP 780
75 IS(12)NORB1 HELP 790
76 K2=NB00S HELP 800
77 K3=NORB1 HELP 810
78 K=NLUTS HELP 820
79 NSEED=ISEED HELP 830
80 NSEED=ISEED1 HELP 840
81 RETURN HELP 850
82 8 CONTINUE HELP 860
83 C HELP 870
84 C C*****GENERATE DEVIATE FOR A TWO PARAMETER EXPONENTIAL DISTRIBUTION HELP 880
85 C HELP 890
86 C HELP 900
87 PARAML,1,1=K2 HELP 910
88 NBETA=K3*K2 HELP 920
89 PARAML,2=NBETA HELP 930
90 K=EXPO(1) HELP 940
91 RETURN HELP 950
92 9 CONTINUE HELP 960
93 C C*****GENERATE DEVIATE FOR THE LOG NORMAL DISTRIBUTION HELP 970
94 C HELP 980
95 C HELP 990
96 F2=FLOAT(K2)/1000. HELP 1000
97 F3=FLOAT(K3)/1000. HELP 1010
98 PARAML,1,2=2*LOG(1+F2*F3+1.1) HELP 1020
99 PARAML,1,1=LOG(2.5*PARAML,1,2)**2 HELP 1030
100 K=LOG(1)+1000 HELP 1040
101 RETURN HELP 1050
102 10 CONTINUE HELP 1060
103 C HELP 1070
104 C*****PRINT OUT OF SUMMARY TABLE HELP 1080
105 C HELP 1090
106 INCALL=CALL=1 HELP 1100
107 CALL PRINT(INCALL,K2,K3,K4,K5) HELP 1110
108 RETURN HELP 1120
109 11 CONTINUE HELP 1130
110 C HELP 1140
111 C****THIS FUNCTION PERMITS THE ADVANCE BLOCK TO BE INCREMENTED BY A
HELP

112   C*****CONSTANT
113   C*****TRANSFER THE VALUE OF ARGUMENT K2 TO ARGUMENT KS
114   C
115   C GPSS OUTPUT CAN BE OBTAINED FROM EITHER THE K4 OR KS FIELDS
116   K5=K2
117   K4=K2
118   RETURN
119   12 CONTINUE
120   C
121   C*****GENERATE DEVIATE FOR UNIFORM DISTRIBUTION
122   C
123   A = K2
124   B = K3
125   C GPSS OUTPUT CAN BE OBTAINED FROM EITHER THE K4 OR KS FIELDS
126   K4 = UNIFRM(A,B)
127   KS=K4
128   RETURN
129   13 CONTINUE
130   C
131   C*****GENERATE DEVIATE FOR PERTA DISTRIBUTION
132   C
133   PARAM(1,1) = K3
134   PARAM(1,2) = K2
135   PARAM(3,3) = K4
136   CALL PERTPM(1,SMEAN,SVAR)
137   KS = BETAÓN(1,SMEAN,SVAR)
138   RETURN
139   END

HELP070

WHOG, P  MAP

QPRT, S  MAP

FORFMT ED-06/30-13:31
SUBROUTINE MISSON(LP1,LP2,LP3,LP4,LP5,K)

C***THIS PROGRAM GENERATES TRAFFIC REQUIREMENTS FOR THE SHUTTLE
C OPERATIONAL MISSIONS.
C THE SELECTION OF NEXT SCHEDULED LAUNCH IS BASED ON THE FREQUENCY
C OF MISSION OCCURRENCE.

REAL LATIME
DIMENSION OPPRT[5,1],[C0THM5,5]
DIMENSION LCNS[5,1],[INTERL5,1],[FRESH5,5]
COMMON /HELP/PAPTH[7,3],[LL,15510,1],[STUNE[2,101,152]
COMMON /HISPTI/HETAL1,HETAL2,HETAL3,HETAL4,HETAL5

C***VARIABLE K DEFINES THE TRAFFIC MODEL TO BE SIMULATED
C K=1 - 20 LAUNCHES/YEAR
C K=2 - 35 LAUNCHES/YEAR
C K=3 - 45 LAUNCHES/YEAR
C K=4 - 55 LAUNCHES/YEAR
C K=5 - 75 LAUNCHES/YEAR
C***ARRAY LFREQ CONTAINS THE FREQUENCY REQUIREMENTS FOR THE 6 TRAFFIC
C MODELS. EACH KEY DEFINES A NEW MODEL.(FLIGHTS/YEAR)
DATA LFREQ/10,3,0,0,2,
A 11,8,2,12,1.
B 18,8,1,6,1.
C 20,8,19,2.
D 35,8,6,19,5.
E 5,3,6,6,20/.
C***VARIABLE NTYPE IS THE NUMBER OF DIFFERENT TYPES OF MISSIONS
C NTYPES
C***VARIABLE 1 DEFINES THE MISSION TYPE
C 1=1 - SHUTTLE PAYLOAD PLACEMENT
C 1=2 - SPACE STATION LOGISTICS
C 1=3 - TUG PAYL PLACEMENT & FUEL RESUPPLY
C 1=4 - DEPARTMENT OF DEFENSE
C 1=5 - SPACE RESCUE & OTHER TYPES
C
C****GO THRU THIS LEG ON THE FIRST CALL ONLY*************
56        LH=LFREQ(I,L)+LPREN2,1+LPREN3,K)+LPREN4,K)+LFREG5,K)
57        LEFST=260/5R
58        DO 7 I=1,N
59        LOAD(I)=LEFST#1
60        C****IF MISSION TYPE IS NOT DEFINED, SET THE LAUNCH DATE = 9999999
61        IF(LFREQ(I,K).EQ.0)DATE(I)=9999999
62        C****MISSIONS ARE TO BE SCHEDULED AT THE SAME FREQUENCY WITH 10 PERCENT
63        DEVIATION.
64        IF(LDATE(I).EQ.0)IF(LDATE(I)*IF(LDATE(I)+1)$2
65        CONTINUE
66        7 CONTINUE
67        C*****************************************************************************
68        2 CONTINUE
69        C*****CALCULATE THE NEXT LAUNCH TRAFFIC REQUIREMENT
70        C
71        NMIN=MIN(LDATE(I),LDATE(2),LDATE(3),LDATE(4),LDATE(5))
72        DO 20 I=1,N
73        IF(LDATE(I).EQ.0)NMIN+21
74        20 CONTINUE
75        ERROR=1
76        WRITE(6,100)ERROR
77        100 FORMAT(14,ERROR+1)
78        C
79        C****ASSIGN LAUNCH HOUR FOR MISSION ASSIGNMENT
80        C
81        21 NP=1
82        TIME=LDATE(I)
83        HOUR=LDATE(I)/24.
84        LATIME=TIME-24.
85        NP=TIME+1000.-SAT
86        NP=ABS(NP)
87        C
88        C*****GENERATE THE HISTORAM FOR THE TIME BETWEEN LAUNCH REQUESTS
89        C
90        IF(NP3*LP*00000+NP3*LP*30000)NP1=NP3*LP+1
91        IF(NP3*LP*00000+NP3*LP*30000)NP1=NP3*LP+1
92        IF(NP3*LP*30000+NP3*LP*30000)NP1=NP3*LP+1
93        IF(NP3*LP*30000+NP3*LP*30000)NP1=NP3*LP+1
94        IF(NP3*LP*30000+NP3*LP*30000)NP1=NP3*LP+1
95        IF(NP3*LP*30000+NP3*LP*30000)NP1=NP3*LP+1
96        IF(NP3*LP*30000+NP3*LP*30000)NP1=NP3*LP+1
97        NP=SAVE
98        C
99        C*****CALCULATE THE FIRST LAUNCH OPPORTUNITY AFTER THE NOMINAL LAUNCH TIME
100        C
101        DO 90 J=1,3
102        90 CONTINUE
103        C
104        XOPPOR = DECRET(I)
105        NP=XOPPOR*24.+1000.
106        C
107        C*****SELECT THE MISSION LENGTH OF THE ORBITER
108        C
109        DO 50 J=1,3
110        50 CONTINUE
C****CALCULATE THE DATE OF THE NEXT LAUNCH
C
N=COUNT+1
40 CONTINUE
N=COUNT+1
A=INT日期(1)
B=INT日期(1)
NVAR=UNFRM(A,B)
NDAT=DATE(N)+260/LFREQ(I,K)*NVAR
DO 45 J=1,NTYPE

C****AFTER 50 RESCHEDULES, THE CONSTRAINT MAY BE OVERWRITTEN
C
IF(NCOUNT.EQ.50)RITE(6,107)
107 FORMAT(/// TRAFFIC MODEL VIOLATED MINIMUM TIME BETWEEN LAUNCH
REQUESTS CONSTRAINT TYPE=1,3)
C
C****Determine IF TIME BETWEEN LAUNCH REQUESTS MEETS THE MINIMUM REQ.
C
IF(IABS(SENTST).LE.LCONS(K))GO TO 45
65 CONTINUE
66 CONTINUE
LDATE(I)NAT
RETURN
END

SHOW P

PRINT 5
FUMPUH MA18-06/18=13:31
SUBROUTINE OUTPUT (ICOM,LOC,NAME,IX,IY,IZ,ISEL,NRA,NRB,MEAN,MOO)
   C    SUBROUTINE TO DETERMINE TYPE OF DISTRIBUTION AND WRITE
   C    CORRESPONDING DATA.
   C
   DIMENSION NAME(2),ICOM(11)
   DATA K11/3H11/K12/3H12/K13/3H13/
   C TEST TO DETERMINE IF DISTRIBUTION IS LOGNORMAL (K9)
   IF (ICOM.EQ.K9) GO TO 1
   C TEST TO DETERMINE IF DISTRIBUTION IS TRIANGULAR (K3)
   IF (ICOM.EQ.K3) GO TO 2
   C TEST TO DETERMINE IF DISTRIBUTION IS NORMAL (K4)
   IF (ICOM.EQ.K4) GO TO 3
   C TEST TO DETERMINE IF DISTRIBUTION IS EXPONENTIAL (K8)
   IF (ICOM.EQ.K8) GO TO 4
   C TEST TO DETERMINE IF DISTRIBUTION IS CONSTANT(K11)
   IF (ICOM.EQ.K11) GO TO 5
   C TEST TO DETERMINE IF DISTRIBUTION IS UNIFORM (K12)
   IF (ICOM.EQ.K12) GO TO 6
   C TEST TO DETERMINE IF DISTRIBUTION IS DATA (K13)
   IF (ICOM.EQ.K13) GO TO 7
   C
   RETURN
   1 CONTINUE
   C CALL SUBROUTINE REALN TO CONVERT ALPHANUMERIC NUMBERS TO REAL NUMBERS.
   CALL REALN (RES1,17)
   CALL REALN (RES2,12)
   RE51 = RES1/1000.0
   RES2 = RES2/100.0
   C
   WRITE (6,901) ICOM,RES1,RES2
   WRITE & EN
   RETURN
   2 CONTINUE
   C CALL SUBROUTINE REALN TO CONVERT ALPHANUMERIC NUMBERS TO REAL NUMBERS.
   CALL REALN (RES1,17)
   CALL REALN (RES2,12)
   CALL REALN (RES3,MEAN)
   RES1 = RES1/1000.0
   RES2 = RES2/1000.0
   RES3 = RES3/1000.0
WRITE RESULTS FOR TRIANGULAR DISTRIBUTION
WRITE (54, 91) ICOM, RES1, RES2, RES3
WRITE (60, 84)
RETURN
3 CONTINUE

CALL subroutine REALN TO CONVERT ALPHANUMERIC NUMBERS TO REAL NUMBERS,
CALL REALN (RES1, IT)
CALL REALN (RES2, IT)

RES1 = RES1 / 1000.0
RES2 = RES2 / 1000.0

WRITE RESULTS FOR NORMAL DISTRIBUTION
WRITE (54, 92) ICOM, RES1, RES2
WRITE (60, 84)
RETURN
4 CONTINUE

CALL subroutine REALN TO CONVERT ALPHANUMERIC NUMBERS TO REAL NUMBERS,
CALL REALN (RES1, IT)
CALL REALN (RES2, IT)

RES1 = RES1 / 1000.0
RES2 = RES2 / 1000.0

WRITE RESULTS FOR EXPONENTIAL DISTRIBUTION
WRITE (54, 93) ICOM, RES1, RES2
WRITE (60, 84)
RETURN
5 CONTINUE

CALL subroutine REALN TO CONVERT ALPHANUMERIC NUMBERS TO REAL NUMBERS,
CALL REALN (RES3, IT)

RES3 = RES3 / 1000.0

WRITE RESULTS FOR CONSTANT DISTRIBUTION
WRITE (54, 94) ICOM, RES3
WRITE (60, 84)
RETURN
6 CONTINUE

CALL subroutine REALN TO CONVERT ALPHANUMERIC NUMBERS TO REAL NUMBERS,
CALL REALN (RES1, IT)
CALL REALN (RES2, IT)
RES3 = (RES1 + RES2) / 2000.0
RES1 = RES3 / 1000.0
RES2 = RES3 / 1000.0

WRITE RESULTS FOR UNIFORM DISTRIBUTION
112      WRITE(*,51) CEN,MES1,MES2,MES3
113      WRITE (6,89)
114      RETURN
115  7 CONTINUE
116      C    CALL SUBROUTINE REALN TO CONVET ALPHANUMERIC NUMBERS TO
117      C REAL NUMBERS
118      C CALL REALN(MES1,1Y).
119      C CALL REALN(MES2,1Z)
120      C CALL REALN(MES3,MES1)
121      C RES1*RES1/1000.0
122      C RES2*RES2/1000.0
123      C RES3*RES3/1000.0
124      C WRITE RESULTS FOR BETA DISTRIBUTION
125      C WRITE (6,96) CEN,MES1,MES2,MES3
126      C RETURN
127      C
131  95 FORMAT (1X,I1,I16,I16,I16,I16,I16,I16,I16,I16,I16,I16,E15.8)
133      C
134      C
135      C
136      C
137      C
138      C
139      C
140      C
141      C
142      C
143      C
144      C
145      C
146      C
147      C
148      C
149      C
150      C
151      C
152      C
153      C
154      C
155      END

SM06,P PERTXF

B28,P PERTXF

FUPFUR MA8=06/30=13:13


PERTEXF

420223 TPFS PERTXF

1 SUBROUTINE PERTXF(J,SMEAN,SVAR)

2 COMMON /MEPS,PARAM(J,3),LL,ISEED,ISEED1,ISTORE(2,10),15(2) PERT 20

3 SVAR = (PARAM(J,1)-PARAM(J,2))**2/36. PERT 30

4 SMEAN = (PARAM(J,1)*4. + PARAM(J,2)) / PARAM(J,3) PERT 40

5 C

6 C*** CALCULATE THE MEAN AND VARIANCE FOR THE GIVEN PARAMETERS

7 C*** PERT 50

8 C*** PARAM(J,1) CONTAINS THE MODE

9 C*** PARAM(J,2) CONTAINS THE LOWER LIMIT

10 C*** PARAM(J,3) CONTAINS THE UPPER LIMIT

11 C*** SMEAN CONTAINS THE NORMALIZED MEAN OVER THE INTERVAL [0,1]. PERT 110

12 C*** SVAR CONTAINS THE NORMALIZED VARIANCE OVER THE INTERVAL [0,1]. PERT 120

13 C

14 C

15 BMEAN = (SMEAN - PARAM(J,2))/PARAM(J,3) PERT 130

16 BVAR = SVAR/(PARAM(J,3)-PARAM(J,2))**2*0 PERT 140

17 SMEAN = BMEAN/BMEAN*(1.0-BMEAN)/BVAR-1.0 PERT 150

18 SVAR = SMEAN*(1.0-BMEAN)/BMEAN PERT 160

19 RETURN

20 END

64 PRINT

80 PRINT

90 END
13 \texttt{WRITE(F,106)} \texttt{HPAUS}

14 \texttt{FORMAT(5,150)} \texttt{NUMBER OF LAUNCH PADS = T10, I3)}

15 \texttt{KZ=JEKS(30)+JEKS(2)+JEKS(13)+JEKS(14)+JEKS(121)+JEKS(123)+JEKS(241)}

16 \texttt{1 \ J K S ( 2 5 ) \ J K S ( 0 )}

17 \texttt{WRITE(F,174)}

18 \texttt{FORMAT(100)} \texttt{TRAFFIC MODEL STATISTICS:}

19 \texttt{NFR=JEKF6000+FLOAT(JEKS(121))/FLOAT(KZ)}

20 \texttt{WRITE(F,175)} \texttt{NFR}

21 \texttt{157} \texttt{FORMAT(A40)} \texttt{MISSION MODEL LAUNCH RATE (FLIGHTS/YEAR)}

22 \texttt{NLK=NLTA1+NLTA2+NLTA3+NLTA4+NLTA5}

23 \texttt{PELT1=FLOAT(NELTA1)} \texttt{1 DIV NLK}

24 \texttt{PELT2=FLOAT(NELTA2)} \texttt{1 DIV NLK}

25 \texttt{PELT3=FLOAT(NELTA3)} \texttt{1 DIV NLK}

26 \texttt{PELT4=FLOAT(NELTA4)} \texttt{1 DIV NLK}

27 \texttt{PELT5=FLOAT(NELTA5)} \texttt{1 DIV NLK}

28 \texttt{WRITE(F,158)} \texttt{PELT1, PELT2, PELT3, PELT4, PELT5}

29 \texttt{158} \texttt{FORMAT(55)} \texttt{DISTRIBUTION OF TIME BETWEEN LAUNCH REQUESTS:}

30 \texttt{A(160,F5.1,1,8.0)} \texttt{OF LAUNCHES ARE SCHEDULED 1 DAY APART:}

31 \texttt{B(160,F5.1,1.8.0)} \texttt{OF LAUNCHES ARE SCHEDULED 2 DAYS APART:}

32 \texttt{C(160,F5.1,1.8.0)} \texttt{OF LAUNCHES ARE SCHEDULED 3 DAYS TO 1 WEEK APART:}

33 \texttt{D(160,F5.1,1.8.0)} \texttt{OF LAUNCHES ARE SCHEDULED 1 WEEK TO 2 WEEKS APART:}

34 \texttt{E(160,F5.1,1.8.0)} \texttt{OF LAUNCHES ARE SCHEDULED 2 WEEKS TO 1 MONTH APART:}

35 \texttt{WRITE(F,107)} \texttt{K2}

36 \texttt{107} \texttt{FORMAT(100)} \texttt{OPERATIONAL EVALUATION PARAMETERS FOR .199 SIMULAP}

37 \texttt{1IONS:}

38 \texttt{PFR=FLOAT(JEKS(30))} \texttt{1 DIV KZ}

39 \texttt{WRITE(F,152)} \texttt{JEKS(30),PFR}

40 \texttt{152} \texttt{FORMAT(150)} \texttt{THE NUMBER OF SUCCESSFUL LAUNCH REQUESTS ARE .199,}

41 \texttt{1 div \texttt{OFR+F5.1,1.8.0 PERCENT:}}

42 \texttt{NMLK=KZ+JEKS(30)}

43 \texttt{PMLK=PMLK+MNLK) DIV NLK}

44 \texttt{WRITE(F,108)} \texttt{MNLK,PMLK}

45 \texttt{108} \texttt{FORMAT(150)} \texttt{THE NUMBER OF UNSUCCESSFUL REQUESTS ARE .199,}

46 \texttt{1 div \texttt{OFR+F5.1,1.8.0 PERCENT:}}

47 \texttt{GLOB=FLOAT(JEKS(26))/FLOAT(JEKS(30))=100,}

48 \texttt{GLOB=JEKS(26)}

49 \texttt{WRITE(F,373)} \texttt{GLOB, GLOB}

50 \texttt{373} \texttt{FORMAT(150)} \texttt{THE NUMBER OF VEHICLES LAUNCHED AT A SUBSEQUENT WINDOW:

51 \texttt{1 div \texttt{OFR+F5.1,1.8.0 PERCENT:}}

52 \texttt{WRITE(F,596)}

53 \texttt{596} \texttt{FORMAT(150)} \texttt{REASONS FOR REQUEST FAILURES:}

54 \texttt{NBN=JEKS(31)}

55 \texttt{PBNA=FLOAT(NBNA) DIV K2}

56 \texttt{WRITE(F,109)} \texttt{NBNA, PBNA}

57 \texttt{109} \texttt{FORMAT(150)} \texttt{BOOSTER UNAVAILABILITY .150,1.1 TIMES OR \texttt{OFR+F5.1,1.8.0 PERCENT:}}

58 \texttt{101 \texttt{JENT}}

59 \texttt{NOUNA=JEKS(4)}

60 \texttt{POUNA=FLOAT(NOUNA) DIV K2}

61 \texttt{WRITE(110)} \texttt{NOUNA, POUNA}

62 \texttt{110} \texttt{FORMAT(150)} \texttt{ORBIT UNAVAILABILITY .150,1.1 TIMES OR \texttt{OFR+F5.1,1.8. PE}}

63 \texttt{104 \texttt{JENT}}

64 \texttt{PUNA=FLOAT(JEKS(21)) DIV K2}

65 \texttt{WRITE(F,114)} \texttt{JENP, PUNA}

66 \texttt{114} \texttt{FORMAT(150)} \texttt{BOTH STAGES UNAVAILABLE,150,1.1 TIMES OR \texttt{OFR+F5.1,1. PE}}

67 \texttt{110 \texttt{JENT}}

68 \texttt{LF=JEKS(8)}}
PLFAIL=PLFAIL,PLFAIL,TOT,2
114 WRITE(F,175)PLFAIL,PLFAIL
115 175 FORMAT(17,X,'LUT UNAVAILABILITY',T50,14,X TIMES OR',FS,1,X PERCENT
116 1)
117 NFAIL=JEKIS(21)+JEKIS(23)
118 PFAIL=FLOAT(NFAIL)*100/XZ
119 WRITE(F,150)NFAIL,PFAIL
120 150 FORMAT(17,X,'PAD UNAVAILABILITY',T50,14,X TIMES OR',FS,1,X PERCENT
121 1)
122 NFAIL=JEKIS(21)+JEKIS(24)+JEKIS(23)
123 PFAIL=FLOAT(NFAIL)*100/XZ
124 WRITE(F,151)NFAIL,PFAIL
125 151 FORMAT(17,X,'FAILURES AND REMOVAL FROM PAD',T50,14,X TIMES OR'
126 WRITE(F,111)
127 111 FORMAT(17,X,'AVG. PHASE TIMES PER VEHICLE ELEMENT',T60,
128 1*BOOSTER',T70,'ORBITER')
129 TSTL=K4/1000.
130 TIME0=K5/1000.
131 RETURN.
132 C***********************************************************************
133 20 CONTINUE
134 TSTL=K2/1000.
135 TSTL=K3/1000.
136 WRITE(F,113)TSTL,TSTL
137 113 FORMAT(17,X,'LANDING TO STORAGE(DAYS)',T61,FS,2,FS,2)
138 STOR=K4/1000.
139 STOR=K5/1000.
140 WRITE(F,114)STOR,STOR
141 114 FORMAT(17,X,'STORAGE(DAYS)',T61,FS,2,FS,2)
142 WRITE(F,115)TSTL,TSTL
143 115 FORMAT(17,X,'LEAVE STORAGE TO LAUNCH(DAYS)',T61,FS,2,FS,2)
144 WRITE(F,116)TIME10
145 116 FORMAT(17,X,'MEAN ORBIT MISSION TIME(DAYS)',T71,FS,2)
146 TOTAL=TOTAL+TSTL+STOR+TSTL
147 TOTAL=TOTAL,TOTAL
148 WRITE(F,112)TOTAL
149 112 FORMAT(17,X,'T/A LAUNCH TO LAUNCH(DAYS)',T61,FS,2,FS,2)
150 RETURN
151 C***********************************************************************
152 30 CONTINUE
153 WRITE(F,180)
154 180 FORMAT(17,X)
155 WRITE(F,115)
156 115 FORMAT(17,X,'AVG. QUEUE TIME FOR SAFING(DAYS)',T61,FS,2,FS,2)
157 1*T61,'BOOTSTRIP',T70,'ORBITER')
158 SAFB=K2/1000.
159 SAFB=K3/1000.
160 PDESB=FLOAT(JG5(1)+JG5(1)))*100./JG5(1)
161 PDESB=FLOAT(JG5(10)+JG5(10)))*100./JG5(10)
162 WRITE(F,300)PDESB,PDESB,SAFB,SAFB
163 300 FORMAT(15,X,'PERCENT OF VEHICLES DELAYED FOR SAFING',T62,FS,2,FS,2)
164 15,X,'AVG. QUEUE TIME FOR SAFING(DAYS)',T62,FS,2,FS,2)
165 PMB=FLOAT(JG5(2)+JG5(2)))*100./JG5(2)
166 PMB=FLOAT(JG5(11)+JG5(11)))*100./JG5(11)
167 WRITE(F,154)PMB,PMB
$\frac{1}{n}$
COTUO = K3/10.

WRITE(P, 177) COTUO, COTUO

177 FORMAT (1X,*CHECKOUT & TEST (PERCENT)*,T61,F5.2,T71,F5.2)

RETURN

C******************************************************************************

90 CONTINUE

PMHU = K2/10.

WRITE(P, 121) PMHU

121 FORMAT (1X,*MATE & HOOK-UP (PERCENT)*,T95,F5.2)

PLRU = K3/10.

WRITE(P, 122) PLRU

122 FORMAT (1X,*LUT REFURishment (PERCENT)*,T95,F5.2)

RETURN

C******************************************************************************

90 CONTINUE

PDU1 = K2/10.

WRITE(P, 123) PDU1

123 FORMAT (1X,*PAD UTILIZATION*).

IF (NPAOS = 2) 61,62,42


WRITE(P, 124) PDU2

124 FORMAT (1X,*LAUNCH PAD 2 (PERCENT)*,T95,F5.2)

IF (NPAOS = 3) 61,1003,1003

1003 PDU3 = K9/10.

WRITE(P, 1004) PDU3

1004 FORMAT (1X,*LAUNCH PAD 3 (PERCENT)*,T95,F5.2)

61 CONTINUE

C**********************************************************

WRITE OUT CASE STUDY COMMENT CARD

WRITE(P, 199) TITLE (11X,11.2D)

199 FORMAT (1X,///,10X,*THE FLEET SIZE IS*12,* BOOSTERS & 12,* ORBITERS

111

WRITE(P, 201) NSKED, NSFD

201 FORMAT (1X,*RANDOM NUMBER SEED FOR TRAFFIC MODEL SIMULATOR = *1,110

1,110)

C DETERMINE IF TABLE III OUTPUT IS REQUIRED

IF (NS = LT, 9) RETURN

CALL SAMPLE (K1, K2, K3, K4, K5)

RETURN

C******************************************************************************

END

PROCS
SUBROUTINE REALN (NE, IN)
C SUBROUTINE TO CHANGE ALPHANUMERIC NUMBERS TO REAL NUMBERS
C
C SUBSCRIPTED VARIABLE IA WILL CONTAIN 1 CHARACTER IN EACH POSITION
C
DIMENSION IA(IN)
C
*************************************************************************
C
FUNCTION FLD IS A LIBRARY FUNCTION WHICH ENABLES USER TO OBTAIN
C INDIVIDUAL BITS FROM AN ALPHANUMERIC WORD AND STORE
C THEM IN ANOTHER WORD.
C
C FLD (I,K,E) I = STARTING BIT   K = BIT WIDTH   E = WORD NAME
C
*************************************************************************
C
C IN POSITION 1 OF IA STORE BITS 0 TO 5 OF WORD IN
IA(1) = FLD (C,6,IN)
C
C IN POSITION 2 OF IA STORE BITS 6 TO 11 OF WORD IN
IA(2) = FLD (C,6,IN)
C
C IN POSITION 3 OF IA STORE BITS 12 TO 17 OF WORD IN
IA(3) = FLD (I2,6,IN)
C
C IN POSITION 4 OF IA STORE BITS 18 TO 23 OF WORD IN
IA(4) = FLD (I8,6,IN)
C
C IN POSITION 5 OF IA STORE BITS 24 TO 29 OF WORD IN
IA(5) = FLD (I2,6,IN)
C
C IN POSITION 6 OF IA STORE BITS 30 TO 35 OF WORD IN
IA(6) = FLD (I2,6,IN)
C
C TEST TO DETERMINE IF 1ST CHARACTER OF WORD IS A K
IF (IA(1),NE,16) GO TO 1
C
C TEST TO DETERMINE IF 4TH CHARACTER OF WORD IS A BLANK
IF (IA(4),NE,5) GO TO 10
C
C TEST TO DETERMINE IF 4TH CHARACTER OF WORD IS A BLANK
IF (IA(4),NE,5) GO TO 11
C
C TEST TO DETERMINE IF 4TH CHARACTER OF WORD IS A BLANK
IF (IA(4),NE,5) GO TO 12
C
C TEST TO DETERMINE IF 3RD CHARACTER OF WORD IS A BLANK
IF (IA(3),NE,5) GO TO 13
C
C TEST TO DETERMINE IF 2ND CHARACTER OF WORD IS A BLANK
IF (IA(2),NE,5) GO TO 14
C
GO TO 1
C
C *********************************************************

C TO CHANGE ALPHANUMERIC NUMBER TO A REAL NUMBER SUBTRACT 48.

C ALPHANUMERIC ZERO IS REPRESENTED BY CHARACTER 48 WHICH
C OCCUPIES 6 BITS IN AN ALPHANUMERIC ACRY.

C ALPHANUMERIC ONE IS REPRESENTED BY CHARACTER 49 ETC.

C *********************************************************

C 10 CONTINUE

C EQUATION TO CHANGE 5 CHARACTER ALPHANUMERIC NUMBER TO 5
C CHARACTER INTEGER

1 = (IA(5)-48)*1000 + (IA(2)-49)*10000

C EQUATION TO CHANGE INTEGER TO REAL NUMBER FOR TABLE
RES = IRES
RETURN

C EQUATION TO CHANGE 4 CHARACTER ALPHANUMERIC NUMBER TO 4
C CHARACTER INTEGER

1 = (IA(4)-48)*1000 + (IA(2)-49)*10000

C EQUATION TO CHANGE INTEGER TO REAL NUMBER FOR TABLE
RES = IRES
RETURN

C EQUATION TO CHANGE 3 CHARACTER ALPHANUMERIC NUMBER TO 3
C CHARACTER INTEGER

1 = (IA(3)-48)*10000 + (IA(2)-49)*10000

C EQUATION TO CHANGE INTEGER TO REAL NUMBER FOR TABLE
RES = IRES
RETURN

C EQUATION TO CHANGE 2 CHARACTER ALPHANUMERIC NUMBER TO 2
C CHARACTER INTEGER

1 = (IA(2)-48)*10000 + (IA(2)-49)*10000

C EQUATION TO CHANGE INTEGER TO REAL NUMBER FOR TABLE
RES = IRES
RETURN

C EQUATION TO CHANGE 1 CHARACTER ALPHANUMERIC NUMBER TO 1
C CHARACTER INTEGER

1 = IA(2)-48

C EQUATION TO CHANGE INTEGER TO REAL NUMBER FOR TABLE
112 RES = IRES
113 RETURN
114 I CONTINUE
115 C EQUATION WILL RESULT IN ERROR, PRINTING STARS
116 RES = 9999999
117 RETURN
118 END

QHGP,P RLOGN

QPHT,S RLOGN
FUMPUR MA18-06/30-13:31
FUNCTION RLOGN (X)
C
C****THE PARAMETERS USED WITH RLOGN ARE THE MEAN AND STANDARD DEVIATION
C****OF A NORMAL DISTRIBUTION
C

V = RNORM (X)
RETURN
END
FUNCTION RANOM (J)
COMMON /HEPL/PARAM(7,3),LL,ISEED,ISEED1,ISUNE(2,10),I5(2)
R=DRAND1(1SEED1)
R=RUPANU(1SEED1)
VR1=2.0*ALCGERA(1)*COS(6.283*9I)
RANOM = VR*PARAM(J,2) = PARAM(J,1)
RETURN
END

SAMPLE

SAMPLE
42023.5075.5070.

1 COMPILER(DATASEC=SHORT)

2 SUBROUTINE SAMPLE(K1,K2,K3,K4,K5)

3 COMMON /I/STAT/ HCONF

4 COMMON/STATS/HLTS

5 COMMON/STATS/HHEAD

6 COMMON/STATS/PH

7 COMMON/STATS/PHSN

8 COMMON K(100)

9 EQUIVALENCE (K(28),IHEECK)

10 INTEGER P

11 DIMENSION T(32,21),SAF(14,51),HHEAD(14,11)

12 C

13 C THESE ARE VALUES OF THE STUDENT T VARIABLE

14 C

15 C

16 DATA(T(J,K),K=1,2),J=1,18)/

17 112.700, 63.657,

18 2 4.303, 9.725,

19 3 3.162, 5.811,

20 4 2.776, 4.604,

21 5 2.521, 4.032,

22 6 2.447, 3.707,

23 7 2.365, 3.402,

24 8 2.306, 3.355,

25 9 2.252, 3.250,

26 10 2.228, 3.149,

27 1 2.201, 3.106,

28 2 2.179, 3.055,

29 3 2.160, 3.012,

30 4 2.145, 2.977,

31 5 2.131, 2.937,

32 6 2.120, 2.921,

33 7 2.110, 2.898,

34 8 2.101, 2.879/

35 DATA(T(J,K),K=1,2),J=1,19)/

36 9 2.093, 2.861,

37 10 2.083, 2.845,

38 1 2.080, 2.831,

39 2 2.077, 2.819,

40 3 2.069, 2.807,

41 4 2.062, 2.797,

42 5 2.050, 2.787,

43 6 2.045, 2.779,

44 7 2.032, 2.771,

45 8 2.024, 2.763,

46 9 2.014, 2.756,

47 10 2.009, 2.750,

48 1 2.003, 2.757/

49 C

50 C STORE MEASUREMENTS TO BE USED IN PRINTING

51 C

52 C DATA(HHEAD(1,J),J=1,11),J=1,9)/

53 C

54 C

55 C 162 THE PERCENTAGE OF SUCCESSFUL LAUNCH REQUESTS
<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>THE PERCENTAGE OF UNSUCCESSFUL LAUNCH REQUESTS</td>
</tr>
<tr>
<td>57</td>
<td>THE PERCENTAGE OF VEHICLES LAUNCHED AT A SUBSEQUENT WINDOW</td>
</tr>
<tr>
<td>58</td>
<td>BOOSTER UNAVAILABILITY</td>
</tr>
<tr>
<td>59</td>
<td>ORBITER UNAVAILABILITY</td>
</tr>
<tr>
<td>60</td>
<td>BOTH STAGES UNAVAILABLE</td>
</tr>
<tr>
<td>61</td>
<td>LUT UNAVAILABILITY</td>
</tr>
<tr>
<td>62</td>
<td>PAD UNAVAILABILITY</td>
</tr>
<tr>
<td>63</td>
<td>FAILURES AND REMOVAL FROM PAD</td>
</tr>
<tr>
<td>64</td>
<td>FIELD DEFINITIONS</td>
</tr>
<tr>
<td>65</td>
<td>K1 IS A DUMMY</td>
</tr>
<tr>
<td>66</td>
<td>K2 CORRESPONDS TO THE &quot;Y&quot; FIELD ENTRY ON THE HELP CARD AND IS THE IDENTIFICATION NUMBER OF THE STATISTIC BEING COLLECTED</td>
</tr>
<tr>
<td>67</td>
<td>K3 CORRESPONDS TO THE &quot;Y&quot; FIELD ENTRY ON THE HELP CARD AND IS THE TYPE OF STATISTICAL BEING COLLECTED</td>
</tr>
<tr>
<td>68</td>
<td>K3=1 FOR A NUMBER</td>
</tr>
<tr>
<td>69</td>
<td>K3=2 FOR PERCENTAGE UTILIZATION</td>
</tr>
<tr>
<td>70</td>
<td>K3=3 FOR AVERAGE TIME</td>
</tr>
<tr>
<td>71</td>
<td>K4 CORRESPONDS TO THE &quot;MEAN&quot; FIELD ENTRY ON THE HELP CARD AND IS THE GPS SYSTEM VARIABLE THAT REPRESENTS</td>
</tr>
<tr>
<td>72</td>
<td>1) NUMBER OF ENTRIES</td>
</tr>
<tr>
<td>73</td>
<td>2) AVERAGE UTILIZATION</td>
</tr>
<tr>
<td>74</td>
<td>3) AVERAGE TIME IN A FACILITY, STORAGE OR QUEUE</td>
</tr>
<tr>
<td>75</td>
<td>K5 CORRESPONDS TO THE &quot;MOD&quot; FIELD ENTRY ON THE HELP CARD AND IS THE GPS SYSTEM VARIABLE (WHEN REQUIRED) THAT REPRESENTS</td>
</tr>
<tr>
<td>76</td>
<td>THE NUMBER OF ENTRIES INTO THE BLOCK TYPE SPECIFIED</td>
</tr>
<tr>
<td>77</td>
<td>IN THE &quot;MEAN&quot; FIELD</td>
</tr>
<tr>
<td>78</td>
<td>ARRAY ELEMENT DEFINITIONS</td>
</tr>
<tr>
<td>79</td>
<td>SAVE(1:1) = PREVIOUS READING</td>
</tr>
<tr>
<td>80</td>
<td>SAVE(1:2) = SUM X15</td>
</tr>
<tr>
<td>81</td>
<td>SAVE(1:3) = SUM X3 SQUARED-S</td>
</tr>
<tr>
<td>82</td>
<td>SAVE(1:4) = KN READING FOR THE FIRST 100 SIMULATIONS</td>
</tr>
<tr>
<td>83</td>
<td>SAVE(1:5) = 1/2 WIDTH OF THE CONFIDENCE INTERVAL</td>
</tr>
<tr>
<td>84</td>
<td>SAVE(1:6) = PREVIOUS KS READING</td>
</tr>
<tr>
<td>85</td>
<td>CONTINUE WITH STATISTICAL SAMPLING</td>
</tr>
<tr>
<td>86</td>
<td>DETERMINE IF A REQUEST FOR OUTPUT HAS OCCURRED</td>
</tr>
<tr>
<td>87</td>
<td>IF(134  = 90) GO TO 99</td>
</tr>
<tr>
<td>88</td>
<td>IF(134  = 90) GO TO 99</td>
</tr>
<tr>
<td>89</td>
<td>LST = I</td>
</tr>
<tr>
<td>90</td>
<td>NCONFC</td>
</tr>
</tbody>
</table>

**DATE 06/072**
112 C
113 C IDENTIFY THE LEVEL OF SIGNIFICANCE
114 IF(INC1+EQ.99) MCONF=1
115 IF(INC1+NE.99) MCONF=1
116 90 CONTINUE
117 C
118 C CHANGE FIXED POINT VARIABLES K4 AND K5 TO FLOATING POINT
119 F4=F4+FLOAT(K4)
120 F5=F5+FLOAT(K5)
121 C SPECIFY THE K5 VALUE BASED ON THE TYPE OF STATISTICAL BEING
122 C COLLECTED AS SPECIFIED BY K3
123 IF(K3.EQ.1) F5=1.
124 IF(K3.EQ.2) F5=FLOAT(CLOCK)/1000.
125 C ADJUST THE K4 VALUE BASED ON THE TYPE OF STATISTICAL BEING
126 C COLLECTED AS SPECIFIED BY K3
127 IF(K3.EQ.2) F4=F4+1./1000.
128 C COUNT THE NUMBER OF OBSERVATIONS THAT HAVE BEEN MADE
129 IF(K2.LE.11) NPA=NPA+1
130 C
131 C COLLECT AND RETAIN THE STATISTICS FROM THE FIRST 100 SIMS
132 IF(NDST.EQ.21) SAVE(K2,1)=F4
133 IF(NDST.EQ.22) SAVE(K2,2)=F5
134 C DETERMINE THE CHANGE IN MEAN FROM THE CURRENT OBSERVATION AND THE
135 C 100TH OBSERVATION
136 X2=FK4=SAVE(K2,4)
137 X2=SAVE(K2,1)
138 C DETERMINE AND RETAIN THE DIFFERENCES IN MEANS BETWEEN THE CURRENT
139 C OBSERVATION AND THE PREVIOUS OBSERVATION TO OBTAIN A MEAN
140 C X2=X2 SAVE(K2,1)
141 C DETERMINE THE FREQUENCY IN BLOCK ENTRIES THAT HAVE OCCURRED
142 C SINCE THE PREVIOUS OBSERVATION
143 COUNTFks=SAVE(K2,5)
144 C RETAIN THE TOTAL NUMBER OF BLOCK ENTRIES
145 C SAVE(K2,6)=FK5
146 C ADJUST THE X2 MEAN BASED ON THE TYPE OF STATISTIC BEING
147 C COLLECTED AS SPECIFIED BY K3
148 IF(K3.EQ.1) X2 = X2+2.
149 IF(K3.EQ.2) X2 = X2+2./1000.
150 C DETERMINE THE T STATISTIC VALUE AND THE ESTIMATED
151 C
SAMPLE

169 C POPULATION STANDARD DEVIATION
170 SAVE(K2,2) = SAVE(K2,2) * K2
171 SAVE(K2,3) = SAVE(K2,3) * (K2*K2)
172 C IF AN INSUFFICIENT NUMBER OF OBSERVATIONS HAS OCCURRED, RETURN
173 N = NOB
174 IF(NEW > 2) RETURN
175 C DETERMINE THE DEGREES OF FREEDOM FOR THE STUDENT T DISTRIBUTION
176 NDREE = N/2
177 C IF(NDREE < 31) NDREE = 31
178 C DETERMINE AND RETAIN THE ESTIMATED DEVIATION
179 CALL STDV(SAVE(K2,2),SAVE(K2,3),N,STDEV)
180 SAVE(K2,5) = NDREE(1+STDEV)*STDEV
181 C
182 RETURN
183 C
184 C
185 C
186 C
187 C
188 C
189 C
190 C
191 C
192 40 CONTINUE
193 C BEGIN OUTPUT OF CONFIDENCE INTERVALS
194 C
195 C
196 C
197 C
198 C OUTPUT FOR TABLE III HEADINGS
199 C
200 C
201 C
202 C
203 C
204 C
205 C
206 C
207 C
208 C
209 C
210 C
211 C
212 C
213 C
214 C
215 C
216 C
217 C
218 C
219 C
220 C OUTPUT FOR THE OPERATIONAL EVALUATION PARAMETERS
221 C
222 00 50 I=1,9
223 AVG=SAVE(1,2)/FLOAT(N)
SAMPLE

224 ALD=AVG+SAVE(1,5)  SAMP2220
225 HIGH=AVG+SAVE(1,5)  SAMP2230
226 IF(HIGH*GE.100)1 HIGH=100.  SAMP2240
227 IF(XLOB**LE.0)XLOB=0.  SAMP2250
228 WRITE(P,200)INHEAD(1,J),J=1,11,XLOB,AVG,HIGH  SAMP2260
229 200 FORMAT(10X,11A,T8);F=Z,B=Z,F=Z,B=Z,F=Z)  SAMP2270
230 C  SAMP2280
231 IF(ISN*EQ.31)GO TO 50  SAMP2290
232 WRITE(P,190)  SAMP2300
233 190 FORMAT(12X,REASONS FOR REQUEST FAILURES)  SAMP2310
234 C  SAMP2320
235 50 CONTINUE  SAMP2330
236 C  SAMP2340
237 C  SAMP2350
238 C DETERMINE IF ANY USER REQUESTED STATISTICS HAVE BEEN REQUESTED  SAMP2360
239 IF(ISN*LE.9)GO TO 500  SAMP2370
240 C  SAMP2380
241 C  SAMP2390
242 C OUTPUT FOR THE USER REQUESTED STATISTICS  SAMP2400
243 C  SAMP2410
244 C WRITE(P,210)  SAMP2420
245 210 FORMAT(///,1X,THE FOLLOWING ARE THE USER REQUESTED STATISTICS/)  SAMP2430
246 DO 52 I=10,ISN  SAMP2440
247 AVGSAVE(I,1) = FLOAT(A)  SAMP2450
248 XLOB+AVG+SAVE(I,5)  SAMP2460
249 HIGH+AVG+SAVE(I,5)  SAMP2470
250 IF(HIGH*GE.100)1 HIGH=100.  SAMP2480
251 IF(XLOB**LE.0)XLOB=0.  SAMP2490
252 WRITE(P,200)INHEAD(1,J),J=1,11,XLOB,AVG,HIGH  SAMP2500
253 52 CONTINUE  SAMP2510
254 C  SAMP2520
255 500 WRITE(P,999)  SAMP2530
256 999 FORMAT(//)  SAMP2540
257 C  SAMP2550
258 RETURN  SAMP2560
259 END  SAMP2570

@HOOP.§ STAT

@PRINT.§ STAT

FURPUR 06/30/13:31
SUBROUTINE STOV(SAVE,ASAVEZ,N,STDEV)

1. DOAO

2. C

3. C ELIMINATE THE ONE OBSERVATION COUNTED FOR THE FIRST 100 SIMULATIONS

4. N = N - 1

5. C

6. C IF AN INSUFFICIENT NUMBER OF OBSERVATIONS HAS OCCURRED, RETURN

7. IF(N.LT.2) RETURN

8. C

9. C DETERMINE THE ESTIMATED STANDARD DEVIATION

10. XN = FLOAT(N)

11. STDEV = ADB(SAVE2-LSAVEZ*XN/ASAVEZ**2/XN11/XN11)

12. STOV = SQRT(STDEV)

13. C

14. C ADJUST TO CONFORM WITH CONFIDENCE INTERVAL EQUATION

15. STDEV = STDEV/SQRT(XN)

16. C

17. RETURN

18. END

END OF SUBROUTINE

DATE 06/072 PAGE 1

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TABLEI

CL SUBROUTINE TABLE

TABLEI IS A SUBROUTINE DESIGNED TO BE USED IN CONJUNCTION WITH
CL A GPSS PROGRAM CARD DECK. THE FUNCTION OF THIS SUBROUTINE IS TO
CL READ EACH CARD IN A GPSS DECK AND DETERMINE IF IT IS A COMMENT
CL CARD WITH THE KEY WORD IN COLUMNS 48-71. (THE KEY WORD IS IDST)
CL AFTER IT HAS FOUND A COMMENT CARD WITH THE PROPER KEY WORD IT THEN
CL READS CARD USRS UNTIL IT FINDS A HELP CARD. AFTER THE HELP CARD IS FOUND
CL THE SUBROUTINE OUTPUT IS CALLED TO PRINT OUT THE INFORMATION.
CL IN TABULAR FORM

DIMENSION NAME(21), ICOM(111)
DATA JAST/IM*, HELP/*, JHELP/*, J6M_IDST/*, IEMO/*, NDEND /
DATA JEND/*, START /

WRITE (6,80)
WRITE (6,81)
WRITE (6,82)
WRITE (6,83)
WRITE (6,84)
WRITE (6,85)
WRITE (6,95)

BEGIN THE SEARCH FOR THE NEXT COMMENT CARD AT THIS POINT
5 CONTINUE
READ (5,100) JAST, ICOM, IREM
100 FORMAT (A1, A5, 2A6, 9A6)

IS THIS THE LAST CARD
IF (ICOM(12)EQ JEND) GO TO 999

NO, THIS IS NOT THE LAST CARD
IS THIS CARD A COMMENT CARD
IF (JAST NE JAST) GO TO 5

YES, THIS CARD IS A COMMENT CARD

DOES THIS COMMENT CARD HAVE A KEY
IF (IREM NE KEY) GO TO 5

YES, THIS COMMENT CARD HAS A KEY
10 CONTINUE
READ (5,100) JAST, LOC, NAME, 1X, 17, 17, ISEL, NBA, NBB, MEAN, MOD, IREM

HAS THE CARD JUST READ A HELP CARD
IF (JHELP NE NAME) GO TO 10

YES, THE CARD JUST READ HAS A HELP CARD

CALL OUTPUT AND PRINT APPROPRIATE INFORMATION
CALL CALL OUTPUT (ICOM, LOC, NAME, 1X, 17, 17, ISEL, NBA, NBB, MEAN, MOD)
<table>
<thead>
<tr>
<th>LINE</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>999 CONTINUE</td>
</tr>
<tr>
<td>57</td>
<td>WRITE (6,99)</td>
</tr>
<tr>
<td>58</td>
<td>WRITE (6,99)</td>
</tr>
<tr>
<td>60</td>
<td>70 FORMAT (1X,130H)</td>
</tr>
<tr>
<td>61</td>
<td>2----------</td>
</tr>
<tr>
<td>62</td>
<td>C</td>
</tr>
<tr>
<td>64</td>
<td>80 FORMAT (1I1)</td>
</tr>
<tr>
<td>65</td>
<td>C</td>
</tr>
<tr>
<td>66</td>
<td>81 FORMAT (9X,18<em>TABLE 1. OPERATION TIME DATA IN DAYS</em>**I)</td>
</tr>
<tr>
<td>67</td>
<td>C</td>
</tr>
<tr>
<td>68</td>
<td>82 FORMAT (1X,1H1,29X*OPERATION,29X,1H1,2X,</td>
</tr>
<tr>
<td>69</td>
<td>1 HINPUT_DATA FOR,1X,1H1)</td>
</tr>
<tr>
<td>70</td>
<td>C</td>
</tr>
<tr>
<td>71</td>
<td>83 FORMAT (1X,1H1,28X,1HDESCRIPTION,28X,1H1,2X,9HINPUT TYPE,2X,</td>
</tr>
<tr>
<td>72</td>
<td>1 HINPUT_PARAMETERS,11X,1H1)</td>
</tr>
<tr>
<td>73</td>
<td>C</td>
</tr>
<tr>
<td>74</td>
<td>84 FORMAT (1X,1H1,67X,1H1,13X,1H1,2X,</td>
</tr>
<tr>
<td>75</td>
<td>C</td>
</tr>
<tr>
<td>76</td>
<td>85 FORMAT (1X,1H1,67X,1H1,13X,1H1,2X,1H1,13X,1H1)</td>
</tr>
<tr>
<td>77</td>
<td>C</td>
</tr>
<tr>
<td>78</td>
<td>88 FORMAT (//)</td>
</tr>
<tr>
<td>79</td>
<td>C</td>
</tr>
<tr>
<td>80</td>
<td>99 FORMAT (1H1)</td>
</tr>
<tr>
<td>81</td>
<td>RETURN</td>
</tr>
<tr>
<td>82</td>
<td>END</td>
</tr>
</tbody>
</table>

**TABLE 1**

<table>
<thead>
<tr>
<th>CODE</th>
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<tbody>
<tr>
<td>62</td>
<td>2----------</td>
</tr>
<tr>
<td>64</td>
<td>80 FORMAT (1I1)</td>
</tr>
<tr>
<td>66</td>
<td>81 FORMAT (9X,18<em>TABLE 1. OPERATION TIME DATA IN DAYS</em>**I)</td>
</tr>
<tr>
<td>68</td>
<td>82 FORMAT (1X,1H1,29X*OPERATION,29X,1H1,2X,</td>
</tr>
<tr>
<td>69</td>
<td>1 HINPUT_DATA FOR,1X,1H1)</td>
</tr>
<tr>
<td>71</td>
<td>83 FORMAT (1X,1H1,28X,1HDESCRIPTION,28X,1H1,2X,9HINPUT TYPE,2X,</td>
</tr>
<tr>
<td>72</td>
<td>1 HINPUT_PARAMETERS,11X,1H1)</td>
</tr>
<tr>
<td>74</td>
<td>84 FORMAT (1X,1H1,67X,1H1,13X,1H1,2X,</td>
</tr>
<tr>
<td>76</td>
<td>85 FORMAT (1X,1H1,67X,1H1,13X,1H1,2X,1H1,13X,1H1)</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>99 FORMAT (1H1)</td>
</tr>
<tr>
<td>81</td>
<td>RETURN</td>
</tr>
<tr>
<td>82</td>
<td>END</td>
</tr>
</tbody>
</table>

**TABLE 3**

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>99 FORMAT (1H1)</td>
</tr>
<tr>
<td>81</td>
<td>RETURN</td>
</tr>
<tr>
<td>82</td>
<td>END</td>
</tr>
</tbody>
</table>
FUNCTION THIAG (JP)
COMMON /HEPL/PARAM(7,3),LL,ISEED,ISEED,ISTORE(2,10),IS(2)
RNUM = DRAND(ISEED)
IF (RNUM - PARAM(JP,2) - PARAM(JP,1)/PARAM(JP,3) - PARAM(JP,1)) = 1.0
TRIAG = PARAM(JP,1) + SQRT((PARAM(JP,3) - PARAM(JP,1)) * RNUM)
RETURN
END

PROCEDURE TRIAG

PROCEDURE THIAG

FUPGM HA18=08/30-13:31

58
FUNCTION TRIAG1(JP)
COMMON /HEPL/PARAM(7,3),LL,ISEED1,ISEED1,ISTONE(2,10),I5(2)
RNUM = DMANG(I5(2))
1IF(RNUM-(PARAM(JP,2)-PARAM(JP,3))*PARAM(JP,11))/PARAM(JP,4),1,2
1TRIAG1 = PARAM(JP,11) - SORT1((PARAM(JP,3)-PARAM(JP,11)))
1*{PARAM(JP,2) - PARAM(JP,3)}*RNUM
2RETURN
3X = (PARAM(JP,3)-PARAM(JP,2))**2 - (PARAM(JP,2) - PARAM(JP,3))
4{PARAM(JP,2) - PARAM(JP,11) - (PARAM(JP,3)-PARAM(JP,11))*RNUM
5TRIAG1 = PARAM(JP,3) - SQRT(X)
6RETURN
7
8GD06,P UNFRM
9
10GHT,S UNFRM
11FURFUR MA18=06/30-13:31
12
APPENDIX C. EXAMPLE TABLE1 OUTPUT
<table>
<thead>
<tr>
<th>OPERATION DESCRIPTION</th>
<th>DISTRIBUTION TYPE</th>
<th>MIN</th>
<th>MODE</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAT, BOOSTER, ORBITER AND LUT</td>
<td>TRIANGULAR</td>
<td>1 A000</td>
<td>2 A000</td>
<td>2.2000</td>
</tr>
<tr>
<td>COUNTDOWN PREPARATION</td>
<td>TRIANGULAR</td>
<td>1 A000</td>
<td>2 A000</td>
<td>2.0000</td>
</tr>
<tr>
<td>FINAL COUNTDOWN</td>
<td>CONSTANT</td>
<td>0.830</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REMOVE POST LAUNCH LUT FROM PAD</td>
<td>TRIANGULAR</td>
<td>1.2500</td>
<td>2.0000</td>
<td>1.7500</td>
</tr>
<tr>
<td>TRANSPORT LUT TO MAINT., REFURBISH/TEST, TRANSPORT TO STORAGE</td>
<td>TRIANGULAR</td>
<td>2.7900</td>
<td>3.0000</td>
<td>3.3000</td>
</tr>
<tr>
<td>REFURBISH LAUNCH PAD</td>
<td>TRIANGULAR</td>
<td>1.9500</td>
<td>1.0000</td>
<td>1.0500</td>
</tr>
<tr>
<td>LIFTOFF THROUGH SEPARATION</td>
<td>CONSTANT</td>
<td>0.020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOOSTER COAST, REENTRY, FLYBACK AND LANDING</td>
<td>TRIANGULAR</td>
<td>0.540</td>
<td>0.070</td>
<td>0.0740</td>
</tr>
<tr>
<td>BOOSTER SAFING</td>
<td>TRIANGULAR</td>
<td>0.9000</td>
<td>1.0000</td>
<td>1.1000</td>
</tr>
<tr>
<td>TRANSPORT BOOSTER TO MAINTENANCE</td>
<td>TRIANGULAR</td>
<td>0.9500</td>
<td>1.0000</td>
<td>1.0500</td>
</tr>
<tr>
<td>BOOSTER MAINTENANCE</td>
<td>EXPONENTIAL</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOOSTER ADDITIONAL MAINTENANCE</td>
<td>EXPONENTIAL</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSPORT BOOSTER TO SYSTEMS TEST, TEST, TRANSPORT TO STORAGE</td>
<td>TRIANGULAR</td>
<td>1.9000</td>
<td>2.0000</td>
<td>2.1000</td>
</tr>
<tr>
<td>ORBITER SAFING</td>
<td>TRIANGULAR</td>
<td>0.5000</td>
<td>1.0000</td>
<td>1.1500</td>
</tr>
<tr>
<td>TRANSPORT ORBITER TO MAINTENANCE</td>
<td>TRIANGULAR</td>
<td>2.2500</td>
<td>2.5000</td>
<td>2.7500</td>
</tr>
<tr>
<td>ORBITER MAINTENANCE</td>
<td>TRIANGULAR</td>
<td>2.2500</td>
<td>2.5000</td>
<td>2.7500</td>
</tr>
<tr>
<td>ORBITER ADDITIONAL MAINTENANCE</td>
<td>EXPONENTIAL</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSPORT ORBITER TO SYSTEMS TEST, TEST, TRANSPORT TO STORAGE</td>
<td>TRIANGULAR</td>
<td>1.9000</td>
<td>2.0000</td>
<td>2.1000</td>
</tr>
<tr>
<td>REMOVE BOOSTER, ORBITER AND LUT FROM THE PAD</td>
<td>TRIANGULAR</td>
<td>1.9000</td>
<td>2.0000</td>
<td>2.2000</td>
</tr>
<tr>
<td>TRANSPORT VEHICLE, SEPARATE ORBITER, TRANSPORT ORBITER TO MAINTENANCE</td>
<td>TRIANGULAR</td>
<td>1.9500</td>
<td>1.9500</td>
<td>1.9500</td>
</tr>
<tr>
<td>SEPARATE BOOSTER FROM LUT, TRANSPORT BOOSTER TO MAINTENANCE</td>
<td>TRIANGULAR</td>
<td>1.9500</td>
<td>1.9500</td>
<td>1.9500</td>
</tr>
<tr>
<td>BOOSTER MAINTENANCE ON RETURN FROM PAD</td>
<td>EXPONENTIAL</td>
<td>7.5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOOSTER VEHICLE SYSTEM TEST FACILITY ON RETURN FROM PAD</td>
<td>TRIANGULAR</td>
<td>1.9000</td>
<td>2.0000</td>
<td>2.1000</td>
</tr>
<tr>
<td>ORBITER MAINTENANCE ON RETURN FROM PAD</td>
<td>EXPONENTIAL</td>
<td>7.5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORBITER VEHICLE SYSTEM TEST FACILITY ON RETURN FROM PAD</td>
<td>TRIANGULAR</td>
<td>1.9000</td>
<td>2.0000</td>
<td>2.1000</td>
</tr>
</tbody>
</table>
APPENDIX D. SAMPLE SOS MODEL OUTPUT
# **TABLE II: SUMMARY RESULTS**

## CASE STUDY: DETERMINATION OF FLEET SIZE REQUIREMENTS

<table>
<thead>
<tr>
<th>INITIAL CONDITIONS</th>
<th>BOOSTER</th>
<th>ORBITER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF VEHICLE STAGES</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SERVICE CAPACITY OF SAFING AREA</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SERVICE CAPACITY OF MAINTENANCE FACILITY</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>SERVICE CAPACITY OF CHECKOUT &amp; TEST FACILITY</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SERVICE CAPACITY OF MATE &amp; HOOK-UP FACILITY</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SERVICE CAPACITY OF LUT REFURBISHMENT FACILITY</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>NUMBER OF LUTS</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>NUMBER OF LAUNCH PADS</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

## TRAFFIC MODEL STATISTICS

- MISSILE MODEL LAUNCH RATE (FLIGHTS/YEAR): 63
- DISTRIBUTION OF TIME BETWEEN LAUNCH REQUESTS:
  - 0% of launches are scheduled 1 day apart
  - 14.16% of launches are scheduled 2 days apart
  - 48.16% of launches are scheduled 3 days to 1 week apart
  - 39.7% of launches are scheduled 1 week to 2 weeks apart
  - 1.2% of launches are scheduled 2 weeks to 1 month apart

## OPERATIONAL EVALUATION PARAMETERS FOR 502 SIMULATIONS:

- The number of successful launch requests are 98% or 0.4% percent
- The number of vehicles launched in a subsequent window is 0 or 1.4% percent

### REASONS FOR REQUEST FAILURES:

- BOOSTER UNAVAILABILITY: 56 times or 1.6% percent
- ORBITER UNAVAILABILITY: 0 times or 0% percent
- BOTH STAGES UNAVAILABLE: 0 times or 0% percent
- LUT UNAVAILABILITY: 11 times or 2.2% percent
- PAD UNAVAILABILITY: 0 times or 0% percent
- FAILURES AND REMOVAL FROM PAD: 12 times or 2.4% percent

## AVERAGE PHASE TIMES PER VEHICLE ELEMENT:

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**STANDARD DEVIATION 3935.608**

**NON-WEIGHTED**

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-2.800

-2.734

-2.581

-2.435

-2.226

-2.152

-2.006

-1.860

-1.756

-1.570

-1.424

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<th>Cumulative Percentage</th>
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<th>Multiple Deviation from Mean</th>
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**Table Number 7**

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<td>85.7</td>
<td>14.3</td>
<td>-1.34</td>
</tr>
<tr>
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<td>0.00</td>
<td>85.7</td>
<td>0.00</td>
<td>-1.26</td>
</tr>
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<tr>
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<td>-0.95</td>
</tr>
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<td>0.00</td>
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<td>0.00</td>
<td>-1.26</td>
</tr>
<tr>
<td>800</td>
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<td>0.00</td>
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<td>0.00</td>
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</tr>
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<td>42.9</td>
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<th>Cumulative Percentage</th>
<th>Remainder of Mean</th>
<th>Multiple of Mean</th>
<th>Deviation from Mean</th>
</tr>
</thead>
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Remaining frequencies are all zero.

#### Table Number 20

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<th>Non-Weighted</th>
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<td>Cumulative Percentage</td>
</tr>
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Remaining frequencies are all zero.

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<td>Cumulative Percentage</td>
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Remaining frequencies are all zero.

### Table Number 22

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<th>Standard Deviation</th>
</tr>
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</table>

This table is partially visible and contains data that requires specific context for interpretation.
<table>
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<tr>
<th>Observed Frequency</th>
<th>Observed Percent of Total</th>
<th>Cumulative Percentage</th>
<th>Cumulative Remainder of Mean</th>
<th>Multiple of Mean</th>
<th>Deviation from Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>96.0</td>
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<td>1.1</td>
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**TABLE NUMBER 23**

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<th>Non-Weighted</th>
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<th>Cumulative Remainder of Mean</th>
<th>Multiple of Mean</th>
<th>Deviation from Mean</th>
</tr>
</thead>
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APPENDIX E. SAMPLE CONFIDENCE INTERVAL OPTION OUTPUT
### Table III: Statistical Results

**Confidence Intervals on Requested Statistics**

*WARNING - CONFIDENCE INTERVALS WITH LIMITS OF 0 OR 100 ARE PROBABLY NOT 99 PERCENT CONFIDENCE INTERVALS*

**Statistics Based on 0 Observations**

<table>
<thead>
<tr>
<th>99 Percent Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOWER LIMIT</td>
</tr>
</tbody>
</table>

#### Statistical Confidence Intervals for 500 Simulations

- The percentage of successful launch requests: 49.06%
- The percentage of unsuccessful launch requests: 50.94%
- The percentage of vehicles launched at a subsequent window: 5.37%

#### Reasons for Request Failures:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Lower Limit</th>
<th>Mean</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booster Unavailability</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Orbiter Unavailability</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Both Stages Unavailable</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>LUT Unavailability</td>
<td>55.69</td>
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<td>61.69</td>
</tr>
<tr>
<td>Pad Unavailability</td>
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<td>0.0</td>
</tr>
<tr>
<td>Failures and Removal from Pad</td>
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<td>2.32</td>
<td></td>
</tr>
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</table>

#### The Following are the User Requested Statistics

<table>
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<th>Statistic</th>
<th>Lower Limit</th>
<th>Mean</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from landing to storage</td>
<td>5.89</td>
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<td>6.05</td>
</tr>
<tr>
<td>Orbiter Safing facility utilization (percent)</td>
<td>11.29</td>
<td>12.94</td>
<td>14.60</td>
</tr>
<tr>
<td>Launch Pad 1 utilization (percent)</td>
<td>40.33</td>
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<tr>
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<td>0.0</td>
</tr>
<tr>
<td>Orbiter Maintenance queue time</td>
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</table>
APPENDIX F. EXPLANATION OF INDIVIDUAL CONTROL CARDS

This appendix gives a brief operational description of the various control cards contained in the example deck setups shown in the document. Further information about these control statements is given in the MSFC Program Procedures Manual with the page numbers in parentheses. (Refer to Figure F-1 for the correct column positioning).

1. @ADD MODEL.
   This card will add the contents of file MODEL to the run stream. This card must follow the @XQT GPSS8, MAPGPS card for each execution of the GPSS program. (6.3.1-80)

2. @ASG, T NAME, F2
   This control card assigns a temporary file location called NAME on a magnetic drum unit. The F2 represents the type of drum selected for mass storage. Note that an @ASG card must be used for each file referenced within the run. (6.3.1-29)

3. @ASG, T TAPENAME, T, SAVEXX
   This card creates a tape called TAPENAME and is maintained in the MSFC tape library for the time specified by the code XX. The code XX represents the following:
   (Technical Bulletin No. 17)
   02--14 day retention
   03--30 day retention
   04--90 day retention
   05--6 month retention

4. @ASG, T TAPENAME, T, 12345
   This card assigns the use of a tape drive to the run. In this example, the tape file is called TAPENAME and reel number 12345 is loaded onto the drive unit. (6.3.1-33)

5. @BRKPT PUNCH$
   This card causes the current normal punch file to be closed and queued for punching and starts a new normal punch file. (6.3.1-101)
6. @BRKPT PUNCH$/FN
This statement causes the current normal punch file to be closed and queued for printing and routes all future output of the normal punch type to a file whose name is FN. The file whose name is FN must be currently assigned to the run. (6.3.1-102)

7. @COPIN TAPENAME, GPSSE8.
This card causes the transfer of the program instruction from the tape called TAPENAME, to a file name GPSSE8. (6.3.1-147)

8. @COPIN TAPENAME, TPF$.
This card causes the transfer of the program instructions from the tape, called TAPENAME, to a temporary program file. (6.3.1-148)

9. @COPOUT GPSSE8, TAPENAME
This card is a reverse operation of the @COPIN card. The program instructions are transferred from the file GPSSE8 to the tape named TAPENAME. (6.3.1-146)

10. @COPY, G TAPENAME, MODEL.
This control card causes the transfer of a data file (the GPSS System Model Description) from the tape named TAPENAME to a drum location named MODEL. (6.3.1-144)

11. @COPY, GM MODEL, TAPENAME
This represents the reverse operation of the @COPY, G TAPENAME, MODEL. command. (6.3.1-144)

12. @COPY, RSA MASTER*GPSSE8., GPSSE8.
This control card is used to command execution from a drum file. This card copies from the drum a program called MASTER*GPSSE8 into temporary location nameL GPSSE8. (6.3.1-144)

13. @DATA FILE2, MODEL
This control card permits the updating of the GPSS model network contained on a file named FILE2. The new revision is stored in a file named MODEL (corrections or changes to MODEL follow this control card and FILE2 remains unchanged). (6.3.1-97)

14. @DATA, L DUMMYP, MODEL
This control allows the revision of the DUMMYP file and creates an updated file named MODEL. The revisions to DUMMYP follow this control card. A listing of the data in MODEL is then generated. (6.3.1-97).
15. @END
   This control card marks the end of the data corrections following the DATA control card. (6.3.1-98)

16. @ERS GPSSE8.
   This control card will erase all contents of the program file named GPSSE8. (This card is used in decks that generate a new program file.) (6.3.1-156)

17. @FIN
   Signifies the end of the control deck. (This is the last card on all deck setups.) (6.3.1-80)

18. @FOR, US GPSSE8, NAME, GPSSE8, NAME
   Control card used to include a new or modified Fortran user written subroutine in the GPSS run stream. The word NAME should be replaced on the control card with the title of the subroutine. The U option allows modification of individual cards in the subroutine. An I option allows the inclusion of an entire subroutine package but not the updating of individual cards (6.3.1-103)

19. @FREE TAPENAME
   Releases the tape called TAPENAME. (In cases where the information on the tape has been copied onto the drums, the tape drive unit is no longer needed and, therefore, released from the run.) (6.3.1-88)

20. @HDG, P CASE STUDY TITLE
   This heading card prints any desired title on the top of each page of the printout. The page number and data are also printed. All columns on the card can be used. In this case, the title CASE STUDY TITLE is printed on top of each page of output. (6.3.1-124)

21. @MAP, LX GPSSE8, MAP, GPSSE8, MAPGPS
   This card causes the collection of all program elements into the program instruction element by the name of MAPGPS. (6.6-4)

22. @MOVE TAPENAME, 2
   This control card is used for positioning the tape called TAPENAME at the beginning of the selected file. (The example indicates the movement of the tape past 2 files from its present position.) (6.3.1-137)

23. @PREP GPSSE8.
   This command is used to prepare a program file on FASTRAND for subsequent referencing as a library by the collector. This card must always be used before a @MAP control card. (6.3.1-153)
24. @PRT, T
   This card produces a table of contents of the temporary
   program file (TPFS). (6.3.1-157)

25. @PRT, T GPSSE8.
   This card will generate a table of contents of all elements
   contained in the program file GPSSE8. (6.3.1-151)

26. @REWIND TAPENAME
   Executive command which causes the rewinding of the
   tape drive called TAPENAME. Execution of this control
   causes the tape to be positioned at the starting point of
   the first tape file. (6.3.1-138)

27. @RUN, //P SAMPLE, 999999, PORTERBIN225, 3, 150
   The run is always the first control card in the 1108 deck
   setup. This card contains all the information used by the
   computer for accounting and identification purposes. The
   three options available on the RUN card are P (production),
   T (development, and A (maintenance and checkout).
   SAMPLE1 is the run I.D. code assigned to the particular
   deck for use by the computer, 999999 is the accounting
   job number, PORTER is the programmer's name in six
   characters, and 225 identifies the programmer's BIN
   location. The 3 is the maximum CPU time (min) for the
   run. The 150 represents the maximum number of pages
   of output produced by the program. (Technical Bulletin
   No. 16)

28. @SETC 2
   Sets the computer condition word to the value of 2 and
   causes the generation of a punched deck of the absolute
   GPSS model. (6.3.1-118)

29. @SETC 3
   Sets the computer condition word to the value of 3, thus
   eliminating the listing of the model network. A separate
   header page is generated for each case to be executed.
   (6.3.1-118)

30. @SETC 4
   Sets the computer condition word to the value of 4, thus
   causing a printout indicating the distributions and their
   associated parameters from the GPSS model that were
   defined for each processing operation. (An extra
   control card, @ADD MODEL, must be inserted into the
   program deck when this control option is used.) (6.3.1-118)
31. **@SETC 5**
Sets the computer condition word to the value of 5, thus causing the System Model to be read for headings used in the collection of confidence interval statistics. (An extra control card, @ADD MODEL, must be inserted into the program deck when this control option is used.)
(6.3.1-118)

32. **@XQT GPSSE8.MAPGPS**
Control card command indicating the execution of the GPSS program instructions called MAPGPS contained on a file named GPSSE8. (6.3.1-108)

33. **@XQT, LA SYS*$MSFC$. LISTIT**
This card executes a special program that generates a listing of the contents of the temporary program file. (6.3.1-106)
<table>
<thead>
<tr>
<th></th>
<th>GENERAL CARD DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>@ ADD MODEL.</td>
</tr>
<tr>
<td>2</td>
<td>@ MAS, T NAME F 2</td>
</tr>
<tr>
<td>3</td>
<td>@ ASO, T TAPE NAME T: SAVEXX</td>
</tr>
<tr>
<td>4</td>
<td>@ ASO, T TAPE NAME T: 12345</td>
</tr>
<tr>
<td>5</td>
<td>@ BREEPT PUNCH.</td>
</tr>
<tr>
<td>6</td>
<td>@ BREEPT PUNCH: FIN</td>
</tr>
<tr>
<td>7</td>
<td>@ C0FIN TAPE NAME: GPSS 8</td>
</tr>
<tr>
<td>8</td>
<td>@ C0FIN TAPE NAME: TPFS</td>
</tr>
<tr>
<td>9</td>
<td>@ C0P0UT GPSS 8. TAPE NAME</td>
</tr>
<tr>
<td>10</td>
<td>@ C0PY G TAPE NAME: MODEL</td>
</tr>
<tr>
<td>11</td>
<td>@ C0PY G M MODEL: TAPE NAME</td>
</tr>
<tr>
<td>12</td>
<td>@ C0PY RSA MASTER: GPSS 8, GPSS 8</td>
</tr>
<tr>
<td>13</td>
<td>@ DATA FILE 2, MODEL</td>
</tr>
<tr>
<td>14</td>
<td>@ DATA 1 DUMMY 2, MODEL</td>
</tr>
<tr>
<td>15</td>
<td>@ END</td>
</tr>
<tr>
<td>16</td>
<td>@ ERG GPSS 8</td>
</tr>
<tr>
<td>17</td>
<td>@ FIN</td>
</tr>
<tr>
<td>18</td>
<td>@ FC0 US GPSS 8. NAME, GPSS 8. NAME</td>
</tr>
<tr>
<td>19</td>
<td>@ FREE TAPE NAME</td>
</tr>
<tr>
<td>20</td>
<td>@ HDG F CASE STUDY TITLE</td>
</tr>
<tr>
<td>21</td>
<td>@ MAP LX GPSS 8, MAP GPSS 8, MAPG</td>
</tr>
<tr>
<td>22</td>
<td>@ MOVE TAPE NAME 2</td>
</tr>
<tr>
<td>23</td>
<td>@ PREP GPSS 8.</td>
</tr>
<tr>
<td>24</td>
<td>@ PRT T</td>
</tr>
<tr>
<td>25</td>
<td>@ PRT T GPSS 8.</td>
</tr>
</tbody>
</table>

**FIGURE F-1. EXAMPLE CONTROL CARD FORMAT (Sheet 1 of 2)**