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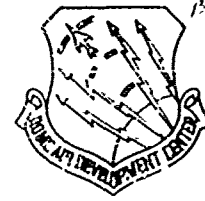
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December 1975



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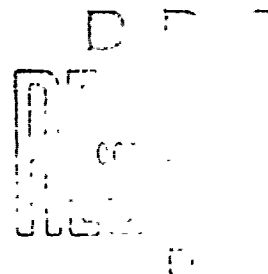
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- i. Variable Description
2. Flow Charts
- . Program Listing

1. Introduction

The purpose of this report is to describe a program written to simulate the Honeywell Time Sharing System (Version 8) operating on the Honeywell 635 computer.

The model includes, in great detail, sections of the TSS Allocator as well as the TSS Executive, the Derail Processor and Line Service. The program simulates the behavior of Subsystem programs and the effects of the scheduling policies of TSS.

The simulation program being described here is written in the SImscript II programming language. SImscript is a high level, event oriented simulation language with several features that are very helpful for this particular use.

The program was written and developed at the Systems Engineering Laboratory at the University of Michigan and was debugged and validated on a Honeywell 3000 system at the Rome Air Development Center, Rome, New York.

2. Event and Routine Summary

As mentioned before, Sinscript is an event oriented language and hence the program is made up of several small events and routines, each corresponding to a subroutine or block of code of TSS. To ease understanding and debugging the names of all routines and events have been preserved from the actual system program listings as far as possible.¹

The events and routines in the simulation program can be classified into six categories. The following is a list of the categories and the routines comprising each one with a brief description of their functions.

2.1 Initialization

INIT - Reads input parameters and values. Initializes data structures. Schedules events for termination and diagnostic printing.

MAIN - Starts simulation.

2.2 Diagnostic and Output

PDIAG - Controls printing of diagnostic information as per input parameters.

REINIT - Reinitializes statistic counters after given simulation period.

CORSAMP - Samples values of program size, hole size and used core for collecting statistics.

MQPRINT - Prints memory queue.

CQPRINT - Prints processor queue.

STERM - Terminates simulation.

1

In certain cases where two names have the same first four characters, the names have been transformed due to a Sinscript requirement that the first four characters of all names be unique. e.g. ALLCC1 and ALLCC2 are renamed as 1ALLCC and 2ALLCC.

OUTPUT - Prints simulation results and statistics.

SNAP.R - Prints debugging and diagnostic information in case the simulation terminates abnormally.

2.3 Allocator Routines

ALLOCI - Main entry point to the TSS allocator and the process of allocator process (PAP).

MAP - Memory allocator process. Selects programs for memory allocation and swap.

SDP, SDP3, SDP4, SDP5, SDP6, SDP7 - Swap decision processors. Find programs for regular and force swaps, handle urgent user logic, core fence for urgent user and TSS swap area size control.

SPMACT - Special memory action processor for changing TSS swap area size.

MBA, MBA3 - Memory buffer allocator process. Attempts core allocation for programs and manages memory map.

MBD - Memory buffer deallocator. Returns blocks of memory to available storage pool in memory map.

MMV - Memory map verification process. Also accumulates some core statistics.

SWOUT - Swap out routine.

SWIN - Swap in routine.

SWPLD - Schedules courtesy call for swap.

SSFINI - Terminates subsystem execution.

BUFDMP - Adjusts subsystem status for keyboard input and output operations.

KIOSRT - Schedules keyboard I/O courtesy calls.

START - Introduces new subsystems into the system and initializes

subsystem attributes.

SACT - Takes subsystem accounting for statistics.

ATCHG - Changes subsystem state times.

EXENTR - Entry to allocator via an interrupt.

EXEACT - Accounting routine after return from subsystem dispatch.

2.4 Derail Routines

KONDRL - Keyboard input derail.

KOTDRL - Keyboard output derail.

DRLDIO - Disk I/O derail.

DRLRET - Subsystem return (termination) derail.

2.5 Courtesy Calls

KIUCC - Keyboard I/O courtesy call.

DIOCC - Disk I/O courtesy call.

1ALLCC - Swap out courtesy call.

2ALLCC - Swap in courtesy call.

2.6 Line Service

LINSV - Controls TSS action during relinquish to GCOS and TSS idle.

Also schedules new program arrivals into TSS.

3. Data Structures

Three major TSS data structures are modelled in the program exactly as they appear in the real system. These are the processor and memory queues and the memory map. In addition, the model also has a disk I/O queue and a queue of scheduled courtesy calls. The purpose of these is discussed below. Finally, a program in TSS is modelled by means of an entity called a UST. (The name UST was chosen because the entity closely resembles an entry in the User Status Table.)

3.1 The UST Entity

Each active program in the system is represented by a temporary entity called a UST. An entity is created when a new job arrives and is destroyed when it terminates.

The UST entity has a number of attributes some of which are similar to those found in the TSS user status table and others which control the activity of the program.

The following is a list of the attributes of the UST entity. The attributes on the left are those that also appear in the TSS user status table and have the same names as the original variables. (Note: The digits 1 and 2 appended to a variable name signify the upper and lower halves of that word respectively.) The attributes on the right are used to control the simulation of the program that the UST represents. A description of each attribute is given in Appendix 1.

UST Attributes

FK19	CHKCPU
FL18	JOBNO
FL19	KILL
FL21	NXTDIO
FL22	NXTKIN
FL23	NXTKOUT
FL24	OUTCC
FL34	DIOIAT
LSIZE	
LSPTS	KIIAT

LST10

KOIAT

LTC21, LTC22

LTC31, LTC32

LTCW

LTIN

LTM0

LTM1

LTM2

LTM3

LTM4

LTM5

LTMRS

LTMWT

The UST entity contains the entire description of a program in the system. It is filed in the different system queues in exactly the same manner as the entries in the TSS user status table are linked into queues.

Usually, attributes of entities are referred to in Simscript by the expression:

attribute (entity pointer)

to denote the particular entity whose attribute is being examined. However, the entity pointer can be omitted and the default global entity name 'UST' is assumed. Throughout most of the program such a scheme is used to refer to attributes since the global variable 'UST' always contains the pointer to the UST on which the allocator is presently working.

3.2 The Processor Queue - CPUQ

The TSS processor queue consists of a linked list of user status table entries. In the program, this queue is modelled as a simple ordered Simscript set called CPUQ. UST entities are filed last in the set and the first entity is always picked for allocation.

3.3 The Memory Queue - MEMQ

The TSS memory queue is a linked list of UST entries ordered by increasing program sizes. This is modelled in the program as a set MEMQ whose members (UST entities) are ranked by low LSIZE attributes. When new UST's are filed in MEMQ, Simscript automatically links them so that the increasing order of the LSIZE attribute is preserved.

3.4 The Memory Map

The memory map data structure is almost identical to its TSS counterpart. The map consists of a doubly linked list of blocks each of which represents one program present in core.

The memory map consists of five vectors: SJOB, SHOLE, SUC, PRED and IDPTR. Each entry in the map is represented by a corresponding element from each of the above vectors. The vectors have the following functions:

SJOB(I) - contains the program size of the program (in units of 1024 words).

SHOLE(I) - contains the size of the "hole" (unused portion of core) following the program in core (in units of 1024 words).

SUC(I) - pointer to the entry in the map succeeding this entry.

PRED(I) - pointer to the entry in the map preceding this entry.

IDPTR(I) - contains the identification number attribute (JOBNO) of

the UST entity that corresponds to this entry in the memory map.

The first entry in the memory map is always a dummy entry which belongs to no program but is kept merely to hold the hole size at the top of TSS core. The variables HEAD and TAIL point to the first and last entries in the map respectively. A possible memory map configuration is shown in Figure 1 below.

I	SJOB	SHOLE	SUC	PRED	IDPTR
1	0	10	3	0	0
2					
3	10	2	7	1	56
4					
5					
6	11	15	0	7	67
7	22	0	6	3	24

Figure 1. Memory Map Configuration

In the example of Figure 1 the values of HEAD and TAIL would be 1 and 6 respectively.

3.5 The Disk I/O Queue - DIOQ

Since no data is obtained on the service time of the disk units the program uses an artificial disk I/O queue to simulate the handling of disk I/O operations.

The disk I/O queue is a fifo queue and is modelled with a single exponential server. The formula for obtaining the exponential server rate from the measured values of the disk I/O queue and disk I/O operation arrival rate is described in Reference 1.

3.6 The Courtesy Call Queue - CCQ

The courtesy call queue is strictly for the internal use of the model and does not exist in the real system. The purpose of this queue is to accurately simulate the arrival of scheduled courtesy calls when they interrupt the execution of a subsystem program.

In the actual system a courtesy call would generate an interrupt to TSS. In the model, this interrupt is generated with the help of the CCQ.

The CCQ consists merely of a list of all future courtesy calls ordered by increasing arrival times. When a new courtesy call is scheduled it is entered in the queue at the appropriate position depending on its arrival time. When a courtesy call arrives, it is removed from the CCQ. Note that at this time it should be at the head of CCQ and the simulation time will be equal to its arrival time.

When the TSS allocator dispatches the CPU to a subsystem, it checks to see if a courtesy call would be the next event to interrupt the subsystem. This is done by checking the arrival time of the first entry in the CCQ. If that is the case, an interrupt and consequent

entry into the allocator is scheduled immediately following the courtesy call.

4. Input Parameters

The input to the simulation program is divided into three categories as follows. For each category the input parameters are given in the order in which they must appear in the input stream. The designations (R) and (I) specify the mode of the variable as real or integer respectively. All time values are in milliseconds and all memory values are in units of 1024 words unless otherwise stated.

4.1 Diagnostic and Control

These input values control the execution of the simulation program and the printing of diagnostic comments. The form of messages printed is described fully in Section 5.6.

STOPTIME - (R) Value of simulated time at which the simulation is to be terminated.

DEVS - (I) Event diagnostics switch. If this switch is set to 1, a message is printed. If no diagnostics are required this switch must be 0.

DRS - (I) This switch is similar to DEVS but is for allocator routines.

DQS - (I) If this switch is non-zero, the MEMQ or CPUQ are displayed whenever that queue is changed.

DMS - (I) If this switch is non-zero, the memory map is displayed every time it is changed.

DSJS - (I) If this switch is non-zero, a message is printed every

time the TSS swap area size is changed, and a sample of core utilization is displayed at every call of routine MMV.

DUS - (I) If this switch is non-zero a message is printed for every urgent user detected and every force swap performed.

DKS - (I) If this switch is non-zero a message is printed for each key I/O derail and courtesy call.

DSS - (I) If this switch is non-zero, a message is printed at the start and termination of every subsystem.

DBEGIN - (R) Simulation time at which diagnostic printing is to begin.

DDUR - (R) Duration of diagnostic printing.

STREAM(1) . . . STREAM(10) - (I) These ten integer numbers are used as seeds for the ten Simscript pseudo-random number generators.

4.2 TSS Parameters

These input values consist of various TSS parameters that are used by the allocator for decision making. These parameters are described more fully in Reference 2, TSS Executive SMD. The values of each parameter in the system can be obtained from the listing of the communications region, TSSA.

AMFTM - (R) Maximum core fence maintenance time.

LNSF - (I) Number of swap files.

TASWT - (R) Minimum memory allocation wait time to cause further memory allocation and swap actions.

TAMIS - (R) Maximum high priority service program size.

TALPP - (R) Large program penalty factor.

TASWF - (R) Factor for program urgency calculation.

TASID - (R) Damper for urgent user size increases.

TLTLM - (R) Maximum time between line service calls.
TAMII - (I) Minimum memory size increase increment.
TAMMS - (I) Maximum TSS swap area size. (In the real system this is total TSS memory size.)

AMTQ - (R) Minimum core residency time before consideration for force swap.

TACMI - (R) Minimum time between requests for core size increases.

TATMC - (R) Maximum time for core size change to stay pending.

TATMD - (R) Delay before scheduled size reduction is completed.

TAMAW - (R) Delay before informing user "NOT ENOUGH CORE TO RUN JCB".

TLNLM - (R) Minimum time between periodic line service functions.

TASMS - (I) Minimum TSS swap area size. (In the real system this is total TSS memory size.)

TAMRI - (R) Minimum time between size reduction considerations.

TAPMR - (R) Value of TAPMU above which memory reduction is not requested.

TASRI - (I) Memory size reduction amount.

TASCF - (R) Minimum interval between urgent user size increases.

ASD3I - (R) Minimum interval between entries to SDP3 for scan of urgent users.

TCDEL - (R) Time slice for each subsystem dispatch.

4.3 Driving Data

The data under this category consists of the data collected from the actual system that is to be used to drive the model. All this data is obtained from the real systems using TSS accounting records and the programs mentioned in References 3 and 4.

INITCORE - (I) Initial TSS swap area size.

INTMEAN - (R) Mean interrupt interarrival times (cpu time/interrupt).

MNDELAY, MXDELAY - (R) Lower and upper limits for a uniform distribution of time delay after each interrupt.

DIOMEAN - (R) Mean disk I/O service time (real time).

OUTMEAN - (R) Mean duration of a keyboard output operation (real time).

USTIAT - Distribution of subsystem interarrival times (real time/subsystem).

NOKIN - (I) Distribution of keyboard inputs per subsystem.

NOKOUT - (I) Distribution of keyboard output per subsystem.

NODIO - (I) Distribution of disk I/O's per subsystem.

SWAPDUR - (R) Distribution of swap channel service time (real time).

CPUDUR - (R) Distribution of cpu time used by subsystems.

KIODUR - (R) Distribution of keyboard input durations (real time).

SIZEDIST - (I) Distribution of subsystem program sizes.

The input data must be terminated with the number 9999. The program uses this as a check to make sure the input data had the correct number of data elements.

Figure 2 shows a sample input data set.

```

10 10800000 0 0 0 0 0 0 0 10800001 0 3600000
20 98275 78985 75300 32388 52300
30 22154 24369 15815 53295 54224
40 20000 4 3000 36 4 .008 1000 500
50 7 98 7000 14000 50000 30000 150000 3000
60 20 300000 75 5 30000 1000 25
70 40 30 7 15 29.3 2200
80 0 7 .315 1192 .53 2741 .589 3370 .71 5233 .213 7323 .260 2414
90 .91 11500 .949 14640 .995 20910 .988 23200 .998 27150
100 .995 33450 .995 39720 1.0 47662 *
110 0 0 .529 0 .754 1 .845 2 .89 3 .899 4 .911 5 .93 5 .941 7
120 .951 8 .956 9 .958 10 .96 11 .97 12 .974 13 .977 14
130 .981 17 .984 18 .986 19 .988 20 .991 27 .993 29 .995 34
140 .998 38 1.0 150 *
150 0 0 .321 0 .584 1 .806 2 .871 3 .881 4 .892 5 .911 6 .923 7
160 .925 9 .927 9 .93 10 .934 11 .944 12 .955 13 .958 14 .963 17
170 .957 18 .97 20 .972 22 .979 24 .981 25 .984 29 .988 30
180 .991 35 .993 36 .995 58 .998 111 1.0 173 *
190 0 0 .340 0 .551 1 .581 2 .717 3 .778 4 .81 5 .834 6 .850 7
200 .876 8 .897 9 .902 10 .911 11 .923 12 .932 13 .944 14
210 .946 19 .948 20 .951 21 .953 25 .956 29 .958 30 .955 31
220 .967 33 .97 36 .979 40 .981 55 .984 62 .986 89 .988 90
230 .991 148 .993 650 .995 1101 .998 2023 1.0 4565 *
240 0 27.5 .015 85.3 .134 220.8 .218 247 .305 281.6 .534 327.8
250 .673 339.4 .829 431.8 .883 489.5 1.0 720 *
260 0 4 .131 12.3 .237 15.1 .365 22.5 .507 33.5 .649 40.9
270 .657 50.8 .789 97.6 .892 472.2 .913 800 .932 1409
280 1.0 39917 *
290 0 0 .001 2275 .023 5832 .234 6340 .386 11330 .399 13250
300 .507 17070 .516 18930 .536 22810 .54 24730 .738 23550
310 .753 32380 .798 35210 .851 38120 .865 41950 .915 45770
320 .930 53430 .951 55340 .963 61080 .965 76390 .971 78300
330 1.0 282381 *
340 0 1 .094 1 .153 2 .199 3 .271 4 .35 5 .364 6 .378 7 .364 8
350 .7 9 .717 10 .738 11 .817 12 .895 13 .91 14 .929 15
360 .934 15 .945 17 .959 18 .967 19 .969 20 .969 21
370 .971 22 .991 23 .991 24 .991 25 1.0 25 *
380 9999
390 DATA FOR MARCH '77 13.5 12 14.00

```

Figure 2. Sample Input Data Set

5. Output

The normal simulation output consists of five categories as described below. The final section deals with output messages printed when the diagnostic switches are set on.

5.1 Input Echo

The first part of the output consists of an echo of the entire input data except for the distributions in Section 4.3.

5.2 Memory Statistics

The mean and standard deviation of the following TSS swap area statistics are printed.

1. Program sizes in core.
2. Hole sizes.
3. Total swap area size.
4. Total used core size.
5. Percentage core utilization.

The values in this section are accumulated automatically by Simscript every time their values are sampled in routines MMV and CORSAMP.

5.3 Overall Mean Rates

This section contains the mean rate of occurrence per hour of the following TSS events and processes.

1. Keyboard inputs.
2. Keyboard outputs.
3. Disk I/O's.
4. Swap outs (total).
5. Swap outs (due to keyboard I/O).
6. Swap outs (due to key output only).
7. Force swaps.
8. TSS swap area size increases.

9. TSS swap area size decreases.
10. Total subsystem CPU time.
11. Subsystem starts.
12. Subsystem terminations.
13. Dispatches of the CPU to subsystems.
14. Urgent users detected.
15. Entries to Processor Allocator.
16. Entries to Memory Allocator.
17. Allocator idles.
18. Interrupts.
19. Total core swapped.

These items are accumulated explicitly in the program and converted to hourly rates in routine OUTPUT.

5.4 Typical Subsystem Behavior

This section contains information on the behavior of a typical subsystem that executed during the simulation period. These statistics are collected at each subsystem termination as in the real system for the TSS accounting records. (See Ref. 3).

1. Subsystem interarrival time.
2. Keyboard input interarrival time.
3. Keyboard output interarrival time.
4. Disk I/O interarrival time.
5. Program size.
6. CPU time (sampled).
7. CPU time (used).
8. Response time (R19).
9. Response time (individual).

10. Time spent in each time state:
 - (a) Non-useful core residency.
 - (b) Swap.
 - (c) Useful core residency.
 - (d) Out of core.
 - (e) Awaiting memory.
 - (f) Awaiting memory after being force swapped.
11. Keyboard inputs.
12. Keyboard outputs.
13. Disk I/O's.
14. Force swaps.
15. Total swaps.

Items 1 through 6 are obtained from the samples of the input distributions and are useful for verifying that the input distributions were correct.

Items 6 and 7 differ because the former is the sampled time whereas the latter is computed only on those subsystems that terminate during the simulation period.

Item 8 is the response time as computed from the TSS accounting records in Reference 3. This response time is the total response time divided by the total number of keyboard inputs and outputs. The "individual" response time consists of samples of response time taken at every courtesy call for a keyboard operation.

5.5 System Queue Data

This section gives information on the average number of subsystems in each system queue as well as the average number of subsystems

BEGINNING OF SIMULATION AT 0.

STOPTIME DEVS DRS DQS DMS DSCS DUS
10800000.000000 0 0 0 0 0 0

DKS DSS DBEGIN DDUR INITIME
0 0 10800001.000000 0.360000.000000

RANDOM NUMBER SEEDS

57839
84934
62192
72206
58023
34548
34886
88730
75442
78955

AMFTM LNSF TASWT TAMIS TALPP TASWF TASID
20000.000000 4 3000.000000 36 4 .008000 1000.000000

TLILM TAMII TAMMS AMTQ TAGMI TATMC TATMD
500.000000 7 58 7000.000000 14000.000000 60000.000000 30000.000000

TAMAW TLNLM TASMS TAMRI TAPMR TASRI TASC
150000.000000 3000.000000 20 300000.000000 75 5 30000.000000

ASD3I TCDEL INITCORE INTMEAN MNDELAV MXDELAV DIOMEAN
1000.000000 25.000000 40 30.000000 7.000000 16.000000 88.299999

OUTMEAN
2200.000000

SIMULATION TERMINATION AT 10800000.000

CORE STATISTICS MEAN STANDARD DEVIATION
PROGRAM SIZES 7.677 4.59893
HOLE SIZES 4.980 9.11604
SWAP AREA SIZE 48.785 8.08320
TOTAL USED CORE 26.746 12.83447

PERCENT CORE USED 54.265 24.29143

Figure 3. Sample Simulation Output

OVERALL MEAN RATES (PER HOUR)
 KEYBOARD OUTPUTS 2338.00
 KEYBOARD INPUTS 1665.50
 DISK I/O'S 12188.50
 SWAP OUTS 1881.50
 SWAP OUTS (KEY I/O) 1827.00
 SWAP OUTS (KEY OUTPUT) 551.50
 FORCE SWAPS 46.50
 SIZE INCREASES 4.50
 SIZE DECREASES 6.00
 SUBSYSTEM CPU TIME 852245.906 MS.
 SUBSYSTEM STARTS 760.50
 SUBSYSTEM KILLS 754.50
 SUBSYSTEM DISPATCHES 69012.50
 URGENT USERS 47.00
 ENTRIES TO PAP 80558.00
 ENTRIES TO MAP 9302.00
 ALLOCATOR IDLES 11545.50
 INTERRUPTS 69003.00
 TOTAL CORE SWAPPED 13017.50 K

SUBSYSTEM STATISTICS MEAN STANDARD DEVIATION
 SUBSYSTEM IAT 4737.04 6200.02
 KEY INPUT IAT 178.42 1453.09
 KEY OUTPUT IAT 242.71 1790.60
 DISK I/O IAT 62.39 881.83
 PROGRAM SIZE 8.14 5.03
 CPU TIME (SAMPLED) 1146.56 5179.26
 CPU TIME (USED) 1080.62 5006.96
 RESPONSE TIME (R19) 3238.88 22184.43
 RESPONSE TIME (INDIVIDUAL) 1740.16 13153.81
 TIME IN STATE
 NON-USEFUL CORE 8159.79 31824.46
 SWAP 1607.56 4395.30
 USEFUL CORE 5053.05 28368.11
 OUT OF CORE 34956.78 150524.82
 AWAIT MEMORY 347.57 1776.40
 AWAIT MEMORY AFTER FS 30.91 336.93
 NO. OF KEY INS 1.83 7.52
 NO. OF KEY OUTS 3.10 11.25
 NO. OF DISK I/O'S 15.43 195.43
 NO. OF FORCE SWAPS .06 .43
 NO. OF SWAPS 4.80 13.15

QUEUE LENGTHS MEAN STANDARD DEVIATION
 PROCESSOR QUEUE 1.11 1.17
 MEMORY QUEUE 11.23 2.91
 DISK I/O QUEUE .40 .58
 USERS SWAPPING .35 .80
 USERS IN CORE 3.48 1.78

URGENT USERS .02 .16
 USERS WAITING FOR CORE .48 .54
 USERS ELIGIBLE FOR CPU .93 1.06

Figure 3 (Contd.). Sample Simulation Output

performing special activities.

1. Processor queue.
2. Memory queue.
3. Disk I/O queue.
4. Number of users swapping.
5. Number of users in core.
6. Number of urgent users.
7. Number of users waiting for core.
8. Number of users eligible for the CPU.

The queue lengths are maintained and accumulated by Simscript automatically. The other items are updated explicitly and accumulated automatically.

Figure 3, on the following page, shows a sample simulation output.

5.6 Diagnostic Output

This section describes the types of messages printed when each of the diagnostic switches described in section 4.1 are turned on.

1. DEVS - A message of the type

eeee AT ttttt.t

is printed whenever an event is entered. eeee is the event name and ttttt.t is the simulation time. For events that are associated with a subsystem (e.g. derails and courtesy calls), one of the phrases

BY nnnn

FOR nnnn

OF nnn.n

TO nnnn

are postfixed to the message as appropriate. nnnn is the subsystem index number.

This switch also causes the printing of the message

```
START AT ttttt.t OF nnnn SIZE = cccc
                        CPU = sssss.s
```

in routine START. cccc and sssss.s are the program size and cpu time allocated to the new subsystem.

2. DRS - A message of the type

```
rrrr CALLED
```

is printed at the beginning of every routine execution. rrrr is the name of the routine. This message is not printed for routine START.

3. DQS - The MEMQ and CPUQ are printed whenever their members are changed or rearranged. The UST's in the queue are printed in the order in which they appear in the queue. For each UST the following line is printed.

```
nnnn b1 b2 b3 b4 b5 b6 b7 s
```

nnnn is the index number of the UST. b1 through b7 represent the flag word bits FL18, FL19, FL21, FL22, FL23, FL24 and FL34 respectively. s represents one of six states that the UST can be in. s takes on values from 0 through 5 and represents the following subsystem states:

- 0 Non-useful core residency.
- 1 Swap.
- 2 Useful core residency.
- 3 Out of core.
- 4 Awaiting memory.
- 5 Awaiting memory after force swap.

4. DMS - The memory map is printed whenever it is altered. For each entry in the map the following line is printed

```
nnnn pppp hhhh
```

where nnnn is the UST index number, ppp is its program size and hhhh is the size of the hole succeeding the program in core. The first entry in the core map, which is a dummy entry has an undefined value for nnnn and a program size of zero.

5. DSCS - A message is printed whenever TSS core size is changed.

The two possible messages are:

SIZE INCREASED TO ssssK AT ttttt.t

SIZE DECREASED TO ssssK AT ttttt.t

where ssss is the new core size and ttttt.t is the time of the size change. In addition, whenever routine CORSAMP is called (at the start of every subsystem) the values of total, used and percent core used are printed as follows:

AT ttttt.t TOTCOR = sss USED = ttt = ppp.p% (MEAN = mmm.m%)

6. DUS - A message is printed whenever an urgent user is detected and a force swap is performed.

The urgent user message is:

nnnn FOUND URGENT FOR ssss.s MS. AT ttttt.t

where nnnn is the UST index number, ssss.s is the time elapsed since this UST was first discovered urgent, and ttttt.t is the current simulation time.

The force swap message is:

nnnn FORCE SWAPPED AT ttttt.t

7. DKS - A message is printed at every keyboard input and output derail and courtesy call. The derail messages are:

nnnn START INPUT AT tttt.t UNTIL ssss.s

nnnn START OUTPUT AT tttt.t UNTIL ssss.s

The courtesy call messages are:

nnnn FINISHED KIO AT ttt.t .

where nnnn and tttt.t are as before, and ssss.s is the time of the scheduled courtesy call for the I/O operation.

8. DSS - Messages are printed at the start and termination of every subsystem. The start message is identical to that for DEVS.

The termination message is:

STOP AT tttt.t OF nnnn KIN = iii KOUT = jjj

TOT RESP = sss.s CPU ALLOC = uuuu.u USED = vvvv.v

where nnnn and tttt.t are as before, iii and jjj are the total keyboard inputs and outputs performed by the subsystem respectively, sss.s is the total response time accumulated. uuuu.u and vvvv.v are the CPU time allocated to the subsystem and total time used by it and must always be equal (See Sec. 8).

6. Using the Program

The program was tested and run on a Honeywell 6000 computer under the GCOS operating system. The use of this program is covered in two sections, compilation and execution.

6.1 Compilation

The program can be compiled by the CACI Simscript II.5 compiler for HIS 600/6000 computers (USAF release 9). Compilation requires approximately 61 k words of storage and 7 minutes of processor time. The following deck would compile the program in the source file SIM and store the object deck in the file SIMOB.


```

1000 #S,U,J           ,8,16,32
1010 $ IDENT BFCAUM01,MULLA J ,558102110001,UNIV. OF MICHIGAN
1020 $ PROGRAM RLHS,0N5,DECK
1030 $ LIMITS 13,61K,,10K
1040 $ PRMFL H*,R,R,SMSCP2.5/COMPILER
1050 $ FILE *1,X1R,20L
1060 $ FILE *2,X2R,20L
1070 $ FILE B*,B1S,20L
1080 $ PRMFL C*,R/W,S,BFCAUM01/SIM0B
1090 $ SELECTA BFCAUM01/SIM
1100 $ ENDJOB

```

To compile the program from TSS the following underlined commands must be issued. It is assumed that the above lines are in the file COMP.

```

SYSTEM ?CARDIN 0LD COMP
READY
*RUN
  SNUMB # 1234T
*

```

To examine the output of the compilation from TSS the following commands must be entered.

```

SYSTEM ?JOUT 1234T
FUNCTION?SCAN 74
FORM?DUMP
EDIT?YES
?PRINT /*** ERROR/**
?DONE
FUNCTION?DIRECT 0NL

```

If no error comments are printed in response to the print command it indicates that the compilation was error-free.

6.2 Execution

To execute the program the following commands are required. Execution requires 25 K words of storage and approximately fifteen minutes of processor time for every hour simulated. It is assumed that the data to be used is in the file SIMDATA.

```
1000 #S,U,J           ,8,16,32
1010 $ IDENT BFCAUM01,MULLA J ,558102110001,UNIV. OF MICHIGAN
1020 $ LØWLØAD
1030 $ ØPTION ØRTRAN
1040 $ LIBRARY SL
1050 $ SELECT BFCAUM01/SIMØB
1060 $ EXECUTE
1070 $ LIMITS 50,25K,-3K
1080 $ PRMFL SL,R,S,SMSCP2.5/LIBRARY
1090 $ PRMFL 17,R,S,SMSCP2.5/ERRØRS
1100 $ FILE B*,B1R
1110 $ DATA I*
1120 $ SELECTA BFCAUM01/SIMDATA
1130 $ ENDJØB
```

To run the program from a terminal the following underlined commands must be entered. It is assumed that the above GCOS commands are in the file RUN.

SYSTEM ?CARDIN OLD RUN

READY

*RUN

SNUMB # 5678T

*

To examine the output from the program on TSS the following commands must be issued.

SYSTEM ?JOUT 5678T

FUNCTION?PRINT 06

7. Detailed Program Description

The following is a detailed, line by line description of each routine and event in the program. The order is as in the program listing in Appendix 3.

7.1 PREAMBLE

- 8 - 11 Text substitutions for the compiler.
- 18 - 33 Random variable distribution entities. See Section 4.3.
- 38 - 49 Definition of UST entity and its attributes.
- 50 Definition of memory queue ordering on LSIZE attribute.
- 54 - 65 Definition of event routines.
- 66 Definition of CCQ set and its limited attributes.
- 70 - 71 Definition of memory map arrays.
- 72 - 91 Definition of global variables. See Appendix 1 for details.
- 95 - 134 Definitions of variables for automatic collection of statistics and global counters.

7.2 INIT

- 145 - 162 Read and echo input data from sections 4.1 and 4.2.
(Diagnostic control and TSS parameters).
- 163 Read input values for distributions in Section 4.3.
(Driving data).
- 164 - 167 Read check and stop if it is not 9999.
- 172 Reserve array locations for memory map vectors.
- 176 - 183 Initialize memory map. Link all blocks in a doubly
linked list. Create dummy block as first one in map.
- 187 - 189 Schedule the arrival of the first subsystem and I/O
interrupt.
- 192 - 195 Schedule entry to allocator termination of simulation,
and event to test diagnostic switches.

7.3 MAIN

- 201 Call INIT to initialize program
- 202 Start simulation clock.

7.4 PDIAG

- 212 - 215 If the call is at the beginning of the diagnostic period
set all internal switches to the values read in INIT.
- 218 - 220 At the end of the diagnostic period reset all switches
to zero.

7.5 REINIT

- 226 - 233 Call Simscript generated routines to initialize counters
for TALLY and ACCUMULATE variables.
- 235 - 238 Reset all global counters to zero.

7.6 CORSAMP

- 246 - 253 Scan through the memory map and add up the program sizes in USED CORE and both program and holesizes in TOTCOR.
- 254 Calculate percent core used in PERUSED.
- 255 - 256 Print core size and percentage used for diagnostics.

7.7 MQPRINT

- 262 - 268 For each UST in the memory queue print the index number, flag word bits and state number.

7.8 CQPRINT

- 274 - 280 Do the same as MQPRINT for each UST in the processor queue.

7.9 STERM

- 286 Call OUTPUT to print simulation results and then terminate the simulation.

7.10 OUTPUT

- 291 - 292 Print time at which simulation was terminated.
- 296 - 304 Print memory utilization statistics.
- 308 - 331 Print the number of certain TSS events that occurred per hour during the simulation period.
- 335 - 364 Print statistics on an average subsystem the executed during the period.
- 368 - 380 Print statistics on queue lengths.

7.11 SNAP.R

- 389 - 393 Print next arrival time for each event in the program.
- 394 Print arrival time of derails for the UST that was being served last by the allocator.

- 397 - 398 Print arrival times of all courtesy calls in the CCQ.
401 Call OUTPUT to print simulation results up to this point.

7.12 ALLOCI

- 409 - 410 Call LINSV or MAP if their respective flags are set.
413 - 414 Increment count of entries to allocator and set allocator flag.
415 - 417 Scan CPUQ for jobs that are not doing I/O and not swapping.
419 See if job found is scheduled for force swap. If so call SDP7.
420 If not call RETSSX to dispatch cpu to job.
421 Reset the UST's new subsystem bit.
426 - 428 If no jobs eligible for cpu, reset allocator flag and go to LINSV.

7.13 MAP

- 436 Increment count of entries to MAP.
437 Reset map flag.
440 If special memory action flag is set call SPMACT.
441 Set time of last entry into MAP
443 If no urgent user is waiting go to MAP.2A.
444 If urgent user can fit in current core fence go to MAP.3.
445 - 447 If he has been urgent for more than 1/4TH ms. reject him and clear the core fence.
451 - 452 Scan MEMQ for jobs that are not doing keyboard I/O, not in core and not swapping.
454 If such a job was not force swapped to go to MAP.4 and try to swap him in immediately.

455 Otherwise remember the first job we find eligible for
 swap in.

459 - 460 If no swap candidate was found and no special memory
 action is waiting return to ALLOC1.

461 - 463 If special memory action waiting, call swap decision
 processor.

467 If swap candidate was found call MBA to allocate storage.

470 - 473. If allocation was unsuccessful call swap decision processor.

476 if successful, call SWIN to swap him in.

477 - 478 Return to MAP to allocate storage for the next program.

481 - 484 If urgent user got core, destroy the core fence.

485 - 487 If he is in the MEMQ and still needs core call MBA to
 allocate it. Otherwise go to MAP.3 to look for another
 swap candidate.

7.14 SDP

496 - 497 If more swaps are in progress than there are swap files,
 go back to ALLOC1.

498 Reset the pointer to job to be swapped.

501 - 502 Scan the MEMQ for jobs that are doing keyboard I/O and
 are in core and not swapping.

504 - 505 If the size of such a job exceeds the required size set
 AMN1 to that UST.

509 - 510 If no swap candidate was found call SDP3.

513 - 515 Call SWOUT to swap out job found.

516 Repeat SDP for more jobs to swap out.

7.15 SDP3

- 526 - 529 Enter only if last entry was at least ASD31 ms. ago or five unsuccessful attempts were made previously.
- 530 - 535 Reset counter, entry time, number of urgent users found, memory needed, largest urgent user wait time.
- 539 - 543 Find user that needs memory and has been waiting at least TASWT ms.
- 547 - 550 Calculate job wait factor depending on size of program.
- 551 - 552 See if wait factor calculated is less than time waited. If so he is eligible to be urgent.
- 555 - 560 If he was force swapped, reset the force swap bit and change his state from "waiting memory after force swap" to "waiting memory", but do not consider him urgent.
- 563 - 564 If he was found urgent, increment urgent user counts.
- 566 - 567 If USWITCH is set print urgent user message.
- 568 - 569 If he is the longest waiting urgent user, set ITALUT to his UST.
- 572 - 573 Record number of urgent users detected in this pass through SDP3. Call SDP4.

7.16 SDP4

- 581 - 582 If no urgent user was found call SDP6.
- 583 - 589 Call SDP5 if (i) longest wait time is less than TASID ms., (ii) it has been less than TASCf ms. since the last size change, or (iii) a size change request is already scheduled.
- 592 - 298 Calculate a new (larger) size for TSS swap area.
- 599 Increment size increase requests.

600 Set special memory action flag.

601 Call SDP5 to set up core fence.

7.17 SDP5

610 If core fence is already up call SDP6.

611 - 613 If urgent user size is greater than TSS swap area size call MBA3 to increase size.

614 - 615 Set core fence size (2AURWT) needed to LSIZE of urgent user.

616 Set time fence was established.

618 Call SDP6 to force swap jobs.

7.18 SDP6

627 If special memory action waiting go directly to scan for force swap jobs.

628 - 632 If an urgent user was found and swap files are not full begin scan for force swaps. Otherwise return to ALLOCI.

633 - 635 Scan CPUQ for a job that has been in core more than AMTQ ms.

636 If the job is not new and is not already scheduled for a force swap, set the force swap bit.

637 - 638 If the job is doing I/O return to ALLOCI.

639 - 640 Otherwise call SDP7 to force swap it immediately.

643 Return to ALLOCI.

7.19 SDP7

652 - 659 Call SWOUT to swap job out. Increment force swap counters for UST and system. Move UST from CPUQ to MEMQ. Print diagnostic messages for QSWITCH and USWITCH.

660 Return to ALLOCI.

7.20 SPMACT

670 - 672 If no size change is scheduled, clear flag and return.

673 If size decrease is scheduled go to SPM.3.

676 If size has been increased less than TAGMI ms. ago,
ignore this request.

678 - 679 Print diagnostics for increase.

683 If new size requested is current size or less than 3K,
ignore it.

684 - 688 If there is no hole at the tail end of core large enough
for the reduction, or the request has been pending
longer than TATMC ms. or less than TATMD ms. go to
SPM.5 to see if request should be ignored.

690 - 691 Print diagnostics for decrease.

695 Update memory map entry.

696 - 697 Clear size request and request flag.

699 Set time of last change or change attempt.

703 - 706 Ignore request if time since last request is greater
than TATMC.

7.21 MBA

714 Clear success return flag.

715 Increment count of entries.

719 - 726 Check memory map for a hole big enough to satisfy
request.

729 - 731 If search was unsuccessful and program will not fit in
TSS size, call MBA3.

734 - 737 If allocated job was the urgent user, clear the core fence.

738 - 740 If he is not the urgent user, make sure he does not use up the core fence set up for the urgent user.

744 - 759 Build and link new entry into the memory map.

760 Set flag to indicate that allocation was successful.

761 Call MMV to verify memory map is still good.

7.22 MBA3

770 - 772 If urgent user has waited more than TAMAW ms. for core, return.

773 - 775 If a size increase is already scheduled, return.

776 Set new request to size of program.

777 Set the special memory action flag.

778 - 780 If urgent user needs more than TAMII plus the current TSS swap area size, return.

781 - 783 Otherwise set the new size request to TAMII more than the current size but not more than TAMMS.

7.23 MBD

793 - 797 Scan memory map for the job with the same pointer as the one to be deallocated.

800 - 807 Remove the entry from the core map and relink preceding and succeeding entries.

808 If the deallocated program was larger than 2K, set the MAP flag.

809 Call MMV to verify the memory map.

7.24 MMV

- 823 - 832 Scan every entry in the memory map and add up each program and hole size in TOTCOR.
- 825 - 827 Print diagnostics when MSWITCH is set.
- 833 Sample value of CORSIZE for statistics.
- 837 - 839 Compare TOTCOR with the current TSS swap area size. If they are not equal print an error message and stop.
- 844 - 848 Scan the MEMQ for jobs waiting for core (i.e., not doing I/O, not swapping, not in core and not new subsystem).
- 849 - 853 Scan the CPUQ for jobs eligible for the cpu (i.e., not doing I/O, not swapping, not scheduled for a force swap and in core).

7.25 SWOUT

- 861 Clear "in core" bit.
- 862 Set "swapping out" bit.
- 863 Increment swap count.
- 864 - 865 If keyboard I/O is in progress, set "roadblocked" bit, and clear "scheduled for force swap" bit.
- 866 Call SWPLD to swap out.

7.26 SWIN

- 875 Set "swapping in" bit.
- 876 Call SWPLD to perform swap in.
- 877 Increment count of jobs in core.

7.27 SWPLD

- 883 DIR specifies direction of the swap to be performed.
(0 = in, 1 = out.)

886 Increment subsystem's swap count.
887 Change subsystem state to "swapping".
888 Increment count of jobs swapping.
890 - 891 Schedule swap in courtesy call. File the courtesy call
in CCQ.
892 Schedule swap out courtesy call.
893 Add program size to total core swapped out.
894 File the courtesy call in CCQ.

7.28 SSFINI

902 Increment count of subsystem terminations.
903 - 904 Decrement count of jobs in core. Change subsystem
state to "out of core".
905 Call MBD to release core.
908 - 911 Remove job from whichever queue it was in and print queue
diagnostics if necessary.
914 - 920 If an output courtesy call is still pending for this
subsystem, cancel it.
921 Call SACT to take subsystem accounting and destroy UST entity.

7.29 BUFDMP

930 For output operation, bypass this routine and call
KIOSRT.
931 - 933 For input, move the UST from the CPUQ to the MEMQ.
934 Change subsystem state to "non-useful core residency".
935 Set "I/O roadblocked" bit.
937 Print queues for diagnostic purposes.

938 Call KIOSRT to start I/O operation.

7.30 KIOSRT

950 - 954 If keyboard I/O is already in progress (FK19 = 1), it must be an output since the subsystem was executing. In this case, cancel the output courtesy call.

955 Set "I/O in progress" bit.

958 If operation is an output:

959 Increment subsystem's count of outputs.

960 - 965 If no output is in progress collect response time value since the last key I/O courtesy call.

966 Set LTIN to the arrival time of the courtesy call.

967 - 969 Schedule the output courtesy call and file it in the CCQ.

970 - 971 Print diagnostic message if KSWITCH is set.

975 If operation is an input:

Increment subsystem's count of inputs.

976 - 981 If no previous output is in progress, collect a response time sample.

982 - 986 Schedule input courtesy call and print diagnostic message if KSWITCH is set.

7.31 START

992 Increment count of subsystem arrivals.

994 Call CORSAMP to sample values for memory map statistics.

997 Create a new UST entity.

998 - 999 Sample, assign and tally values for program size and cpu time allocated.

- 100 - 1006 Sample values for the number of disk I/O's, keyboard inputs and outputs for this subsystem, and calculate the mean interarrival time between each. If zero operations are sampled the interarrival time is set to RINF.C (Simsript constant for the largest possible real number).
- 1007 Set time until next disk I/O, and key input and outputs as half the interarrival time. The I/O operations are equally spaced in cpu time throughout the subsystem execution period.
- 1008 Set "new subsystem" bit.
- 1009 Assign sequential index number.
- 1010 Initialize LTIN, LTMWT.
- 1011 File the UST in the memory queue.
- 1012 - 1013 Print message for diagnostics.
- 1014 Change subsystem state to "awaiting memory".
- 1015 Print MEMQ if QSWITCH is set.

7.32 RETSSX

- 1026 - 1027 Set NXTCC to the arrival time of the next courtesy call.
- 1028 Set NEXT to the smallest of the following times:
- Time until the next disk I/O.
 - Time until the next key input.
 - Time until the next key output.
 - Cpu time remaining for the subsystem.
 - Time until the next interrupt.
 - Subsystem quantum (TCDEL).
 - Time until next courtesy call.

- 1029 Initialize DISPT to the time of dispatch.
- 1030 - 1034 Reduce each of the above times by the minimum value.
- 1038 - 1042 Schedule the derail which was to occur next. In case TCDEL, NXTINT or NXTCC was the least time, schedule an EXENTR to re-enter the allocator via an interrupt.

7.33 SACT

- 1052 - 1062 Sample each of the following values from the UST entity and assign them to their respective global tallied variables:

Time spent in each of the six subsystem states.

Keyboard inputs.

Keyboard outputs.

Disk I/O's.

Force swaps.

Swaps.

- 1065 - 1067 Calculate response time by dividing total response time accumulated by the total number of keyboard I/O's. If no key I/O's were done, response time is total subsystem duration.
- 1068 Sample subsystem cpu time allocated.
- 1069 - 1072 Print message if SSSWITCH is set.

7.34 ATCHG

- 1080 - 1086 Add current time minus time of previous call to ATCHG for this subsystem to the accumulated time for the previous state (specified by LTCW).
- 1087 Set LTCW to new state (N).
- 1088 Update time of last state change.

7.35 EXENTR

- 1097 - 1098 Move the interrupted UST to the last position in the CPUQ.
- 1099 Print CPUQ for diagnostic aid.
- 1100 Call EXEACT to take accounting.
- 1101 Re-enter the allocator via ALLOCI.
- 1104 Sample the arrival time of the next interrupt.

7.36 EXEACT

- 1115 Increment count of interrupts.
- 1116 - 1118 Add cpu time used by subsystem to totals for subsystem and overall system.
- 1119 If MAP was last called more than ASD3I ms. ago, set MAP flag.
- 1120 If LINSV was last called more than TLTLM ms. ago, set LINSV flag.

7.37 KONDRL

- 1128 Set input operation flag.
- 1129 Call EXEACT to take accounting.
- 1130 Increment global key input count.
- 1131 Call BUFDMF to process input.
- 1134 Reset time until next input to mean input arrival time.
- 1135 Return to ALLOCI.

7.38 KOTDRL

- 1143 Set output operation flag.
- 1144 Call EXEACT to take accounting.
- 1145 Increment global key output count.

- 1146 Call BUFDMP to process output.
- 1149 Reset time until next output to mean output arrival time.
- 1150 Return to ALLOCI.

7.39 DRLDIO

- 1158 Set "disk I/O in operation" bit.
- 1159 Call EXEACT to take accounting.
- 1160 - 1161 Increment UST's and system's count of disk I/O operations.
- 1162 Reset time until next disk I/O to mean disk I/O arrival time.
- 1166 - 1168 If the DIOQ is empty, schedule the courtesy call for this UST and file it in the CCQ.
- 1169 File the UST at the end of the DIOQ.
- 1170 Return to ALLOCI.

7.40 DRLRET

- 1178 Call EXEACT to take accounting.
- 1181 Check to see that the subsystem utilized all the cpu time allocated.
- 1182 - 1183 If not, print an error message.
- 1184 Call SSFINI to terminate the subsystem.
- 1185 Return to ALLOCI.

7.41 KIOCC

- 1191 Save UST pointer in TUST and set UST to the subsystem for which KIOCC was scheduled.
- 1192 - 1193 Print message if KSWITCH set.
- 1196 Set time of courtesy call in LTIN.
- 1197 Reset "data in transmission" bit.

- 1200 If operation was an input:
- 1202 Reset "roadblocked" bit.
- 1203 - 1207 If program is not swapping out and not in core, move
 the UST from the MEMQ to the CPUQ. Change state to
 "useful core residency".
- 1208 Print MEMQ and CPUQ for diagnostics.
- 1211 If program is not in core, set MAP flag, and change
 state to "awaiting memory".
- 1213 Restore UST pointer and return.

7.42 DIOCC

- 1220 Save UST pointer as in KIOCC.
- 1223 Remove the UST from the top of the DIOQ. He must be
 the one whose courtesy call is being serviced.
- 1224 Clear "disk I/O in progress" bit.
- 1227 - 1228 Move the UST to the top of the CPUQ.
- 1229 Print CPUQ for diagnostics.
- 1230 Restore UST pointer.
- 1234 - 1237 If there are more UST's in the DIOQ, schedule the first
 one.

7.43 IALLCC

- 1244 Save the UST pointer as in KIOCC.
- 1247 Decrement count of users in core.
- 1248 Clear "swapping out" bit.
- 1249 Set MAP work flag on.
- 1251 - 1253 If UST was not doing key I/O and was force swapped
 change state to "awaiting memory after force swap".

1255 If UST was not force swapped and not doing key I/O
change state to "awaiting memory".

1258 If UST was doing key I/O change state to "out of core".

1259 Call MBD to deallocate core.

1260 Decrement count of jobs swapping.

1261 - 1262 Restore UST pointer. Remove the courtesy call from the
CCQ and destroy it.

7.44 2ALLCC

1268 Save UST pointer as in KIOCC.

1271 Set "program in core" bit.

1272 - 1273 Clear "swapping in" and "scheduled for force swap" bits.

1274 - 1275 Move the UST from the MEMQ to the top of the CPUQ.

1276 Change state to "useful core residency".

1277 Print MEMQ and CPUQ for diagnostics.

1278 Decrement count of users swapping.

1279 - 1280 Restore UST pointer, remove this 2ALLCC call from the
CCQ and destroy it.

7.45 LINSV

1288 Clear LINSV flag.

1289 Clear "no users" switch.

1290 Reset time of last call to LINSV.

1292 Test if at least TLNLM ms. have passed before last
entering the next section. If not, bypass the next
section and go to MSRK.

1293 Update TLOLD, time of entry to this section.

1295 Test to see if both CPUQ and MEMQ are empty. If so,
set MSR240 indicating no users.

1296 If the current core size is not at the minimum go to
MSRKS to try to reduce it.

1297 If core is at its minimum, go to MSR300 to relinquish.

1301 Clear "no users" flag.

1302 If less than TAMRI ms. passed since the last time
through the next section, skip to MSR300 to scan for
new subsystems.

1306 - 1309 Calculate percentage core being used and average it with
the previous value.

1312 - 1318 Find the largest program in the system.

1319 If no users, skip to MSR250.

1320 - 1325 Skip memory reduction if either of the following is
true:

- (i) Time since last here is less than TAMRI ms.
- (ii) An urgent user was found since the last time
through here.
- (iii) The last size change was less than TATMD ms. ago.
- (iv) A program has been awaiting memory since the last
time through here.
- (v) The percent core utilization (TAPMU) is greater
than TAPMR.

1326 - 1327 If current size minus TASRI is less than the minimum
size, set change request to minimum. Otherwise set
request to reduction by TASRI.

1328 If a change request is already scheduled, ignore this
one.

1329 If new size is less than largest program found, ignore
 it.

1330 If time since last change is less than TASC \bar{r} , ignore
 this request.

1331 Set special memory action flag.

1332 Set TAHOL to the new requested core size.

1333 Increment count of reduction requests.

1339 If the arrival time of the next UST is past, call
 START to create it.

1340 - 1341 Sample time of next UST arrival.

1342 Loop back to see if next arrival is also past.

1343 If either Allocator or MAP flags are set, return to
 ALLOC1.

1348 Increment count of idles.

1349 If MAP was last called more than ASD31 ms. ago, set
 MPWF.

1350 - 1351 Set time of next courtesy call.

1352 - 1353 Schedule an entry into the allocator at the arrival of
 the next UST, courtesy call or TAGMI ms., whichever is
 smallest.

8. Error Messages

This section describes only those error messages printed by the program. For Simscript generated error messages see Reference 5.

1. After reading the input data the program reads a check value and compares it with a preset value (see Section 7.2). If this value is not correct the program terminates with the following error message.

```
### ERROR - INPUT FORMAT INCORRECT
```

2. When the memory buffer allocator (MBA) is called to find memory for a certain job, it checks to see if the program is already in core. If such a call is made the error is considered fatal and the following message is printed.

```
### ERROR - MBA CALLED FOR UST ALREADY IN MEMORY
```

3. The memory map arrays (see section 3) are all dimensioned 50. If more than fifty jobs are ever allocated memory, the MBA process prints the following message and terminates the program. In this case the dimension figure in the INIT routine must be increased.

```
### ERROR - NO MORE AVAILABLE BLOCKS FOR MEMORY MAP ARRAY
```

4. The memory map verification routine (MMV) prints a fatal message if the map does not verify. This occurs if the sum of all programs and holes in the map does not equal the total core size. The message printed is:

```
### ERROR - MEMORY MAP DOES NOT VERIFY
```

5. The only non fatal error occurs when a program terminates without using up all the cpu time allocated to it. In such a case the return derail (DRLRET) prints the following message:

```
### ERROR - nnnn ALLOCATED
```

```
CPU = tttt.t          USED = ssss.s
```

where nnnn is the UST index number and tttt.t and ssss.s are the allocated and used cpu times respectively.

APPENDIX 1

Variable Description

The following is an alphabetically ordered list of variable names used in the program and their functions. When a name is followed by (M/S) it means that its mean and standard deviation are automatically collected by Simscript in the variables Mname and Sname respectively.

For certain TSS system constants, their values at the time this program was debugged are given in parentheses. Most variable and parameter names are the same as those in TSS and can be found described in Reference 2.

- ALOCI - Number of entries to the allocator.
- ALUTM - Time at which urgent user was last detected.
- AMAP - Number of entries to MAP.
- AMAP2 - Number of times the core fence limit was exceeded.
- AMBA - Number of entries to MBA.
- AMBA4 - Number of times a hole fit was detected by MBA.
- AMBA5 - Number of successful allocations after hole fit detected.
- AMFTM - Maximum force fence maintenance time (20000 ms.).
- AMN1 - Pointer to UST for SDP.
- AMN2 - Size of memory requested from SDP.
- AMTQ - Minimum core residency time (7000 ms.).
- APAP1 - Number of allocator idles.
- APAP2 - Number of times subsystem selected for processor allocation.
- ASDP - Number of entries to SDP because program awaiting memory.
- ASDP7 - Number of force swaps.

ASD3C - Counter to override timer for entry to SDP3.

ASD3I - Minimum time between entries to SDP3 (1000 ms.).

ASD3T - Time of last entry to SDP3.

AVAIL - Pointer to the list of available blocks in the memory map arrays.

CCQ - Queue of pending courtesy calls. Ordered FIFO.

CHANGE - Temporary variable to hold core size change in LINSV.

CHECK - Check value (9999) to verify that data was read correctly in INIT.

CHKCPU - Allocated cpu time attribute of UST. Used to check used against allocated cpu time.

CORSIZE - Global sample of TACOR in MMV (M/S).

CPUDUR - Input distribution of cpu time per subsystem.

CPUQ - Processor queue.

DBEGIN - Time at which diagnostic printing is to start.

DDUR - Duration of diagnostic period.

DEVS - Diagnostic switch for event trace.

DIOIAT - UST attribute, disk I/O interarrival time.

DIOMEAN - Input mean of disk I/O service time for exponential distribution.

DIOQ - Disk I/O queue. Ordered FIFO.

DIR - Argument for SWPLD routine to specify direction of swap.
1 = out, 0 = in.

DISKIO - Global count of disk I/O's.

DISPT - Time at which last subsystem was dispatched.

DKS - Diagnostic switch for key I/O trace.

DMS - Diagnostic switch for memory activity trace.

DQS - Diagnostic switch for queue activity trace.
 DRS - Diagnostic switch for routine trace.
 DSCS - Diagnostic switch for core size and percentage core utilization trace.
 DSS - Diagnostic switch for subsystem start and termination trace.
 DUS - Diagnostic switch for urgent user and force swap trace.
 DUST - Temporary location for UST in DIOCC.
 ELIGCPU - Number of UST's eligible for the processor (M/S).
 ES - Temporary index.
 EVDIAG - Short for "FOR ES=1 TO EVSWITCH".
 EVSWITCH - See DEVS.
 EXT - Variable for accumulating time used to execute TSS code.
 The values for EXT were calculated from the actual TSS listings with the assumption that the average instruction execution takes approximately 2.2 microseconds.
 FK19 - UST attribute bit, "data in transmission."
 FL18 - UST attribute bit, "disk I/O in progress."
 FL19 - UST attribute bit, "keyboard I/O in progress."
 FL21 - UST attribute bit, "swap out in progress."
 FL22 - UST attribute bit, "program in core."
 FL23 - UST attribute bit, "swap in in progress."
 FL24 - UST attribute bit, "new subsystem."
 FL34 - UST attribute bit, "force swap scheduled."
 HEAD - Pointer to the head entry in the memory map.
 HOLSIZE - Samples of hole sizes in memory map (M/S).
 I - Temporary index.
 IDPTR - Memory map array to hold UST pointer.

INCORE - Number of UST's in core (M/S).
 INDDRL - Flag set by keyboard I/O derails. 1 = input; 0 = output.
 INITCORE - Input data value of initial TSS swap area size.
 INITIME - Input data value of time at which statistic counters are to
 be reinitialized via event REINIT.
 INTMEAN - Input data value of mean interrupt interarrival time for
 exponential distribution.
 J - Temporary index.
 JOBNO - UST attribute, subsystem index number.
 KEYIN - Global count of keyboard inputs.
 KEYOUT - Global count of keyboard outputs.
 KIIAT - UST attribute, keyboard input interarrival time.
 KILL - UST attribute, remaining cpu time until termination.
 KIODUR - Input data distribution, keyboard input duration.
 KOIAT - UST attribute, keyboard output interarrival time.
 KOSWAP - Global count of swaps due to keyboard output activity
 after subsystem termination.
 KSWITCH - See DKS.
 KUST - Temporary location for UST in KIOCC.
 LNSF - Maximum number of swap files (4).
 LSFLG - Line service flag.
 LSIZE - UST attribute, program size.
 LSPTS - UST attribute, subsystem processor time used.
 LSTIO - UST attribute, disk I/O count.
 LTCW - UST attribute, current time state.
 LTC21 - UST attribute, keyboard input count.
 LTC22 - UST attribute, keyboard output count.

LTC31 - UST attribute, force swap count.

LTC32 - UST attribute, swap count.

LTIN - UST attribute, response timer.

LTMRS - UST attribute, accumulated response time.

LTMWT - UST attribute, working timer.

LTM0 - UST attribute, non useful core residency time.

LTM0SS - Global sample of LTM0 (M/S).

LTM1 - UST attribute, swap time.

LTM1SS - Global sample of LTM1 (M/S).

LTM2 - UST attribute, useful core time.

LTM2SS - Global sample of LTM2 (M/S).

LTM3 - UST attribute out of core time.

LTM3SS - Global sample of LTM3 (M/S).

LTM4 - UST attribute, waiting for core time.

LTM4SS - Global sample of LTM4 (M/S).

LTM5 - UST attribute, waiting for memory after force swap time.

LTM5SS - Global sample of LTM5 (M/S).

MAPTM - Time of last entry to MAP.

MEMALOCOK - Return value from memory buffer allocator (MBA).
0 = unsuccessful, 1 = successful.

MEMQ - Memory queue, ordered by increasing LSIZE.

MNDELAY - Input data value, minimum of uniform distribution for
interrupt delay.

MPACT - Special memory action flag.

MPWF - MAP work flag.

MS. - Short for "UNITS".

MSR240 - "No users" flag in LINSV.

MSWITCH - See DMS.

MXDELAY - Input data value, maximum of uniform distribution for interrupt delay.

N - Argument for ATCHG, new time state of UST.

NEXT - Cpu time interval allocated to subsystem in RETSSX.

NODIO - UST attribute, number of disk I/O's.

NOKIN - UST attribute, number of keyboard inputs.

NOKOUT - UST attribute, number of keyboard outputs.

NXTCC - Time until next courtesy call.

NXTDIO - UST attribute, cpu time until next disk I/O.

NXTINT - Cpu time until next interrupt.

NXTKIN - UST attribute, cpu time until next keyboard input.

NXTKOUT - UST attribute, cpu time until next keyboard output.

NXTUST - Real time until next subsystem arrival.

OUTCC - UST attribute, pointer to pending output courtesy call.

OUTMEAN - Input data value, mean output duration.

PERUSED - Percent core utilization (M/S).

PRED - Memory map array of backward pointers.

PROGSIZE - Samples of program sizes in memory map (M/S).

QSWITCH - See DQS.

RDIAG - Short for "FOR RS=1 TO RSWITCH PRINT 1 LINE THUS".

RESPT - Global sample of response time calculated for individual key I/O operations (M/S).

RS - Temporary index.

RSWITCH - See DRS.

R6 - Temporary UST pointer in MAP.

SCSWITCH - See DSCS.

SFUSE - Number of UST's swapping (M/S).
 SHOLE - Memory map array to hold hole values.
 SHOW - Short for "PRINT 1 LINE WITH TIME.V".
 SIZEDIST - Input data distribution of program sizes.
 SIZEINCR - Number of TSS swap area size increases.
 SIZERED - Number of TSS swap area size reductions.
 SJOB - Memory map array to hold program sizes.
 SPMFR - Time of last size increase request.
 SSCPU - Global sample of .LSPTS (M/S).
 SSDIO - Global sample of LSTIO (M/S).
 SSFSWAP - Global sample of LTC31 (M/S).
 SSKIN - Global sample of LTC21 (M/S).
 SSKOUT - Global sample of LTC22 (M/S).
 SSRESP - Global sample of response time calculated by dividing the
 total response time by total keyboard I/O's (M/S).
 SSSWAPO - Global sample of LTC32 (M/S).
 SSSWITCH - See DSS.
 STOPTIME - Input data value, simulation duration.
 SUC - Memory map array for forward pointers.
 SUST1 - Temporary variable to hold UST pointer in 1ALLCC.
 SUST2 - Same as SUST1 for 2ALLCC.
 SWAPDUR - Input data distribution, swap channel service time.
 T - Temporary variable.
 TAAUG - Number of urgent users detected.
 TACOR - TSS swap area size.
 TAGMI - Minimum time between size increases (14000 ms.).
 TAGPT - Cumulative cpu time used by TSS since last relinquish to GCOS.

TAGTC - Number of interrupts.
 TACTU - Sum of subsystem cpu time.
 TAHOL - New requested TSS swap area size.
 TAIL - Pointer to last entry in memory map.
 TALCT - Time of last size change attempt.
 TALPP - Large program penalty multiplier for wait factor calculation
 in SDP3 (4).
 TALPS - Largest program detected in LINSV size reduction logic.
 TALUT - Longest urgent user wait time.
 TAMAW - Maximum wait time for core before rejection of program
 (150000 ms.).
 TAMII - Minimum memory size increment (7K).
 TAMIS - Maximum size of programs considered under high priority (36K).
 TAMMS - Maximum TSS swap area size (58K).
 TAMRI - Minimum time between size reduction attempts (300000 ms.).
 TAPMR - Minimum value of TAPMU required to prevent size reduction
 (75%).
 TAPMU - Moving average percent core utilization.
 TASCf - Minimum time between size increase requests due to urgent
 users (30000 ms.).
 TASID - Damper for urgent user size increases (1000 ms.).
 TASIO - Count of swap outs due to key I/O.
 TASMS - Minimum TSS swap area size (20K).
 TASRI - Memory size reduction amount (5K).
 TASRT - Time of last entry to size reduction logic.
 TASWF - Divisor to convert size into time units for wait factor
 calculations in SDP3 (.008).

TASWT - Minimum wait time before swap decision logic is invoked
(3000 ms.).

TATMC - Maximum time allowed for size change to occur (60000 ms.).

TATMD - Delay before scheduled size reduction request is completed
(30000 ms.).

TATMN - Total program size belonging to urgent users.

TAURG - Current number of urgent users (M/S).

TAUSE - Temporary variable to add up size being used.

TCDEL - Subsystem cpu time slice (25 ms.).

TEMP - Temporary variable.

TKILL - Number of subsystem terminations.

TLFLG - Allocator work flag.

TLLST - Time of last entry to LINSV.

TLNAA - Count of TSS idles.

TLNLM - Interval between line service functions (3000 ms.).

TIOLD - Time of last entry to idle status check in LINSV.

TLTLM - Minimum time between scan for new UST's in LINSV (500 ms.).

TOTCOR - Temporary variable to accumulate TSS core size in MMV.

TSIRC - Number of times size increase was requested because of
waiting program.

TSRRC - Number of size reduction requests.

TSIRT - Number of subsystem starts.

TSWAP - Number of program swaps.

TSWPK - Total core swapped.

TUST - Temporary UST pointer storage.

URGT - Urgent user wait time.

USEDSize - Amount of TACOR being used by programs (M/S).

UST - Global pointer to UST currently being served by the allocator.

USTIAT - Input data distribution, UST interarrival times.

USWITCH - See DUS.

VCPUDUR - Sampled values of CPUDUR (M/S).

VDIOIAT - Sampled values of DIOIAT (M/S).

VKIAT - Sampled values of KIIAT (M/S).

VKOIAT - Sampled values of KOIAT (M/S).

VSIZE - Sampled values of SIZEDIST (M/S).

VUSTIAT - Sampled values of USTIAT (M/S).

WAITCOR - Current number of users waiting for core (M/S).

WAKET - Time to reenter TSS after relinquish to GCOS.

WTFAC - Wait factor calculated for subsystem.

LAURWT - UST pointer to urgent user for whom core fence is established.

ITALUT - Pointer to UST that has been urgent the longest.

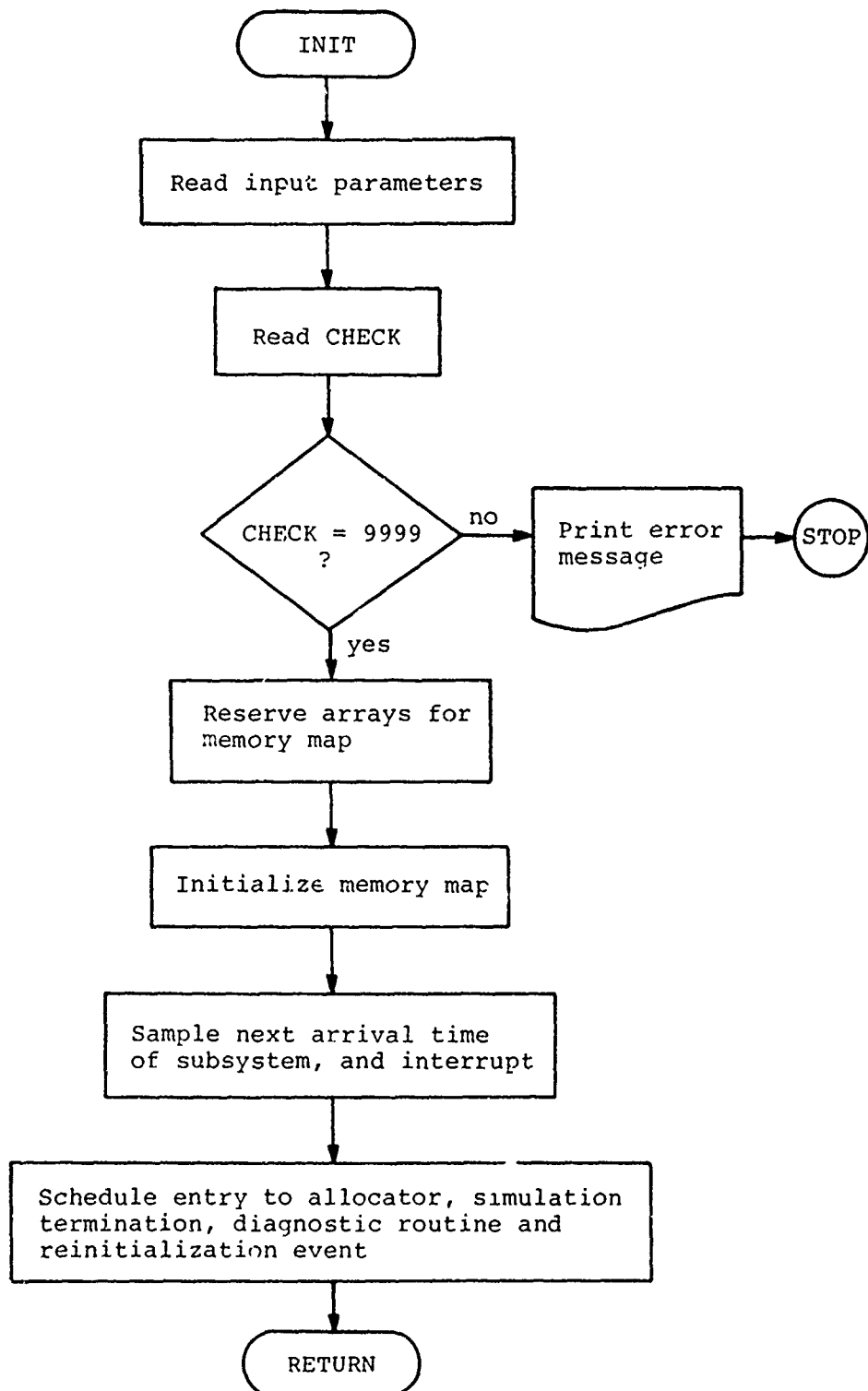
ZAURWT - Program size of UST for which core fence is established.

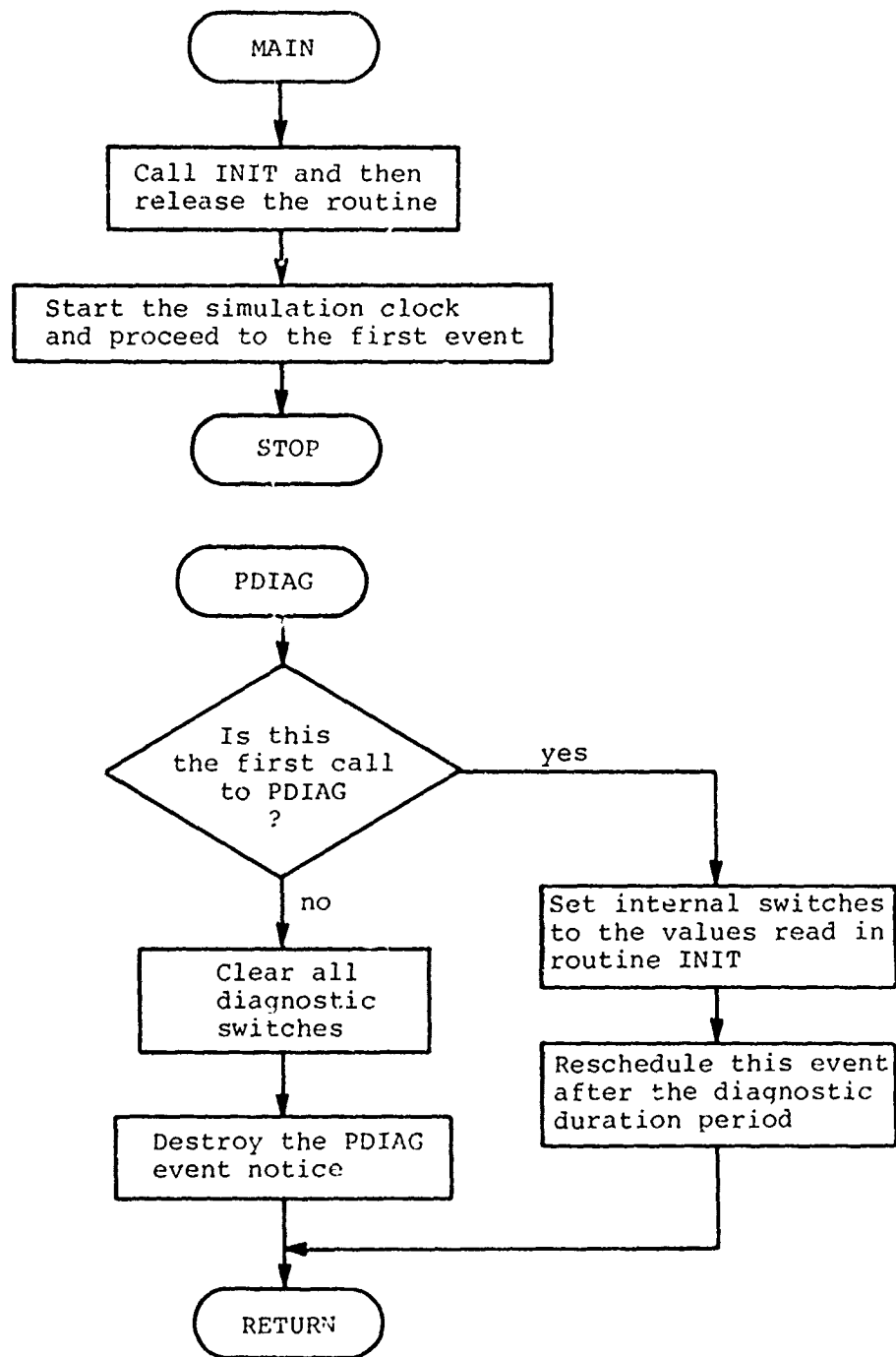
Appendix 2

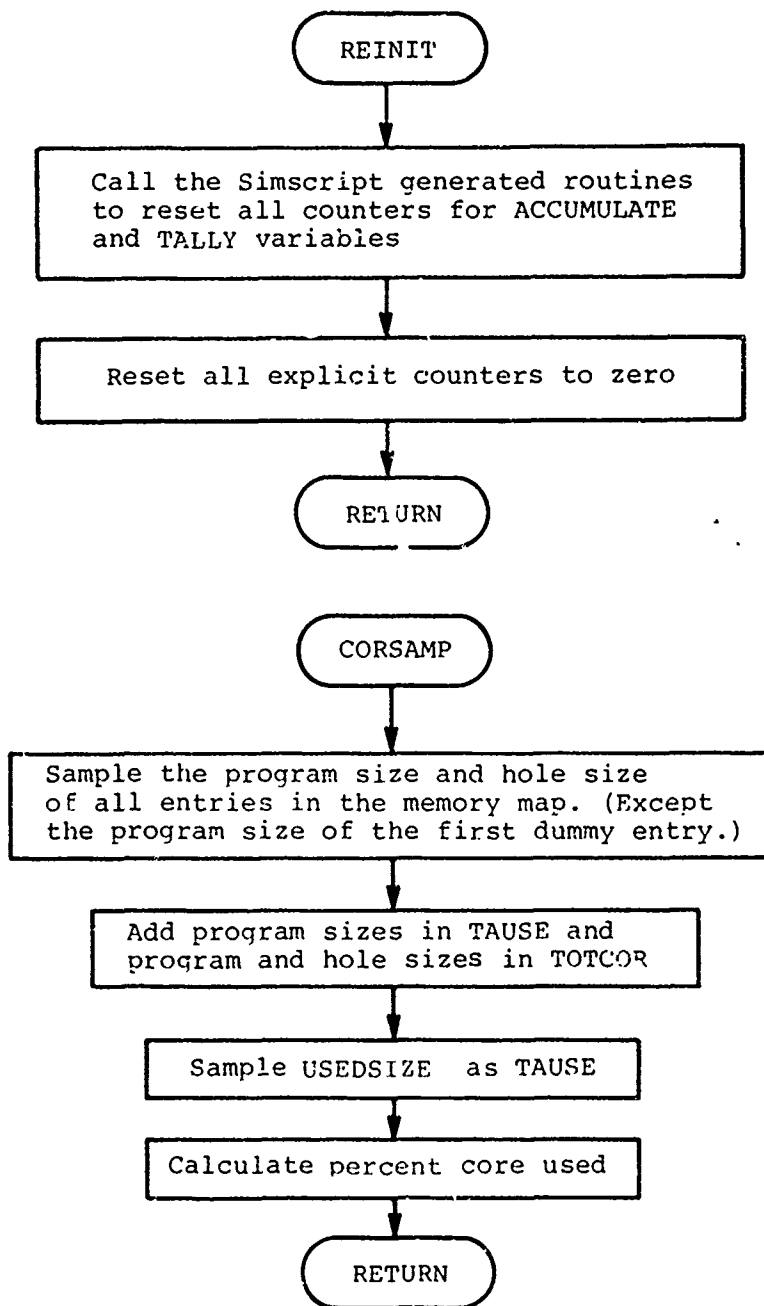
Flowcharts

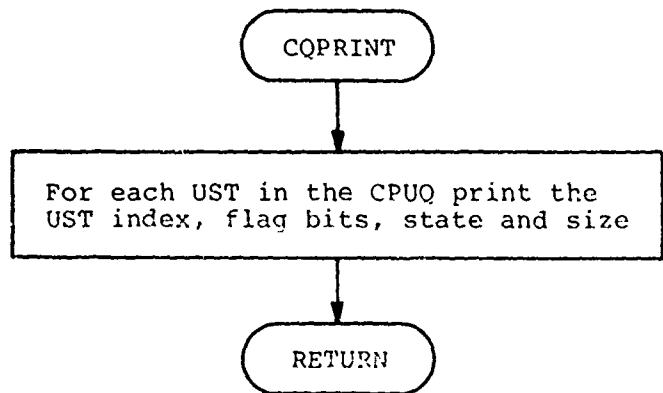
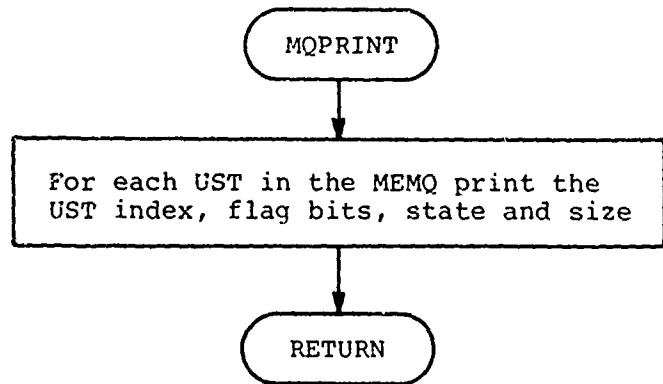
Routine	Page
INIT	1
MAIN	2
PDIAG	2
REINIT	3
CORSAMP	3
MQPRINT	4
CQPRINT	4
STEM	5
OUTPUT	5
SNAP.R	6
ALLOCI	7-8
MAP	9-12
SDP	13-14
SDP3	14-17
SDP4	18-19
SDP5	20
SDP6	21-22
SDP7	22
SPMACT	23-26
MLA	26-28
MBA3	29
MBD	30-31
MMV	31-32
SWOUT	33
SWIN	33
SWPLD	34
SSFINI	35-36
BUFDMP	36
KIOSRT	37-38

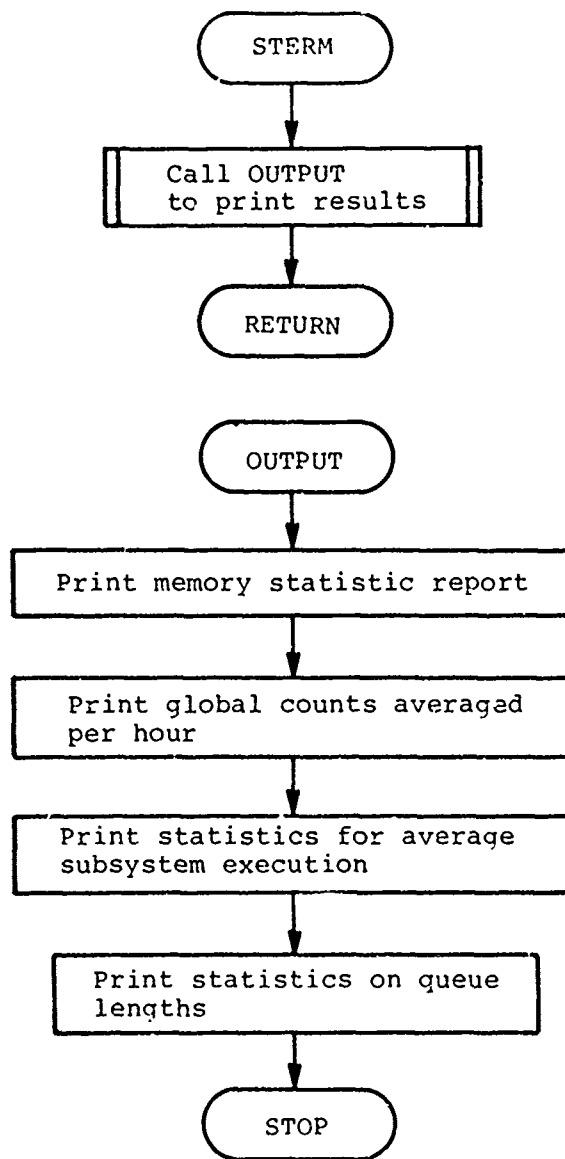
Routine	Page
START	39-40
RETSSX	40
SACT	41
ATCHG	41
EXENTR	42
ENEACT	42-43
KONDRL	43
KOTDRL	44
DRLDIO	44-45
DRLRET	45
KIOCC	46-47
DIOCC	47
1ALLCC	48
2ALLCC	49
LINSV	50-51

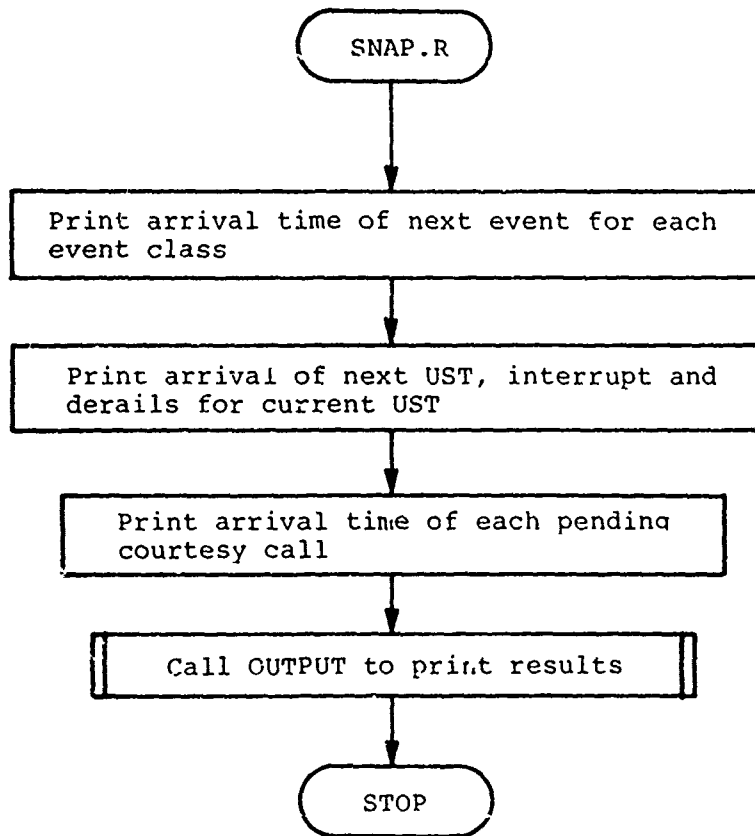


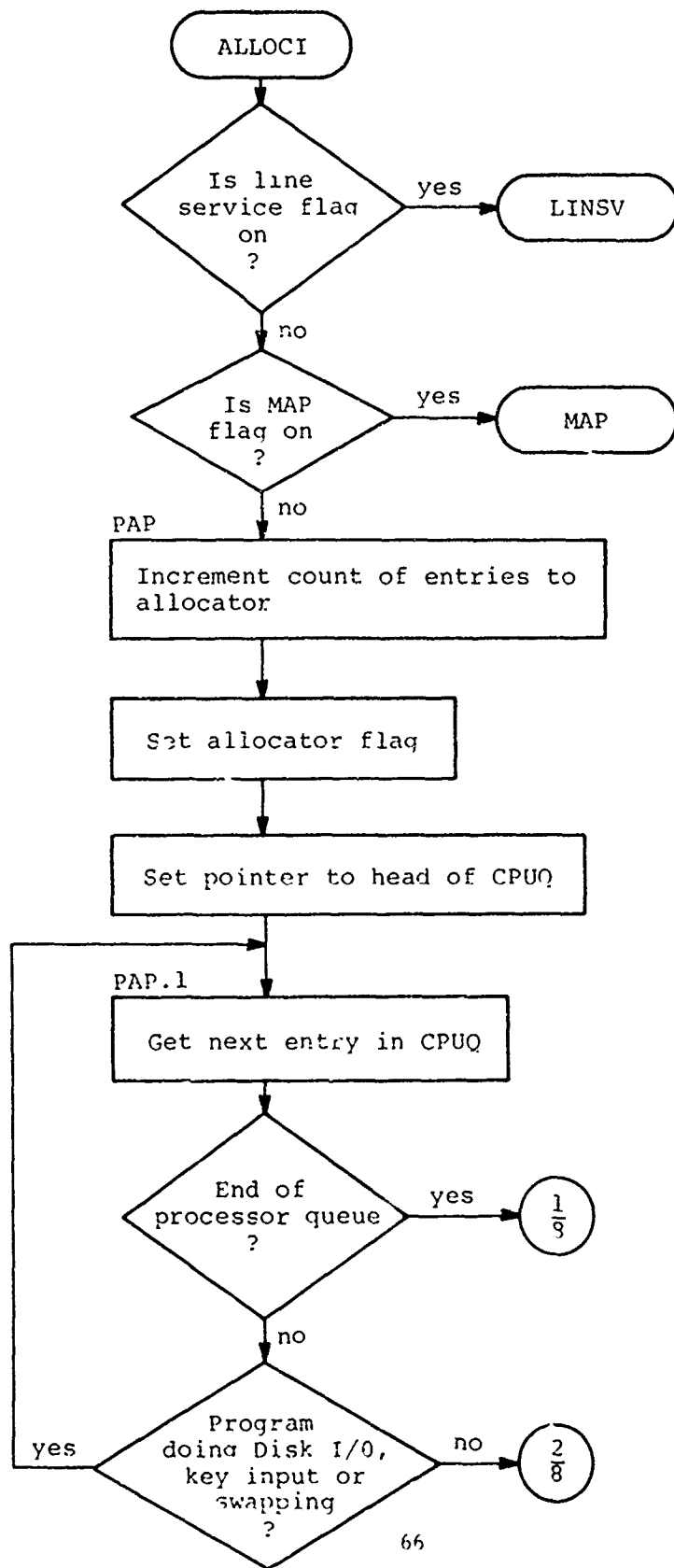


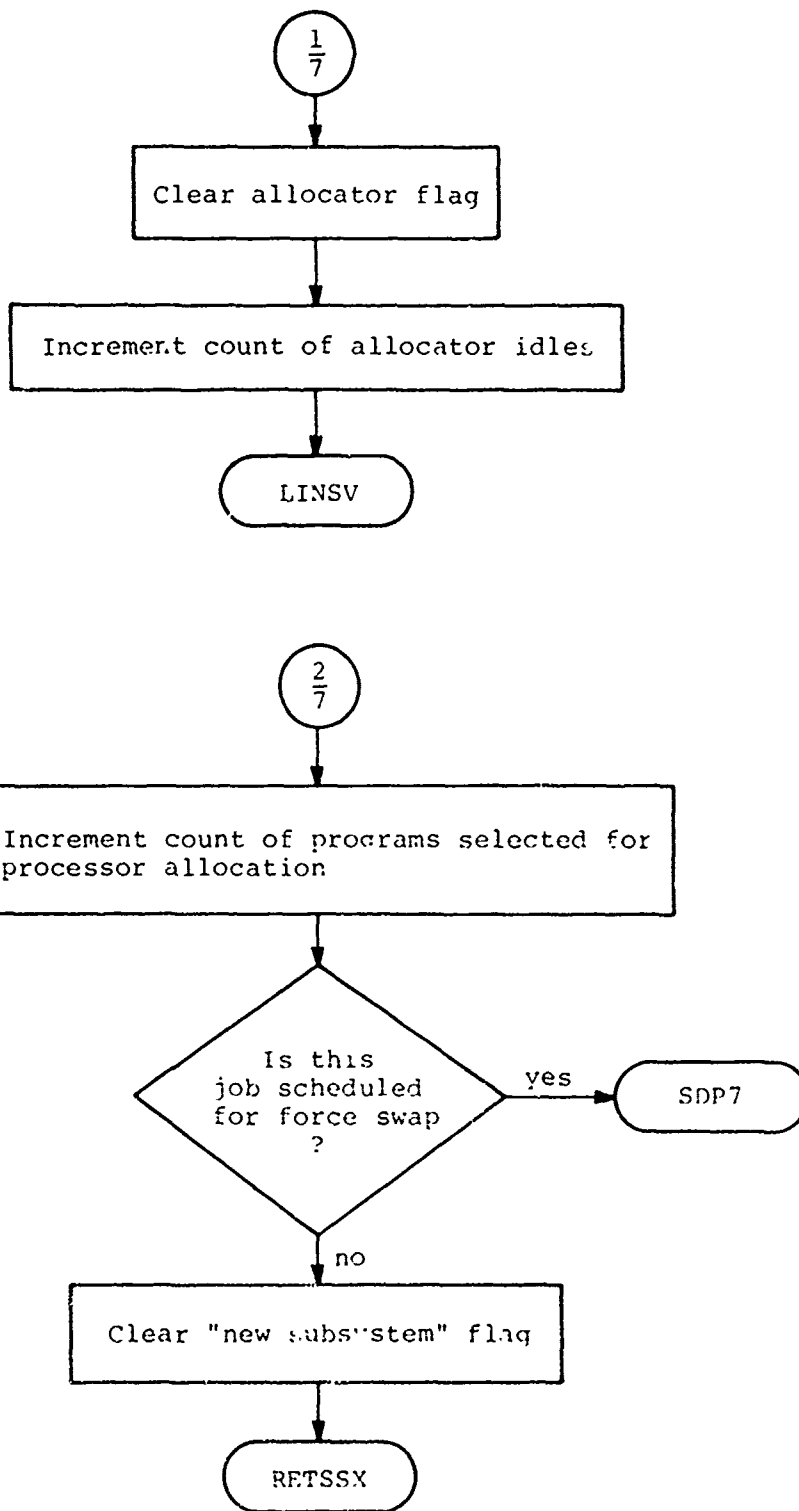


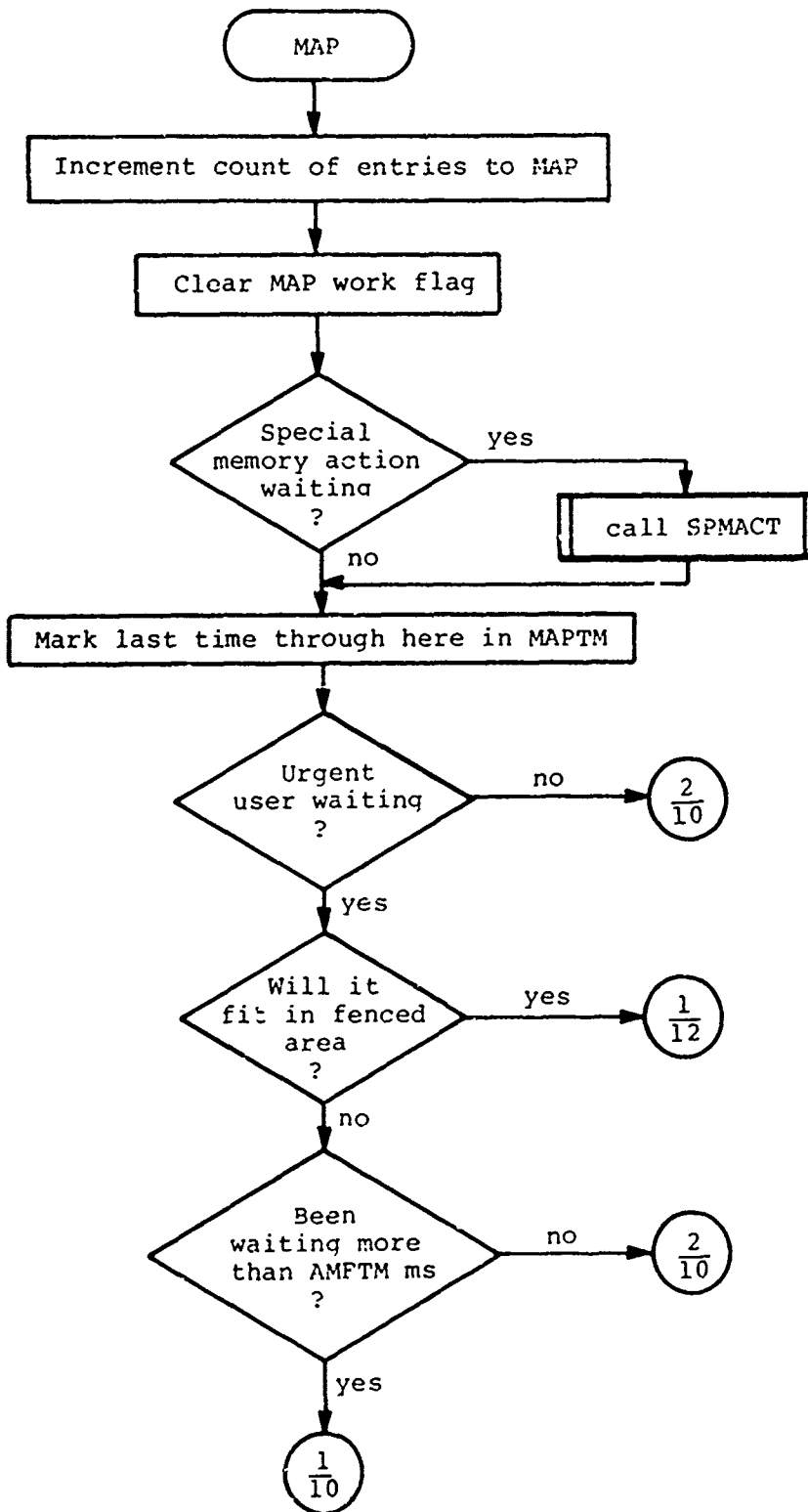


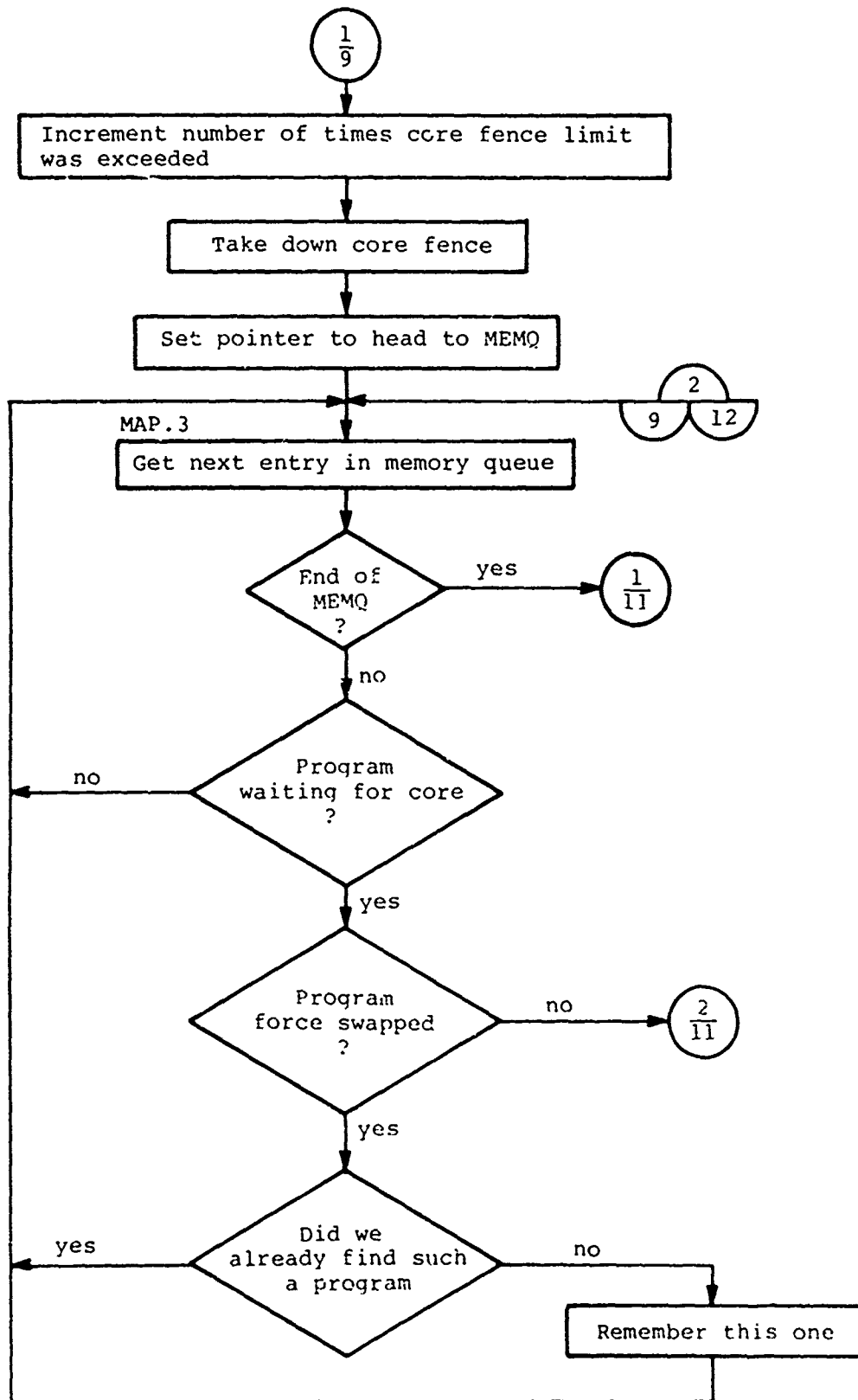


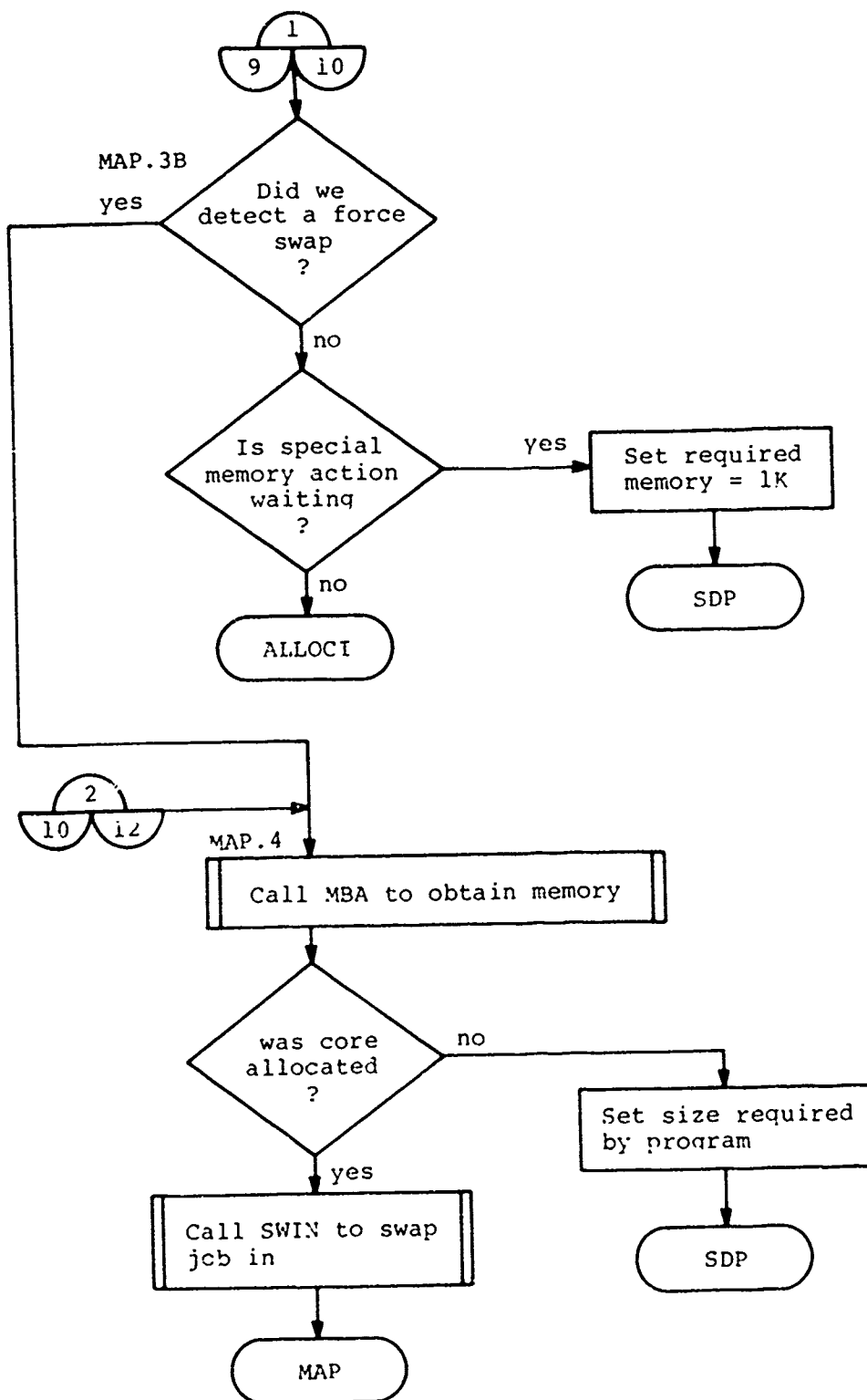


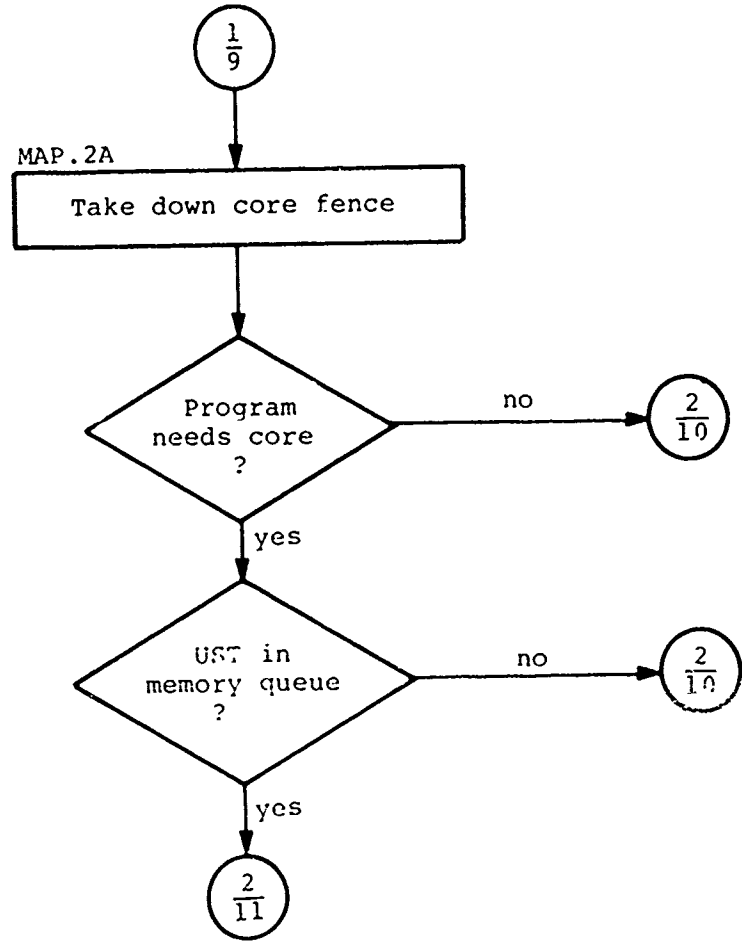


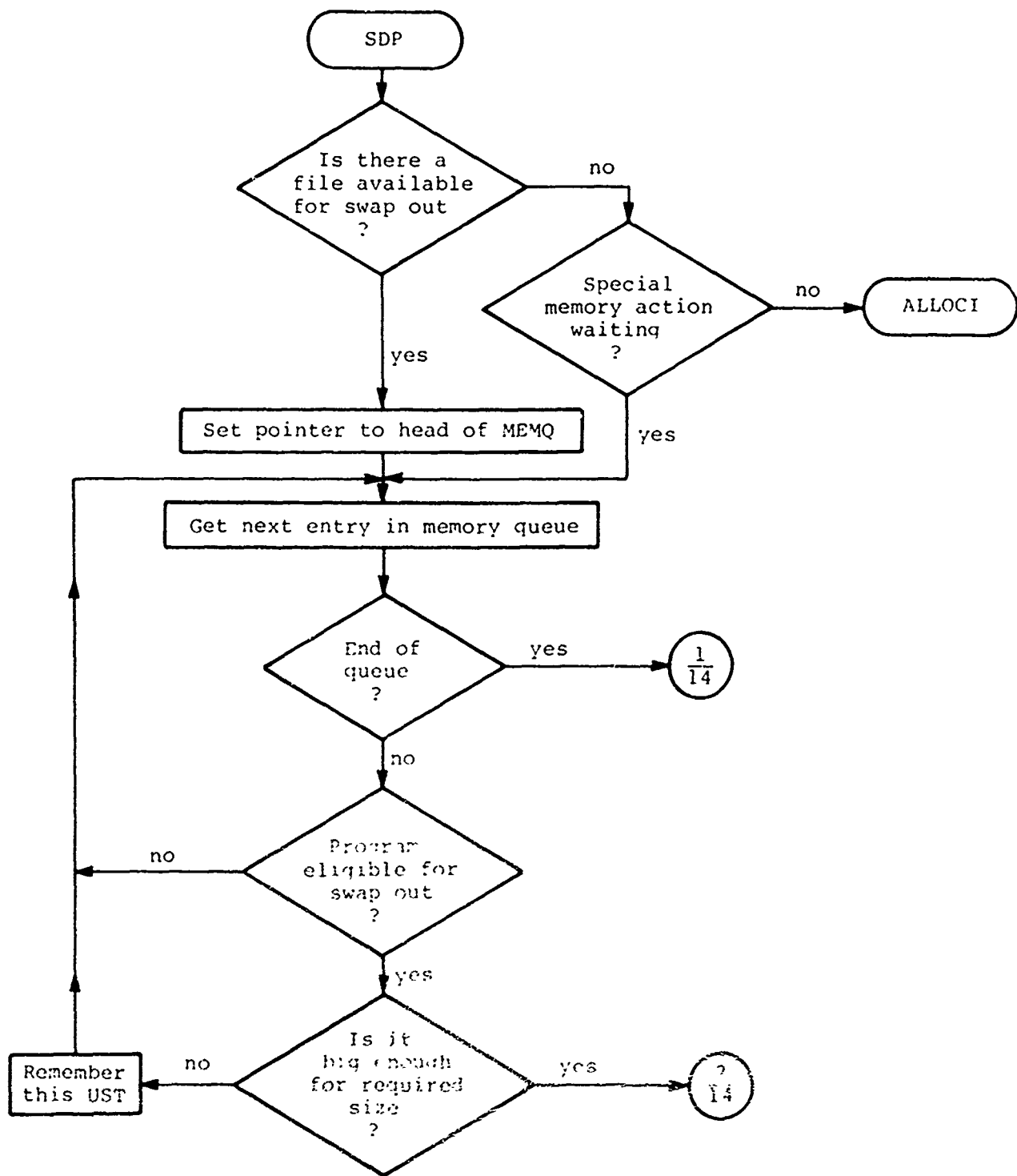


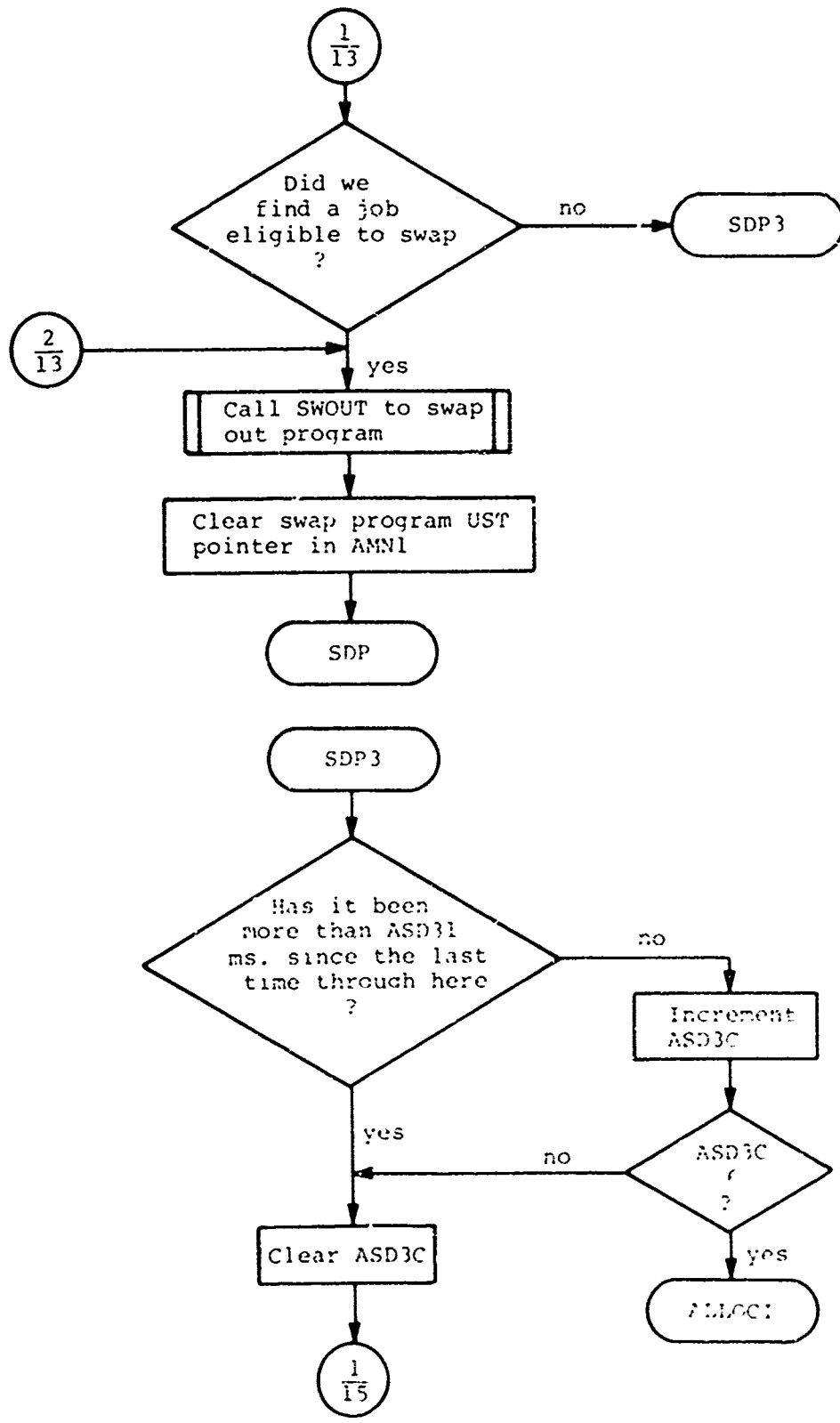


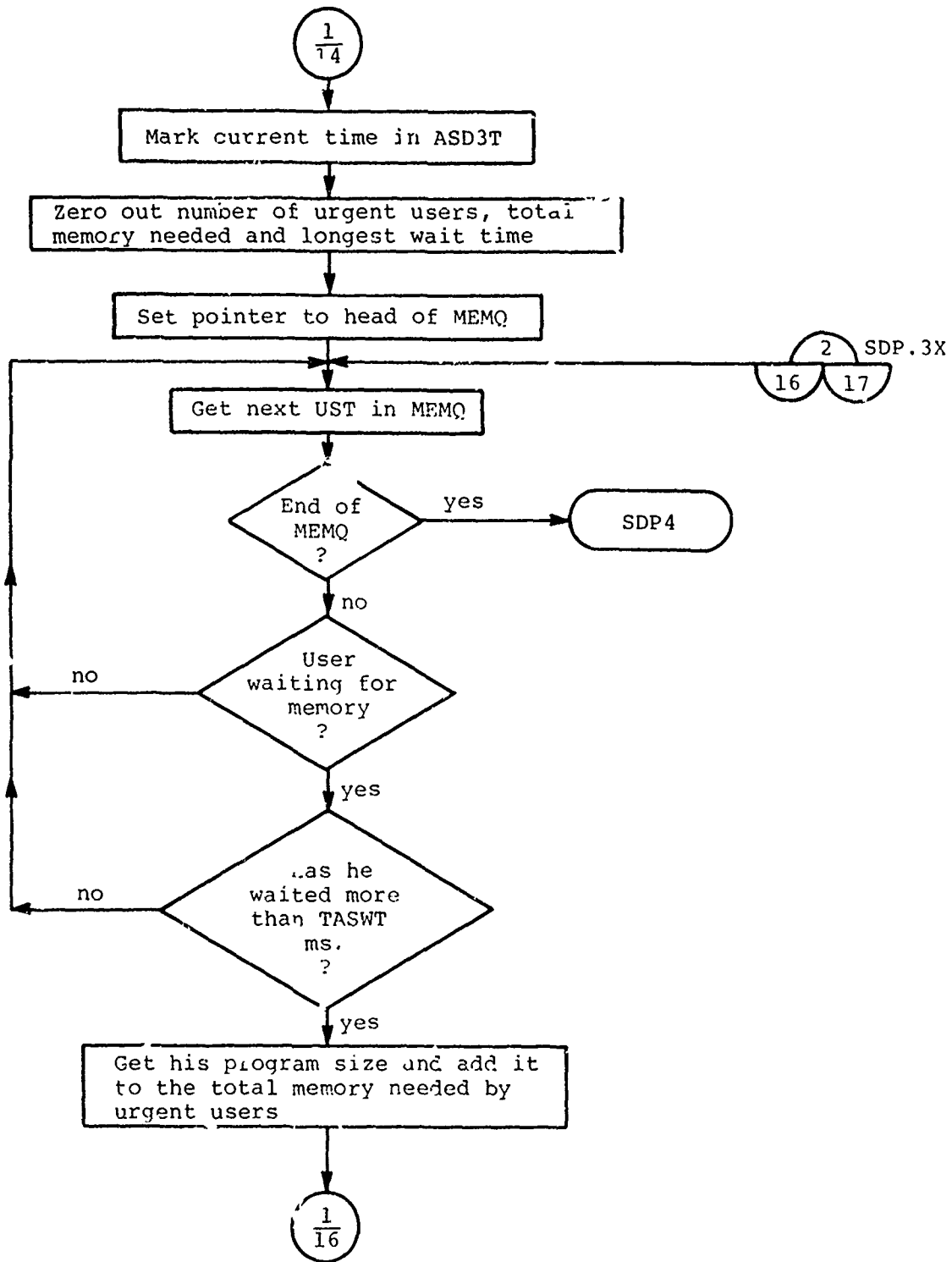


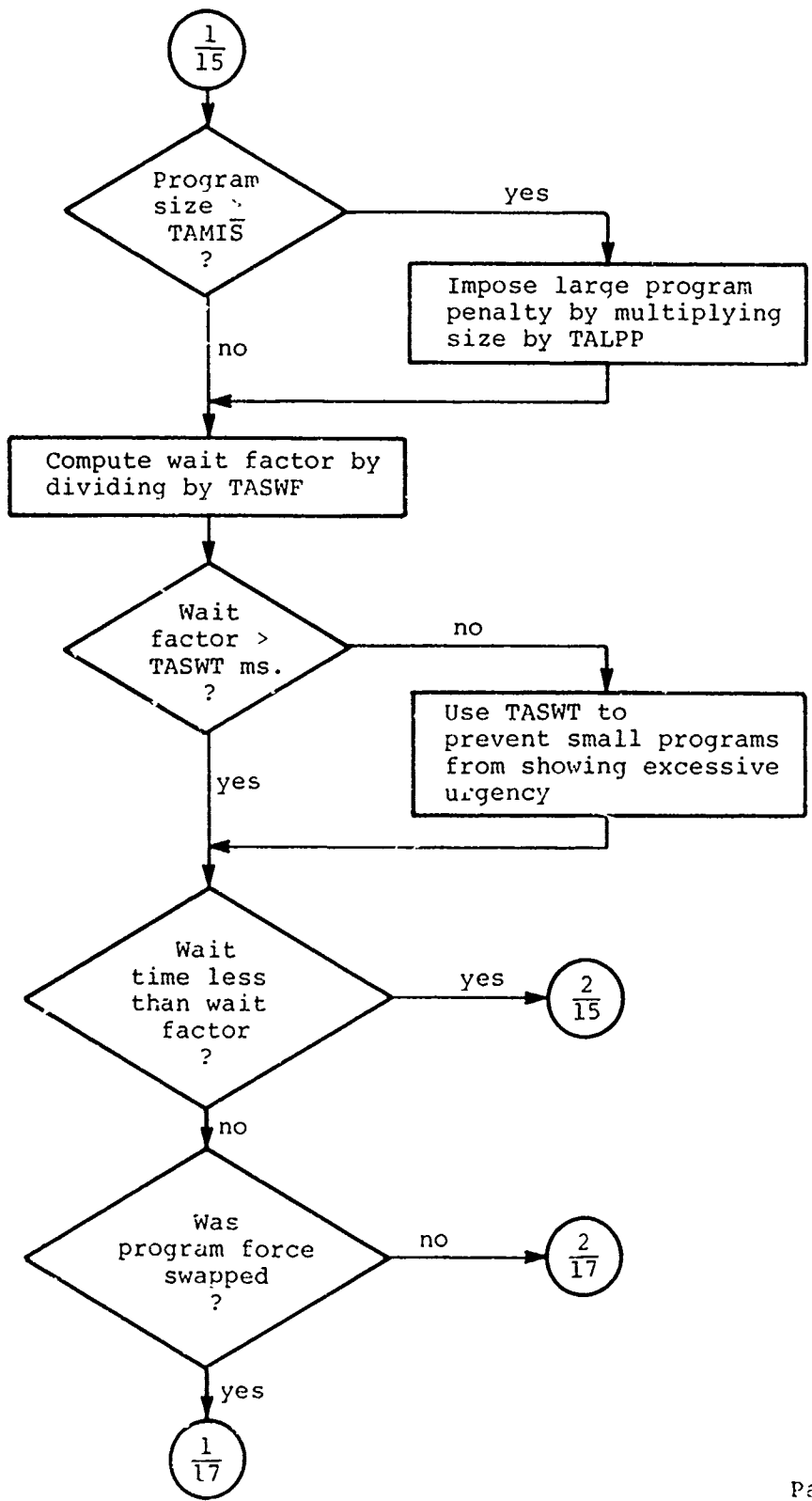


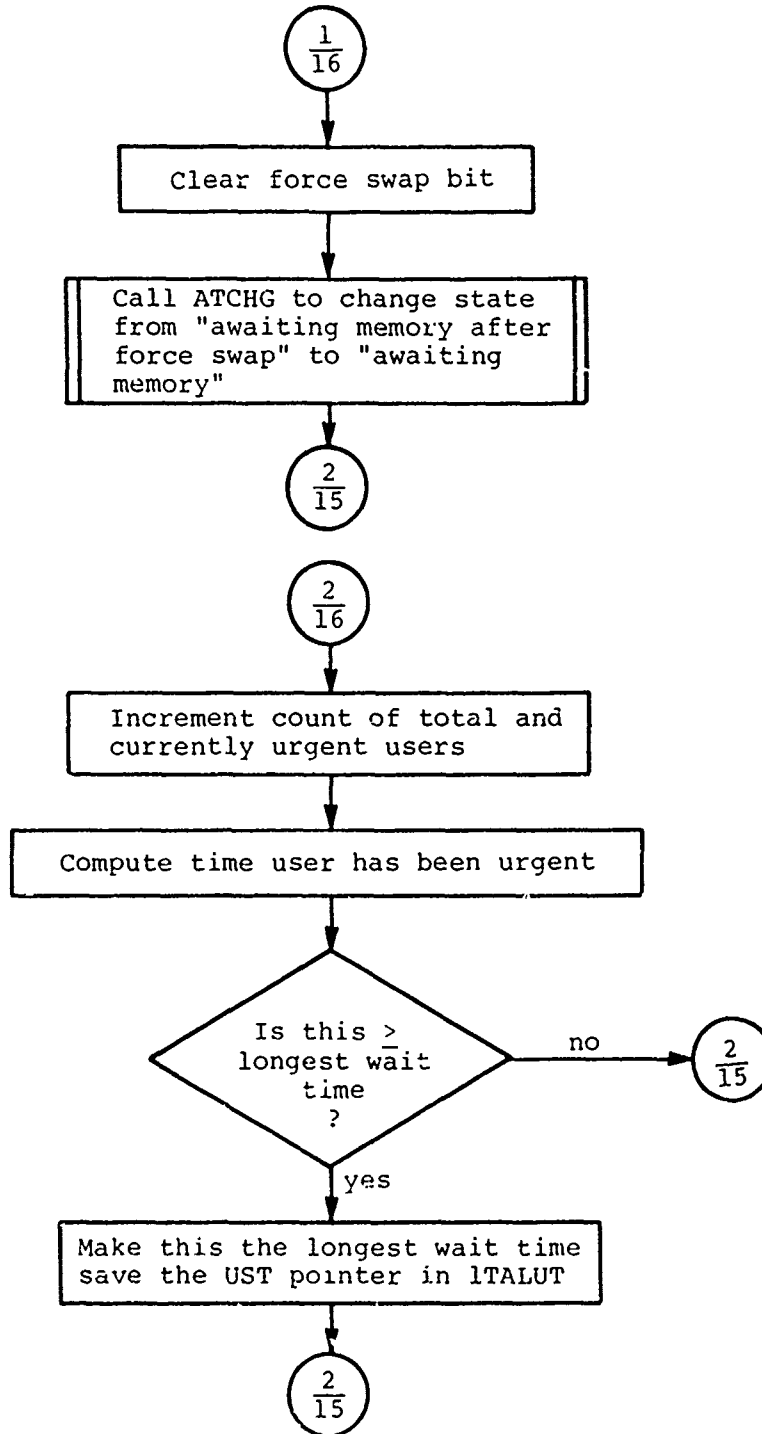


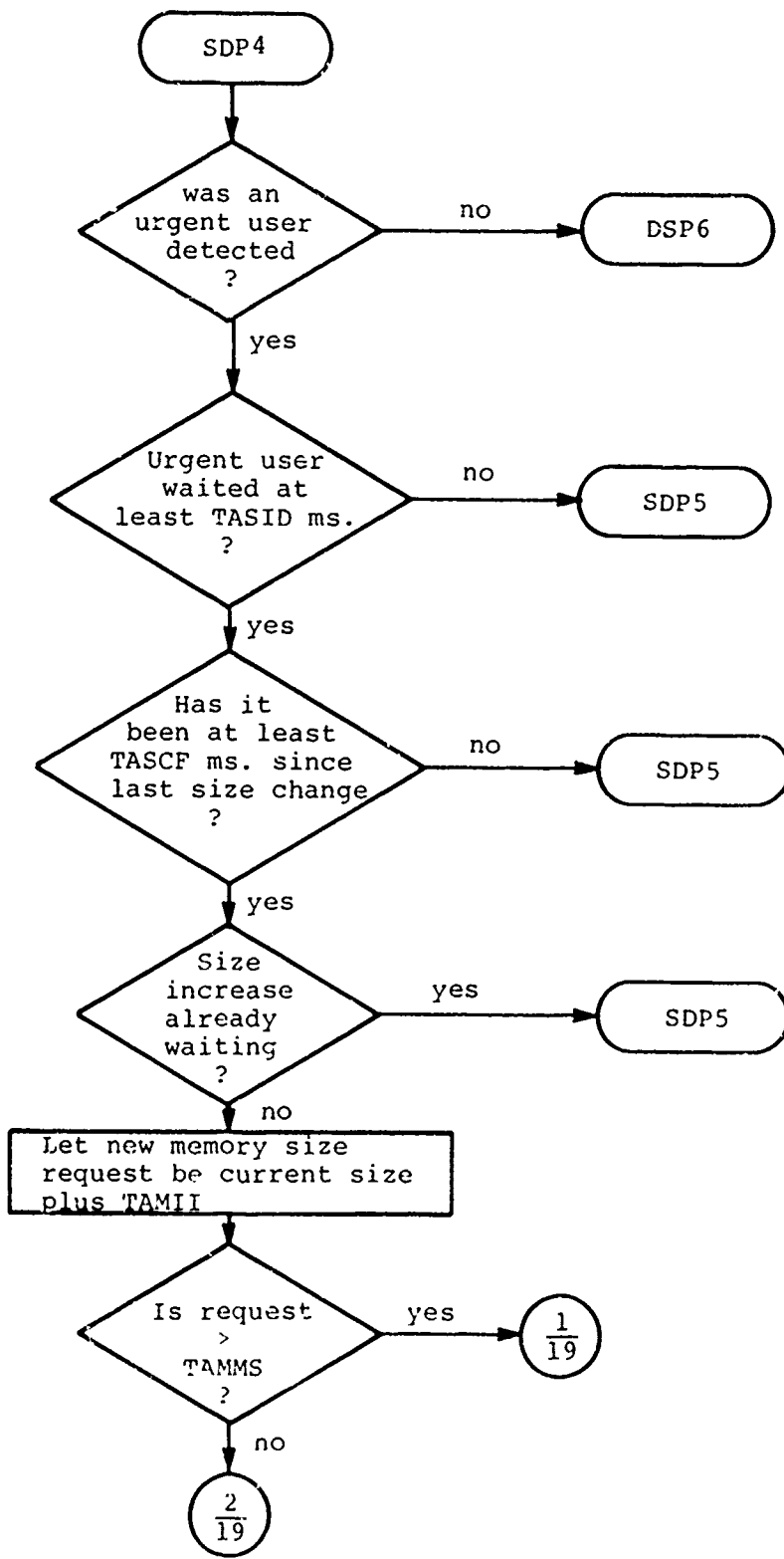


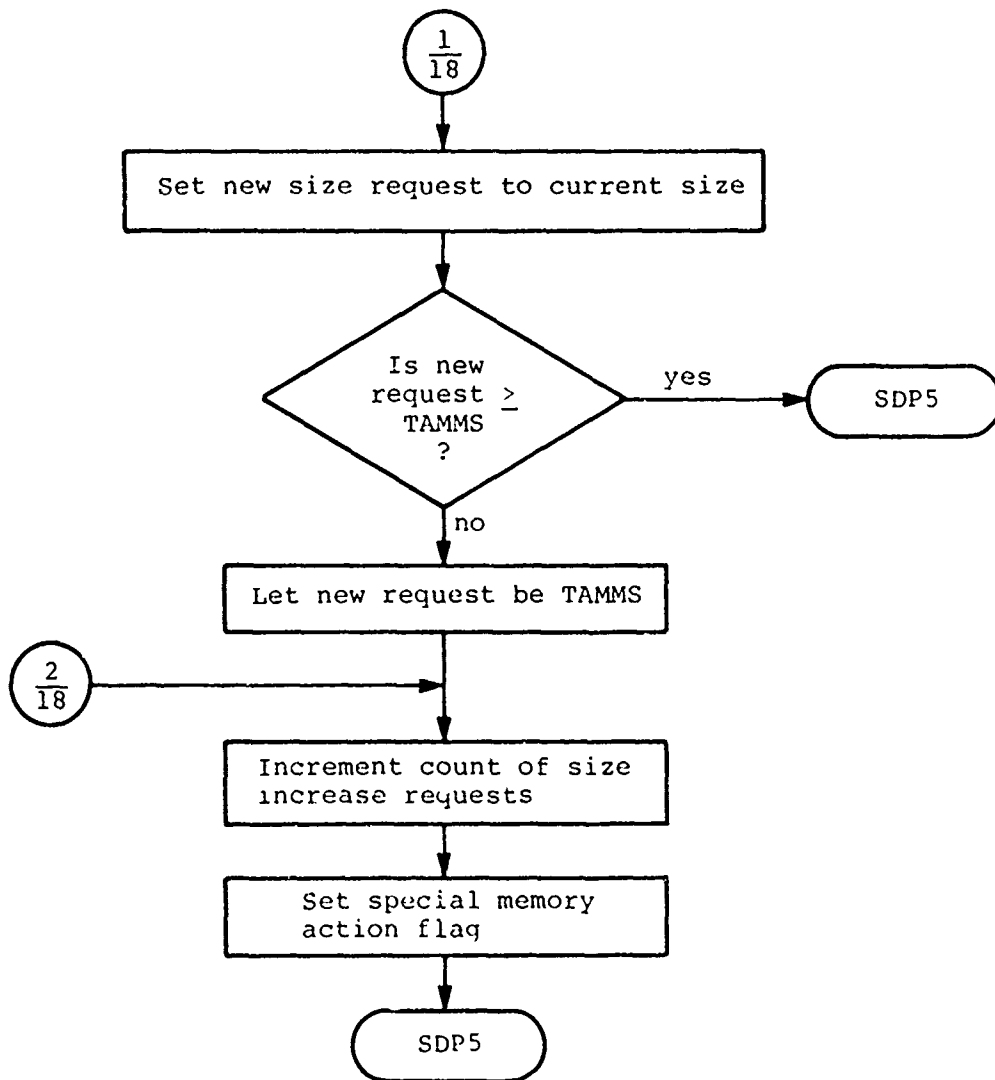


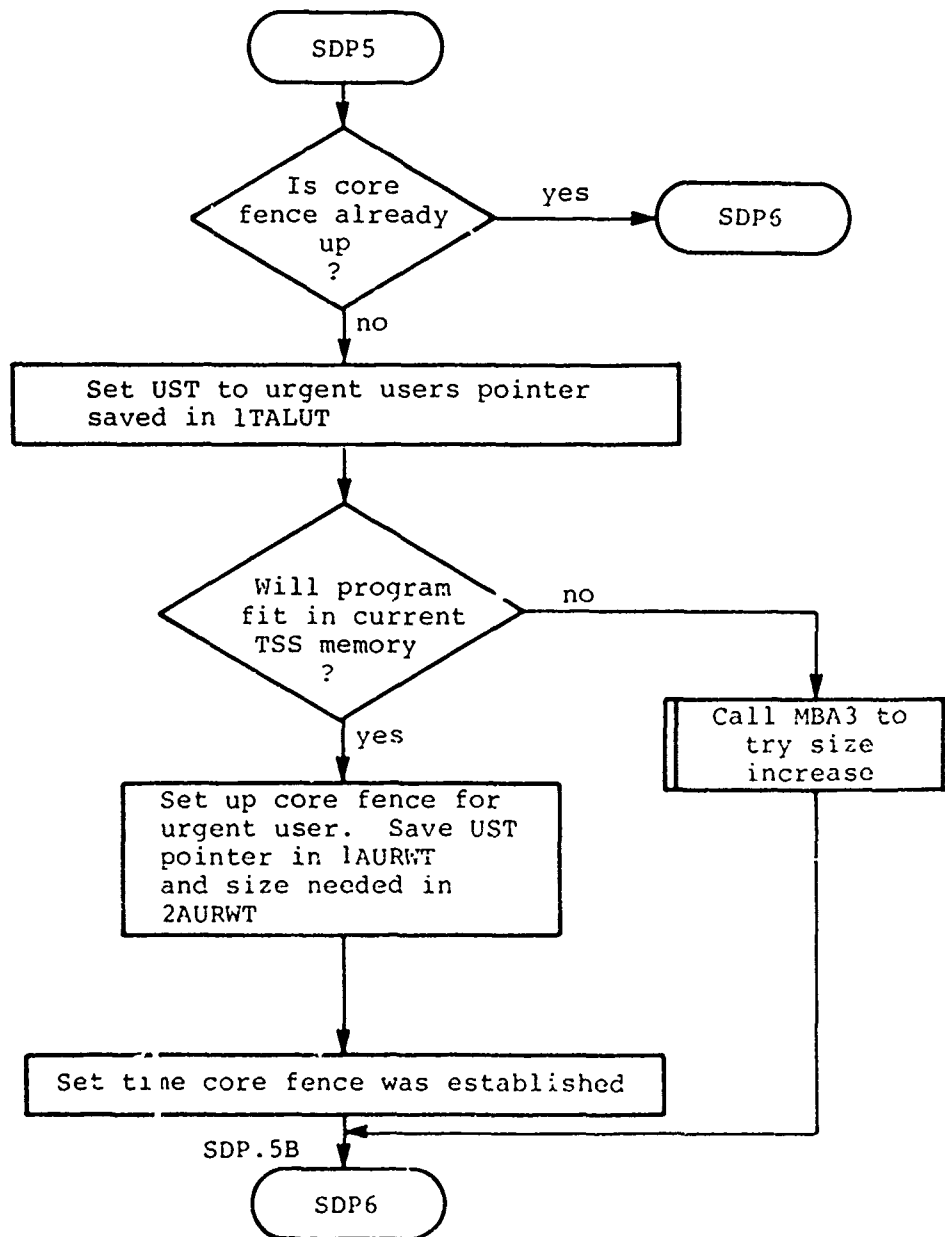


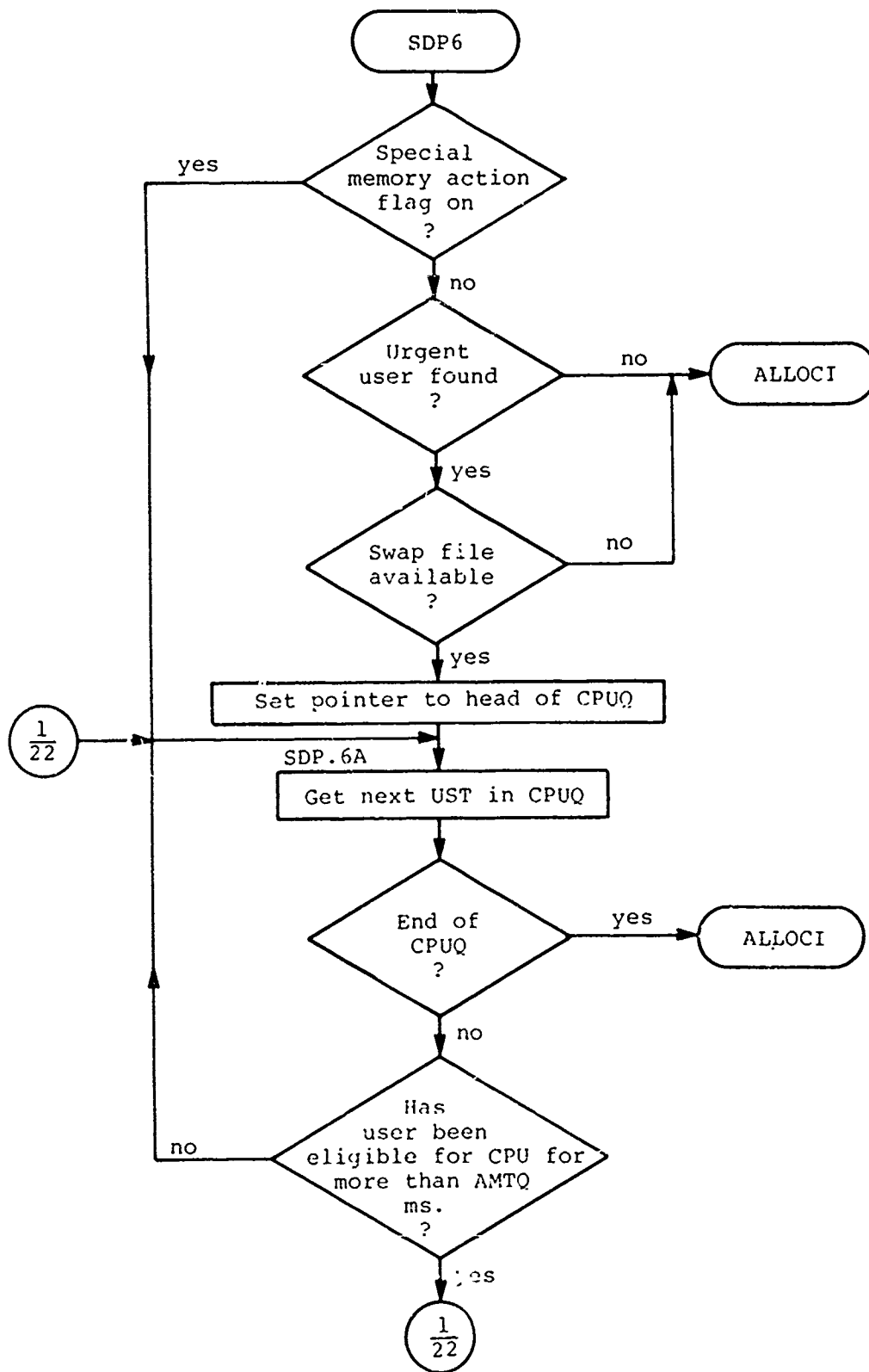


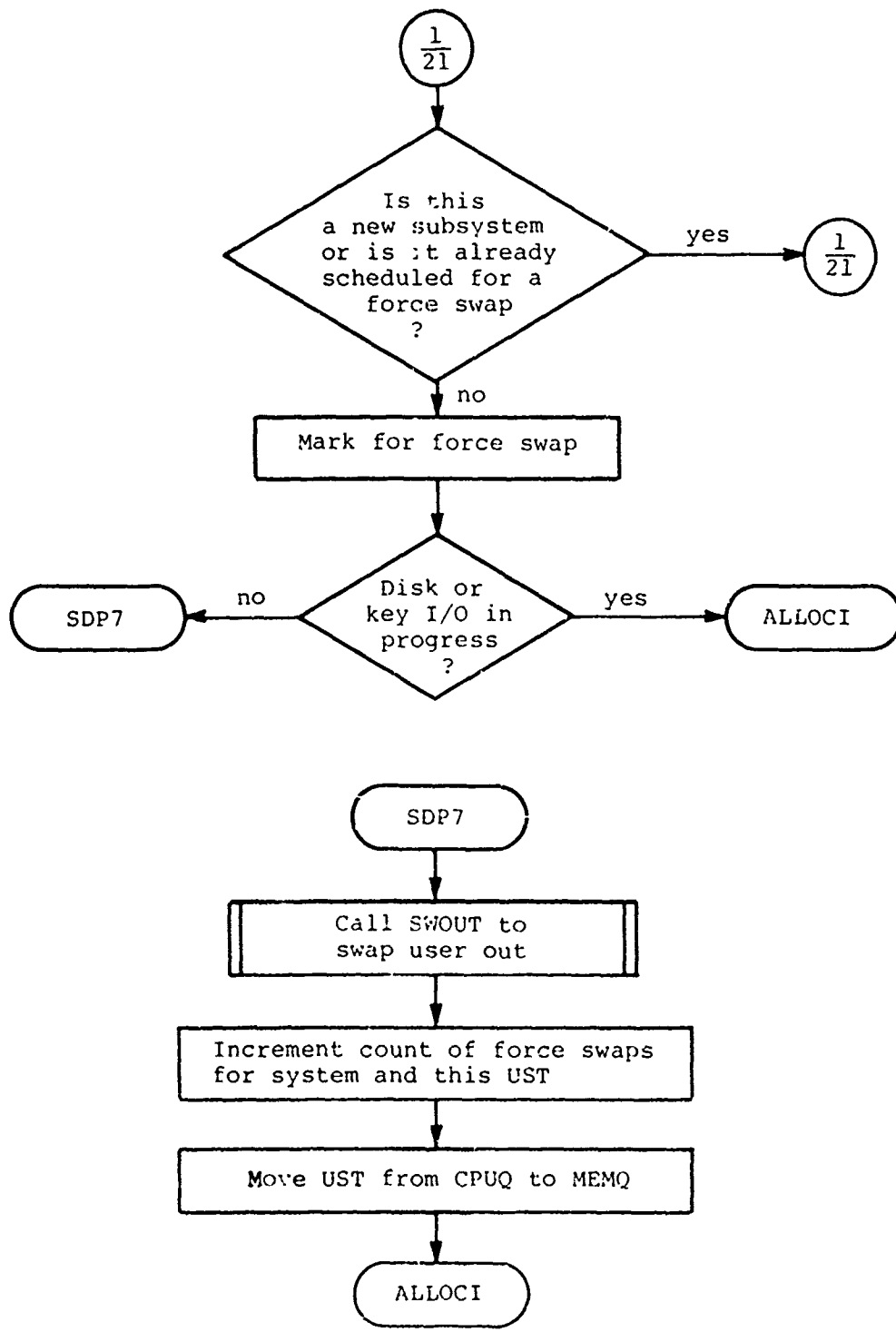


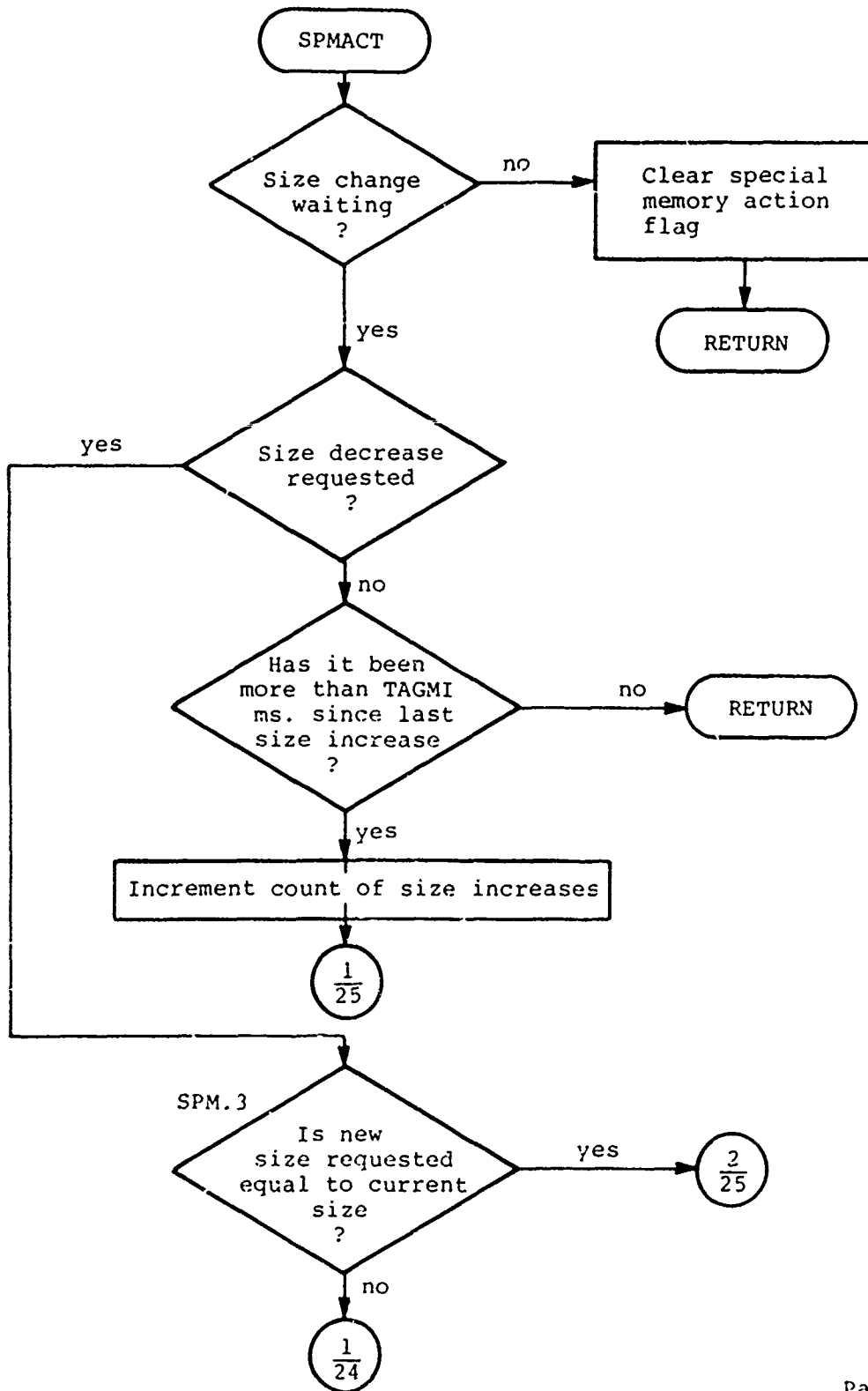


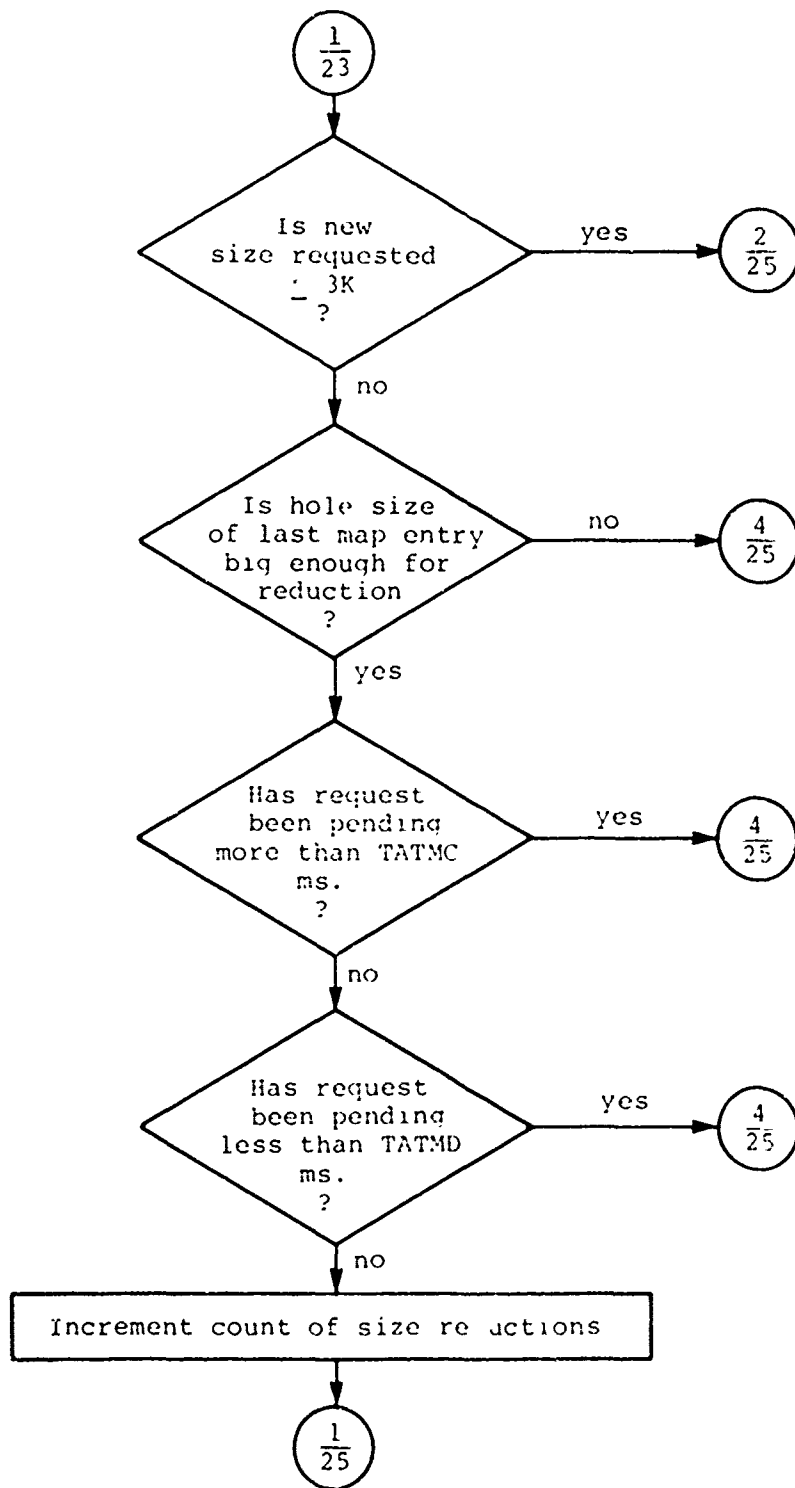


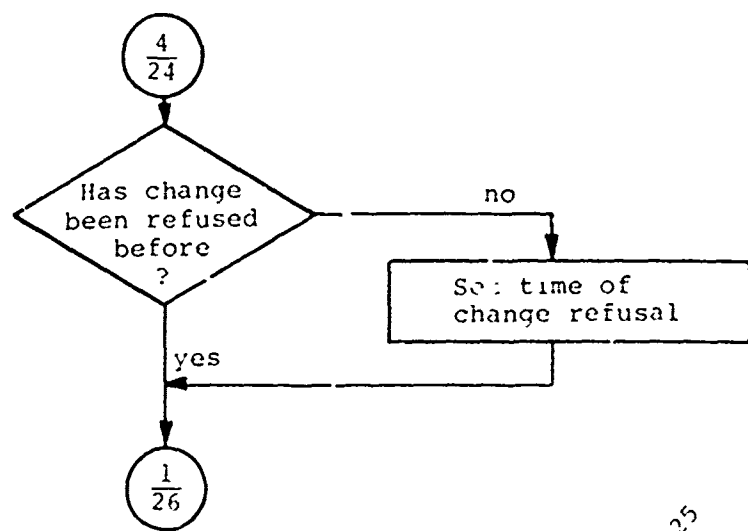
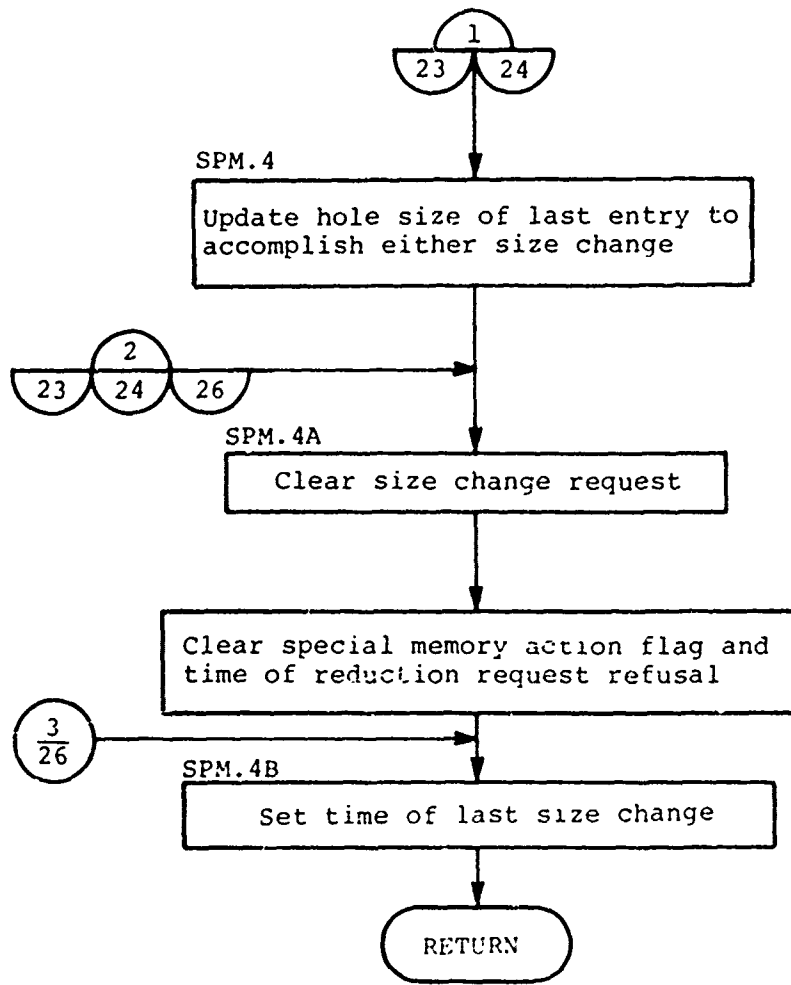


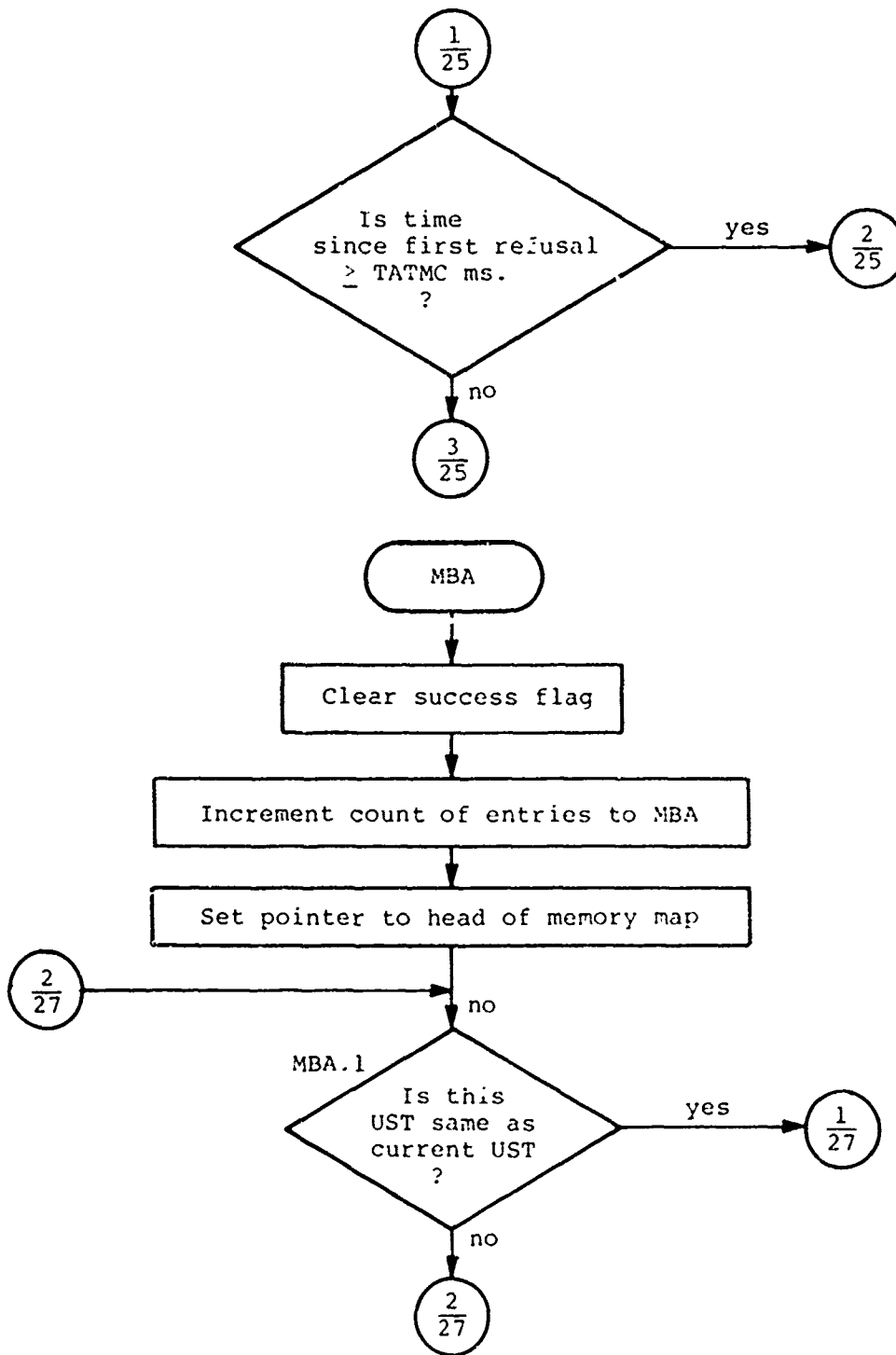


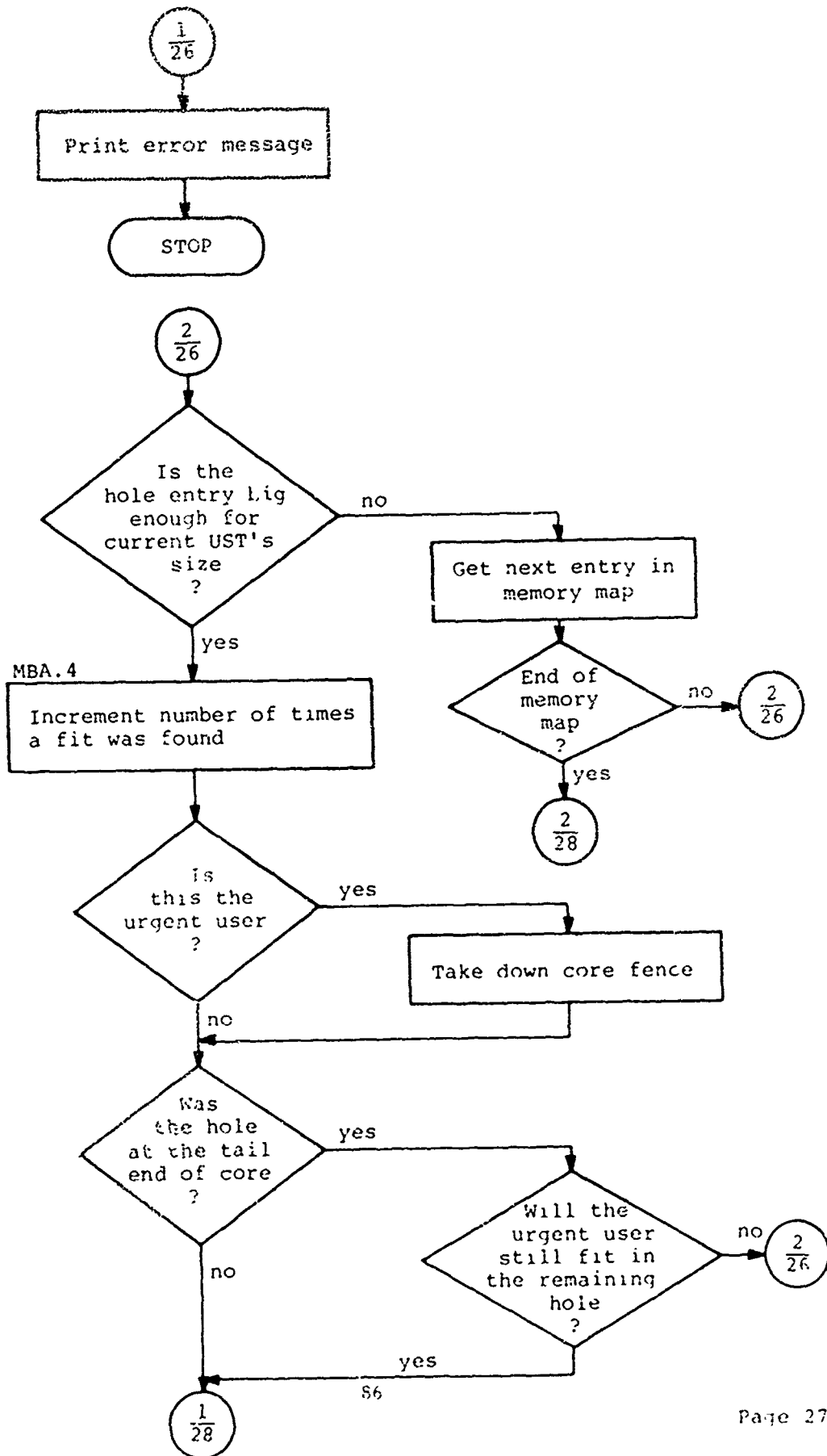


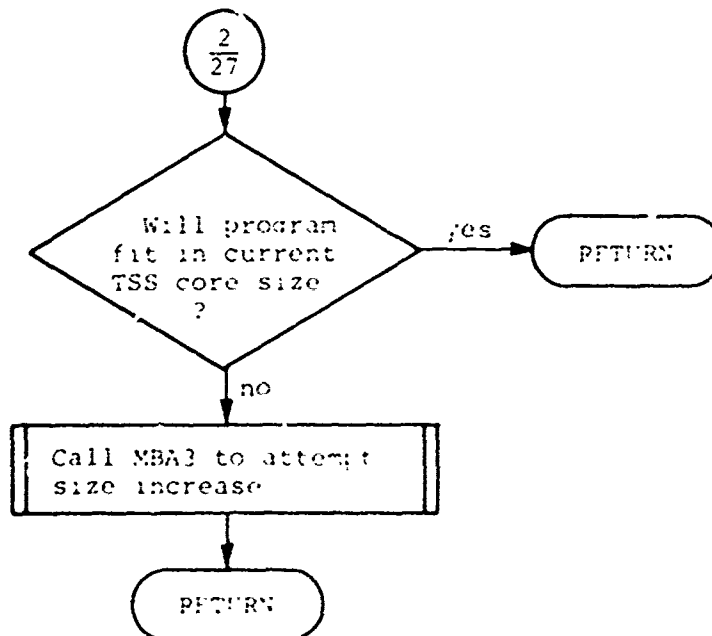
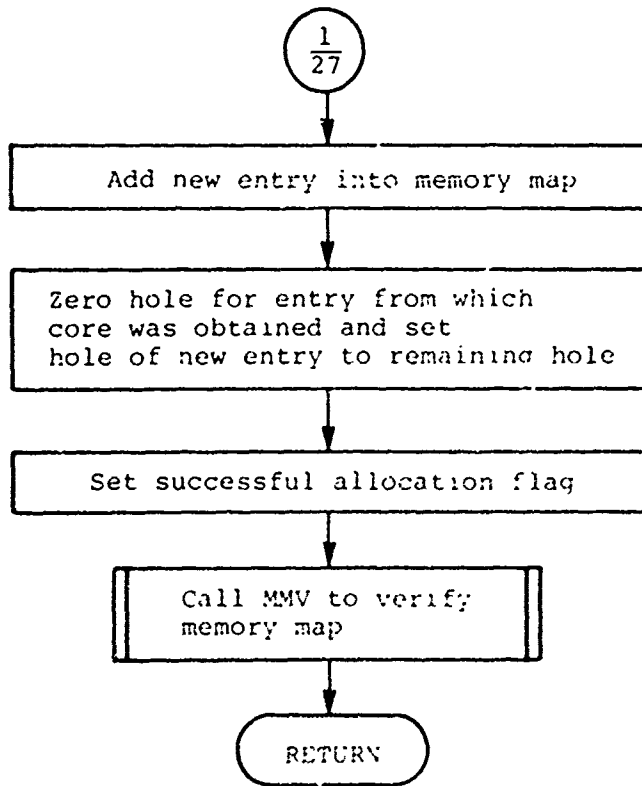


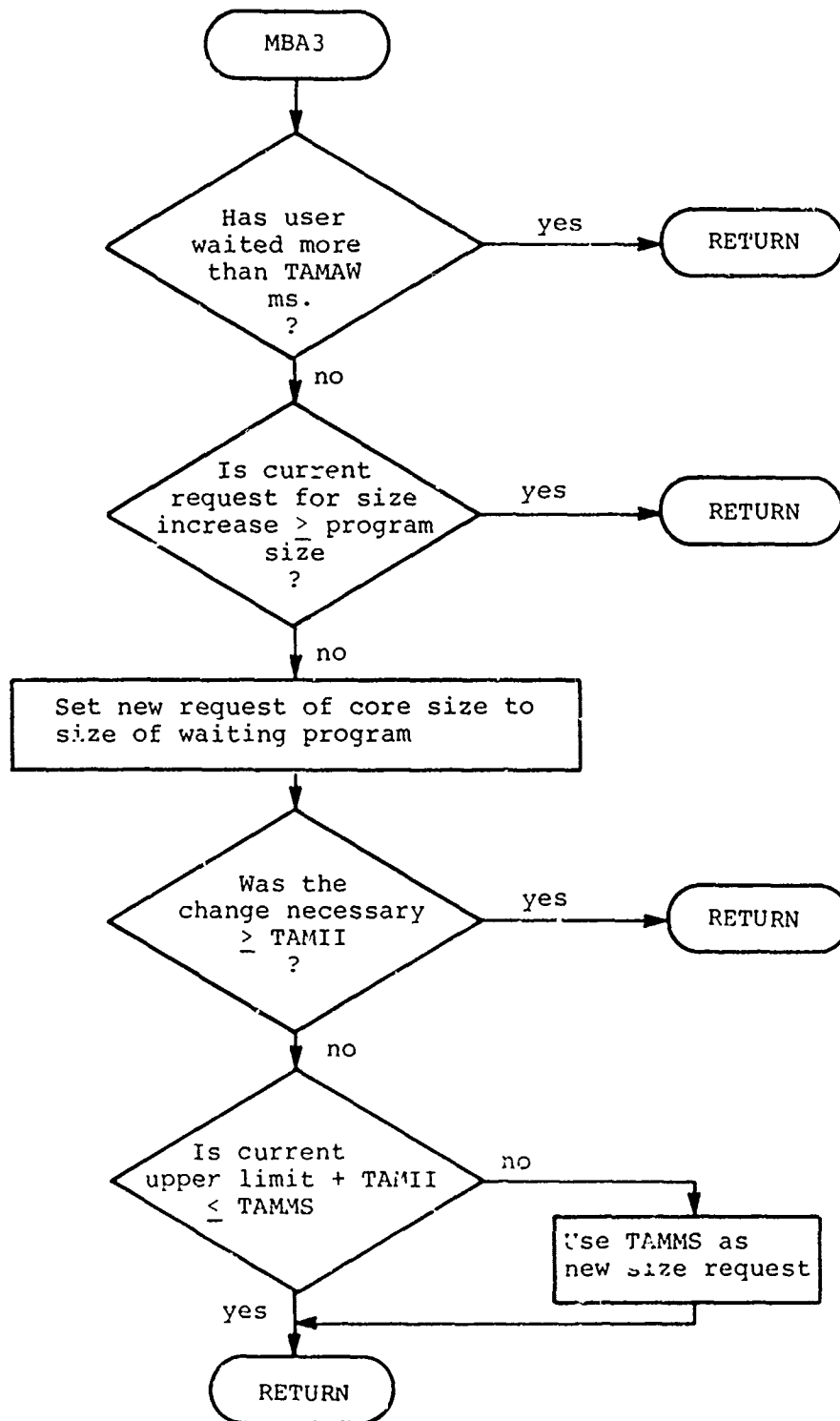


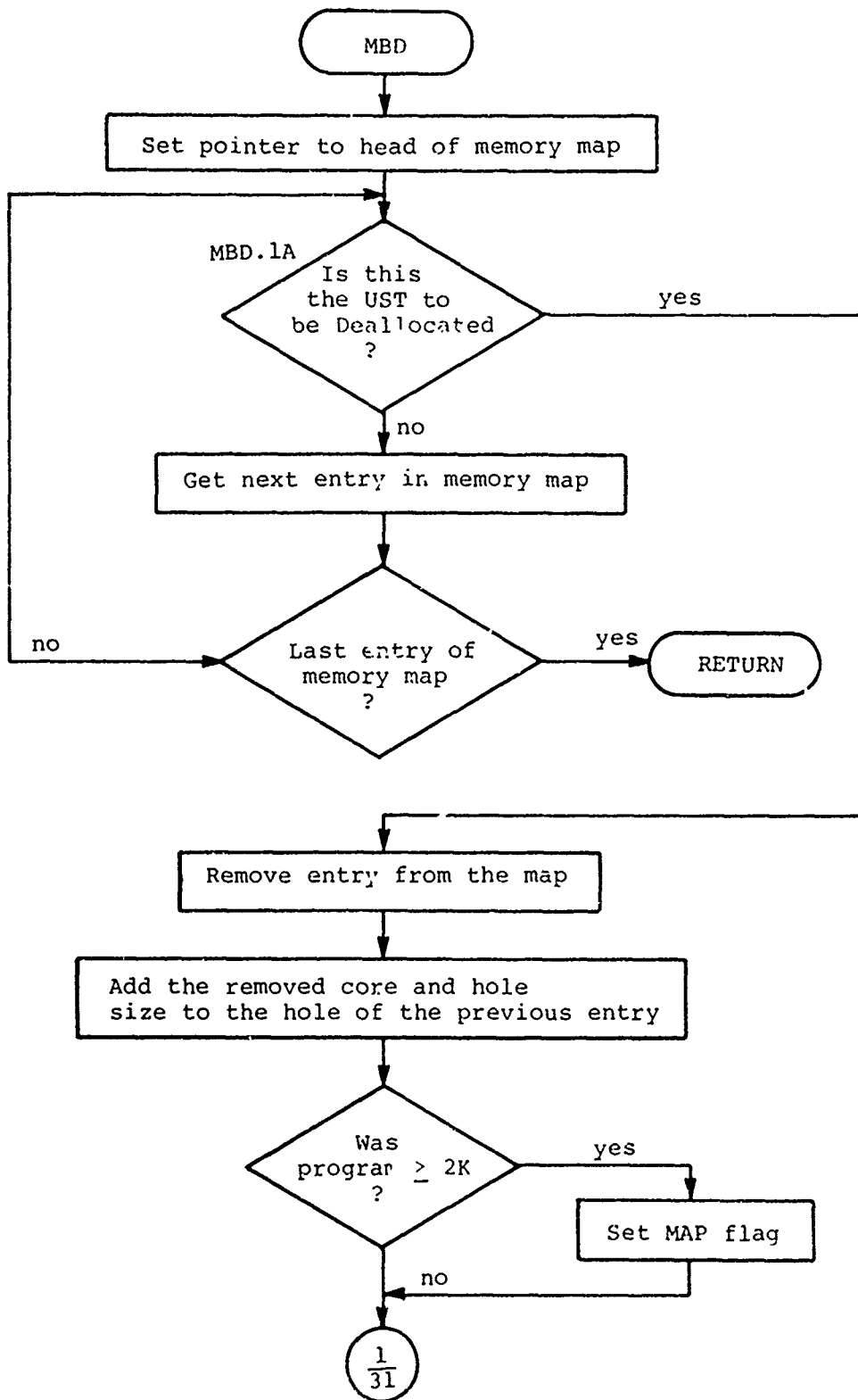


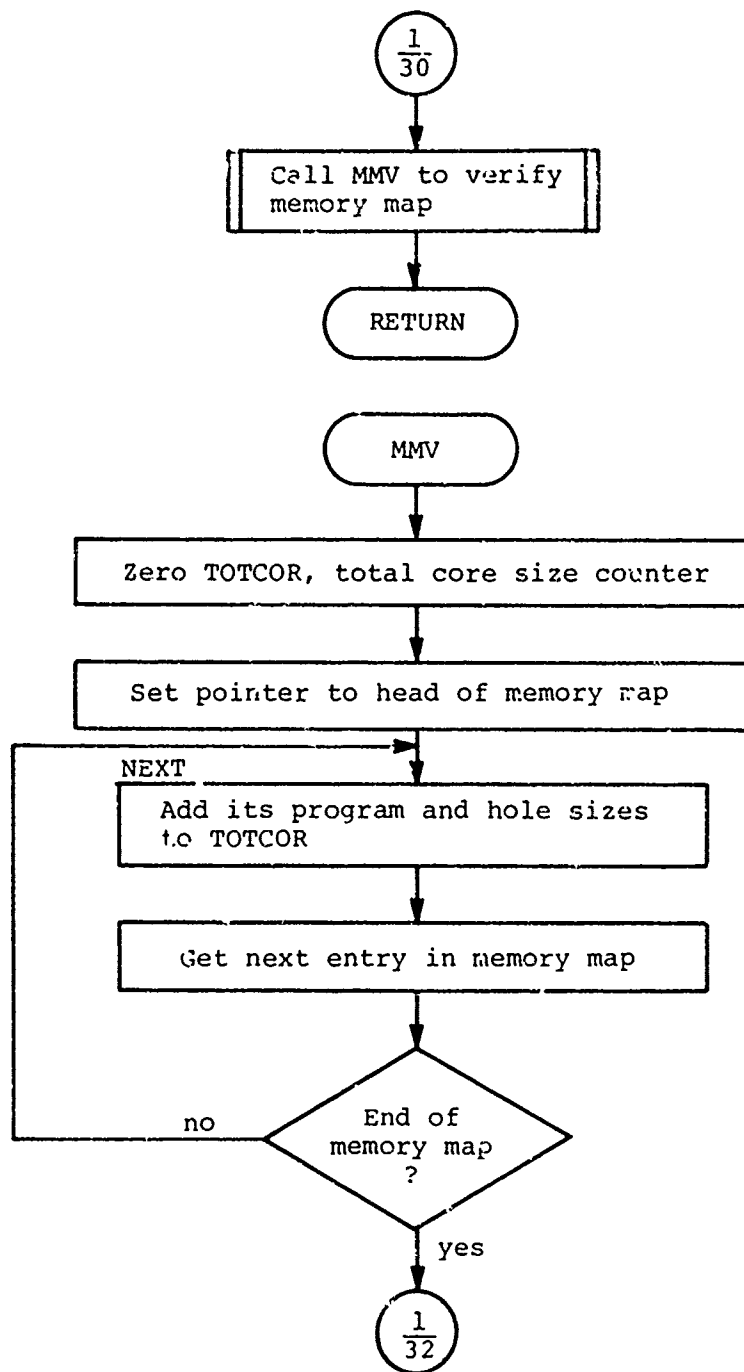


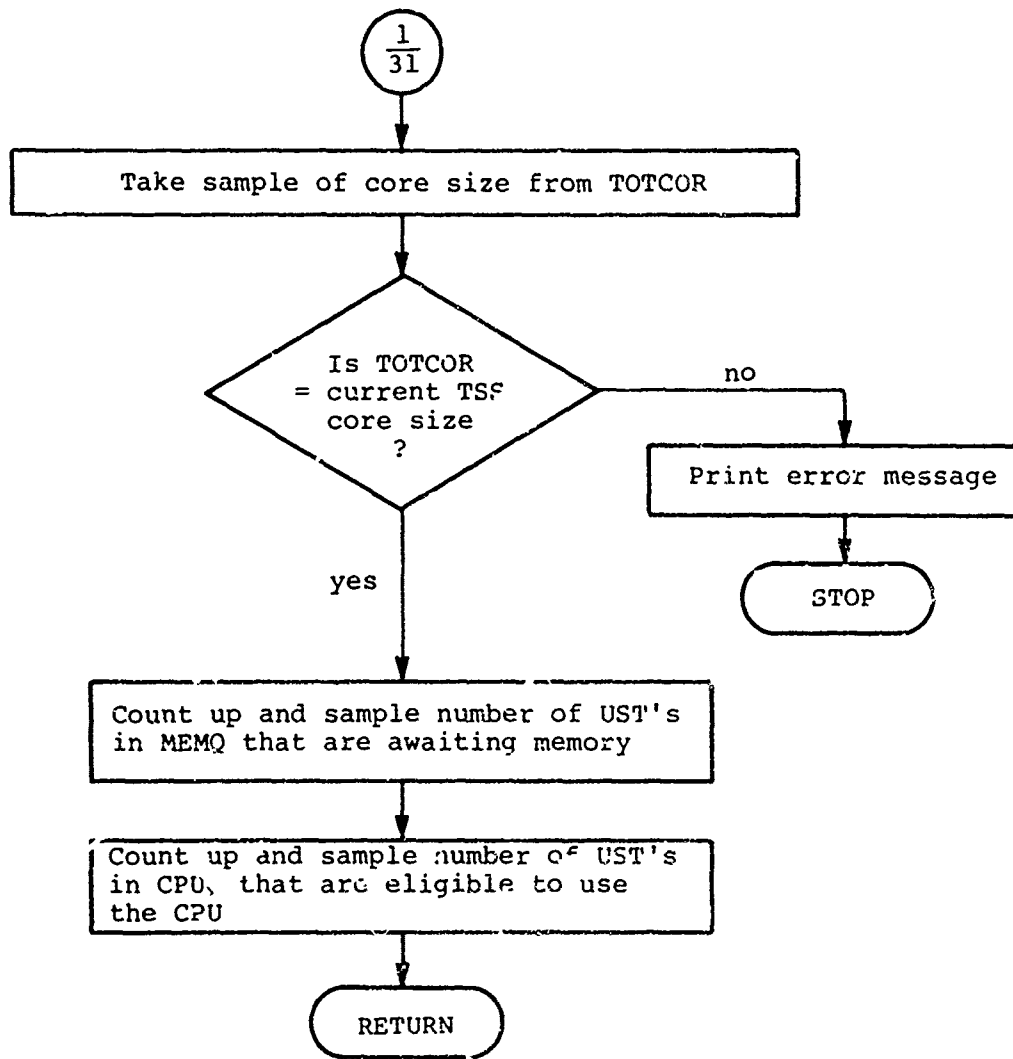


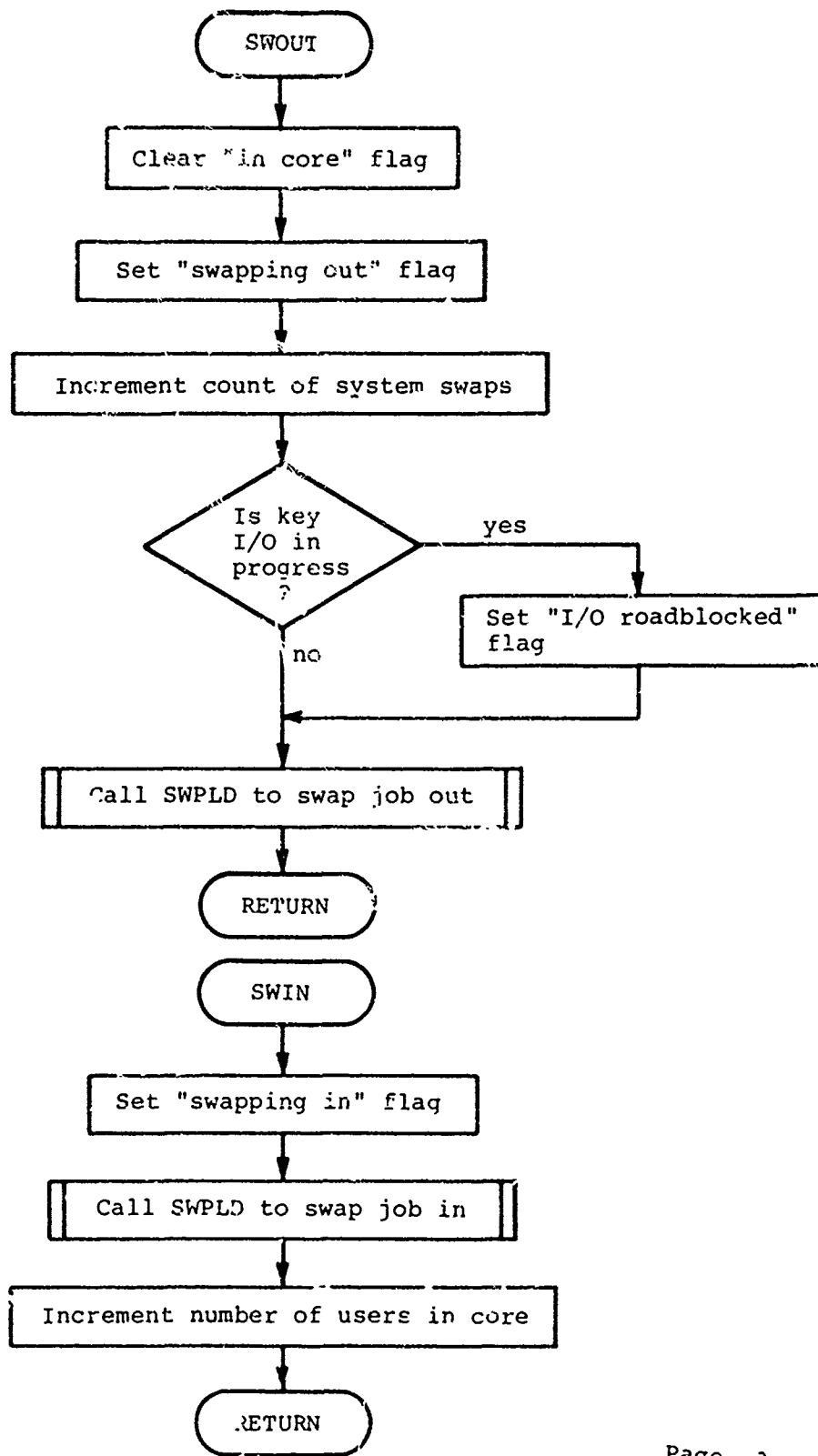


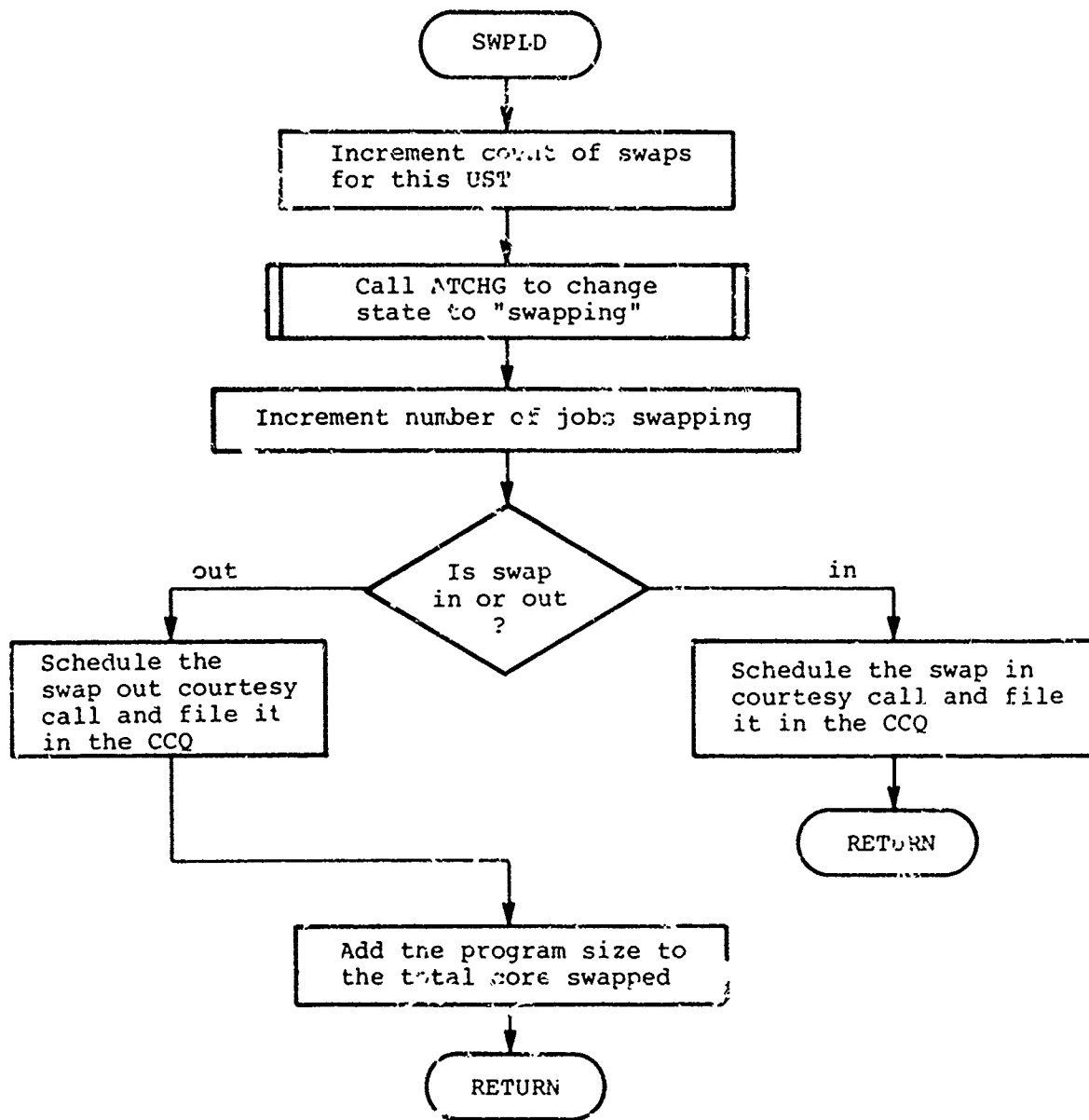


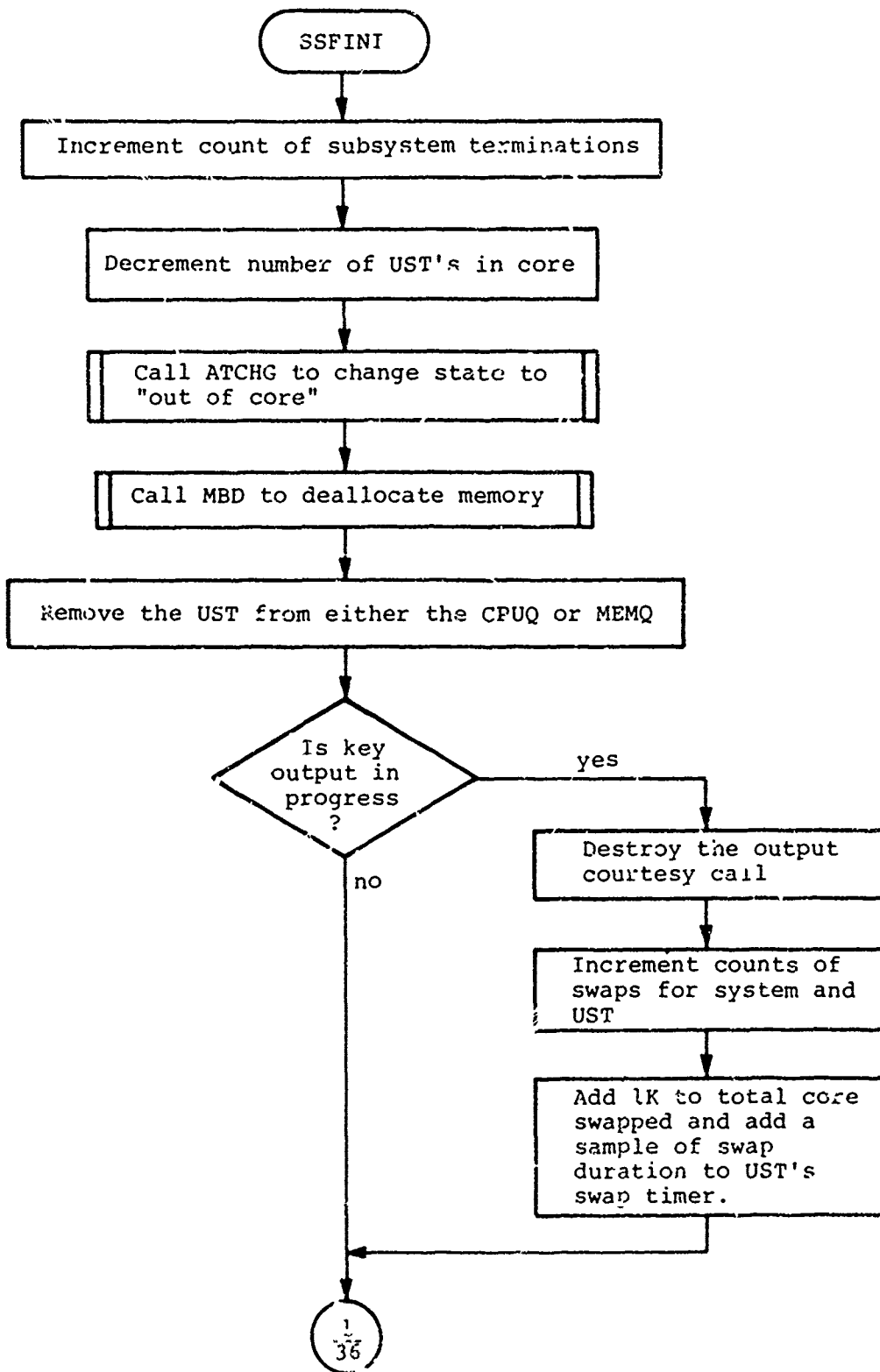


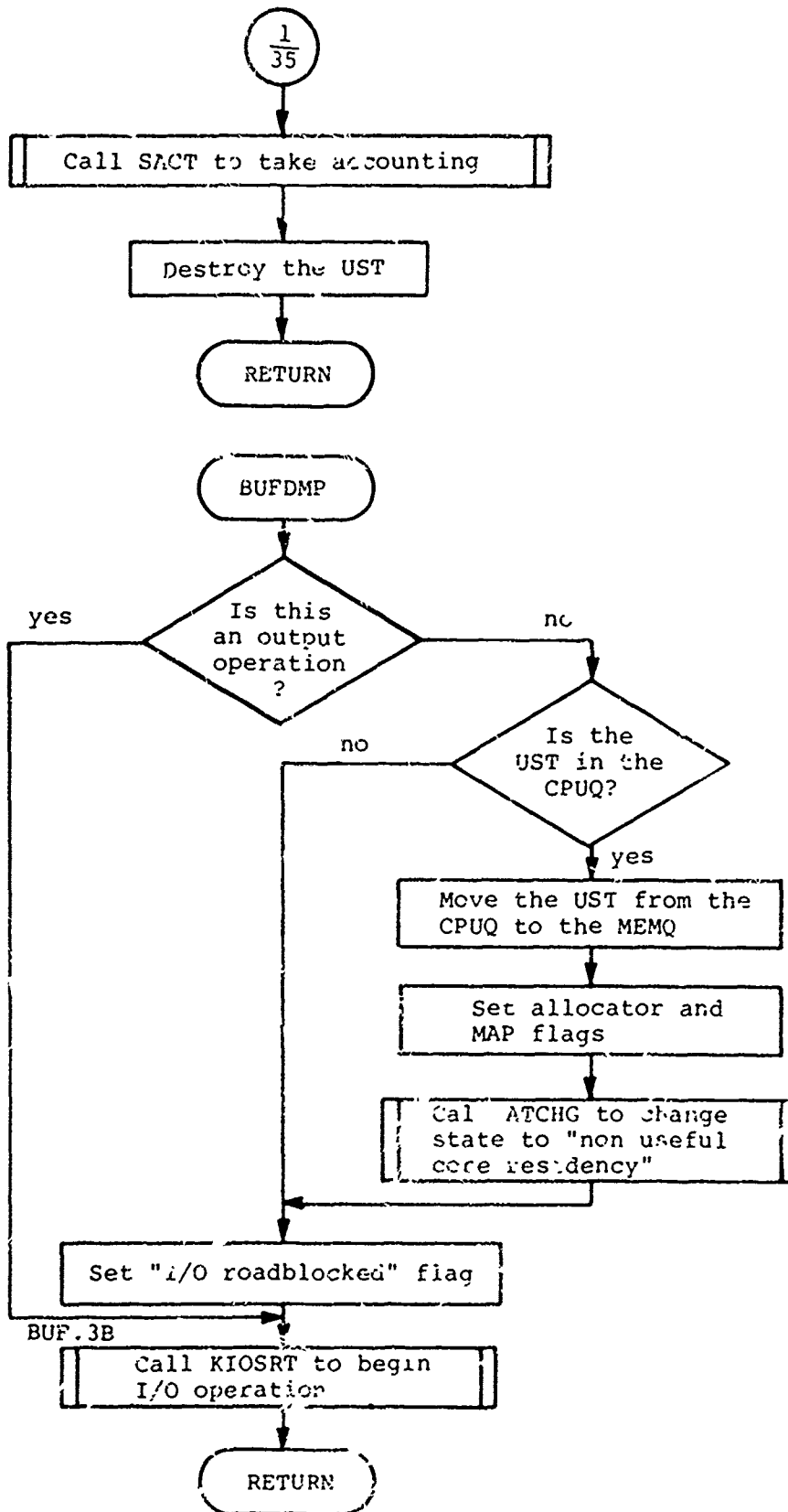


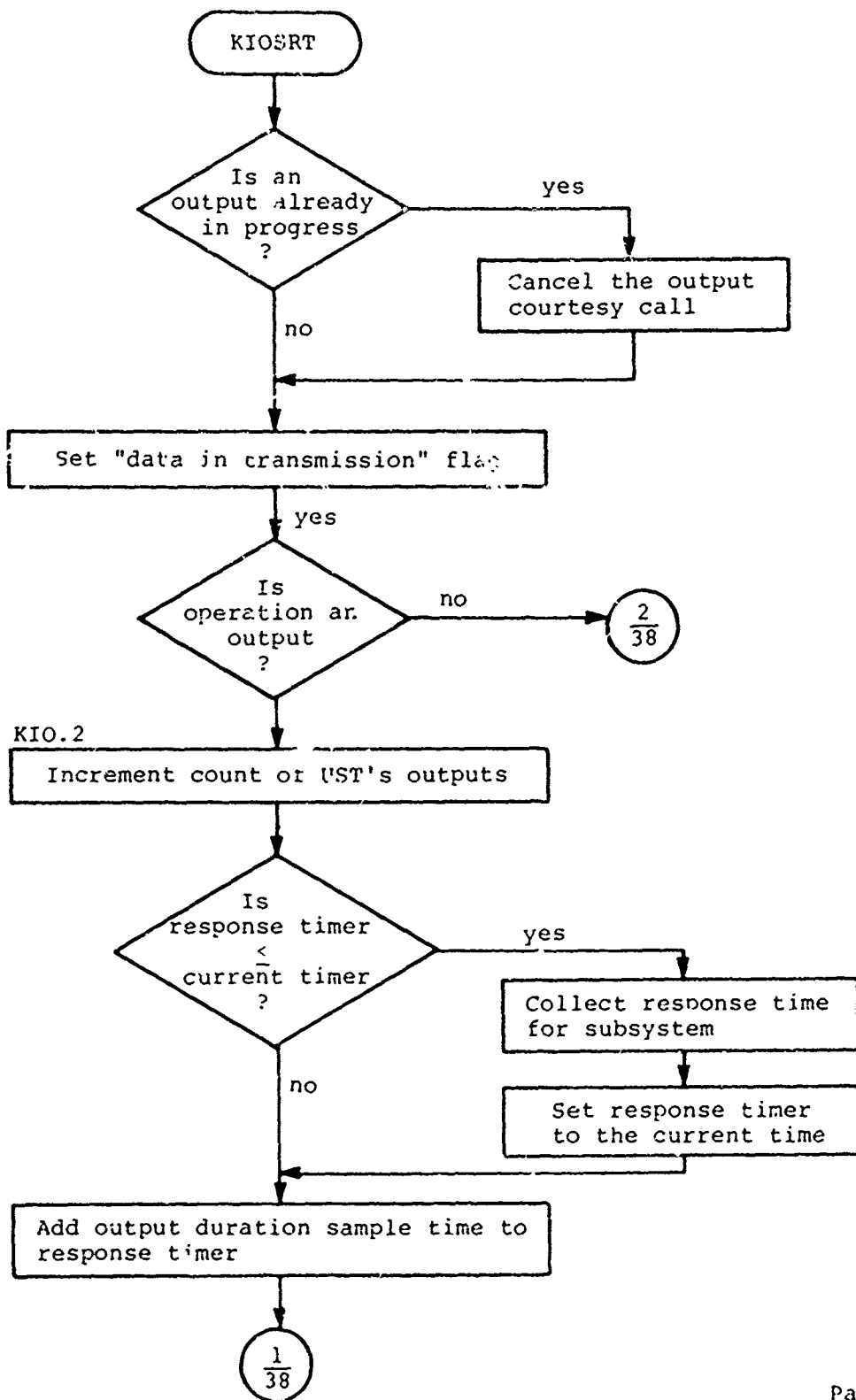


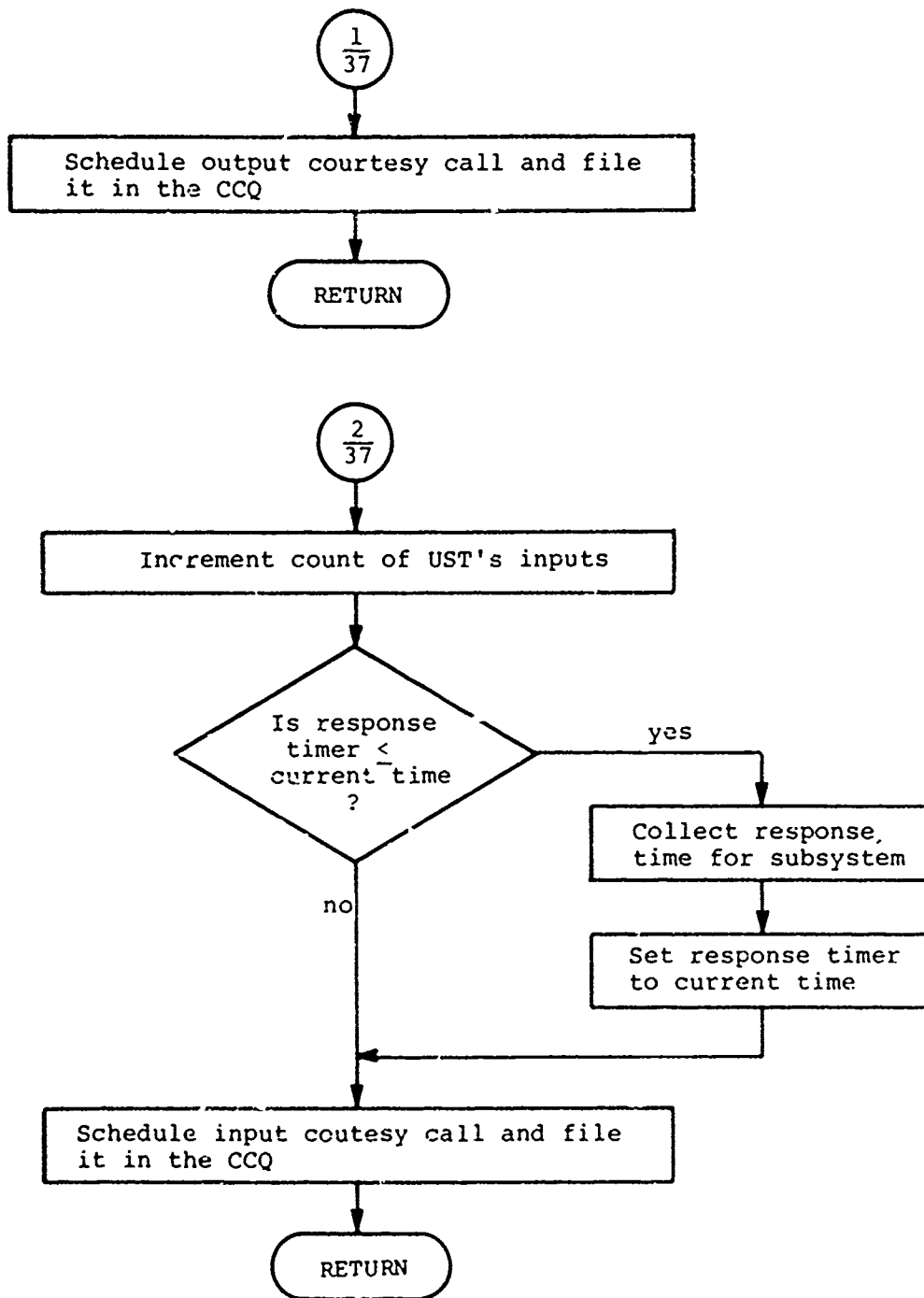


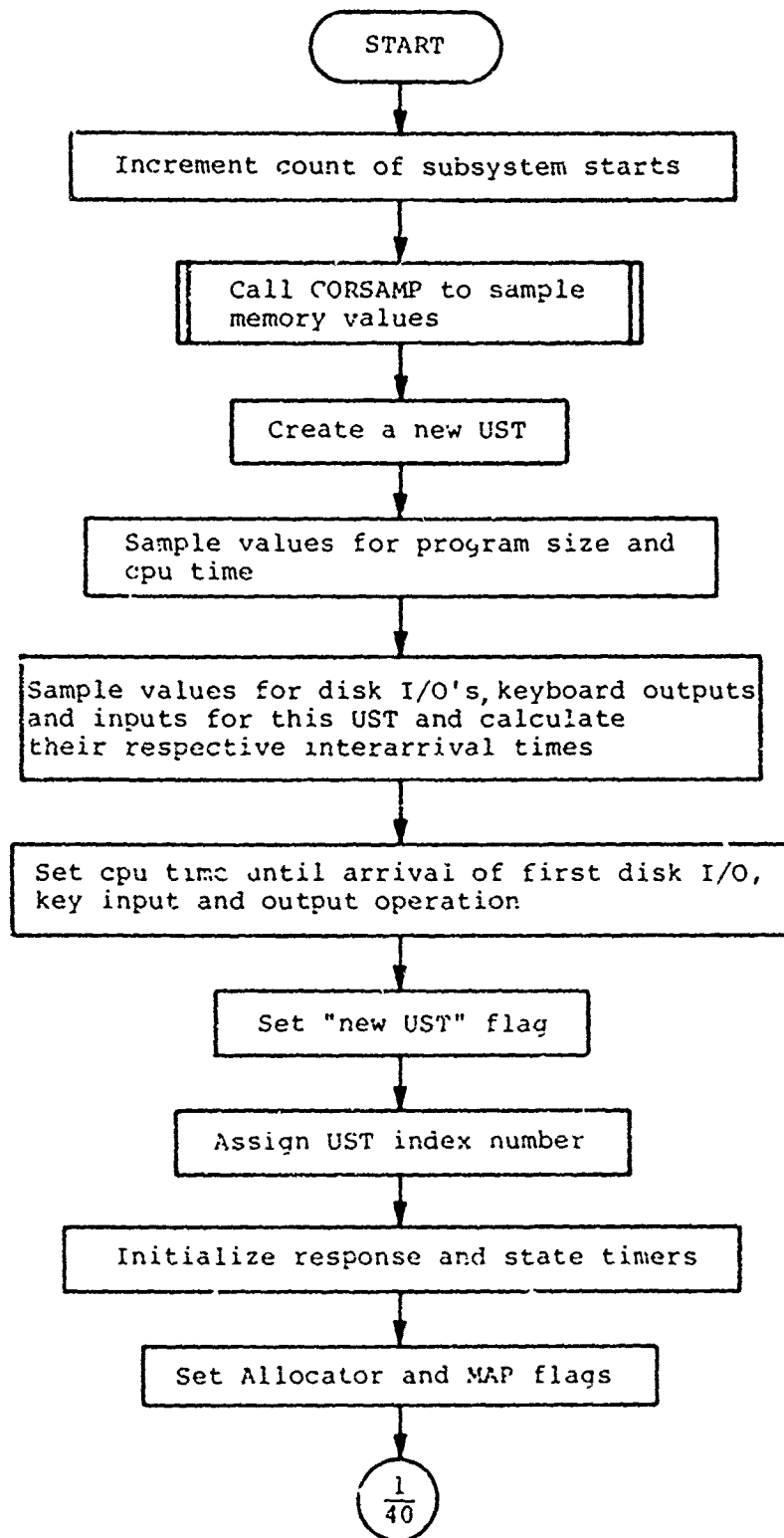


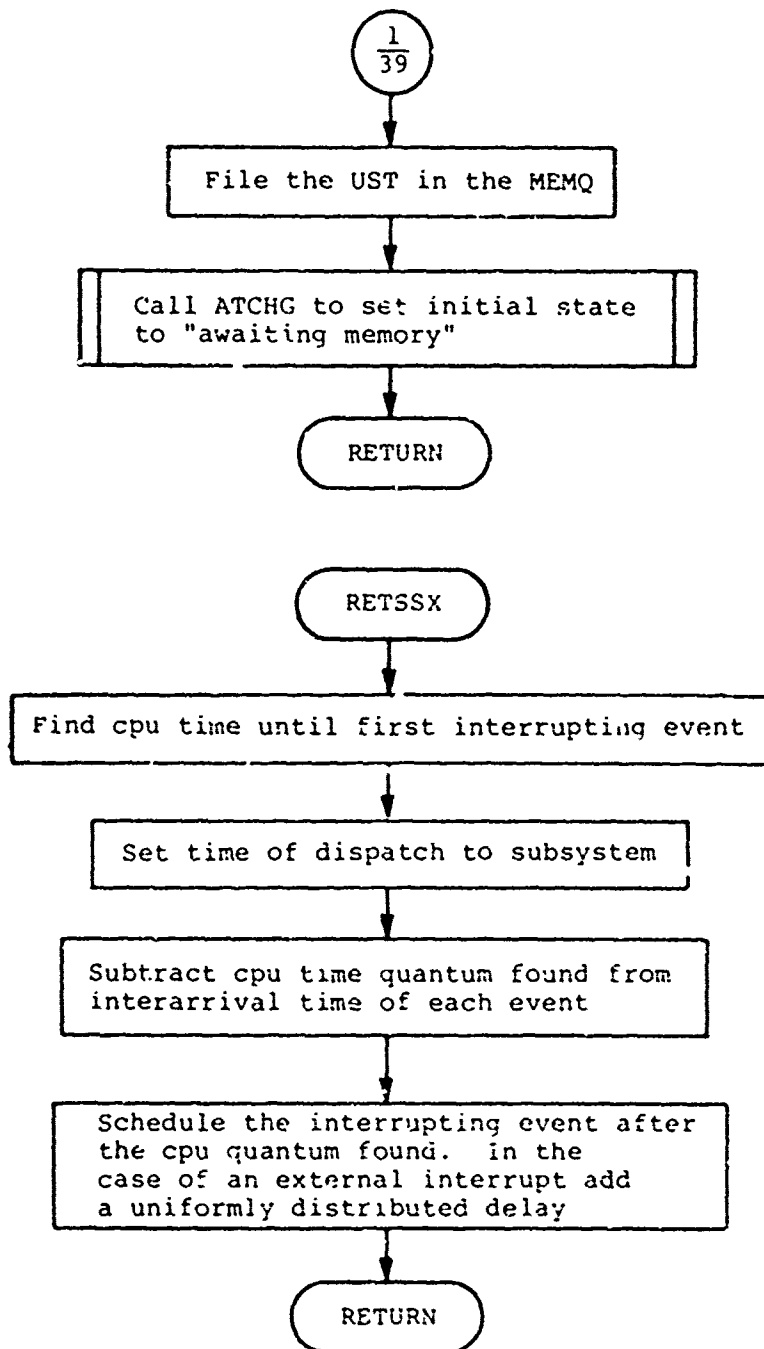


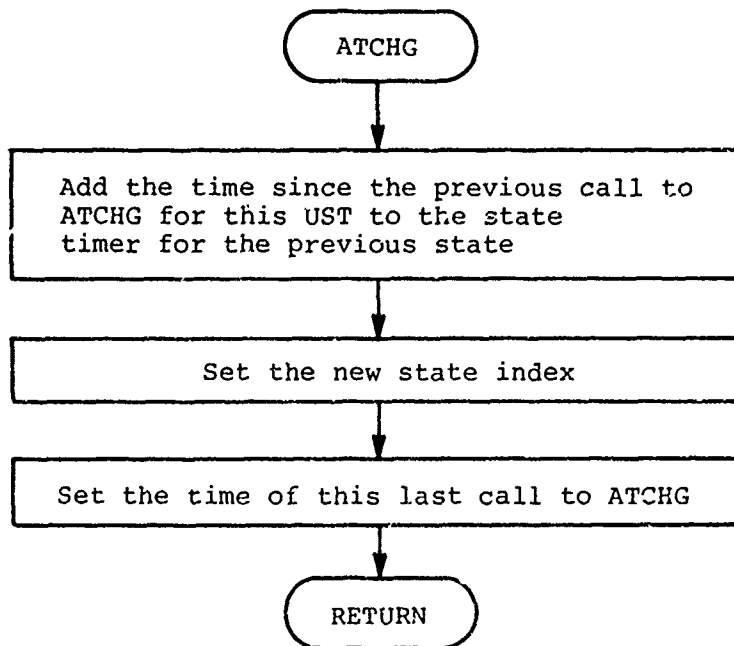
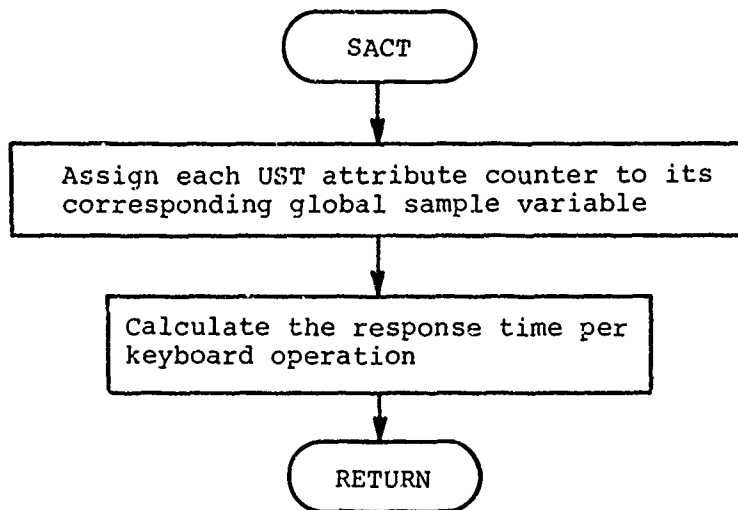


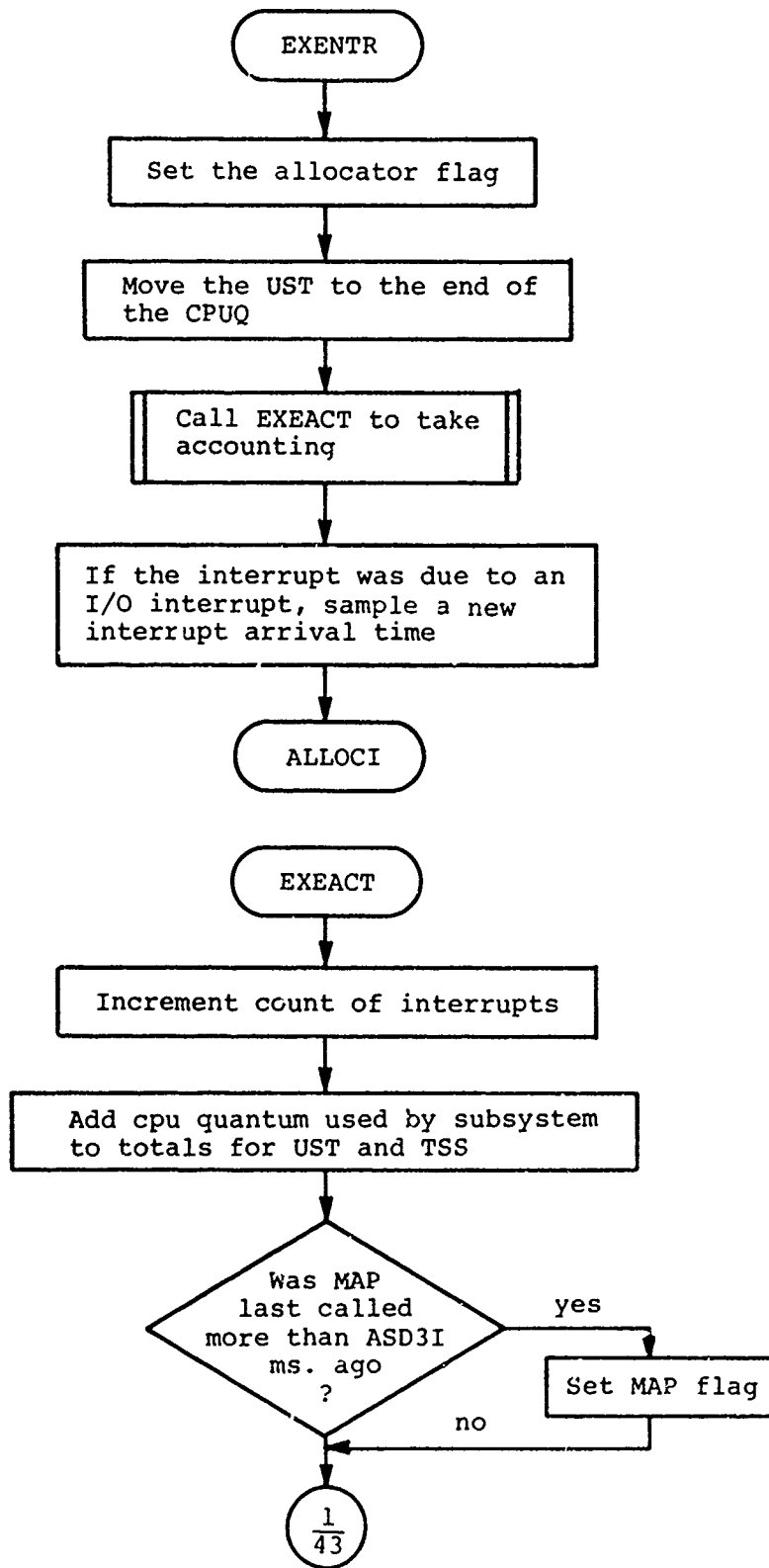


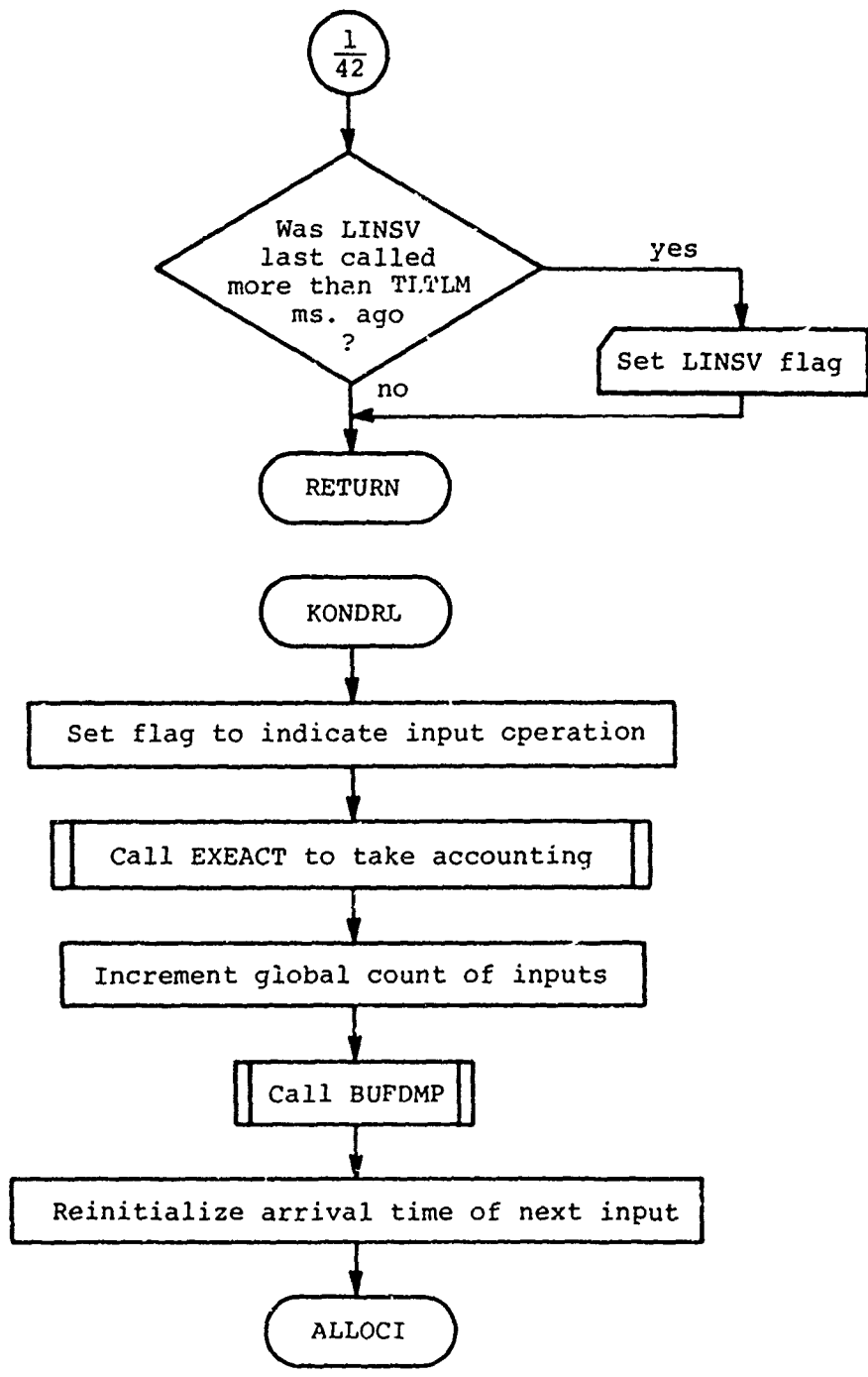


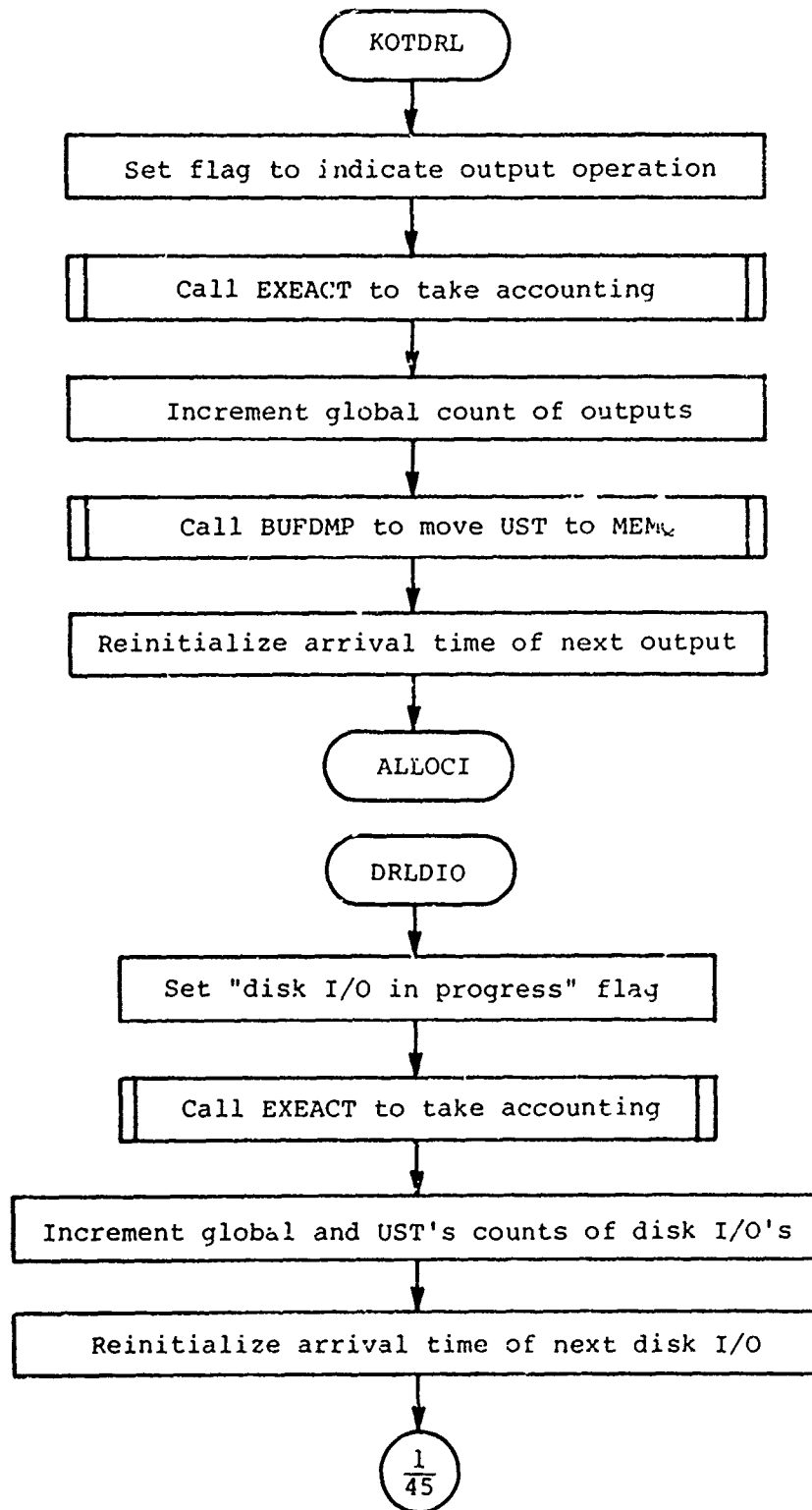


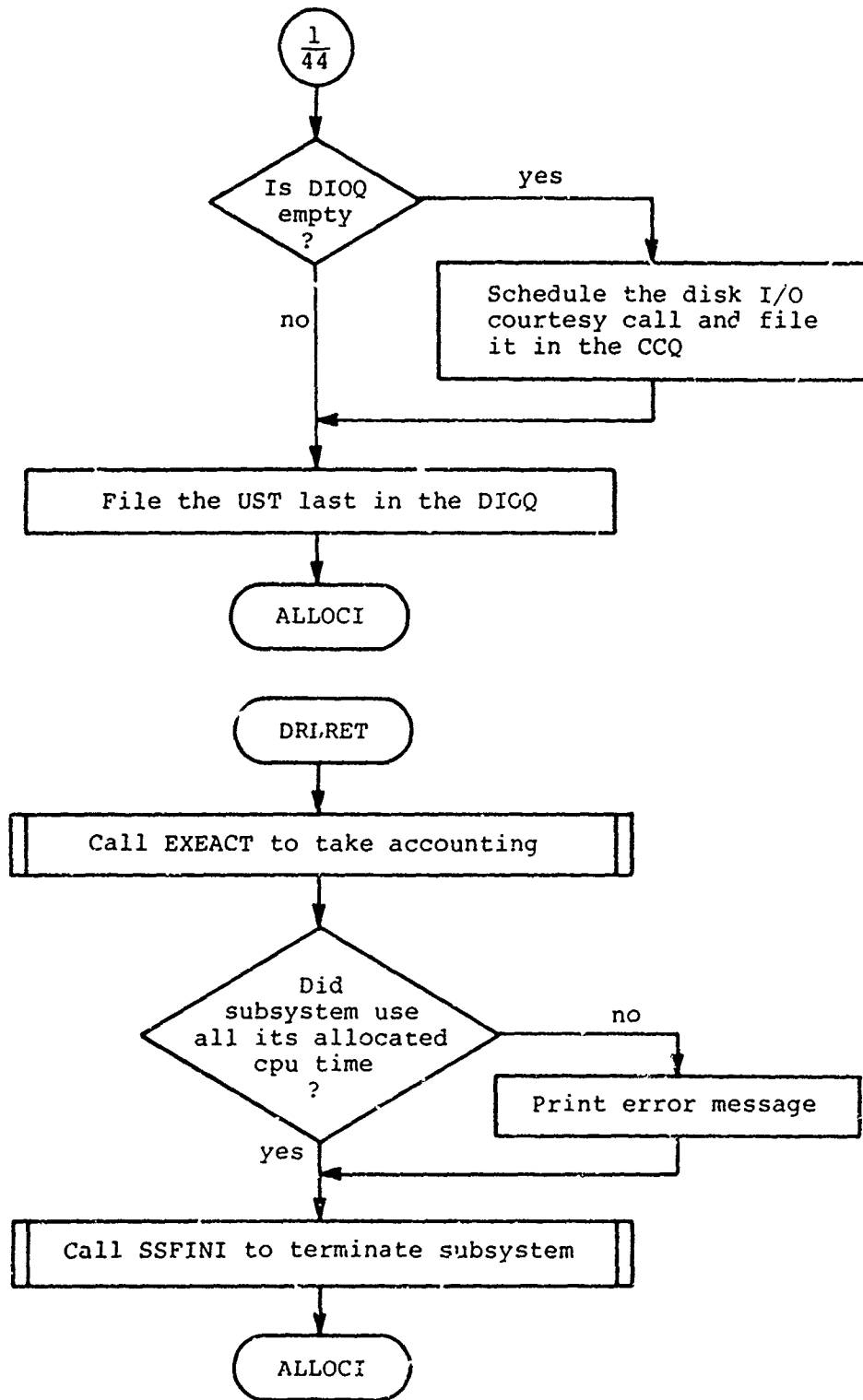


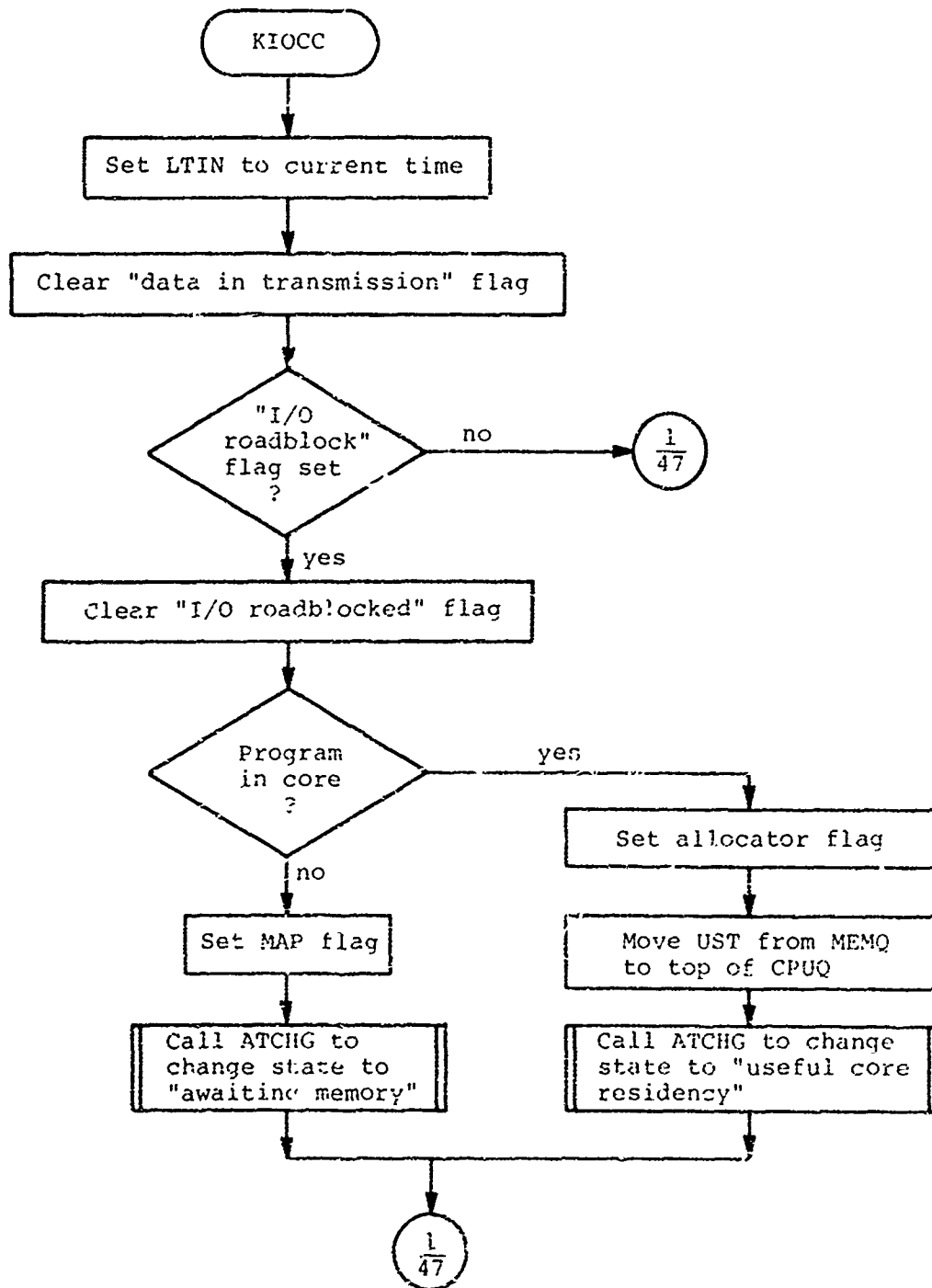


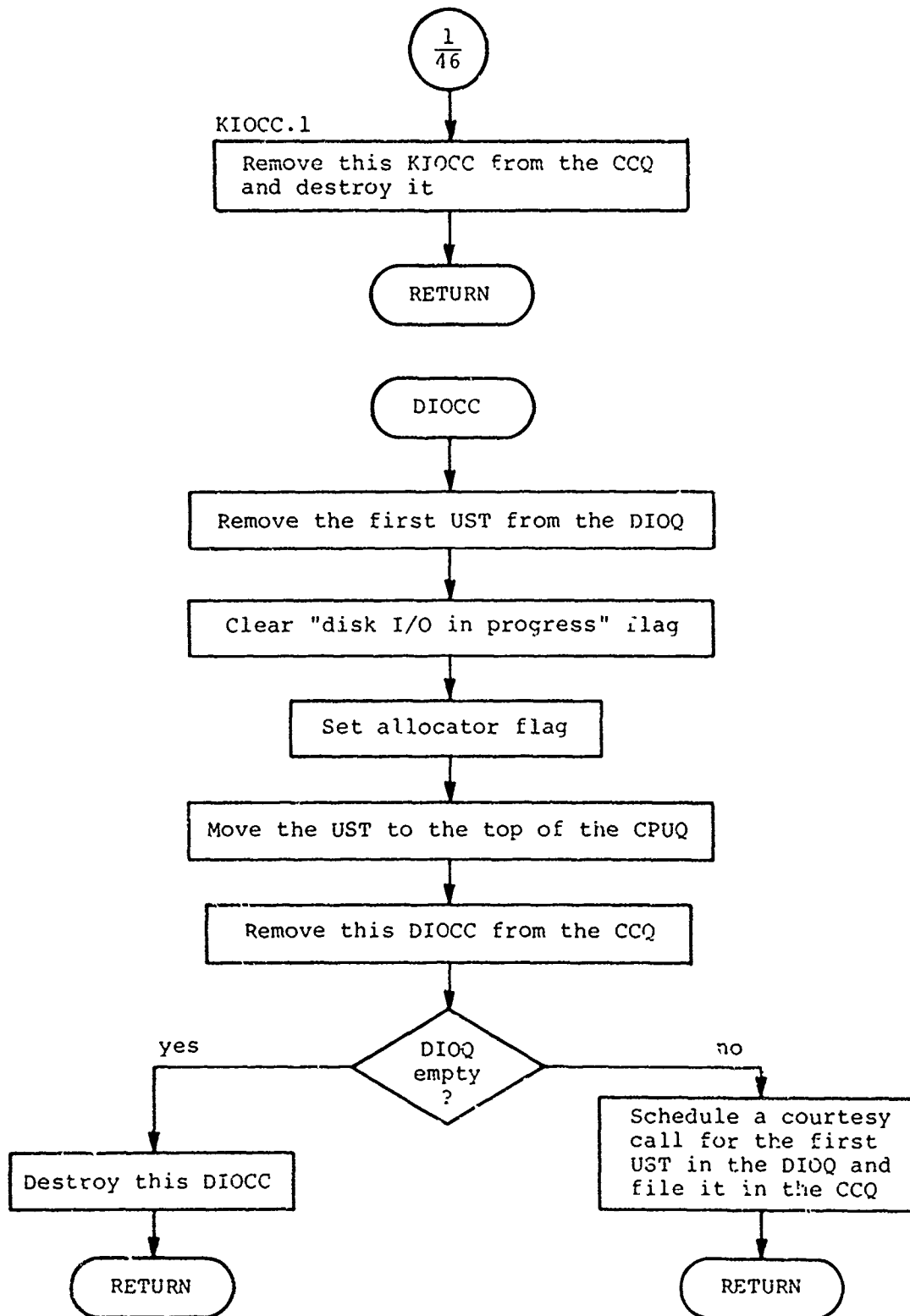


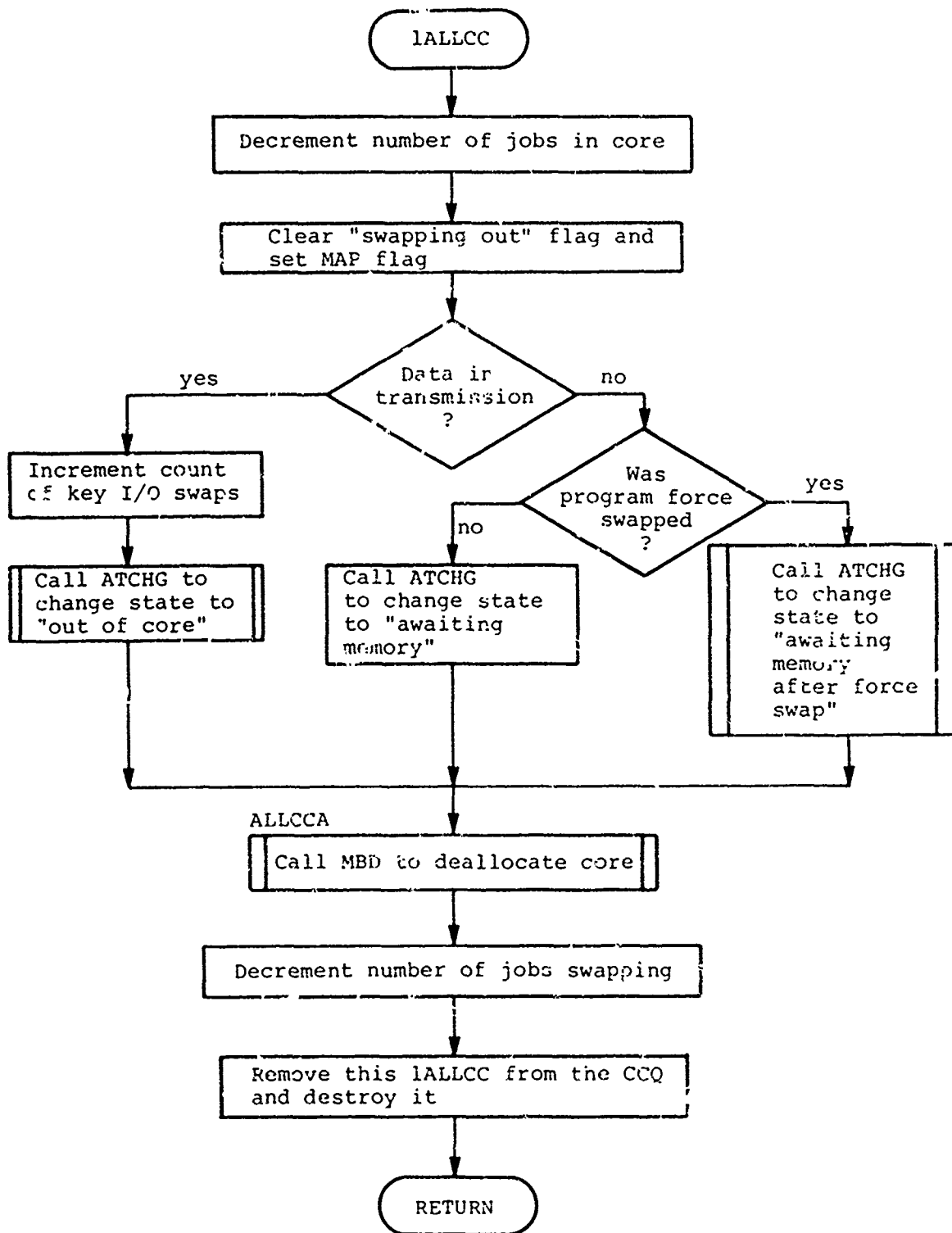


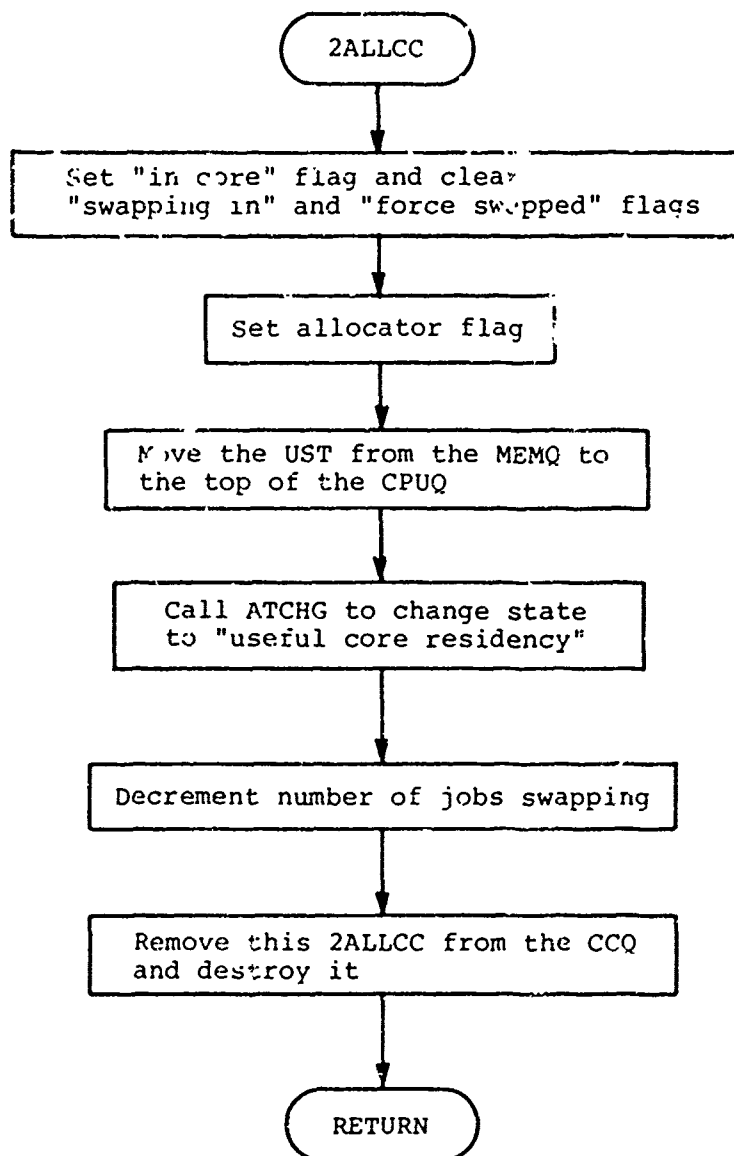


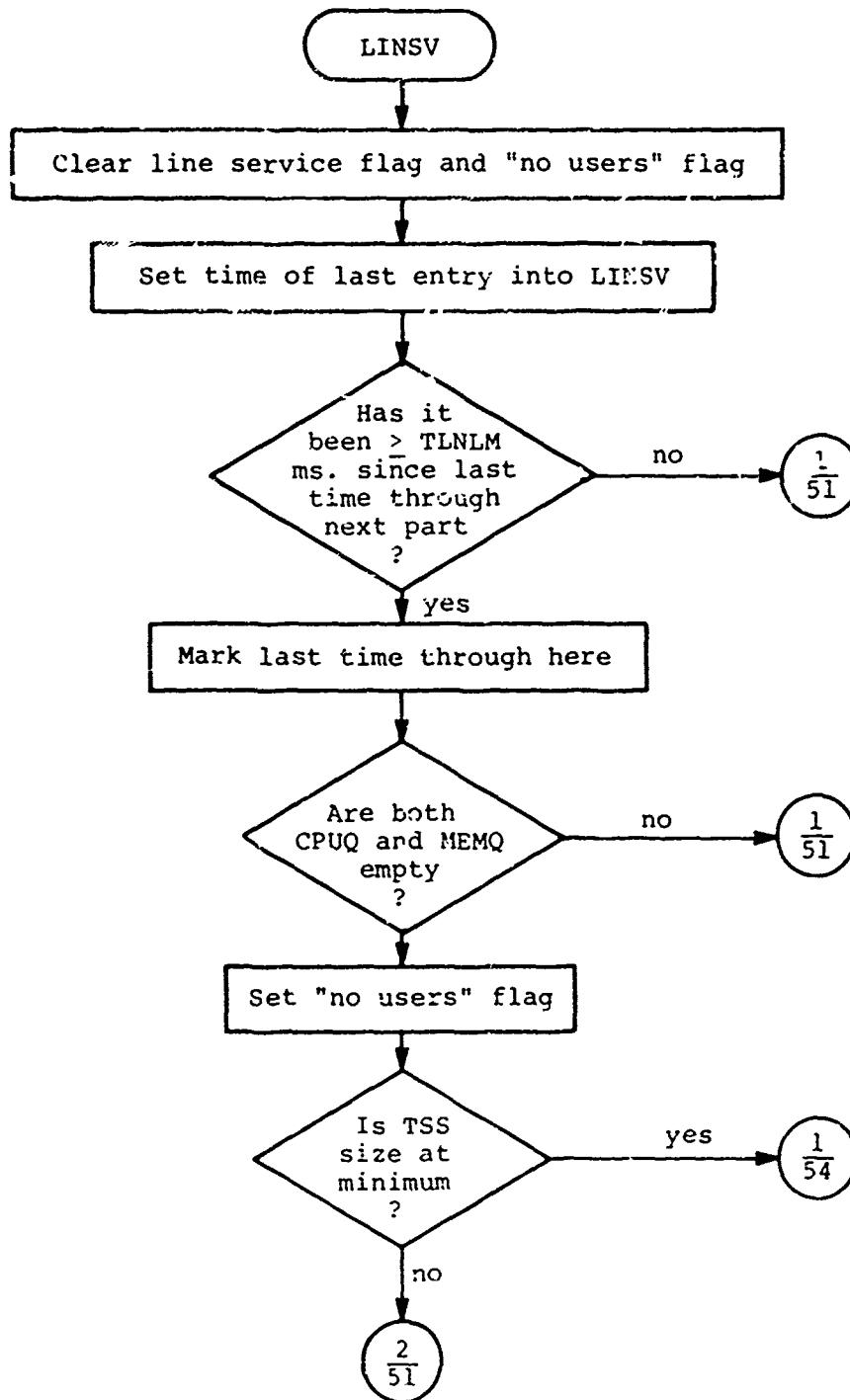


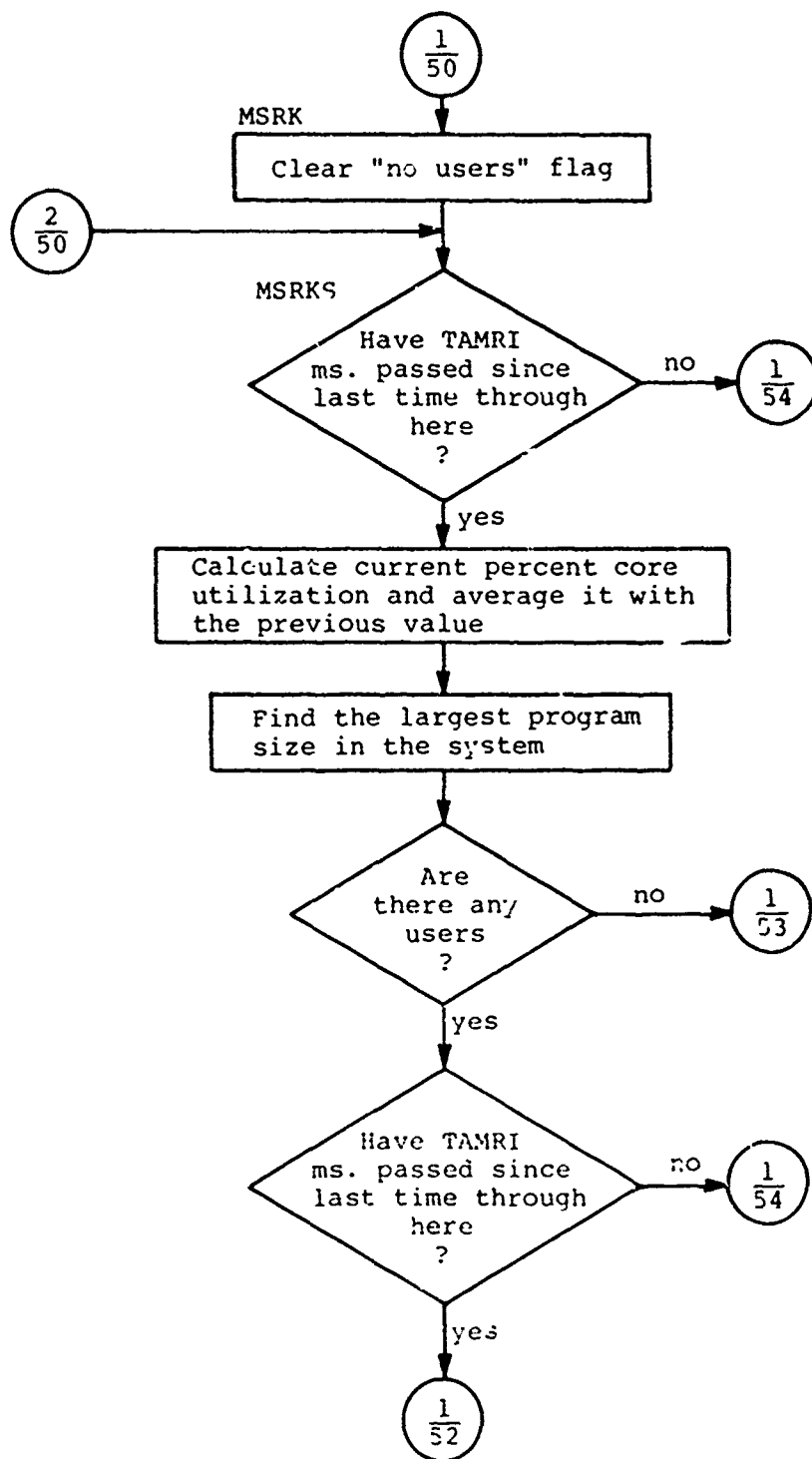


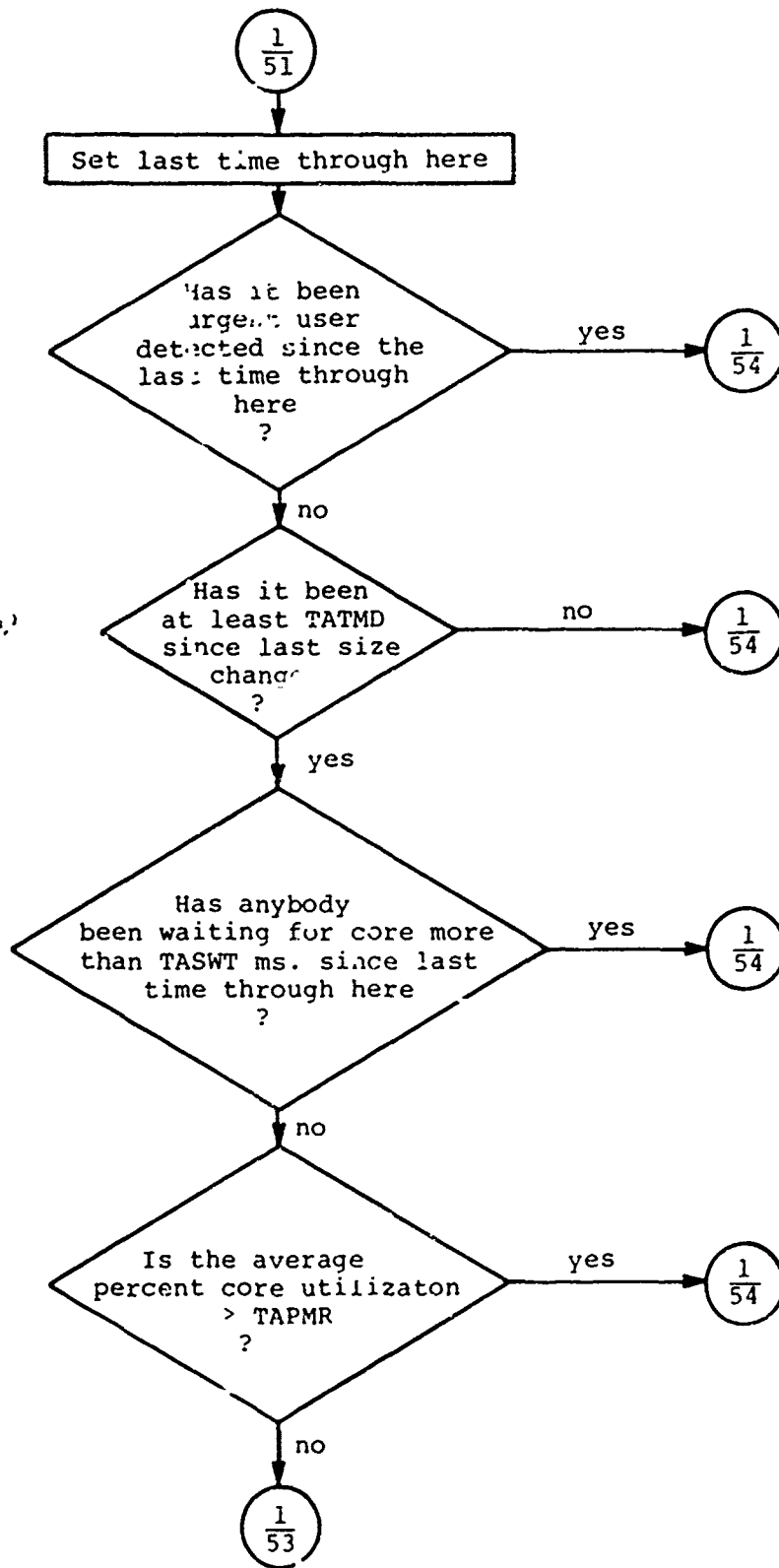


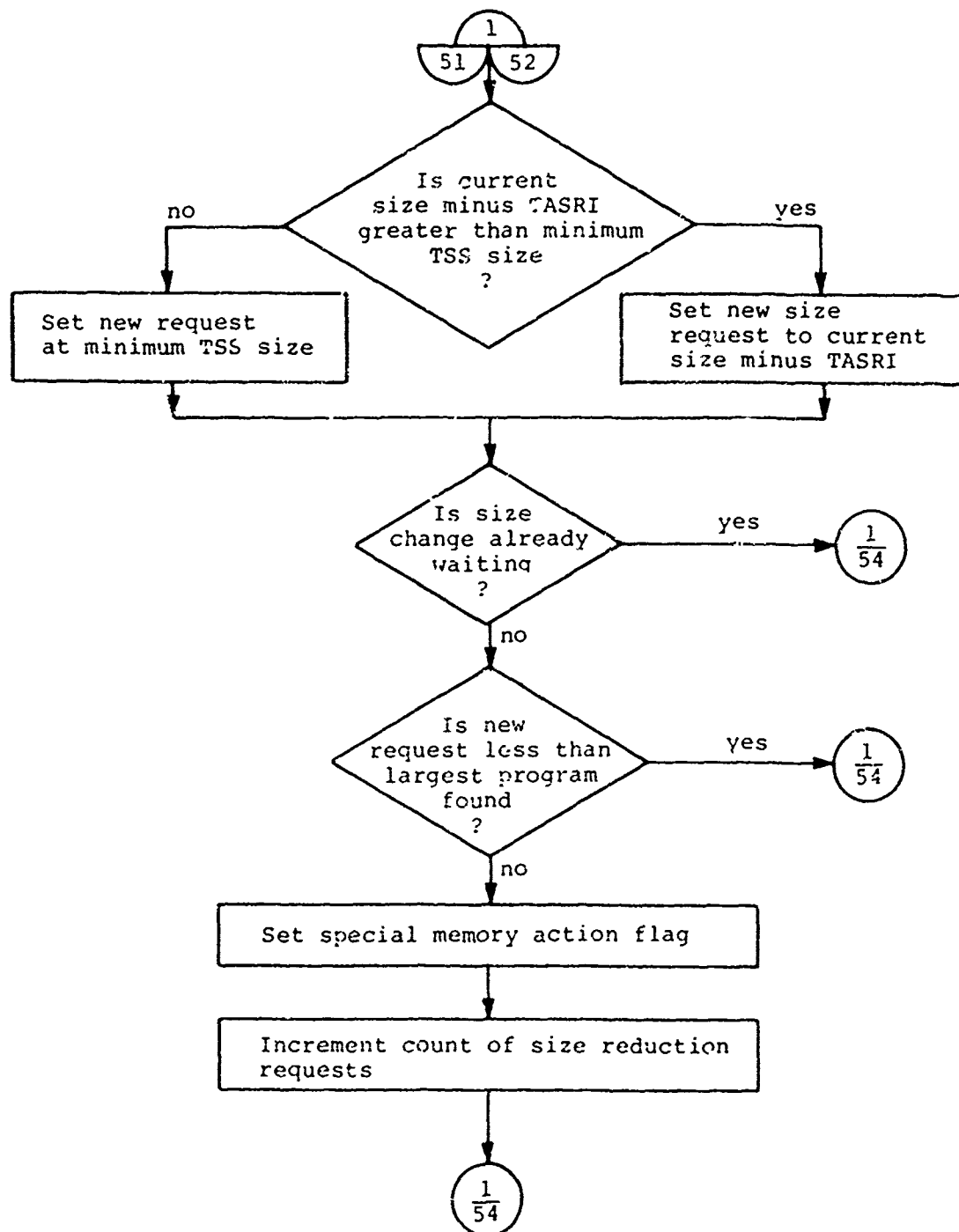


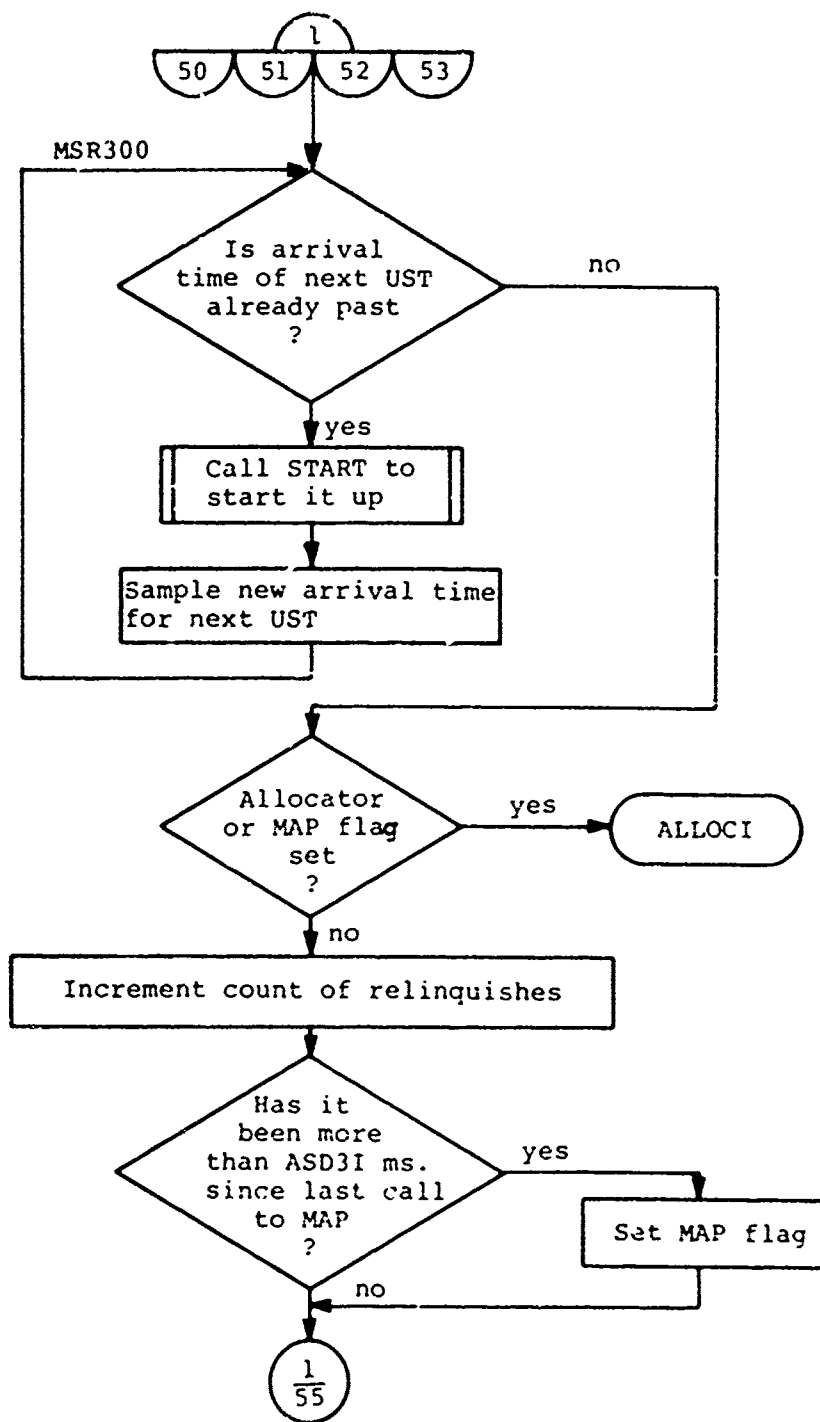












MSR300

Is arrival time of next UST already past?

Call START to start it up

Sample new arrival time for next UST

Allocator or MAP flag set?

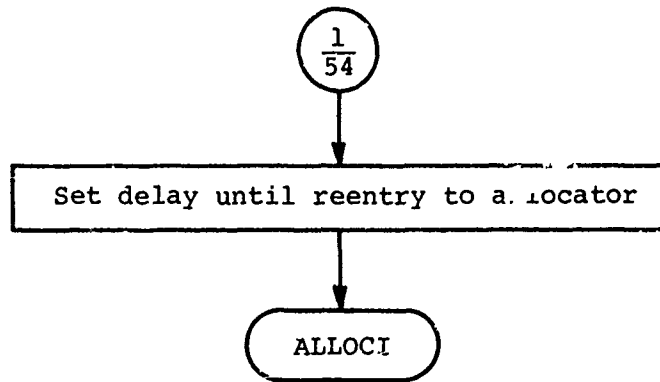
ALLOCI

Increment count of relinquishes

Has it been more than ASD3I ms. since last call to MAP?

Set MAP flag

1/55



Appendix 3

Program Listing

BEST AVAILABLE

```

1 1 **
2 2 ** SIMULATION MODEL FOR TSS ALLOCATOR
3 3 ** (RELEASE 8)
4 4 **
5 5 **
6 6 PREAMBLE
7 7 NORMALLY MODN IS INTEGER AND DIMENSION IS 0
8 8 DEFINE EVDIAG TO MEAN FOR ES=1 TO EVSWITCH
9 9 DEFINE RS. TO MEAN UNITS
10 10 DEFINE SHOW TO MEAN PRINT 1 LINE WITH TIME,V
11 11 DEFINE RDIAG TO MEAN FOR RS=1 TO RSWITCH PRINT 1 LINE THUS
12 12 DEFINE INIT AS A RELEASABLE ROUTINE
13 13 **
14 14 ** DEFINITION OF SYSTEM QUEUES AND RANDOM VARIABLES
15 15 **
16 16 PERMANENT ENTITIES
17 17 THE SYSTEM OWNS A CPUQ, A MEMQ, A CCQ AND A DIOQ
18 18 THE SYSTEM HAS A USTAT RANDOM LINEAR VARIABLE
19 19 THE SYSTEM HAS A NOKIN RANDOM STEP VARIABLE
20 20 THE SYSTEM HAS A NOKOUT RANDOM STEP VARIABLE
21 21 THE SYSTEM HAS A NODIO RANDOM STEP VARIABLE
22 22 THE SYSTEM HAS A SLOWUP RANDOM LINEAR VARIABLE
23 23 THE SYSTEM HAS A CUPUP RANDOM LINEAR VARIABLE
24 24 THE SYSTEM HAS A KTOUP RANDOM LINEAR VARIABLE
25 25 THE SYSTEM HAS A SIZEDIST RANDOM STEP VARIABLE
26 26 DEFINE USTAT AS A REAL, STREAM 1 VARIABLE
27 27 DEFINE NOKIN AS AN INTEGER, STREAM 2 VARIABLE
28 28 DEFINE NOKOUT AS AN INTEGER, STREAM 3 VARIABLE
29 29 DEFINE NODIO AS AN INTEGER, STREAM 4 VARIABLE
30 30 DEFINE SLOWUP AS A REAL, STREAM 5 VARIABLE
31 31 DEFINE CUPUP AS A REAL, STREAM 6 VARIABLE
32 32 DEFINE KTOUP AS A REAL, STREAM 7 VARIABLE
33 33 DEFINE SIZEDIST AS AN INTEGER, STREAM 8 VARIABLE
34 34 **
35 35 ** DEFINITION OF UST ENTITY
36 36 **
37 37 TEMPORARY ENTITIES
38 38 EVERY UST HAS A LTIM, A LSIZE, A LSTIO, A LSPTS, A LTHWT, A LTCW,
39 39 A LTM, A LTM1, A LTM2, A LTM3, A LTM4, A LTHS, A LTHRS,
40 40 A LTC21, A LTC22, A LTC31, A LTC32, A FL18, A FL19, AN OUTCC,
41 41 A FL21, A FL22, A FL23, A FL24, A FL34, A FK19,
42 42 A NXTDIO, A NXTKIN, A NXTKOUT, A KILL, A CHKCPU,
43 43 A JOENO, A KIAT, A KOIAT, A DIOIAT
44 44 AND MAY BELONG TO THE CPUQ, THE MEMQ AND THE DIOQ
45 45 DEFINE LTIM, LSPTS, LTHWT, LTM, LTM1, LTM2, LTM3, LTM4,
46 46 LTHS, LTHRS, NYTDIO, NXTKIN, NXTKOUT, KILL, NXTUST, NXTCC,
47 47 KAT, CHKCPU, KIAT, KOIAT, DIOIAT AS REAL VARIABLES
48 48 DEFINE LSIZE, LTCW, LTC21, LTC22, LTC31, LTC32, FL18, FL19, FL21,
49 49 FL22, FL23, FL24, FL34, FK19, OUTCC, JOENO, LSTIO AS VARIABLES
50 50 DEFINE MEMQ AS A SET BANKED BY LOW LSIZE
51 51 **

```

52 52 ** DEFINITION OF EVENTS

53 53 **

54 54 EVENT NOTICES

55 55 INCLUDE ALLOC1, MAP, SDP, SDP3, SDP4, SDP5, SDP6, SDP7, KONDRL,

56 56 KOTDRL, DRDIO, DRLET, LINSV, EXENTR, RETSSX, STERN, REINIT,

57 57 AND PDIAG

58 58 EVERY KIOCC HAS A MUST, BELONGS TO THE CCQ,

59 59 HAS A S.CCQ IN WORD 7, AND HAS A P.CCQ IN WORD 8

60 60 EVERY 1ALLCC HAS A MUST, BELONGS TO THE CCQ,

61 61 HAS A S.CCQ IN WORD 7, AND HAS A P.CCQ IN WORD 8

62 62 EVERY 2ALLCC HAS A MUST, BELONGS TO THE CCQ,

63 63 HAS A S.CCQ IN WORD 7, AND HAS A P.CCQ IN WORD 8

64 64 EVERY 3IOCC HAS A MUST, BELONGS TO THE CCQ,

65 65 HAS A S.CCQ IN WORD 7, AND HAS A P.CCQ IN WORD 8

66 66 DEFINE CCQ AS A SET RANKED BY LOW TIME, A WITHOUT L,N AND M ATTRIBUTES

67 67 **

68 68 ** DEFINITION OF MEMORY MAP ARRAYS AND DIAGNOSTIC SWITCHES

69 69 **

70 70 DEFINE SJOB, SHOLE, SUC, PRED, IDPTR AS 1-DIMENSIONAL

71 71 ARRAYS

72 72 DEFINE HEAD, TAIL, AVAIL, EVSWITCH, QSWITCH, MSWITCH, SCSWITCH,

73 73 RSWITCH, PS, RS, TSTRT, TKILL, TLKAA, DEVS, DRS, DOS, DMS,

74 74 DSCS, I, J, USWITCH, KSWITCH, DUS, DKS, SSSWITCH, DSS AS VARIABLES

75 75 **

76 76 ** DEFINITION OF FLAGS, VARIABLES AND COUNTERS

77 77 **

78 78 DEFINE LSPLG, MPWP, ALCCI, TLFLG, APAP1, APAP2, AMAP,

79 79 MPACT, 1AUFMT, 2AUFMT, AMAP2, AMN1, AMN2, ASDP, SPUSE,

80 80 ASDPC, TUSG, TATM, 1AUG, TAOI, TACOR, TSIRC, ASDP7, TSWPK,

81 81 INCOME, LICCP, WAITCOR AS VARIABLES

82 82 DEFINE MMLLOCOK, AMBA, AMBA4, AMBA5, INDDRL, TAUSE, TEMP,

83 83 TAPKO, TELPS, TSNRC, TATIO, KOSVAP, TAGTC, REFUSED AS VARIABLES

84 84 DEFINE MAFTT, ALUT, ASOBT, TALUT, WIFAC, URG, TALCT,

85 85 T, SPME, RESPT, ILLST, TLCLD, TASRT, TASXT, DISPT, TAGPT,

86 86 TAGTU, TITLM, XTINT, DICMEAN, INTMEAN, STOPTIME, NEXT,

87 87 WAKET, OUTMEAN, DBEGIN, DDUR, MNDLAY, MXDELAY, INITIME AS REAL VARIABLES

88 88 DEFINE AMPTM, TASWT, TASIC, AMTC, TAGMI, TATMC, TATMD,

89 89 TAMAW, TLLM, TAMRI, TASC, ASDBI, TCDEL AS REAL VARIABLES

90 90 DEFINE LRSF, TAPIS, TAPF, TAMII, TAMMS, TAPMM, TAPRI,

91 91 TALUT, ITCORE AS VARIABLES

92 92 **

93 93 ** DEFINITION OF VARIABLES FOR COLLECTING STATISTICS

94 94 **

95 95 OFFINE KEYOUT, KEYIN, DISKIO, TSWAP, SIZEINCR, SIZERED,

96 96 PROGSIZE, HOLSIZE, CORSIZE, USEDIZE AS VARIABLES

97 97 DEFINE VKIAT, VKOAT, VUSTIAT, VDOIAT, VSIZE, VCFUDUR AS REAL

98 98 VARIABLES

99 99 DEFINE LTMSS, LTM1SS, LTM2SS, LTM3SS, LTM4SS, LTM5SS, SSRESP,

100 100 SSCPU AS REAL VARIABLES

101 101 DEFINE SSKIN, SSKOUT, SSDIO, SSWAP, SSWAPO AS VARIABLES

102 102 TALLY MPROGSIZ AS THE MEAN AND SPROGSIZ AS THE STD OF PROGSIZ

103 103 TALLY MHOLSIZE AS THE MEAN AND SHOLSIZE AS THE STD OF HOLSIZE

104	104	TALLY MCORSIZE AS THE MEAN AND SCORSIZE AS THE STD OF CORSIZE
105	105	TALLY MUSEDSEIZ AS THE MEAN AND SUSEDSEIZ AS THE STD OF USEDSEIZ
106	106	TALLY MFRUSED AS THE MEAN AND SFRUSED AS THE STD OF PERUSED
107	107	TALLY MKKIAT AS THE MEAN AND SKKIAT AS THE STD OF VKKIAT
108	108	TALLY MKKOIAT AS THE MEAN AND SKKOIAT AS THE STD OF VKOIAT
109	109	TALLY MVUSTIAT AS THE MEAN AND SVUSTIAT AS THE STD OF VUSTIAT
110	110	TALLY MVDIOIAT AS THE MEAN AND SVDIOIAT AS THE STD OF VDIOIAT
111	111	TALLY MVSIZ AS THE MEAN AND SVSIZ AS THE STD OF VSIZ
112	112	TALLY MFCPUDUR AS THE MEAN AND SFCPUDUR AS THE STD OF VCPUDUR
113	113	TALLY MLTMOSS AS THE MEAN AND SLTMOSS AS THE STD OF LTMOSS
114	114	TALLY MLTM1SS AS THE MEAN AND SLTM1SS AS THE STD OF LTM1SS
115	115	TALLY MLTM2SS AS THE MEAN AND SLTM2SS AS THE STD OF LTM2SS
116	116	TALLY MLTM3SS AS THE MEAN AND SLTM3SS AS THE STD OF LTM3SS
117	117	TALLY MLTM4SS AS THE MEAN AND SLTM4SS AS THE STD OF LTM4SS
118	118	TALLY MLTM5SS AS THE MEAN AND SLTM5SS AS THE STD OF LTM5SS
119	119	TALLY MSSHESP AS THE MEAN AND SSSHESP AS THE STD OF SSRESP
120	120	TALLY MSSCPU AS THE MEAN AND SSSCPU AS THE STD OF SSCPU
121	121	TALLY MRESPT AS THE MEAN AND SRESPT AS THE STD OF RESPT
122	122	TALLY MSSKIN AS THE MEAN AND SSSKIN AS THE STD OF SSKIN
123	123	TALLY MSSKOUT AS THE MEAN AND SSSKOUT AS THE STD OF SSKOUT
124	124	TALLY MSSDIO AS THE MEAN AND SSSDIO AS THE STD OF SSDIO
125	125	TALLY MSSFSWAP AS THE MEAN AND SSSFSWAP AS THE STD OF SSFSWAP
126	126	TALLY MSSSWAPO AS THE MEAN AND SSSSWAPO AS THE STD OF SSSWAP
127	127	ACCUMULATE M.CPUQ AS THE MEAN AND S.CPUQ AS THE STD OF N.CPUQ
128	128	ACCUMULATE M.DIOQ AS THE MEAN AND S.DIOQ AS THE STD OF N.DIOQ
129	129	ACCUMULATE M.MEMQ AS THE MEAN AND S.MEMQ AS THE STD OF N.MEMQ
130	130	ACCUMULATE M.SFUSE AS THE MEAN AND S.SFUSE AS THE STD OF SFUSE
131	131	ACCUMULATE M.INCORE AS THE MEAN AND S.INCORE AS THE STD OF INCORE
132	132	ACCUMULATE M.TAURG AS THE MEAN AND S.TAURG AS THE STD OF TAURG
133	133	ACCUMULATE M.WAIT AS THE MEAN AND S.WAIT AS THE STD OF WAITCOR
134	134	ACCUMULATE M.ELIG AS THE MEAN AND S.ELIG AS THE STD OF ELIGCPU
135	135	END

```

136 1  "
137 2  "      ROUTINE TO INITIALIZE SIMULATION
138 3  "
139 4  ROUTINE INIT
140 5  SHOW THUS
BEGINNING OF SIMULATION AT *****
142 5  "
143 7  "      READ INPUT PARAMETERS, CONSTANTS AND DISTRIBUTIONS
144 8  "
145 9  READ STOPTIME, DEVS, DRS, DQS, DMS, DSCS, DUS, DKS, DSS, DBEGIN,
146 10  DIUR, INITIME
147 11 LIST STOPTIME, DEVS, DRS, DQS, DMS, DSCS, DUS, DKS, DSS, DBEGIN,
148 12  DIUR, INITIME
149 13 PRINT 1 LINE THUS
RANDOM NUMBER SEEDS
151 14 FOR J=1 TO 10 DO
152 15  READ SEED.V(J) PRINT 1 LINE WITH SEED.V(J) THUS
*****
154 16 LOOP
155 17 READ AMPTM, INSP, ISWT, IAMS, TALPP, TASF, TASID, TLTM,
156 18  TAMRI, TAMMS, AMTO, TAGMI, TATMC, TATMD, TAMAN, TLNLM,
157 19  TASHS, TAMRI, TAPMR, TASHI, TASC, ASDSI, TCDEL,
158 20  INITCORE, INTMEAN, MXDELAY, MYDELAY, XIOMEAN, OUTMEAN
159 21 LIST AMPTM, INSP, ISWT, IAMS, TALPP, TASF, TASID, TLTM,
160 22  TAMRI, TAMMS, AMTO, TAGMI, TATMC, TATMD, TAMAN, TLNLM,
161 23  TASHS, TAMRI, TAPMR, TASHI, TASC, ASDSI, TCDEL,
162 24  INITCORE, INTMEAN, MXDELAY, MYDELAY, XIOMEAN, OUTMEAN
163 25 READ USTIAT, NOKIN, NOKOUT, NODIO, SWAPDUR, CPUDUR, KIODUR, SIZEDISI,
164 26  CHECK
165 27 IF CHECK NE 9999 PRINT 1 LINE THUS
*** ERROR - INPUT FORMAT INCORRECT
167 28 STOP
168 29 ELSE
169 30 "
170 31 "      RESERVE ARRAYS FOR MEMORY MAP
171 32 "
172 33 RESERVE SJOB, SHOLE, SUC, PRED, IDPTH AS 50
173 34 "
174 35 "      INITIALIZE MEMORY MAP
175 36 "
176 37 LET HEAD=1 LET TAIL=1
177 38 LET SHOLE(1)=INITCORE LET SJOB(1)=0 LET TACOR=INITCORE
178 39 LET AVAIL=2 LET SUC(1)=0 LET PRED(1)=0
179 40 FOR I=2 TO 5 DO
180 41  LET SUC(I)=I+1
181 42 LOOP
182 43 LET SUC(50)=
183 44 LET TAPMU=10 LET CORSIZE=INITCORE
184 45 "
185 46 "      TAKE FIRST SAMPLE OF UST ARRIVAL AND INTERRUPT
186 47 "
187 48 LET NXTUST=USTIAT

```



```
188 49 LET VUSTIAT=NXTUST
189 50 LET NXTINT=EXPONENTIAL.F(INTRKAN,9)
190 51 ''
191 52 '' SCHEDULE ENTRY TO ALLOCATOR AND TERMINATION EVENTS
192 53 SCHEDULE AN ALLOC NOW LET LSFLG=1
193 54 SCHEDULE A STEEM AT STOPTIME
194 55 SCHEDULE A PDIG AT DBEGIN '' SCHEDULE EVENT TO PRINT DIAGNOSTICS
195 56 SCHEDULE A REINIT AT INIIME '' SCHEDULE EVENT TO RE-INITIALIZE COUNTERS
196 57 RETURN END
```

79501 01 08-28-75 17.504 CACI SIMSCRIPT 12.5 FOR HIS 600/6000 USAF RELEASE 9,

197	1	''
198	2	'' MAIN ROUTINE
199	3	''
200	4	MAIN
201	5	PERFORM INIT RELEASE INIT
202	6	START SIMULATION
203	7	STOP
204	8	END

```
205 1 ..  
206 2 .. EVENT TO START AND STOP PRINTING OF DIAGNOSTICS  
207 3 ..  
208 4 EVENT PDIAG SAVING THE EVENT NOTICE  
209 5 IF TIME.V LT DBEGIN+0.5  
210 6 ..  
211 7 .. SET SWITCHES AT START OF DIAGNOSTIC PERIOD.  
212 8 LET PVSWITCH=DVS LET RSWITCH=DKS LET QSWITCH=QDS  
213 9 LET MSWITCH=DMS LET SCSWITCH=DSCS LET USWITCH=DUS LET KSWITCH=DKS  
214 10 LET SSSWITCH=DSS  
215 11 RESCHEDULE THIS PDIAG AT TIME.V+DEUR RETURN  
216 12 ..  
217 13 .. RESET SWITCHES AT END OF DIAGNOSTIC PERIOD.  
218 14 ELSE LET PVSWITCH=0 LET RSWITCH=0 LET QSWITCH=0 LET MSWITCH=0  
219 15 LET USWITCH=0 LET KSWITCH=0 LET SSSWITCH=0  
220 16 LET SCSWITCH=0 DESTROY THIS PDIAG  
221 17 RETURN END
```

```
222 1 ..
223 2 .. EVENT TO RE-INITIALIZE COUNTERS FOR COLLECTION OF STATISTICS
224 3 ..
225 4 EVENT REINIT
226 5 CALL R.PROGSIIZE CALL R.MOLSIIZE CALL R.CORSIZE CALL R.USEDSIZE
227 6 CALL R.PERUSED CALL R.VKIAT CALL R.VKOIAT CALL R.VUSTIAT
228 7 CALL R.VDIOIAT CALL R.VSICE CALL R.VCUDUR CALL R.LTHOSS
229 8 CALL R.LTM1SS CALL R.LTM2SS CALL R.LTM3SS CALL R.LTM4SS
230 9 CALL R.LTM5SS CALL R.SSSRESP CALL R.SSCPU CALL R.RESPT
231 10 CALL R.SSMI CALL R.SSKOUT CALL R.SSDIO CALL R.SSFAP
232 11 CALL R.SSSKAP0 CALL R.N.CPU CALL R.N.MEM0 CALL R.N.DIO0
233 12 CALL R.SFUSE CALL R.INCORE CALL R.TAURG CALL R.WAITCOR CALL R.ELIGCPU
234 13
235 14 LET KEYOUT=0 LET KEYIN=0 LET DISKIO=0 LET TSWAP=0 LET TASIO=0
236 15 LET AS.F7=0 LET SIFINCF=0 LET SIZERED=0 LET TAGTU=0
237 16 LET TSTART=0 LET CKILL=0 LET APAP2=0 LET TAAUG=0 LET ALOC1=0
238 17 LET AXAP=0 LET APAP1=0 LET TAGTC=0 LET TSWPK=0
239 18 RETURN END
```

```

240 1  **
241 2  ** THIS ROUTINE TAKES A SHAPSHOT OF THE MEMORY MAP
242 3  ** TO OBTAIN VALUES FOR PROGRAM SIZE, HOLE SIZE.
243 4  ** USED SIZE, AND PERCENTAGE CORE USED.
244 5  **
245 6  ROUTINE CORSAMP
246 7  LET TOTCOR=0 LET TAUSE=0
247 8  LET I=HEAD GO TO SAMP 'I DO'NT LOOK AT DUMMY PROG SIZE
248 9  'NEXT' LET PROSSIZE=SJOB(I)
249 10 'SVID' LET HOLE=SHOLE(I)
250 11 LET TOTCOR=TOTCOR+SJOB(I)+SHOLE(I)
251 12 LET TAUSE=TAUSE+SJOB(I)
252 13 LET I=SUC(I)
253 14 IF I NE 0 GO TO NEXT
254 15 ELSE LET USESIZE=TAUSE LET PERUSED=(USESIZE*100)/TOTCOR
255 16 IF SWITCH NE 0 SHOW, TOTCOR, USESIZE, PERUSED, MPERUSED THUS
AT ***** TOTCOR=*** USED=*** = ***.**% (MEAN=***,**%)
257 17 ELSE RETURN END

```

```
258 1 ..  
259 2 .. PRINT MEMO FOR DIAGNOSTIC AID  
260 3 ..  
261 4 ROUTINE HQPRINT  
262 5 PRINT 2 LINES THUS  
UST  FLAGS STATE SIZE  
MEMORY QUEUE  
265 6 FOR EACH I OF MEMO PRINT 1 LINE WITH JOBNO(I), FL18(I), FL19(I),  
266 7 FL20(I), FL22(I), FL23(I), FL24(I), FL34(I),  
267 8 LTCW(I), LSIZE(I) THUS  
****  
269 9 RETURN END
```

```
270 1 ..  
271 2 .. PRINT CPUQ FOR DIAGNOSTIC AID  
272 3 ..  
273 4 ROUTINE CQPRINT  
274 5 PRINT 2 LINE THUS  
UST FLAGS STATE SIZE  
PROCESSOR QUEUE  
277 6 FOR EACH Y OF CPUQ PRINT 1 LINE WITH JOBNO(I), FL18(I), FL19(I),  
278 7 FL21(I), FL22(I), FL23(I), FL24(I), FL34(I),  
279 8 ITCW(I), LSIZE(I) THUS  
*** . . . . . ***  
281 9 RETURN END
```

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282	1	**	
283	2	**	EVENT TO END SIMULATION
284	3	**	
285	4	**	EVENT STERN
286	5	**	CALL OUTPUT RETURN END


```

287 1 ..
288 2 .. ROUTINE TO PRINT SIMULATION RESULTS.
289 3 ..
290 4 ROUTINE OUTPUT
291 5 SHOW THUS
SIMULATION TERMINATION AT *****
293 6 ..
294 7 .. PRINT CORE STATISTICS
295 8 ..
296 9 SKIP 2 OUTPUT LINES
297 10 PRINT 6 LINES WITH MPROG SIZE, SPROG SIZE, MHCL SIZE, SHOL SIZE,
298 11 M CORSIZE, SCORSIZE, MUSED SIZE, SUSP SIZE, MPERUSED, SPERUSED THUS
CORE STATISTICS
PROGRAM SIZES MEAN STANDARD DEVIATION
JOB SIZES *****
SWAP AREA SIZE *****
TOTAL USED CORE *****
PERCENT CORE USED *****
305 12 ..
306 13 .. PRINT MEAN RATES AND COUNTS
307 14 ..
308 15 LET T=(TIME-V-INITIME)/3600000.0 SKIP 2 OUTPUT LINES
309 16 PRINT 2 LINES WITH KEYOUT/T, KEYIN/T, DISKIO/T, TSWAP/T, TATIO/T,
310 17 KOSWAP/T, APSP7/T, SIZEINCR/T, SIZEPRD/L, TAGTU/T, TSTRT/T, TKILL/T,
311 18 APAP2/T, MAUS/T, ALOCI/T, AMAP/T, APAP1/T, TAGTC/T, TSWPK/T THUS
OVERALL MEAN RATES (PER HOUR)
KEYCARD OUTPUTS *****
KEYCARD INPUTS *****
DISK I/O'S *****
SWAP OUTS *****
SWAP OUTS (KEY I/O) *****
SWAP OUTS (X-Y OUTPUT) *****
PAGE SWAPS *****
LINE INCREASES *****
LINE DECREASES *****
SUBSYSTEM CPU TIME ***** MS.
SUBSYSTEM STARTS *****
SUBSYSTEM KILLS *****
SUBSYSTEM DISPATCHES *****
URGENT USERS *****
ENTRIES TO PAP *****
ENTRIES TO MAP *****
ALLOCATION IDLES *****
INTERRUPTS *****
TOTAL CORE SWAPPED ***** K
332 19 ..
333 20 .. PRINT SUBSYSTEM STATISTICS
334 21 ..
335 22 SKIP 2 OUTPUT LINES
336 23 PRINT 22 LINES WITH MVUSTIAT, SVUSTIAT, MVKIAT, SVKIAT, MVKOIAT,
337 24 SVKOIAT, MVCIAT, SVCIAT, MVSIZE, SVSIZE, MVCPUDUR, SVCPUDUR,
338 25 MSSCPU, SSSCPU, MSSPES, SSSRES, MPESPT, SRESPT,

```

339 26 MLTM0SS, SLTM0SS, MLTM1SS, SLTM1SS, MLTM2SS,
 340 27 SLTM2SS, MLTM3SS, SLTM3SS, MLTM4SS, SLTM4SS, MLTM5SS, SLTM5SS.
 341 28 HSSKIN, SSSKIN, HSSKOUT, SSSKOUT, MSSDIO, SSSDIO, MSSFSWAP,
 342 29 SSSFSWAP, MSSSWAPO, SSSSWAPO THUS

SUBSYSTEM STATISTICS		MEAN	STANDARD DEVIATION
SUBSYSTEM IAT		*****	*****
KEY INPUT IAT		*****	*****
KEY OUTPUT IAT		*****	*****
DISK I/O IAT		*****	*****
PROGRAM SIZE		*****	*****
CPU TIME (SAMPLED)		*****	*****
CPU TIME (USED)		*****	*****
RESPONSE TIME (R19)		*****	*****
RESPONSE TIME (INDIVIDUAL)		*****	*****
CL' E IN STATE			
NON-USEFUL CORE		*****	*****
SWAP		*****	*****
USEFUL CORE		*****	*****
OUT OF CORE		*****	*****
WAIT MEMORY		*****	*****
WAIT MEMORY AFTER FS		*****	*****
NO. OF KEY INS		*****	*****
NO. OF KEY OUTS		*****	*****
NO. OF DISK I/O'S		*****	*****
NO. OF FORCED SWAPS		*****	*****
NO. OF SWAPS		*****	*****

365 30 ..
 366 31 .. PRINT QUEUE STATISTICS

367 32 ..
 368 33 SKIP 2 OUTPUT LINES
 369 34 PRINT 9 LINES WITH MCPUC, SCPUC, MMEMQ, SMMQ, MDIOQ, SDIOQ,
 370 35 MEFUSE, SFSUSE, MINCORE, SINCORE, MTAURG, STAURG, MWAIT, SWAIT.

371 36 MELIG, SELIG THUS		MEAN	STANDARD DEVIATION
CURRENT LENGTHS		*****	*****
PROCESSOR QUEUE		*****	*****
MEMORY QUEUE		*****	*****
DISK I/O QUEUE		*****	*****
USERS SWAPPING		*****	*****
USERS IN CORE		*****	*****
MCPUC USERS		*****	*****
USERS WAITING FOR CPU		*****	*****
USERS ELIGIBLE FOR CPU		*****	*****

381 37 STOP END

```
382 1 ..  
383 2 .. THIS ROUTINE IS CALLED IF THE SIMULATION IS TERMINATED  
384 3 .. ABNORMALLY FOR ANY REASON. IT PRINTS CERTAIN VALUABLE  
385 4 .. DATA FOR DEBUGGING AND LOCATING A POSSIBLE ERROR.  
386 5 ..  
387 6 ROUTINE SNAP.R  
388 7 ..  
389 8 .. PRINT EVENT TIMES FOR EVERY EVENT  
390 9 FOR I=1 TO EVENTS.V DO  
391 10 PRINT 1 LINE WITH I, TIME.A(F.EV.S(I)) THUS  
****  
393 11 LCP  
394 12 LIST TIME.V, NXTUST, NXTDIO, NXTKIN, NXTKOUT, KILL, NXTINT  
395 13 ..  
396 14 .. PRINT ALL WAITING COURTESY CALL TIMES  
397 15 FOR EACH I OF CCQ PRINT 1 LINE WITH TIME.A(I) THUS  
*****  
399 16 ..  
400 17 .. PRINT SIMULATION OUTPUT UPTO THIS POINT.  
401 18 CALL OUTPUT  
402 19 STOP END
```

```
403 1 ..  
404 2 .. ENTRY TO ALLOCATOR  
405 3 ..  
406 4 EVENT ALLOC  
407 5 EVDIAG SHOW THUS  
ALLOCI AT *****  
409 6 IF LSPFG EQ 1 SCHEDULE A LINSV IN .006 MS. RETURN  
410 7 ELSE IF HPWF EQ 1 SCHEDULE A MAP IN .01 MS. RETURN  
411 8 ..  
412 9 .. SCHEDULE NEXT SUBSYSTEM IN CPUQ  
413 10 ELSE 'PAP' ADD 1 TO ALOCI  
414 11 LET TLPLG=1 LET EXT=.04  
415 12 'PAP.1' FOR EACH UST OF CPUQ DO  
416 13 ADD .02 TO EXT  
417 14 IF FL18+FL19+FL21+FL23 EQ 0  
418 15 ADD 1 TO APAP2  
419 16 IF FL34 EQ 1 SCHEDULE AN SDP7 IN EXT+.022 MS. RETURN  
420 17 ELSE SCHEDULE A RETSSX IN EXT+0.1 MS.  
421 18 LET FL24=0  
422 19 RETURN  
423 20 ELSE LOOP  
424 21 ..  
425 22 .. ALLOCATOR IS IDLE. CALL LINE SERVICE  
426 23 LET TLPLG=0  
427 24 ADD 1 TO APAP1  
428 25 SCHEDULE A LINSV IN EXT MS.  
429 26 RETURN END
```

```

430 1 **
431 2 ** MEMORY ALLOCATOR PROCESS
432 3 **
433 4 EVENT MAP
434 5 EVDIAG SHOW THUS
MAP AT *****
435 6 ADD 1 TO AMAP LET EXT=0
437 7 LET MPVF=0
438 8 **
439 9 ** SEE IF SPECIAL MEM ACTION WAITING
440 10 IF MPACT EQ 1 CALL SPMACT
441 11 ELSE LET MACTM=TIME.V
442 12 ** CHECK UP ON URGENT USER IF ANY
443 13 IF 1AURWT EQ 0 ADD .025 TO EXT GO TO MAP.3
444 14 ELSE IF 2AURWT LE SHOLE(TAIL) ADD .039 TO EXT GO TO MAP.2A
445 15 ELSE ADD .045 TO EXT IF TIME.V-ALUTM LE AMFTM GO TO MAP.3
446 16 ELSE ADD 1 TO AMAP2
447 17 LET 1AURWT= LET 2AURWT=0
448 18 **
449 19 ** FIND USERS TO SWAP OUT
450 20 *MAP.3* LET R6=0
451 21 FOR EACH UST OF MEMO DO
452 22 IF FL19+FL21+FL22+FL23 EQ 0
453 23 ADD .03 TO EXT
454 24 IF FL34 EQ 0 GO TO MAP.4
455 25 ELSE IF R6 EQ 0 LET R6=UST
456 26 ELSE ELSE LOOP
457 27 **
458 28 ** DID WE DETECT A FORCE SWAP?
459 29 *MAP.3* IF R6 EQ 0 IF MPACT EQ 0 SCHEDULE AN ALLOC IN EXT+0.04 MS.
460 30 RETURN
461 31 ELSE SCHEDULE AN SGP IN EXT MS.
462 32 LET AMN2=1
463 33 RETURN
464 34 ELSE LET UST=R6
465 35 **
466 36 ** TRY TO GET CORE FOR JOB
467 37 *MAP.4* CALL MBA
468 38 **
469 39 ** IF UNSUCCESSFUL, CALL SWAP DECISION PROCESSOR
470 40 IF MEMALOCOK EQ 0 SCHEDULE AN SGP IN EXT+0.016 MS.
471 41 ADD 1 TO ASDP
472 42 LET AMN2=LSIZE
473 43 RETURN
474 44 **
475 45 ** SUCCESSFUL, SWAP JOB IN
476 46 ELSE CALL SWIN
477 47 RESCHEDULE A MAP IN EXT+0.03 MS.
478 48 RETURN
479 49 **
480 50 ** URGENT USER GET CORE, TAKE DOWN CORE FENCE
481 51 *MAP.2A* LET UST=1AURWT

```

```
482 52 ADD .013 TO EXT  
483 53 LET 1AURWT=0  
484 54 LET 2AUPWT=0  
485 55 IF FL19+FL21+FL22+FL23 NE 0 GO TO MAP.3  
486 56 ELSE IF UST IS NOT IN MEMQ GO TO MAP.3  
487 57 ELSE GO TO MAP.4  
488 58 END
```

```

489 1 **
490 2 ** SWAP DECISION PROCESSOR
491 3 **
492 4 ** SWAP ALL JOBS > OR = SIZE REQUIRED
493 5 EVENT SDP
494 6 EVDIAG SHOW THUS
SDP AT *****
496 7 IF SPUSF GE 2*LNSE IF MFACT EQ 0 SCHEDULE AN ALLOC IN 0.04 MS.
497 8 RETURN
498 9 ELSE ELSE LET AMN1=0
499 10 **
500 11 ** SEARCH MEMORY QUEUE FOR KEY I/O ROADBLOCKED JOBS
501 12 LET EXT=0.05 FOR EVERY UST OF MEMQ DO
502 13 IF FL19+FL22 EQ 2 AND FL21+FL23 EQ 0
503 14 ADD .024 TO EXT
504 15 IF LSIZE GE AMN2 GO TO SDP,2E
505 16 ELSE LET AMN1=UST
506 17 ELSE LOOP
507 18 **
508 19 ** DID WE FIND ANY JOB TO SWAP OUT?
509 20 IF AMN1 EQ SCHEDULE AN SDP3 IN EXT MS.
510 21 RETURN
511 22 **
512 23 ** SWAP OUT JOB FOUND.
513 24 ELSE LET UST=AMN1
514 25 'SDP,2E' CALL SWOUT
515 26 LET AMN1=0
516 27 **
517 28 ** REPEAT FOR MORE JOBS.
518 29 RESCHEDULE AN SDP IN EXT MS.
519 30 RETURN END

```

```

520 1  **
521 2  ** SCAN MEMORY QUEUE FOR URGENT USERS
522 3  **
523 4  EVENT SDP3
524 5  EVDIAG SHOW THUS
SDP3 AT *****
526 6  IF TIME.V-ASD3T LE ASD3X
527 7  ADD 1 TO ASD3C
528 8  IF ASD3C LT 5 SCHEDULE AN ALLOC IN .017 MS.
529 9  RETURN
530 10 ELSE LET ASD3C=0
531 11 ELSE
532 12 LET ASD3T=TIME.V
533 13 LET I=0
534 14 LET TATMN=0
535 15 LET TALUT=0
536 16 **
537 17 ** SCAN ENTIRE MEMORY QUEUE
538 18 LET EXT=0.04
539 19 FOR EVERY UST OF MEMO DO
540 20 IF FL19+FL21+FL22+FL23 NE 0 GO TO SDP.3X
541 21 ELSE ADD 0.057 TO EXT
542 22 IF TIME.V-LTWT LE TASWT GO TO SDP.3X
543 23 ELSE
544 24 **
545 25 ** CALCULATE JOB WAIT FACTOR DEPENDING
546 26 ** ON SIZE AND TIME ALREADY WAITED
547 27 *SDP.3X* LET WTFAC=LSTZE
548 28 IF TATMN=0 LET WTFAC=LSTZE
549 29 IF LSTZE GE TATMN LET WTFAC=WTFAC*TALPP
550 30 ELSE LET WTFAC=WTFAC/TASWT
551 31 IF WTFAC LE TASWT LET WTFAC=TASWT
552 32 ELSE IF TIME.V-LTWT LT WTFAC GO TO SDP.3X
553 33 **
554 34 ** SEE IF HE WAS SCHEDULED TO BE FORCIB SWAPPED.
555 35 ELSE IF FL34 EQ 1
556 36 LET FL34=0
557 37 CALL AICHG(4)
558 38 ADD .02 TO EXT
559 39 GO TO SDP.3X
560 40 ELSE
561 41 **
562 42 ** REGISTER HIM AS AN URGENT USER.
563 43 ADD 1 TO I
564 44 ADD 1 TO TAAUG
565 45 LET URGT=TIME.V-LTWT-WTFAC
566 46 IF USWICH NE 0 PRINT 1 LINE WITH JOBN, URGT, TIME.V THUS
*** POUND URGENT FOR ***** MS. AT *****
569 47 ELSE IF URGT GE TALUT
569 48 LET TALUT=URGT LET ITALUT=UST
570 49 ELSE ADD 0.02 TO EXT
571 50 *SDP.3X* LOOP

```


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572 51 LET TAURG=I
573 52 SCHEDULE AM SDP4 IN EXT HS. RETURN
574 53 END

```
575 1 **
576 2 ** DECIDE WHETHER TO GROW TSS SIZE
577 3 **
578 4 EVENT SDP4
579 5 EVDIAG SHOW THUS
SDF4 AT *****
581 6 IF TALUT GE 0 SCHEDULE AN SDP6 IN 0.005 MS.
582 7 RETURN
583 8 ELSE IF TALUT LT TASID SCHEDULE AN SDP5 IN 0.009 MS.
584 9 RETURN
585 10 ELSE IF TIME.V-TALCT LT TASCFC SCHEDULE AN SDP5 IN 0.017 MS.
586 11 RETURN
587 12 ELSE IF TAHOL GE TACOR SCHEDULE AN SDP5 IN 0.028 MS.
588 13 RETURN
589 14 ELSE
590 15 **
591 16 ** FIND NEW SIZE REQUEST
592 17 LET TAHOL=TA-OR+TAMM
593 18 IF TAHOL GT TAMMS LET TAHOL=TACOR
594 19 IF TAHOL GE TAMMS SCHEDULE AN SDP5 IN .048 MS.
595 20 LET TAHOL=0 RETURN
596 21 ELSE
597 22 LET TAHOL=TAMMS
598 23 ELSE
599 24 ADD 1 TO TSIFC
600 25 LET MPACT=1
601 26 SCHEDULE AN SDP5 IN .057 MS.
602 27 RETURN END
```

```
603 1 ..
604 2 .. SET UP CORE FENCE FOR URGENT USER
605 3 ..
606 4 EVENT SDP5
607 5 EVDIAG SHOW THUS
SDP5 AT *****
608 6 LET EXT=0.075
609 7 IF 2,URVT GT 0 GO TO SDP.5a
611 8 ELSE LET UST=11ALUF
612 9 IF LSIZE GT FACOP CALL M3A3 ADD 0.027 TO EXT GO TO SDP.5b
613 10 ELSE
614 11 LET 1AUPNT=HST
615 12 LET 2AUPNT=LSIZE
616 13 LET ALUTH=TIME,V
617 14 ADD 0.05 TO EXT
618 15 'SDP.5a' SCHEDULE AN SDP6 IN EXT MS,
619 16 RETURN END
```

```
620 1  **
621 2  ** CHECK JOBS TO FORCE SWAP
622 3  **
623 4  EVENT SDP6
624 5  EVDIAG SHOW INUS
SDP6 AT *****
626 6  LET EXT=0.013
627 7  IF MPACT GT  GO TO SDP.6A
628 8  ELSE IF TALUI NE 0
629 9  IF SPUSE LT 2*LNSF GO TO SDP.6A
630 10  ELSE
631 11  ELSE SCHEDULE AN ALLOC1 IN 0.015 MS.
632 12  RETURN
633 13  'SDP.6:' FOR EVERY UST OF CPUQ DO
634 14  Add 0.013 TO EXT
635 15  IF TIME.V-LT*NT GT AMTQ
636 16  IF FL24+FL30 EQ 0 LET FL34=1
637 17  IF FL18+FL19 GT 0 SCHEDULE AN ALLOC1 IN EXT+0.015 MS.
638 18  RETURN
639 19  ELSE SCHEDULE AN SDP7 IN EXT+0.015 MS.
640 20  RETURN
641 21  ELSE
642 22  ELSE LOOP
643 23  SCHEDULE AN ALLOC1 IN EXT MS.
644 24  RETURN END
```

```
645 1 ..  
646 2 .. DUMP OUT FORCE SWAP JOBS  
647 3 ..  
648 4 EVENT SDR7  
649 5 EVDIAG SHOW JOBN0 THUS  
SDR7 AT ***** FOR *****  
651 6 LET EXT=0.11  
652 7 CALL S-OUT  
653 8 ADD 1 TO LTC31  
654 9 ADD 1 TO ASDP7  
655 10 REMOVE THIS USE FROM CPU0  
656 11 LET TLFLG=1 LET MPVF=1 FILE THIS USE IN MZMQ  
657 12 IF CSPTOR NE CALL MOPRINT CALL COPRINT ELSE  
658 13 IF CSPTOR NE COPRINT 1 LINE WITH JOBN0, TIME.V THUS  
***** FORCE SWAPPED AT *****  
660 14 ELSE SCHEDULE AN ALLOC IN EXT MS.  
661 15 RETURN END
```

```

662 1  **
663 2  **   PERFORM SPECIAL MEMORY ACTION
664 3  **   (TSS MEMORY INCREASE OR DECREASE)
665 4  **
666 5  ROUTINE SPFACT
667 6  RDIAG
SPFACT CALLED
669 7  ADD 0.011 TO EXT
670 8  IF TANHOL EQ 0
671 9  LET MPACT=0
672 10  RETURN
673 11  ELSE IF TANHOL LE TACOR GO TO SPM.3
674 12  **
675 13  **   INCREASE TSS CORE SIZE
676 14  ELSE ADD 0.17 TO EXT IF TIME.V-TALCT LT TACHY RETURN
677 15  ELSE ADD 1 TO SIZPINC ADD 0.8 TO EXT
678 16  IF SC SWITCH NE 0 PRINT 1 LINE WITH TANHOL, TIME.V THUS
SIZE INCREASED TO ***** AT *****
680 17  ELSE GO TO SPM.4
681 18  **
682 19  **   DECREASE TSS CORE SIZE
683 20  SPM.3' IF TANHOL EQ TACOR ADD 0.017 TO EXT GO TO SPM.4A
684 21  ELSE IF TANHOL LE 3 GO TO SPM.4A
685 22  ELSE IF SHOLD(TAIL) LT TACOR-TANHOL GO TO SPM.5
686 23  ELSE LET T=TIME.V-SPMFR
687 24  IF T GE TATMC GO TO SPM.5
688 25  ELSE IF T LT TATMC GO TO SPM.5
689 26  ELSE ADD 1 TO SIZPINC ADD 0.22 TO EXT
690 27  IF SC SWITCH NE 0 PRINT 1 LINE WITH TANHOL, TIME.V THUS
SIZE DECREASED TO ***** AT *****
691 28  ELSE
692 29  **
693 30  **   UPDATE CORE SIZE AND MEMORY MAP
694 31  SPM.4' LET SHOLD(TAIL)=SHOLD(TAIL)-(TACOR-TANHOL) LET TACOR=TANHOL
695 32  SPM.4A' LET TANHOL=0
696 33  LET MPACT=0
697 34  LET SPMFR=0
698 35  SPM.4B' LET TALCT=TIME.V
700 36  RETURN
701 37  **
702 38  **   SEE IF REQUEST HAS WAITED TOO LONG WITHOUT ACTION
703 39  SPM.5' IF SPMFR EQ 0 LET SPMFR=TIME.V
704 40  ELSE LET T=TIME.V-SPMFR ADD 0.017 TO EXT
705 41  IF T GE TATMC GO TO SPM.4A
706 42  ELSE GO TO SPM.4B
707 43  END

```

```

708 1  **
709 2  ** MEMORY BUFFER ALLOCATOR
710 3  **
711 4  ROUTINE MBA
712 5  PDIAG
MBA CALLED
714 6  LET MEMALOCOK=0
715 7  ADD 1 TO AMBA
716 8  **
717 9  ** TRY FINDING HOLE BIG ENOUGH IN MEMORY MAP
718 10 LET I=HEAD
719 11 'MBA.1' IF UST=IDPTR(I)
720 12 PRINT 1 LINE AS FOLLOWS
### ERROR - MBA CALLED FOR UST ALREADY IN MEMORY
722 13 STOP
723 14 ELSE IF SHOLE(I) GE LSIZE GO TO MBA.4
724 15 ELSE
725 16 'MBA.2' LET I=SUC(I)
726 17 IF I NE J GO TO MBA.1
727 18 **
728 19 ** UNSUCCESSFUL, SEE IF MEMORY CAN BE GROWN
729 20 ELSE IF LSIZE LE TACOR_ADD_0.057 TO EXT RETURN
730 21 ELSE CALL MBA3
731 22 RETURN
732 23 **
733 24 ** SEE IF HE WAS THE URGENT USER
734 25 'MBA.4' ADD 1 TO AMBA4
735 26 IF UST EQ 1AURWT
736 27 LET 1AURWT=0
737 28 LET 2AURWT=0
738 29 ELSE IF I EQ TAIL
739 30 IF SHOLE(I)-LSIZE LT 2AURWT GO TO MBA.2
740 31 ELSE
741 32 ELSE ADD 1 TO AMBA5
742 33 **
743 34 ** BUILD MBA ENTRY IN MEMORY MAP
744 35 IF AVAIL EQ ** PRINT 1 LINE AS FOLLOWS
### ERROR - NO MORE AVAILABLE BLOCKS FOR MEMORY MAP ARRAY
746 36 STOP
747 37 ELSE LET PRD(AVAIL)=I
748 38 IF I EQ TAIL
749 39 LET PRD(SUC(I))=AVAIL
750 40 ELSE LET TEMP=AVAIL
751 41 LET AVAIL=SUC(AVAIL)
752 42 LET SUC(TEMP)=SUC(I)
753 43 LET SUC(I)=TEMP
754 44 LET IDPTR(TEMP)=UST
755 45 LET SJOR(TEMP)=LSIZE
756 46 LET SHOLE(TEMP)=SHOLE(I)-LSIZE
757 47 LET SHOLE(I)=0
758 48 IF I EQ TAIL
759 49 LET TAIL=TEMP

```

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760	50	ELSE LET NEMALOCOK=1
761	51	CALL MMV
762	52	ADD 0.13 TO EXT
763	53	RETURN END


```
764 1  **
765 2  **   SEE IF WE CAN INCREASE TSS CORE SIZE
766 3  **
767 4  ROUTINE MBA3
768 5  RDIAG
      MBA3 CALLED
770 6  IF TIME-V-LTWT GE TAMAW
771 7     ADD 0.025 TO EXT
772 8     RETURN
773 9  ELSE IF TAHOL GE LSIZE
774 10     ADD 0.037 TO EXT
775 11     RETURN
776 12  ELSE LET TAHOL=LSIZE
777 13  LET MFACT=1
778 14  IF TAHOL-TACOR GE TAMII
779 15     ADD 0.057 TO EXT
780 16     RETURN
781 17  ELSE IF TACOR+TAMII GT TAMMS LET TAHOL=TAMMS
782 18  ELSE ADD 0. 8 TO EXT
783 19  RETURN END
```

```
784 1 ..  
785 2 .. MEMORY BUFFER DEALLOCATOR  
786 3 ..  
787 4 ROUTINE MBB  
788 5 RDIAG  
MBD CALLED  
790 6 ..  
791 7 .. SEARCH MEMORY MAP FOR UST TO BE DEALLOCATED  
792 8 ADD 0.093 TO EXT  
793 9 LET I=HEAD  
794 10 'MBD.1A' IF IDPTR(I) NE UST LET I=SUC(I)  
795 11 IF I EQ  
796 12 RETURN  
797 13 ELSE GO TO MBD.1A  
798 14 ..  
799 15 .. REMOVE UST AND UPDATE MEMORY MAP  
800 16 ELSE LET SUC(PRED(I))=SUC(I)  
801 17 IF I NE TAIL  
802 18 LET PRED(SUC(I))=PRED(I)  
803 19 ELSE IF I EQ TAIL  
804 20 LET TAIL=PRED(I)  
805 21 ELSE ADD SHOLE(I)+SJOB(I) TO SHOLE(PRED(I))  
806 22 LET SUC(I)=AVAIL  
807 23 LET AVAIL=I  
808 24 IF SJOB(I) GE 2 LET MPWF=1 ELSE  
809 25 CALL F=V  
810 26 ADD 0.055 TO EXT  
811 27 RETURN END
```

```

812 1  ''
813 2  ''  VERIFY MEMORY MAP AND CALCULATE COPE STATISTICS
814 3  ''
815 4  ROUTINE MMV
816 5  RDIAG
      MMV CALLED
818 6  ADD 0.019 TO EXT
819 7  IF MSWITCH NE 0 PRINT 2 LINES THUS
      MEMORY MAP
UST  PROGRAM  HOLE
822 8  ELSE LET TOTCOR=0
823 9  LET I=HEAD  ''  START_SCAN_OF_MEMORY_MAP
824 10 'NEXT' ADD 1.013 TO EXT
825 11 IF MSWITCH NE 0 PRINT 1 LINE WITH JOBNO(IDPTR(I)),
826 12 SJOB(I), SVOLE(I) THUS
      ***  ***  ***
828 13 ELSE
829 14 LET TOTCOR=TOTCOR+SJOB(I)+SHOLE(I)
830 15 IF I NE TAIL
831 16 LET I=SUCC(I)
832 17 GO TO NEXT
833 18 ELSE LET CORSIZE=TOTCOR
834 19 ''
835 20 ''  COMPARE SUM OF MEMORY MAP PROGRAM AND
836 21 ''  HOLE SIZES WITH TSS CORE SIZE.
837 22 IF TOTCOR LE TSSCORE PRINT 1 LINE AS FOLLOWS
      *** ERROR - MEMORY MAP DOES NOT VERIFY
839 23 STOP
840 24 ''
841 25 ''  SCAN QUEUES FOR JOBS (1) WAITING FOR CORE,
842 26 ''  AND (2) ELIGIBLE FOR THE CPU.
843 27 ''
844 28 ELSE LET J=0  LET TUST=UST
845 29 FOR EVERY 'UST' OF MMT TO
846 30 IF FL19+FL21+FL22+FL23+FL24 EQ 0 ADD 1 TO J
847 31 ELSE LOOP
848 32 LET WAITCOR=J  LET J=0
849 33 FOR EVERY UST OF CPU DO
850 34 IF FL18+FL19+FL21+FL23+FL34 EQ 0 AND FL22 EQ 1
851 35 ADD 1 TO J
852 36 ELSE LOOP
853 37 LET ELIGCPU=J  LET UST=TUST
854 38 RETURN END

```

```
855 1  "
856 2  " SWAP OUT JOB
857 3  "
858 4  ROUTINE SWOUT
859 5  RDIAG
      SWOUT CALLED
861 6  LET FL22=0
862 7  LET FL21=1
863 8  ADD 1 TO TSWAP
864 9  IF EK19 EQ 1 LET FL19=1
865 10 LET FL34=0
866 11 ELSE CALL SWPLD(1)
867 12 ADD C.11 TO EXT
868 13 RETURN END
```

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869 1 **
870 2 ** SWAP IF JOB
871 3 **
872 4 ROUTINE SWIN
873 5 PDIAG
SWIN CALLED
875 6 LET FL23=1
876 7 CALL SWFLP(0)
877 8 ADD 1 TO INCORE
878 9 ADD 0.035 TO EXT
879 10 RETURN END

```
880 1  ;  
881 2  ; PERFORM SWAP (IN AND OUT)  
882 3  ;  
883 4  ROUTINE SWPLD(DIR)  
884 5  RDIAG  
      SWPLD CALLED  
886 6  ADD 1 TO LTC32  
887 7  CALL ATCHG(1)  
888 8  ADD 1 TO SFUSE  
889 9  ADD 0.42 TO EXT  
890 10 IF DIR EQ 0 SCHEDULE AN 2 ALLCC GIVEN UST IN SWAPDUR MS.  
891 11 FILE THIS 2 ALLCC IN THE CCQ RETURN  
892 12 ELSE SCHEDULE AN 1 ALLCC GIVEN UST IN SWAPDUR MS.  
893 13 ADD LSIZR TO TSWPK  
894 14 FILE THIS 1 ALLCC IN THE CCQ RETURN END
```

```
895 1 **
896 2 ** TERMINATE EXECUTION OF SUBSYSTEM
897 3 ** AND TAKE ACCOUNTING INFORMATION
898 4 **
899 5 ROUTINE SSFINI
900 6 PDIAG
SSFINI CALLED
902 7 ADD 1 TO TRILL
903 8 SUBTRACT 1 FROM INCOME
904 9 CALL ATCHG(3)
905 10 CALL MBD
906 11 **
907 12 ** REMOVE JOB FROM QUEUES
908 13 IF THIS UST IS IN CPUQ REMOVE THIS UST FROM CPUQ
909 14 IF SWITCH NE 0 CALL COPFINI ELSE
910 15 ELSE IF THIS UST IS IN MEMO REMOVE THIS UST FROM MEMO
911 16 IF SWITCH NE 0 CALL MOPFINI ELSE
912 17 **
913 18 ** KILL ANY REMAINING COURTESY CALL
914 19 ELSE IF EK19 EQ 1
915 20 LET I=OUTCC
916 21 ADD 1 TO TSWAP ADD 1 TO TASIO ADD 1 TO KOSWAP
917 22 ADD 1 TO LID32 ADD 1 TO TSWPK ADD SWAPDUR TO LTM1
918 23 CANCEL THIS KICCC CALLED I
919 24 REMOVE THIS I FROM THE CCC
920 25 DESTROY THIS KICCC CALLED I
921 26 ELSE CALL SACT DESTROY THIS UST
922 27 ADD 0.24 TO EXT
923 28 RETURN END
```

```
924 1 ''
925 2 '' REMOVE KEY INPUT JOBS FROM THE CPUQ
926 3 ''
927 4 ROUTINE BUFDMP
928 5 RDIAG
    BUFDMP CALLED
930 6 IF INDEPI EQ 0 ADD 0.046 TO EXT GO TO BUF.3B
931 7 ELSE IF UST IS IN CPUQ
932 8 REMOVE THIS UST FROM CPUQ
933 9 LET TLPLG=1 LET MPWF=1 FILE THIS UST IN MEMQ
934 10 CALL ATCHG(0)
935 11 ELSE LET FL19=1
936 12 ADD 0.17 TO EXT
937 13 IF GSWITCH NE 0 CALL MOPRINT CALL CQPRINT ELSE
938 14 'BUF.3B' CALL KIOSRT
939 15 RETURN END
```



```

940 1  **
941 2  **   START KEY I/O AND SCHEDULE COURTESY CALL FOR INPUT
942 3  **
943 4  ROUTINE KIOSRT
944 5  RDIAG
KIOSRT_CALLED
946 6  ADD 0.22 TO EXT
947 7  **
948 8  **   SEE IF OUTPUT ALREADY IN PROGRESS,
949 9  **   IF SO, DESTROY THAT COURTESY CALL.
950 10 IF FK19 EQ 1
951 11   LET I=OUICC
952 12   CANCEL THIS KIOCC CALLED I
953 12   REMOVE THIS 1 FROM THE CCO
954 14   DESTROY THIS KIOCC CALLED I
955 15 ELSE LET FK19=1
956 16 **
957 17 **   PROCESS OUTPUT DERRAIL
958 18 IF INDDRL EQ 0
959 19   *KIO'2' ADD 1 TO LTC22
960 20   IF LTIN LE TIME.V
961 21 **
962 22 **   COLLECT RESPONSE TIME
963 23   LET RESPT=TIME.V-LTIN
964 24   LET LTYRS=LT'RS+RESPT
965 25   LET LTIN=TIME.V
966 26   ELSE ADD EXPONENTIAL.F(OUTMEAN,10) TO LTIN
967 27   SCHEDULE A KIOCC GIVEN UST IN MAX.F(LTIN-TIME.V,0,0) MS.
968 28   ADD THIS KIOCC IN THE CCO
969 29   LET OUICC=*KIOCC
970 30   IF *SWITCH NE 0 PRINT 1 LINE WITH JOBN0, TIME.V, LTIN THUS
*** START OUTPUT AT *****,** UNTIL *****,**
972 31   ELSE RETURN
973 32 **
974 33 **   PROCESS INPUT DERRAIL
975 34 ELSE ADD 1 TO LTC21
976 35 IF LTIN LE TIME.V
977 36 **
978 37 **   COLLECT RESPONSE TIME
979 38   LET RESPT=TIME.V-LTIN
980 39   LET LTYRS=LT'RS+RESPT
981 40   LET LTIN=TIME.V
982 41 ELSE LET T=KIODUP
983 42 SCHEDULE A KIOCC GIVEN UST IN T MS.
984 43 IF *SWITCH NE 0 PRINT 1 LINE WITH JOBN0, TIME.V, TIME.V+T THUS
*** START INPUT AT *****,** UNTIL *****,**
986 44 ELSE FILE THIS KIOCC IN THE CCO
987 45 RETURN END

```

```

988 1 ..
989 2 .. START NEW UST ON ARRIVAL
990 3 ..
991 4 ROUTINE START
992 5 ADD 1 TO TSTRT
993 6 ..
994 7 CALL CORSAMP
995 8 ..
996 9 .. CREATE UST ENTITY AND ASSIGN ATTRIBUTES
997 10 CREATE A UST
998 11 LET LSIZE=SI/ELIST LET VSIZE=LSIZE
999 12 LET KILL=CPUUP LET VCPUUR=KILL LET CHK-FU=KILL
1000 13 LET DIOIAT=PINF.C LET KIIAT=PINF.C LET KOIAT=RIINF.C
1001 14 LET I=NOIC IF I GT 0
1002 15 LET DIOIAT=KILL/I LET VDIOIAT=0.5*DIOIAT
1003 16 ELSE LET I=NOKIN IF I GT 0
1004 17 LET KIIAT=KILL/I LET VKIIAT=0.5*KIIAT
1005 18 ELSE LET I=NOKOUT IF I GT 0
1006 19 LET KOIAT=KILL/I LET VKOIAT=0.5*KOIAT
1007 20 ELSE LET I=NOXT=0.5*NOIAT LET NXTKIN=0.5*KIIAT LET NXTKOUT=0.5*KOIAT
1008 21 LET FL2=1
1009 22 LET JOING=TSTRT
1010 23 LET LITN=IYAF.V LET LITAI=TIME.V
1011 24 LET TIFLG=1 LET LPPF=1 FILE THIS UST IN MEMO
1012 25 IF FVSWITCH+SSSWITCH GT 0 SHOW,JOING,LSIZE,KILL THUS
START AT ***** OF ***** SIZE=*** CPU=*****
1014 26 ELSE CALL ATCHG(0)
1015 27 IF OSWITCH NE 0 CALL NOPRINT ELSE
1016 28 ADD 0.13 TO PXT
1017 29 RETURN END

```

```

1018 1  ..
1019 2  ..   DISPATCH CPU TO SUBSYSTEM
-----
1020 3  ..
1021 4  EVENT RETSSX
1022 5  EVDIAG SHOW, JOBNO THUS
RETSSX AT ***** TO ****
-----
1024 6  ..
1025 7  ..   SEE WHAT WILL INTERRUPT IT.
-----
1026 8  LET NXTCC=RNIF.C
1027 9  IF CCC IS NOT EMPTY LET NXTCC=TIME.A(F.CCC)-TIME.V+0.5 ELSE
1028 10 LET NEXT=MIN.F(NXTDIO,NXTKIN,NXTKOUT,KILL,NXTINT,TODEL,NXTCC)
1029 11 LET DISPT=TIME.V
1030 12 LET NXTDIO=NXTDIO-NEXT
1031 13 LET NXTKIN=NXTKIN-NEXT
-----
1032 14 LET NXTKOUT=NXTKOUT-NEXT
1033 15 LET KILL=KILL-NEXT
1034 16 LET NXTINT=NXTINT-NEXT
1035 17 IF NEXT LE 0 LET NEXT=0 ELSE
-----
1036 18  ..
1037 19  ..   SCHEDULE THE INTERRUPTING EVENT
-----
1038 20 IF NXTDIO LE 0 SCHEDULE A DRLDIO IN NEXT+0.063 MS. RETURN
1039 21 ELSE IF NXTKIN LE 0 SCHEDULE A KONDEL IN NEXT+0.063 MS. RETURN
1040 22 ELSE IF NXTKOUT LE 0 SCHEDULE A KOTDEL IN NEXT+0.063 MS. RETURN
1041 23 ELSE IF KILL LE 0 SCHEDULE A DPRET IN NEXT+0.063 MS. RETURN
1042 24 ELSE SCHEDULE A EXENTA IN NEXT+0.063+UNIFC.F(NXDELAY, MXDELAY, 10) MS.
-----
1043 25 RETURN END

```

```

1044 1  **
1045 2  **  ACCUMULATE STATISTICS AFTER SUBSYSTEM TERMINATION
1046 3  **
1047 4  ROUTINE SACT
1048 5  RDIAG
      SACT CALLED
1050 6  **
1051 7  **  TALLY SUBSYSTEM STATE TIMES AND COUNTS.
1052 8  LET LTM0SS=LTM0
1053 9  LET LTM1SS=LTM1
1054 10 LET LTM2SS=LTM2
1055 11 LET LTM3SS=LTM3
1056 12 LET LTM4SS=LTM4
1057 13 LET LTM5SS=LTM5
1058 14 LET SSKIN=LTC21
1059 15 LET SSKOUT=LTC22
1060 16 LET SSKIO=LSTIO
1061 17 LET SSKSWAP=LTC31
1062 18 LET SSKVAPC=LTC32
1063 19 **
1064 20 **  CALCULATE RESPONSE TIMES.
1065 21 IF LTC21+LTC22 EQ 0
1066 22 LET LTMRS=TIME.V-LTIM LET LTC21=1 LET RESP1=LTMRS
1067 23 ELSE LET SSKRS=LTMRS/(LTC21+LTC22)
1068 24 LET SSKCPU=LSTIS
1069 25 IF SSKVAPC NE 0 PRINT 2 LINES WITH TIME.V,JOBNO,SSKIN,SSKOUT,
1070 26 LTMRS,CHYCPU,LSP'S INUS
STOP  AT ***** OF **** KIN=*** KOUT=***
      TOT RESP=***** CPU ALLOC=***** USED=*****
1071 27 ELSE RETURN END

```

```
1074 1 ''
1075 2 '' UPDATE SUBSYSTEM STATE TIMES
1076 3 ''
1077 4 ROUTINE_ATCHG(N)
1078 5 EDIAG
      ATCHG CALLED
1080 6 GO TO AT0,AT1,AT2,AT3,AT4 OR AT5 PER LICH+1
1081 7 'AT0' LET LTM0=LTM0+(TIME.V-LTMWT) GO TO LT6
1082 8 'AT1' LET LTM1=LTM1+(TIME.V-LTMWT) GO TO LT6
1083 9 'AT2' LET LTM2=LTM2+(TIME.V-LTMWT) GO TO LT6
1084 10 'AT3' LET LTM3=LTM3+(TIME.V-LTMWT) GO TO LT6
1085 11 'AT4' LET LTM4=LTM4+(TIME.V-LTMWT) GO TO LT6
1086 12 'AT5' LET LTM5=LTM5+(TIME.V-LTMWT)
1087 13 'LT6' LET LICH=N
1088 14 LET LTMWT=TIME.V
1089 15 ADD 0.11 TO EXT
1090 16 RETURN END
```

```
1091 1 ..  
1092 2 .. ENTRY TO ALLOCATOR BY INTERRUPT  
1093 3 ..  
1094 4 EVENT EXPNTR  
1095 5 EVDIAG SHOW, JOPNO THUS  
EXNTR AT ***** BY ****  
1097 6 REMOVE UST FROM CPU0  
1098 7 LET TLF LG=1 FILE UST LAST IN CPU0  
1099 8 IF QSWITCH NE 0 CALL CCFPIPT ELSE  
1100 9 CALL EXEACI  
1101 10 SCHEDULE AN ALLOC I 0.22 MS.  
1102 11 ..  
1103 12 .. SAMPLE NEXT INTERRUPT TIME,  
1104 13 IF NXTINT LE 0 LET NXTINT=EXPONENTIAL.F(INTMAN,9)  
1105 14 ELSE RETURN END
```

```
1106 1  "
1107 2  " TAKE ACCOUNTING AFTER INTERRUPT
1108 3  "
1109 4  ROUTINE EXEACT
1110 5  RDIAG
      EXEACT CALLED
1112 6  ADD 0.11 TO EXT
1113 7  "
1114 8  " ACCUMULATE CPU TIME USED BY SUBSYSTEM AND TSS.
1115 9  ADD 1 TO TIG'C
1116 10 ADD NEXT TO LSPTS
1117 11 ADD NEXT TO TAGPT
1118 12 ADD NEXT TO LASTU
1119 13 IF TIME.V-PAFT GE ASD31 LET MPWF=1
1120 14 ELSE IF TIME.V-TLST GE TLTLV LET LSPLG=1
1121 15 ELSE RETURN INQ
```

```
1122 1 **
1123 2 ** KEY INPUT DEFAIL
1124 3 **
1125 4 EVENT KONDEL
1126 5 FVDIAG SHOW,JOENO THUS
KONDEL AT ***** BY ****
1128 6 LET INDDRL=1
1129 7 CALL EXEACT
1130 8 ADD 1 TO KPYIN
1131 9 CALL BUFDMP
1132 10 **
1133 11 ** SAMPLE NFXT INPUT TIME
1134 12 LET NXXIN=KIIAT LET VKIAT=NXTIN
1135 13 SCHEDULE AN ALLOC IN 0.2 MS.
1136 14 RETURN END
```



```
1137 1 ''  
1138 2 '' KEY OUTPUT DERRAIL  
1139 3 ''  
1140 4 EVENT KOTDRL  
1141 5 EVDIAG SHOW JORNO THUS  
KOTDRL AT ***** By ***f  
1143 6 LET IVDDRL=0  
1144 7 CALL EXFACT  
1145 8 ADD 1 TO KEYOUT  
1146 9 CALL BUFDMP  
1147 10 ''  
1148 11 '' SAMPLE NFXT OUTPUT TIME  
1149 12 LET NXXKOUT=XOIAT LET VKOIAT=NXXKOUT  
1150 13 SCHEDULE AN ALLOC IN C.22 MS.  
1151 14 RETURN END
```

```
1152 1 ..  
1153 2 .. CERAIL TO PEFFORM DISK I/O  
1154 3 ..  
1155 4 EVENT DRLDIO  
1156 5 EVDIAG SHOW, JOENO THUS  
DRLDIO AT ***** BY ****  
1158 6 LET FL18=1  
1159 7 CALL EXEACT  
1160 8 ADD 1 TO DISYIO  
1161 9 ADD 1 TO LSTIO  
1162 10 LET NXTDIO=DIOIAT LET VDIOIAT=NXTDIO  
1163 11 ..  
1164 12 .. FILE REQUEST IN DIOCC. IF DIOQ WAS EMPTY  
1165 13 .. START TO NOW AND SCHEDULE DIO COURTESY CALL.  
1166 14 IF DIOQ IS E PTY  
1167 15 SCHEDULE A DIOCC GIVEN UST IN EXPONENTIAL.F(DIOMEAN,10) MS.  
1168 16 FILE THIS DIOCC IN THE CCQ  
1169 17 ELSE FILE THIS UST LAST IN DIOQ  
1170 18 SCHEDULE AN ALLOC IN 0.35 MS.  
1171 19 RETURN END
```

```
1172 1 **
1173 2 **   DERAIL TO TEPMINATE SUBSYSTEM
1174 3 **
1175 4 EVENT DRLRET
1176 5 SVCIAG SHOW,JOENO THUS
DRLRET AT ***** BY ****
1178 6 CALL EXEACT
1179 7 **
1180 8 **   CHECK CPU USAGE OF SUBSYSTEM.
1181 9 IF ABS.V(CHKCPU-LSPTS) GT 1
1182 10 PRINT 1 LINE WITH JOENO,CHKCPU,LSPTS THUS
*** ERROR - **** ALLOCATED CPU=***** USED *****
1184 11 ELSE CALL SS:INI
1185 12 SCHEDULE AN ALLOC IN 0.176 MS.
1186 13 RETURN END
```

```

1187 1 **
1188 2 ** KEY INPUT AND OUTPUT COURTESY CALLS
1189 3 **
1190 4 EVENT KIOCC SAVING THE EVENT NOTICE
1191 5 LET TUST=UST LET UST=KUST
1192 6 EVDIAG SHOW, JOENO THUS
KIOCC AT ***** POF *****
1193 7 IF KSWITCH NE 0 PRINT 1 LINE WITH JOENO, TIME.V THUS
***** FINISHED KIO AT *****
1196 8 ELSE LET LTIME=TIME.V
1197 9 LET FK19=
1198 10
1199 11 ** SEE IF IT WAS AN OUTPUT
1200 12 IF FL19 EQ
1201 13 GO TO KIOCC.1
1202 14 ELSE LET FL19=0
1203 15 IF FL21 EQ 0
1204 16 IF FL22 EQ 1
1205 17 REMOVE THIS UST FROM MEMO
1206 18 LET IFL13=1 FILE THIS UST FIRST IN CPUQ
1207 19 CALL ATCHG(2)
1208 20 IF KSWITCH NE 0 CALL MOPRINT CALL COPRINT ELSE
1209 21 GO TO KIOCC.1
1210 22 ELSE LET IPRPF=1
1211 23 CALL ATCHG(4)
1212 24 ELSE
1213 25 *KIOCC.1* LET UST=TUST REMOVE THIS KIOCC FROM THE CCO
1214 26 DESTROY THIS KIOCC
1215 27 RETURN END

```

```
1216 1 **
1217 2 ** DISK I/O COURTESY CALL
1218 3 **
1219 4 EVENT DIOCC SAVING THE EVENT NOTICE
1220 5 LET TUST=DUST LET UST=DUST
1221 6 EVDIAG SHOW, JOENO THUS
DIOCC AT ***** OF ****
1223 7 REMOVE FIRST UST FROM DIOQ
1224 8 LET FL(8=)
1225 9 **
1226 10 ** MOVE HIM TO TOP OF THE CPUQ.
1227 11 REMOVE THIS UST FROM THE CPUQ
1228 12 LET TPLG=1 FILE THIS UST FIRST IN THE CPUQ
1229 13 IF QSWITCH NE J CALL COPPINT ELSE
1230 14 LET UST=TUST
1231 15 **
1232 16 ** SEE IF ANY MORE DISK I/O'S ARE WAITING.
1233 17 REMOVE THIS DIOCC FROM THE CCQ
1234 18 IF DIOQ IS NOT EMPTY
1235 19 RESCHEDULE THIS DIOCC GIVEN F.DIOQ IN EXPONENTIAL.F(DIOMEAN,10) MS.
1236 20 FILE THIS DIOCC IN THE CCQ
1237 21 RETURN
1238 22 ELSE DESTROY THIS DIOCC
1239 23 RETURN END
```

```
1240 1 **
1241 2 ** SWAP OUT COURTESY CALL
1242 3 **
1243 4 EVENT 1ALLCC SAVING THE EVENT NOTICE
1244 5 LET TUST=UST LET UST=SUST1
1245 6 EVDIAG SHOR,JOENO THUS
1ALLCC AT ***** OF ***
1247 7 SUBTRACT 1 FROM INCORE
1248 8 LET FL21=)
1249 9 LET MPWF=1
1250 10 ** SEE WHAT HE GOT SWAPPED OUT FOR.
1251 11 IF FL19 EQ 0
1252 12 IF FL34 EQ 1
1253 13 CALL ATCHG(5)
1254 14 GO TO ALLCCA
1255 15 ELSE CALL ATCHG(4)
1256 16 GO TO ALLCCA
1257 17 ELSE ADD 1 TO TASTO
1258 18 CALL ATCHG(3)
1259 19 CALL MCD
1260 20 SUBTRACT 1 FROM SFUSE
1261 21 LET UST=TUST REMOVE THIS 1ALLCC FROM THE CCO
1262 22 DESTROY THIS 1ALLCC
1263 23 RETURN END
```

```
1264 1 **
1265 2 ** SWAP IN COURTEST CALL
1266 3 **
1267 4 EVENT 2ALLCC SAVING THE EVENT NOTICE
1268 5 LET TUSY=US. LET UST=UST2
1269 6 EVDIAG SHOW, JO=NO THUS
2ALLCC AT ***** OF ****
1271 7 LET LL22=1
1272 8 LET FL23=0
1273 9 LET FL34=0
1274 10 REMOVE THIS UST FROM MEMO
1275 11 LET TPLG=1 FILE THIS UST FIRST IN THE CPUO
1276 12 CALL ARCHG(2)
1277 13 IF QSKTCH N: CALL MOFRINT CALL CLPRINT ELSE
1278 14 SUBTRACT 1 FROM SFUSE
1279 15 LET UST=US: REMOVE THIS 2ALLCC FROM THE CCO
1280 16 DESTROY THIS 2ALLCC
1281 17 RETURN END
```

```

1282 1  **
1283 2  ** LINE SERVICE
1284 3  **
1285 4  EVENT LINSV
1286 5  EVDIAG SHOW THUS
LINSV AT *****
1285 6  LET MSR240=0
1286 7  LET MSR240=1
1287 8  LET TMSL=TIME.V
1291 9  LET TMSL=0.03
1292 10 IF TIME.V-TMSL LT TMSL GO TO MSR240
1293 11 ELSE LET TMSL=TIME.V
1294 12 ** CPU IN TSS IS IDLE
1295 13 IF MEMO IS EMPTY AND CPU IS EMPTY LET MSR240=1
1296 14 IF TMSL GT TMSL GO TO MSR240
1297 15 ELSE GO TO MSR300
1298 16 ELSE
1299 17 **
1300 18 **
1301 19 'MSR240' LET MSR240=0
1302 20 'MSR240' IF TIME.V-TMSL LT TMSL GO TO MSR300
1303 21 **
1304 22 ** CALCULATE % CORE UTILIZATION TO SEE IF TSS
1305 23 ** CORE SIZE SHOULD BE REDUCED
1306 24 ELSE LET TMSL=0
1307 25 'LOOP' LET TMSL=TMSL+SUC(I) LET I=SUC(I)
1308 26 IF I NE 0 GO TO LOOP
1309 27 ELSE LET TMSL=((TMSL*100)/TACOR)+TAP*U)/2
1310 28 **
1311 29 ** FIND LARGEST PROGRAM IN SYSTEM.
1312 30 LET TALPS=0
1313 31 FOR EVERY USE OF MEMO DO
1314 32 IF LSIZE GT TALPS LET TALPS=LSIZE
1315 33 ELSE LOOP
1316 34 FOR EVERY USE OF CPU DO
1317 35 IF LSIZE GT TALPS LET TALPS=LSIZE
1318 36 ELSE LOOP
1319 37 IF MSR240 EQ 1 GO TO MSR250
1320 38 ELSE LET TMSL=TIME.V-TMSL LET TMSL GO TO MSR300
1321 39 ELSE LET TMSL=TIME.V
1322 40 IF ALTH GT TMSL-TMSL GO TO MSR300
1323 41 ELSE IF TMSL-TMSL LT TMSL GO TO MSR300
1324 42 ELSE IF TMSL EQ 0 GO TO MSR300
1325 43 ELSE IF TMSL GT TMSL GO TO MSR300
1326 44 ELSE 'MSR240' IF TMSL-TMSL GT TMSL LET CHANGE=TMSL-TMSL
1327 45 ELSE IF TMSL-TMSL LE TMSL LET CHANGE=TMSL
1328 46 ELSE IF TMSL EQ 0 GO TO MSR300
1329 47 ELSE IF CHANGE LT TALPS GO TO MSR300
1330 48 ELSE LET TMSL-TMSL LET TMSL GO TO MSR300
1331 49 ELSE LET TMSL=1
1332 50 LET TMSL=CHANGE
1333 51 ADD 1 TO TMSL

```



```

1334 52 ADD 0.44 TO EXT
1335 53 **
1336 54 ** SEE IF ANY NEW SUBSYSTEMS (UST'S) NEED TO
1337 55 ** BE STARTED.
1338 56 **
1339 57 *MSR300* IF *XTUST LE TIME.V CALL START
1340 58 LET VUSTIAT=USTIAT
1341 59 LET NXTUST=NXTUST+VUSTIAT
1342 60 GO TO MSR300
1343 61 ELSE IF TLF13+MPWF GE 1 SCHEDULE AN ALLOC IN EXT MS. RETURN
1344 62 **
1345 63 ** TSS IS IDLE.....
1346 64 ** RELINQUISH TO GPCS UNTIL NEXT INTERRUPT,
1347 65 ** "SUBSYSTEM" ARRIVAL, OR COURTESY CALL.
1348 66 FLSH ADD 1 TO TLF13 LET TAGPT=0
1349 67 IF TIME.V+TAGPT GE 300 LET MPWF=1
1350 68 ELSE LET NEXTCC=MIN.F.C
1351 69 IF CCG IS NOT EMPTY LET NEXTCC=TIME.A(F.CCG)
1352 70 ELSE LET WAKIT=MIN.F(NXTUST+.001,TIME.V+TAGHI,NXTCC+.16)
1353 71 SCHEDULE AN ALLOC AT WAKIT+EXT
1354 72 RETURN FNC

```

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