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DAS PERFORMANCE ANALYSIS

G. Bates, S. Bodine, T. Carroll, and M. Keller

Plasma Physics Laboratory, Princeton University

Princeton, New Jersey 08544

ABSTRACT

This report begins with an overview of the Data Acquisition System (DAS), which supports several of PPPL's experimental devices. Performance measurements which were taken on DAS and the tools used to make them are then described.

1.0 INTRODUCTION

The data acquisition, analysis, and archiving facilities for a number of PPPL experimental machines are provided by a network of computers known as the Data Acquisition System (DAS). DAS is based on two families of computers manufactured by the Digital Equipment Corporation (DEC): a 36-bit DECsystem-10 (PDP-10) mainframe, and several 16-bit PDP-11 minicomputers.

The DAS data acquisition system is composed of a three-level computer network. The top level consists of a DECsystem-10 computer with a KL10 CPU running the TOPS-10 operating system. This system provides the major data archiving and analysis facilities. The second level is composed of five PDP-11/34 computers running the RSX-11M operating system, connected to the PDP-10 through a DMA10 direct memory access interface. These computers provide the major data acquisition capabilities. The third level is composed of various computers from other PDP-11/34's to PDP-11/04's, a PDP-8, a Data General NOVA-II, and nonintelligent devices such as Pulse Height Analyzers. Some of these computers run the RSX-11M operating system, while others are standalone. These systems provide specialized data acquisition facilities. A VAX-11/780 is also connected to this network. Figure 1 shows a diagram of the current DAS configuration.

The TOPS-10 and RSX-11M operating systems have been modified to provide task-to-task communication facilities between the computers. Data are acquired on the PDP-11's, and archived and analyzed on the PDP-10. Each system on the first and second levels has a scheduler program which runs the appropriate acquisition and analysis programs in response to timing signals from the main experiment timers. File traffic between the PDP-10 and PDP-11's is processed by a program called FTU (File Transfer Utility) running on the PDP-10.

The major portion of the data acquired by the second level computers is by means of CAMAC instrumentation highways. The CAMAC (Computer Automated Measurement and Control) instrumentation system consists of standarized modules (analog-to-digital converters, histogramming memories, etc.) and the dataway which interconnects them. Two of the second-level systems (CPU1 and CPU2) have a PPPL-built communication device called the Parallel Data Channel (PDC). This device connects up to eight third-level devices to a second-level host system.

The basic machine operation cycle starts with a timer pulse at T-30 seconds. This triggers the second-level computers to start running initialization programs which arm the various data acquisition instrumentation systems. The PDP-10 is also notified of this event and performs its own initialization process. At T0, the machine is pulsed, generating a plasma discharge which is recorded by the data acquisition hardware. Approximately two seconds after this, the second-level computers receive another timing signal which causes a series of acquisition programs to be run which read out the data stored in the acquisition hardware systems and archive it on the PDP-10. The PDP-10 is also notified of this event and, as the data files become available, the appropriate analysis programs are run. The analysis programs generate a series of graphs which are displayed on screens in the control room.

2.0 DAS LOAD GROWTH

The DAS system currently supports three active experimental machines: the Princeton Large Torus (PLT), the Pre-Spheromak (PS), and the Spheromak (S1). The Poloidal Divertor Experiment (PDX), which recently shut down, was the heaviest user. The Radio Frequency Test Facility (RFTF) is about to begin operations, and PDX is undergoing modifications before being brought back on-line. This will give a total of five on-line experiments.

Table 1 shows a summary of some typical PLT and PDX experiment runs and the computer resources (PDP-10) used. Figures 2(a-i) and 3(a-i) show a graphic representation of this data. In Figs. 2a and 3a, Archive Profile is the amount of data archived in Megabytes. Notice in Figs. 2 and 3 that the axes in the corresponding graphs are not all to the same scale.

The growth in the DAS load is not only due to the increase in the number of experiments which must be supported; but, also, as experimental operations progress, the number of diagnostics on the machines and the amount of data they take tends to increase substantially. In 1981 PDX acquired approximately 1.2 Megabytes of data per shot with 18 diagnostics. By 1982 the PDX load had increased to 1.7 Megabytes of data per shot with 23 diagnostics. This represents an increase of almost 42%. The DAS system currently acquires approximately 2 Megabytes of data under normal load conditions. The maximum load to date has been approximately 2.8 Megabytes. System degradation begins to manifest itself when these load levels are approached.

Future load levels will be compounded by the prospect of concurrent operation of several machines. The DAS system was designed with the guaranty that only one machine would run at a given time. This has been voided by the need to run S1 and RFTF concurrently with PLT. System software modifications will be required in order to support this load. This will be difficult to accomplish due to staff reductions. In 1980 there were four systems programmers supporting the DAS system. This has been reduced to one full-time systems programmer with some support from others in the group.

The extreme demands about to be placed on an already overloaded system have necessitated a system performance study of DAS in order to identify current limitations and determine optimum hardware and software upgrades.

3.0 SYSTEM PERFORMANCE STUDY

The purpose of the system performance study is to measure the current utilization of the DAS system so that optimizations can be performed, and needed additional resources identified.

3.1 System Performance Study

Items Measured

The items measured were:

1. CPU utilization,
2. Memory utilization,
3. Disk channel utilization,
4. Monitor overhead.

3.2 Measurement Tools

The following tools were used to take the performance measurements:

1. SYSTAT

   This program displays a wide variety of system information including the status of all jobs, high segments, swapping space, file structures, etc.

2. SYSDPY

   This program displays the same information as SYSTAT in the form of a dynamically updated video screen. Only the data that change are updated. The information can also be logged in a disk file.

3. LINES/LNSRPT

LINES is a program that records the monitor performance data at one-minute intervals. LNSRPT is a program that formats the data from LINES to provide detailed reports. The reports available include data on resource utilization, processor queue data, special queue data, and class percentages.

4. SNOOPY/TATTLE

SNOOPY is a program which collects statistics of where a program spent CPU time. It can collect data on an individual job, on all jobs, and on the monitor and/or interrupt service routines. TATTLE is a program which processes the data output by SNOOPY.

5. KLBPA

This is a program to control the gathering of general background system performance statistics of a 7-series TOPS-10 monitor via the performance meter available on all KL-10 CPUs.

6. CPU

This program shows the cache hit ratio vs idle time.

7. DBUSY

This program tells the length of the position wait and transfer wait queues.

8. DDB4

This program shows file activity.

9. TRACK

This program monitors the progress and performance of individual jobs and the performance and utilization of an entire system.

3.3 Standard Load

In order to measure system performance, a standard load system was developed. This system allowed selected system parameters, such as memory and disk configurations, to be varied while placing a constant and repeatable load on the system. The standard load system can be set to simulate any desired combination of archived data volume, number of acquisition tasks, and acquisition data rate.

The standard load system is composed of four software components:

1. Timer/Scheduler program

   This program simulates the experiment timer and also schedules the data acquisition simulation programs in response to the simulated timer events. One copy of this program runs on one or more of the second-level systems. If more than RSX system is being used in the simulation, one is selected to be the master timer and the others are slaved to it. The master timer also synchronizes the PDP-10 real-time system.

2. Data Acquisition Simulation program

Multiple copies of this program are installed in the RSX systems under unique task names. Each task name corresponds to a simulated diagnostic. The number of channels written, the size of each channel, and the I/O rate can be controlled. The simulated analysis load on the PDP-10 can be controlled by varying the above three parameters. As each simulated diagnostic task completes, it triggers its corresponding simulated analysis program on the PDP-10.

3. Acquisition Control program

This interactive program sets the number of channels to be archived, the size of the channels, and the I/O rate. It can be run on any of the RSX computers.

4. Data Analysis Simulation program

Multiple copies of this program reside on the PDP-10. When triggered to run by its corresponding acquisition program, this program reads the appropriate archived data file in the following manner: four reads of 2K points each are taken from channel 1 and a plot is generated; then, one read of 4K points is taken from each of channels 1 through 10 and a second plot is generated. This gives a total of 48K data points accessed. Figure 4(a-b) shows an example of these plots.

3.4 Simulation Tests

The simulation tests were performed with the DAS system in standalone mode. Test were performed with memory configurations of 512K and 1 Megaword on the PDP-10. Tests were also performed with an RP06 disk drive and an RP07 disk drive as the primary archiving device. The goal of the tests was to determine the saturation areas of the PDP-10.

3.5 Measurement Criteria

Digital Equipment Corporation has established the following criteria as a guideline in determining PDP-10 system saturation levels:

1. Processor saturation

   The central processor is considered to be saturated if one or more of the following conditions are met:

   1. The percent idle time is 0%.
   2. The percent overhead time is greater than 20%.
   3. The number of jobs in run queues is greater than 7.

2. Memory saturation

   The main memory is considered to be saturated if one or more of the following conditions are met:

   1. The number of core blocks swapped per second is greater than 400.
   2. The percent lost time is greater than 5%.
   3. The active swapping ratio is greater than 2.0.

3. Disk and Channel saturation

Disk saturation is determined by observing saturation at the disk unit level or a uniform load across all "Public" units. This is determined with the SYSTAT program. Channel saturation is determined by observing the length of the transfer wait queues with the TRACK and DBUSY programs.

4.0 RESULTS

The results of the data acquired for the performance study are discussed below.

4.1 Memory utilization

Table 2 shows a summary of data from the LINES program for July 26 and July 27, 1983. On July 26, the DAS DECsystem-10 was configured with 0.5 Megaword of memory. On July 27, the system was running with 1 Megaword. The numbers in parentheses are peak values, the lower numbers are the average values. The system was taking 0.8 Megabytes of data per shot on both days. Figures 5(a-h) and 6(a-h) show the data in detail for the respective configurations. The following discussion will compare the corresponding graphs between Figs. 5 and 6 in relation to the effects of the different memory complements.

Graph (a) displays the number of jobs on the system. These were comparable on both days and vary as a function of interactive timesharing users. The number of users on the system is relatively consistent.

Graph (b) shows the CPU utilization percentage. In Fig. 5b, with 0.5 Megaword of memory, the average CPU utilization is 70%. In Figure 6b, with 1

Megaword of memory, it is 100%. We believe that the CPU utilization with the 1 Megaword system is most likely due to a memory diagnostic or some other activity on the system. We cannot attribute the increase in CPU utilization to the increase in the memory.

Graph (c) shows the monitor overhead in percent. The monitor overhead did not change appreciably with the change in memory size. Since the monitor is performing the same functions, this is to be expected.

Graph (d) shows the number of disk blocks read and written per minute. This also is comparable on both days; and since the archiving load is the same on both days, this result is expected.

Graph (e) shows the number of 128 word core blocks swapped per minute, that is, the swapping rate. As can be seen, with 0.5 Megaword of memory, the swapping rate averages nearly 10,000 blocks per minute with a peak of 35,000 blocks per minute. This is an average of 167 blocks per second with a peak of 583 blocks per second. With 1 Megaword of memory, swapping has been reduced to an average of 1,000 blocks per minute with a peak of 8,000 blocks per minute. That converts to 17 blocks per second with a peak of 133 blocks per second. The additional 0.5 Megaword of memory has reduced swapping by an average of 90%. It should be noted that with a heavier load, swapping would be considerably higher, which makes additional memory even more important.

Graphs (f), (g), and (h) show the percent buffer space, percent 4-word core blocks, and the percent swapping space used, respectively. There is no appreciable change in any of these parameters.

A similar memory experiment was performed on the User Service Center (USC), another DECsystem-10 installation at PPPL. On July 25, 1983, the USC was configured with 0.5 Megaword of memory. At 1800 hours, the system was configured with 1 Megaword of memory. The system ran with 1 Megaword until

1900 hours on July 26, when it was configured back to 0.5 Megaword. The system ran with 0.5 Megaword on July 27. Table 3 shows a summary of the results. Figures 7(a-h), 8(a-h), and 9(a-h) show the detailed data for the configuration of July 25, July 26, and July 27, respectively. A memory exerciser diagnostic was run on July 26 between 1400 and 1500 hours. The impact of this program is clearly evident in Fig. 8. The overall results of the USC memory test are comparable to the test on DAS. Swapping was nearly eliminated with the additional memory.

4.2 Standard Load simulation

A series of tests were run with the standard load simulation system. These tests measured system performance under varying simulated load conditions and also measured the effect of using an RP07 disk drive as the primary archiving device as opposed to an RP06 disk. The RP07 is a non-removable Winchester disk drive with a higher recording density and faster transfer speed than the removable pack RP06. Also considered is an actual PLT experimental shot. The statistics for data rates of 0.57 Megabyte, 0.93 Megabyte, 1.12 Megabyte, 3.65 Megabytes (RP06), and 3.65 Megabytes (RP07) are shown in Figs. 10, 11, 12, 13, and 14, respectively. Tables 4 through 8 show the actual diagnostics enabled and the amount of data each archived for the respective shots. The figures show the following statistics: idle time in percent, number of jobs in run queues, FTU memory and CPU usage in percent, real-time job CPU usage in percent and number of real-time jobs, the number of context switches per second, and the number of UUO (system service calls) per second. Figure 10 is an actual PLT shot, the others are simulations.

Graph (a) shows the percentage of the time that the CPU was idle, that is, there was no job which wanted to run. This is extremely small in Fig.

10. This can be attributed to the number of interactive users on the system during actual machine operation. Most terminals in the control room are logged on to the system running interactive control and analysis programs. Software development and operator functions are also active during this time. The nature of a timesharing system must be considered when discussing CPU utilization. The nature of a job can vary from being CPU intensive to being I/O intensive. Timesharing shares the CPU among many users. A user job will run until either its alloted time slice has been exhausted or it blocks for I/O. The monitor will then schedule another job from the run queue. Even if there is only a single job on the system, if that job is CPU bound, the monitor will schedule it to run and the CPU will appear to be saturated, that is, CPU utilization will approach 100%. On the contrary, if that job is I/O bound, CPU utilization will appear low. Figure 10a shows that the excess CPU time not absorbed by the real-time system is being effectively utilized by the interactive jobs. Figures 11a through 14a show that the real-time system absorbs a longer period of the CPU as the data rate is increased. There is a much higher idle rate outside of the real-time cycle on these figures since the system was standalone during the simulation and there were no users to absorb the CPU.

Graph (b) shows the number of jobs in the run queues. The same general trend as for idle time is indicated, that is, the real-time system absorbs the systems resources for a longer period of time as the load is increased. In Fig. 10b the cycle ends at 80 seconds after T0 with a load of 0.57 Megabyte. In Fig. 11b with 0.93 Megabyte, the duration has increased by 10 seconds. The length of the run queues has also increased. This indicates that the CPU has been able to absorb the increased load. In Fig. 12b, with 1.12 Megabyte of data being archived, the run queues are comparable to those with 0.93

Megabyte, however, the cycle has extended to 130 seconds. It has required an additional 50 seconds to process the shot. There is no run queue data available for the two tests at the 3.65 Megabytes load level.

Graph (c) shows the number of pages of memory used by FTU and the percentage of the CPU used by FTU during the cycle. Again, as the load increases, the resources used increase in both magnitude and time. The CPU time used by FTU peaks at approximately 50% when the data rate reaches 0.93 Megabyte. The duration of the FTU CPU utilization increased from 50 seconds for 0.93 Megabyte to 150 seconds for 3.65 Megabytes. Figures 13c and 14c show the effect of using an RP07 disk as the primary archive device. In Fig. 14c, the RP07 has reduced the number of pages required by FTU from over 300 to approximately 250. The duration of CPU time used by FTU has been reduced from 150 seconds after T0 to 125 seconds. The RP07 has made a 20% improvement in the number of physical pages used by FTU and the time duration that FTU is using the CPU.

Graph (d) shows the percentage of the CPU utilized by real-time jobs over the duration of a shot cycle and the number of real-time jobs in a run queue. The CPU utilization peaks at approximately 60%. The number of real-time jobs peaks at four, the number of jobs currently allocated to the real-time system. Again, the cycle is extended as the load is increased. In Fig. 13d, the real-time system is active from 140 to 200 seconds after T0. In Fig. 14d, the cycle is active from 120 to 185 seconds. The RP07 has allowed the cycle to begin and end 20 seconds earlier. Notice, however, that 60 seconds are required in both cases to process the analysis portion of the cycle. The RP07 has improved the acquisition portion of the cycle, but has not affected the analysis phase.

Graph (e) shows the effect of the data load on context switching. No appreciable changes are evident.

Graph (f) shows the number of UUO's (monitor calls) per second. Again, the RP07 has made an improvement. In Fig. 14f, FTU has processed the data with approximately 15% fewer monitor calls than were required with the RP06.

4.3 Cache Memory Utilization

The KL10 central processor includes a 2K-word cache memory. We consistently found a cache hit rate above 90% over the entire cycle. This indicates that the cache is being utilized effectively.

4.4 Disk speed

Tests were run on the DAS and USC systems to measure the difference in disk access speed between FORTRAN and MACRO I/O routines. The tests were made writing 50 block files. It was found that with the FORTRAN language, only 1 sector per revolution could be obtained. With more than one stream, only every third sector or less could be obtained per revolution due to head positioning. Preallocation of disk space had no substantial effect on these results, nor did the type of disk used. Tests were made with disk configurations of single RP04, RP06, and RP07 disks, and also with two-pack RP04 structures and two-pack RP06 structures. Disk access using MACRO routines was found to be more than 30 times faster. The real-time system uses a standardized archive file format with MACRO access routines. The ratio of archive Reads/Writes to all Reads/Writes varies from 1:5 to 1:11 depending on the data acquisition load. Tables 9, 10, and 11 show the data from these tests. Table 9 shows the results of the FORTRAN test runs with both preallocation and multiple streams. Table 10 shows tests of the MACRO archive read routines to different disk structures. DSKB consists of two RP04 disk drives, DSKC is the RP07, and PK## is an RP06. These tests read the entire file in a single read. As can be seen, there is no appreciable difference in speed between the RP04 and RP06. The RP07, however, is more than twice as fast. Table 11 shows a similar test except the file is read in three segments. The speed advantage of the RP07 is diminished as the size of the read is decreased.

Figures 15 and 16 show the Position Wait and Transfer Wait queues, respectively, for PLT shot 99572 taken on July 27, 1983. The archive rate was 0.7 Megabyte. Figure 15 shows that the Position Wait queue had multiple requests pending over most of the cycle. At the peak at 40 seconds after T0, there were seven requests in the queue. The Transfer Wait queue shown in Fig. 16, however, never has more than one request in it. This indicates that most of the time spent waiting for the disk is involved in head positioning. The RP07 has twice the capacity of the RP06 with a higher recording density. Therefore, an RP07 can fit more data onto a track and has to reposition less.

5.0 CONCLUSIONS

The experimental devices supported by the DAS system are about to be expanded which will considerably increase the amount of data generated. New devices are also anticipated. The DAS system is currently saturated and cannot support a greater load without additional resources. Nonstandard systems must be standardized to facilitate support. Weaknesses must be identified and eliminated. Adequate hardware resources must be acquired in order to provide a reliable and stable system.

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FIGURE CAPTIONS

FIG. 1 DAS computer network configuration.

FIG. 2a-i Typical PLT shot

PLT data archive on 08-May-82

132 shots taken (76653-76800)

Peak of 17 diagnostics at 16:14

Total archived: 135.4 Megabytes

FIG. 3a-i Typical PDX shot.

PDX data archived on 26-May-82

66 shots taken (50642-50758)

Peak of 23 diagnostics at 14:53

Total archived: 95.3 Megabytes

FIG. 4 Sample plots from analysis simulation program.

FIG. 5 DAS performance statistics with 0.5 Megaword main memory (7/26/83).

FIG. 6 DAS performance statistics with 1 Megaword main memory (7/27/83).

FIG. 7 USC performance statistics with 0.5 Megaword main memory (7/25/83).

FIG. 8 USC performance statistics with 1 Megaword main memory (7/26/83).

FIG. 9 USC performance statistics with 0.5 Megaword main memory (7/27/83).

FIG. 10 PLT #1211, 16-Aug-83 18:34, 3-minute cycle, 1 Megaword memory, 0.57 Megabyte of data, 10 diagnostics, 51 jobs.

FIG. 11 Test shot# 83204, 17-Aug-83 22:22, 3-minute cycle, 1 Megaword memory, 0.93 Megabyte of data, 10 diagnostics, 36 jobs.

FIG. 12 Test shot# 83219, 17-Aug-83 18:34, 3-minute cycle, 1 Megaword memory, 1.12 Megabyte of data, 16 diagnostics.

FIG. 13 Test shot# 83287, 19-Aug-83 02:02, 3-minute cycle, 1 Megaword memory, 3.65 Megabytes of data, 15 diagnostics, RP06.

FIG. 14 Test shot# 83298, 19-Aug-83 05:37, 3-minute cycle, 1 Megaword memory, 3.65 Megabytes of data, 15 diagnostics, RP07.

FIG. 15 Length of Position Wait queue (PLT shot# 99572)

FIG. 16 Length of Transfer Wait queue (PLT shot# 99572)

TABLE 1

DAS Performance Statistics

	PLT	PDX	PDX S1	PLT	PLT	PLT	(1MW) PLT
	08May82	26May82	30June83	05Jul83	06Jul83	07Jul83	20Jul83
Hours of Interest	1000: 1600	1400: 1000	1300: 1600	1000: 1400	1000: 1400	1000: 1400	1000: 1400
Megabytes Per Shot	(1.3) 1.05	(2.1) 1.7	S1 0.02 PLT 0.65			S1 0.45 PLT 0.38	
Number Jobs	(44) 42	(70) 63	(61) 57	(60) 50	(56) 50	(70) 60	(58) 54
% CPU Time Used	(85) 65	(100) 95	(100) 80	(100) 75	(100) 60	(100) 92	(100) 80
Monitor Overhead	(14) 9	(17) 14	(20) 13	(18) 10	(18) 8	(20) 14	(14) 11
DSK Blks R/W per min	(4000) 2800	(4200) 3800	(6000) 3000	(9000) 1600	(5000) 1500	(10000) 2500	(7800) 2300
Core Blks Swapped per min	(28000) 15000	(55000) 32000	(42000) 9000	(36000) 5000	(7000) 1500	(40000) 10000	(8000) 1700
% TTY Buf Space Used	(40) 38	(44) 38	(42) 38	(38) 38	(45) 38	(42) 38	(42) 38
% Monitor Core Blks Used	(18) 16	(60) 50	(40) 30	(32) 25	(17) 14	(35) 30	(23) 20
% Swap Space Used	(33) 28	(25) 23	(29) 27	(33) 18	(17) 14	(38) 23	(28) 16

NOTES: Number in ( ) is peak value, number below is average.

TABLE 2

DAS Performance Statistics

(0.5 Megaword Memory vs 1 Megaword Memory)

	0.5 MW 26Jul83	1 MW 27Jul83
Hours of Interest	1000 1400	1400 1800
Megabytes Per Shot	0.8Mb	0.8Mb
Number Jobs	(65) 60	(58) 50
% CPU Time used	(100) 70	(100) 100
Monitor Overhead	(17) 10	(14) 10
DSK Blks R/W per min	(10000) 4000	(12000) 5000
Core Blks Swapped per min	(35000) 8000	(9000) 1000
% TTY Buf Space Used	(42) 38	(42) 38
% Monitor Core Blks Used	(26) 22	(26) 23
% Swap Space Used	(33) 25	(29) 22

NOTES: Number in ( ) is peak value, number below is average.

TABLE 3

USC Performance Statistics

(0.5 Megaword Memory vs 1 Megaword Memory)

	0.5 MW 25Jul83	1 MW 26Jul83	1 MW 27Jul83
Hours of Interest	1200 1500	0900 1100	1300 1600
Number Jobs	(82) 70	(70) 60	(80) 65
% CPU Time used	(23) 17	(23) 15	(16) 13
DSK Blks R/W per min	(5000) 3000	(55000) 2100	(5000) 3500
Core Blks Swapped per min	(18000) 3000	(500) 500	(24000) 18000
% TTY Buf Space Used	(48) 33	42 38	42 38
% Monitor Core Blks Used	(38) 28	(26) 22	(30) 23
% Swap Space Used	(28) 25		(28) 30

NOTES: Number in ( ) is peak value, number below is average.

TABLE 4

Shot Summary for PLT Shot# 1211, 16-Aug-83 18:34, 0.57 Megabyte of data

1004 DSK Blks (0.578304 Mb) For Shot 01211 on 16-Aug-83, 18:34 - 10 Diags.

257 BLKS	66,4777	LV	PLT	-	Low Energy Neutral System
173 BLKS	66,5053	MW	PLT	-	Microwave Scattering
135 BLKS	66,4177	CY	PLT	-	Cyclotron Emission
133 BLKS	66,4030	AH	PLT	-	ADH ADC 32 Channels
115 BLKS	66,4761	LH	PLT	-	Lower Hybrid Heating
76 BLKS	66,4074	BA	PLT	-	Bolometer Array
67 BLKS	66,5507	TF	PLT	-	Toroidal Field Monitor
31 BLKS	66,5524	TS	PLT	-	TV Thomson Scattering
14 BLKS	66,5123	NT	PLT	-	Neutron Temperature
3 BLKS	66,4251	DX	PLT	-	Datax Replacement

TABLE 5

Shot Summary for Test Shot# 83204, 17-Aug-83 22:22, 0.93 Megabyte of Data

1620 DSK BLKS (0.93312 Mb) FOR SHOT 83204 ON 17-Aug-83 22:22 - 10 Diags.

162 BLKS	66,5456	SX	PDX	-	Spectroscopy
162 BLKS	66,5236	PI	PDX	-	Pellet Injection
162 BLKS	66,5047	MS	PDX	-	Microwave Scattering
162 BLKS	66,5030	MD	PDX	-	Machine Diagnostics
162 BLKS	66,4774	LS	PDX	-	C02 Laser Scattering
162 BLKS	66,4566	IN	PDX	-	MHD Instability
162 BLKS	66,4444	GR	PDX	-	Grating Polychrometer
162 BLKS	66,4433	GI	PDX	-	Gas Injection
162 BLKS	66,4245	DT	PDX	-	Diagmagnetic Diagnostic
162 BLKS	66,4243	DR	PDX	-	Plasma Disruption

TABLE 6

Shot Summary for Test Shot# 83219, 17-Aug-83 23:28, 1.12 Megabytes of data

1952 DSK BLKS (1.124352 Mb) FOR SHOT 83219 ON 17-Aug-83 23:28 - 16 Diags.

122 BLKS	66,5644	VM	PDX	-	Visible Acquisition
122 BLKS	66,5632	VC	PDX	-	Visual Continuum
122 BLKS	66,5512	TI	PDX	-	Charge Exchange
122 BLKS	66,5456	SX	PDX	-	Spectroscopy
122 BLKS	66,5236	PI	PDX	-	Pellet Injection
122 BLKS	66,5110	NI	PDX	-	Neutron Ion Temperature
122 BLKS	66,5054	MX	PDX	-	Microwave Interferometer
122 BLKS	66,5051	MU	PDX	-	Multichannel Spectrometer
122 BLKS	66,5047	MS	PDX	-	Microwave Scattering
122 BLKS	66,5030	MD	PDX	-	Machine Diagnostics
122 BLKS	66,4774	LS	PDX	-	CO_2 Laser Scattering
122 BLKS	66,4566	IN	PDX	-	MHD Instability
122 BLKS	66,4444	GR	PDX	-	Grating Polychrometer
122 BLKS	66,4433	GI	PDX	-	Gas Injection
122 BLKS	66,4245	DY	PDX	-	Diagmagnetic Diagnostic
122 BLKS	66,4243	DR	PDX	-	Plasma Disruption

TABLE 7

Shot Summary for Test Shot# 83287, 19-Aug-83 02:02,
3.65 Megabytes of data, RP06

6345 DSK BLKS (3.65472 Mb) FOR SHOT 83287 ON 17-Aug-83 2:02 - 15 Diags.

423 BLKS	66,5644	VM	PDX	-	Visible Acquisition
423 BLKS	66,5512	TI	PDX	-	Charge Exchange
423 BLKS	66,5456	SX	PDX	-	Spectroscopy
423 BLKS	66,5236	PI	PDX	-	Pellet Injection
423 BLKS	66,5226	PA	PDX	-	Probe Acquisition
423 BLKS	66,5051	MU	PDX	-	Multichannel Spectrometer
423 BLKS	66,5047	MS	PDX	-	Microwave Scattering
423 BLKS	66,5030	MD	PDX	-	Machine Diagnostics
423 BLKS	66,4774	LS	PDX	-	CO_2 Laser Scattering
423 BLKS	66,4576	IV	PDX	-	Infrared Video Camera
423 BLKS	66,4566	IN	PDX	-	MHD Instability
423 BLKS	66,4444	GR	PDX	-	Grating Polychrometer
423 BLKS	66,4433	GI	PDX	-	Gas Injection
423 BLKS	66,4245	DT	PDX	-	Diagmagnetic Diagnostic
423 BLKS	66,4243	DR	PDX	-	Plasma Disruption

TABLE 8

Shot Summary for Test Shot# 83298, 19-Aug-83 05:37,
3.65 Megabytes of Data, RP07

6345 DSK BLKS (3.65472 Mb) FOR SHOT 83298 ON 19-Aug-83 5:37 - 15 Diags.

423 BLKS	66,5644	VM	PDX	-	Visible Acquisition
423 BLKS	66,5512	TI	PDX	-	Charge Exchange
423 BLKS	66,5456	SX	PDX	-	Spectroscopy
423 BLKS	66,5236	PI	PDX	-	Pellet Injection
423 BLKS	66,5226	PA	PDX	-	Probe Acquisition
423 BLKS	66,5051	MU	PDX	-	Multichannel Spectrometer
423 BLKS	66,5047	MS	PDX	-	Microwave Scattering
423 BLKS	66,5030	MD	PDX	-	Machine Diagnostics
423 BLKS	66,4774	LS	PDX	-	CO_2 Laser Scattering
423 BLKS	66,4576	IV	PDX	-	Infrared Video Camera
423 BLKS	66,4566	IN	PDX	-	MHD Instability
423 BLKS	66,4444	GR	PDX	-	Grating Polychrometer
423 BLKS	66,4433	GI	PDX	-	Gas Injection
423 BLKS	66,4245	DT	PDX	-	Diagmagnetic Diagnostic
423 BLKS	66,4243	DR	PDX	-	Plasma Disruption

TABLE 9

FORTRAN Disk Measurements

DAS Standalone 7-July-83

Summary

50 Block

Alloc	#DSKB	#DSKC	#PK	WAL	W/s
N	1	-	-	0.950	6734
N	-	1	-	1.025	6369
N	-	-	[02] 1	0.958	6679
N	-	-	[03] 1	0.900	7121
==================AVERAGE=================>				0.958	6727
Y	1	-	-	0.883	7245
Y	-	1	-	0.917	6982
Y	-	-	[02] 1	1.085	5909
Y	-	-	[03] 1	0.984	6511
==================AVERAGE=================>				0.967	6662
N	2	-	-	4.788	2185
N	-	2	-	5.006	2666
N	1	1	-	6.942	1844
N	-	-	2	5.600	2292
N	1	-	1	8.01	1688
N	-	1	1	4.8	2668
==================AVERAGE=================>				5.86	2214

TABLE 10

Archive Software Disk Measurements (Single Read)

DAS System Performance
Disk Measurements Using The Archive Random Access Routines

WEDNESDAY JULY 20, 1983
8:48 - 8:49 a.m.

	NO. OF STREAMS TO A DISK			WALL TIME	WORDS READ
	DSKB	DSKC	PK**	(SECS)	(WORDS/SEC)
	1	-	-	0.294	117,894
2.25:1 ==>	-	1	-	0.133	260,160 *
==>	-	-	1	0.300	115,865
============AVERAGES==========>>>				0.242	164,640
2.2:1 ==>	2	-	-	0.550	126,138 *
==>	-	2	-	0.250	227,504 *
	-	-	2	0.550	126,138 *
	1	1	-	0.556	124,701
	-	1	1	0.550	126,138 *
	1	-	1	0.557	124,901
============AVERAGES==========>>>				0.502	150,953
2.16:1 ==>	3	-	-	0.828	125,753
==>	-	3	-	0.383	271,514
	-	-	3	0.828	125,726
	1	1	1	0.825	126,151
============AVERAGES==========>>>				0.716	162,362

NOTES:

170 Block archive file

*Times identical for all four (4) runs.

HPQ=7 Times all close (±2%) submitted.
DSKPRI=3 By batch. Approx 1 min elapsed time. With new memory on multiple streams, read entire file at once with one copy of disk read prog.

TABLE 11

Archive Software Disk Measurements (Multiple Reads)

DAS System Performance
Disk Measurements Using The Archive Random Access Routines

<u>TUESDAY, JULY 27, 1983</u>
<u>7:10 A.M.</u>

NO. OF STREAMS TO A DISK			WALL TIME	WORDS READ
DSKB	DSKC	PK**	(SECS)	(WORDS/SEC)
1	-	-	0.325	106,805
-	1	-	0.217	160,098
-	-	1	0.309	112,584
============AVERAGES==========>>>			-	-
2	-	-	0.615	230,450
-	2	-	0.380	361,960
-	-	2	0.600	231,253
1	1	-	0.650	225,500
-	1	1	0.600	231,253
1	-	1	0.600	251,253
============AVERAGES==========>>>			-	-
1	1	1	0.891	350,152
3	-	-	0.883	355,425
-	3	-	0.553	568,627
-	-	3	0.891	350,152
============AVERAGES==========>>>			-	-

NOTES:

VERSION OF PROGRAM: 3.0
HPQ=7
DSKPRI = 3
System at standlone.

Averages do not make sense here due to high rate of DSKC with respect to DSKB & PK#.
Size of reads = 1/3 block (of 170 block file).

#83E0108

DAS COMPUTER NETWORK

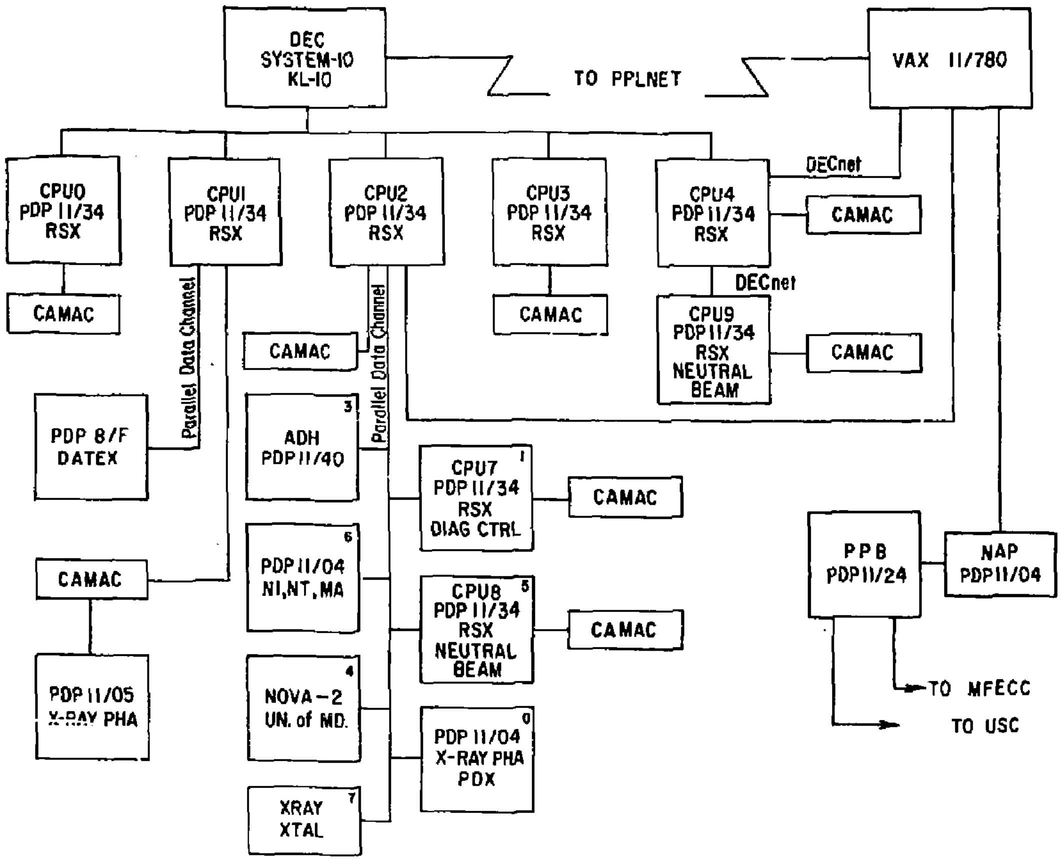


Fig. 1

#83E0114

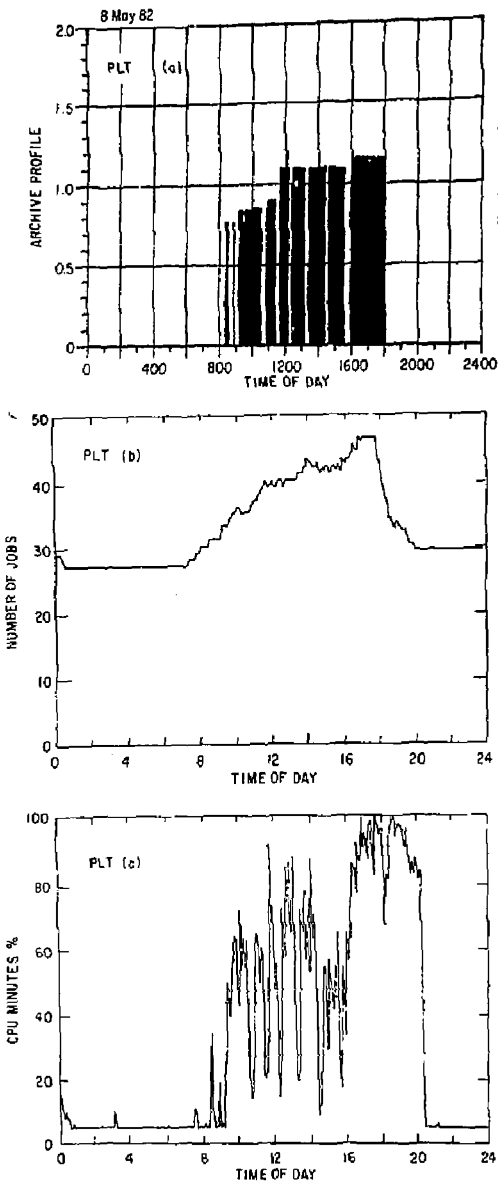


Fig. 2
(a,b,c)

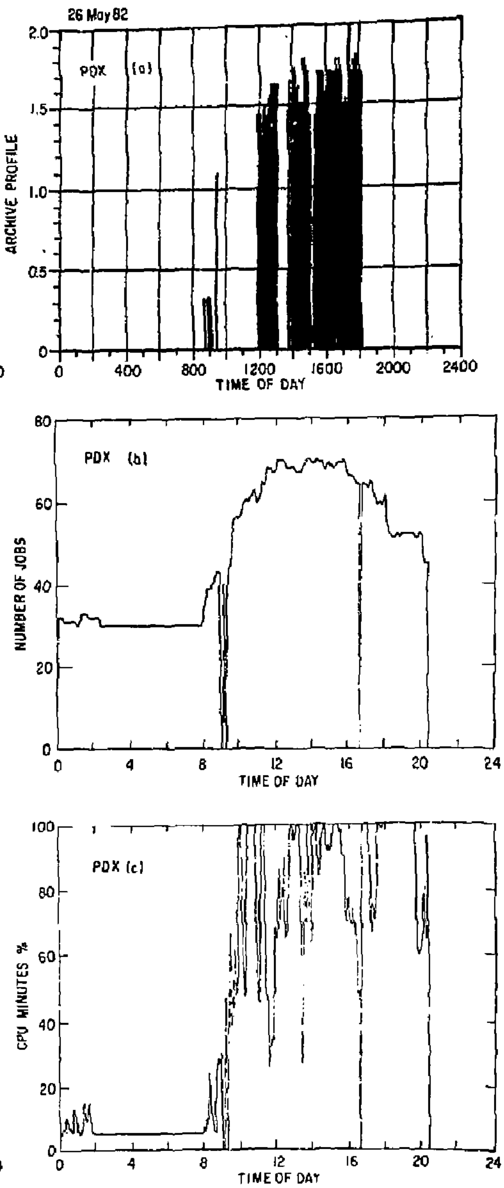


Fig. 3
(a,b,c)

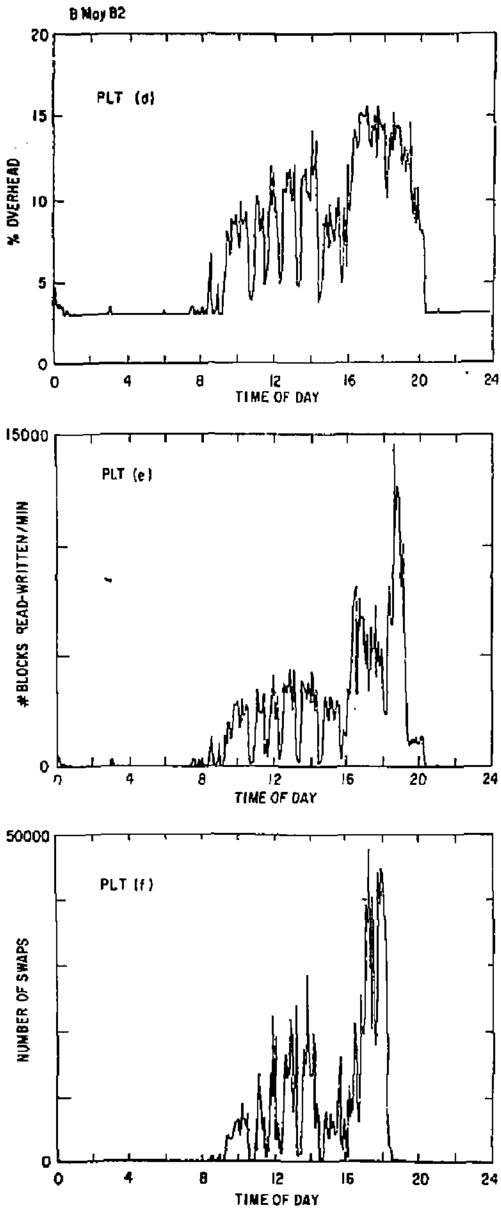


Fig. 2
(d,e,f)

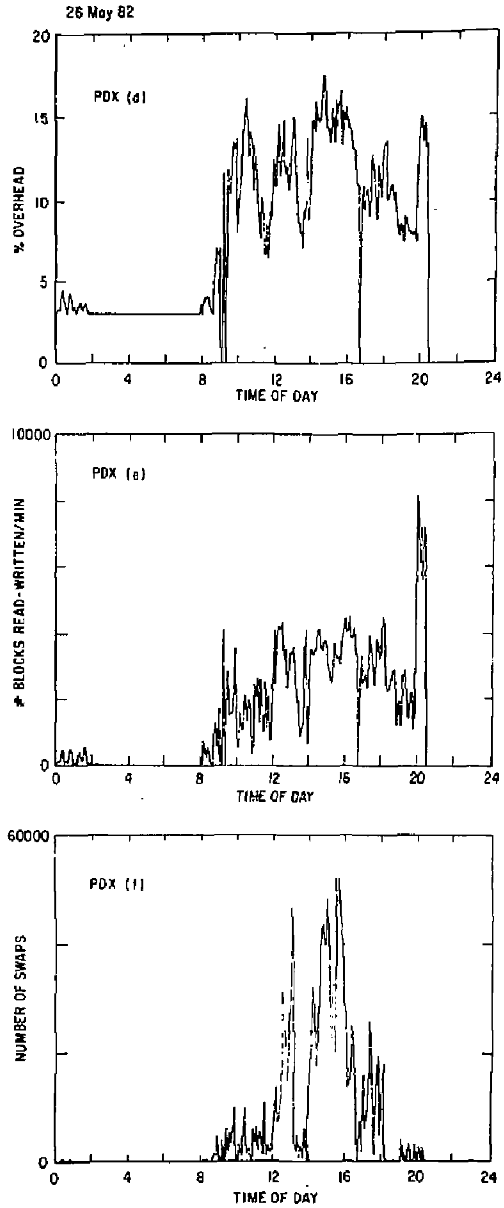


Fig. 3
(d,e,f)

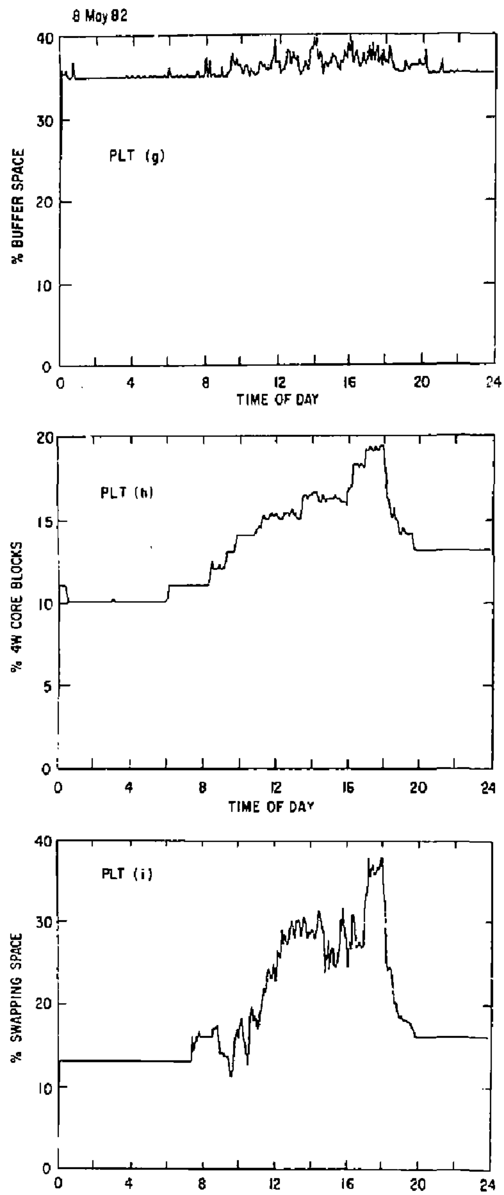


Fig. 2
(g,h,i)

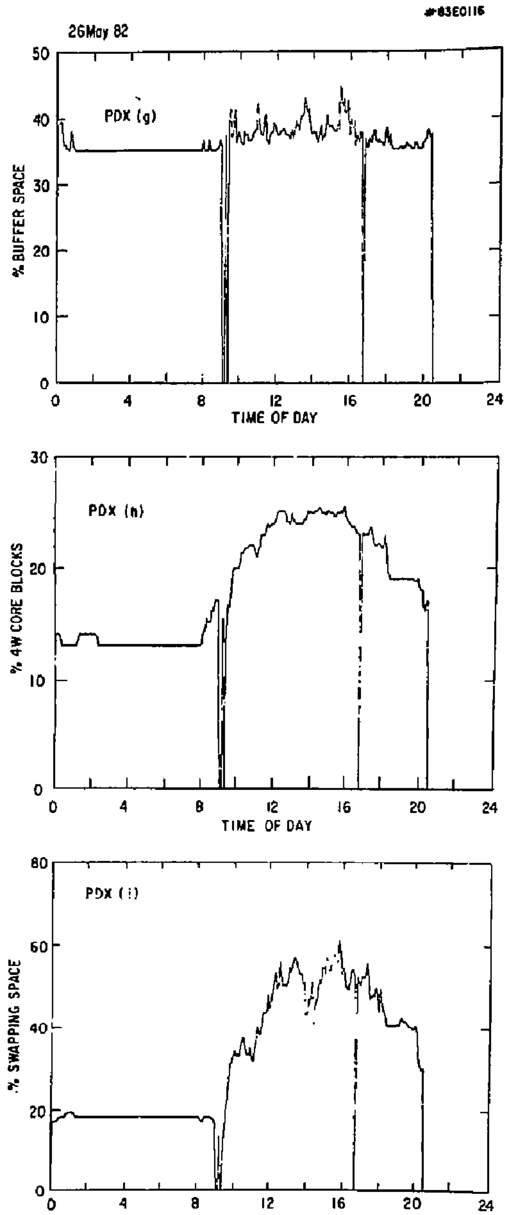


Fig. 3
(g,h,i)

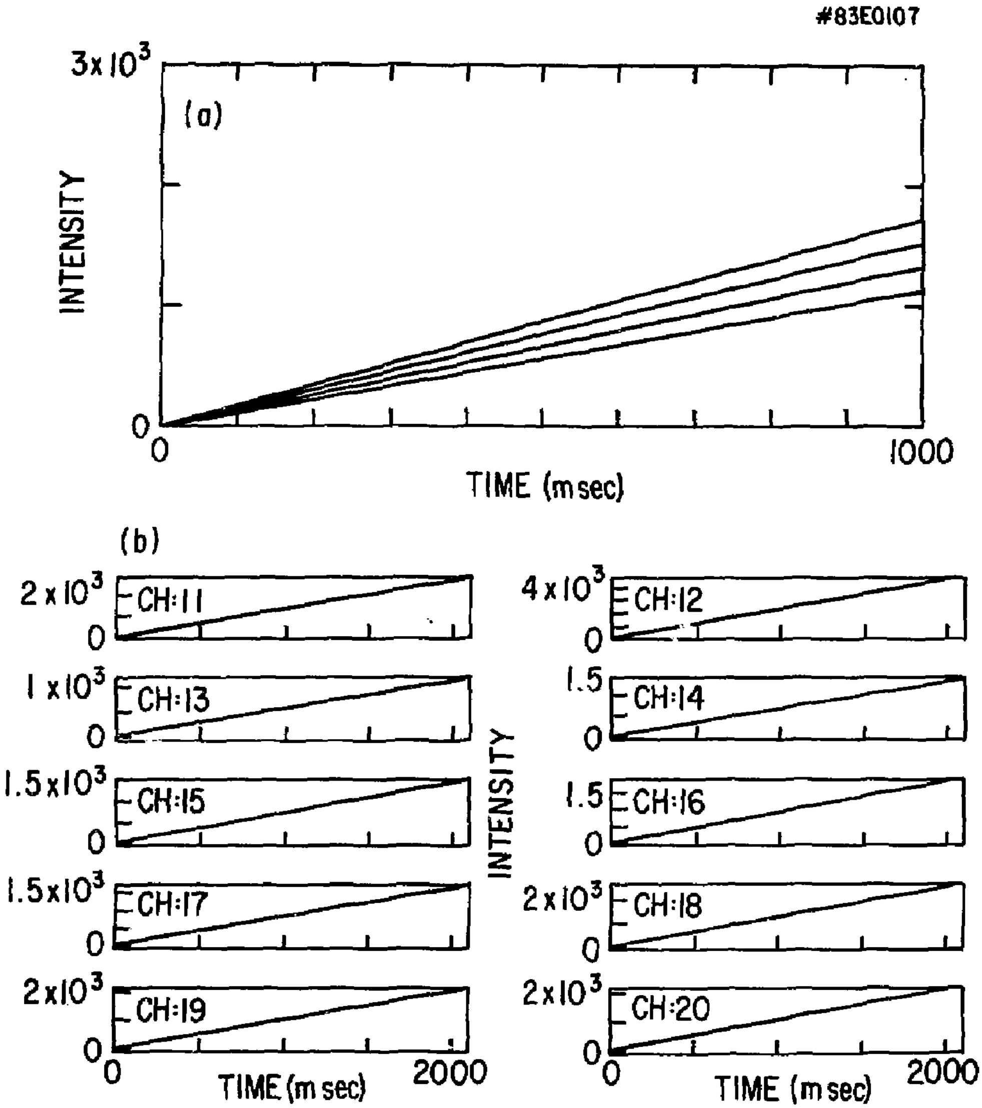

#83E0107
3x10^3
(a)
INTENSITY
0
0
1000
TIME (msec)
(b)
2x10^3
CH:11
0
4x10^3
CH:12
0
1x10^3
CH:13
0
1.5
CH:14
0
1.5x10^3
CH:15
0
INTENSITY
1.5
CH:16
0
1.5x10^3
CH:17
0
2x10^3
CH:18
0
2x10^3
CH:19
0
0
TIME (msec)
2000
2x10^3
CH:20
0
0
TIME (msec)
2000

Fig. 4

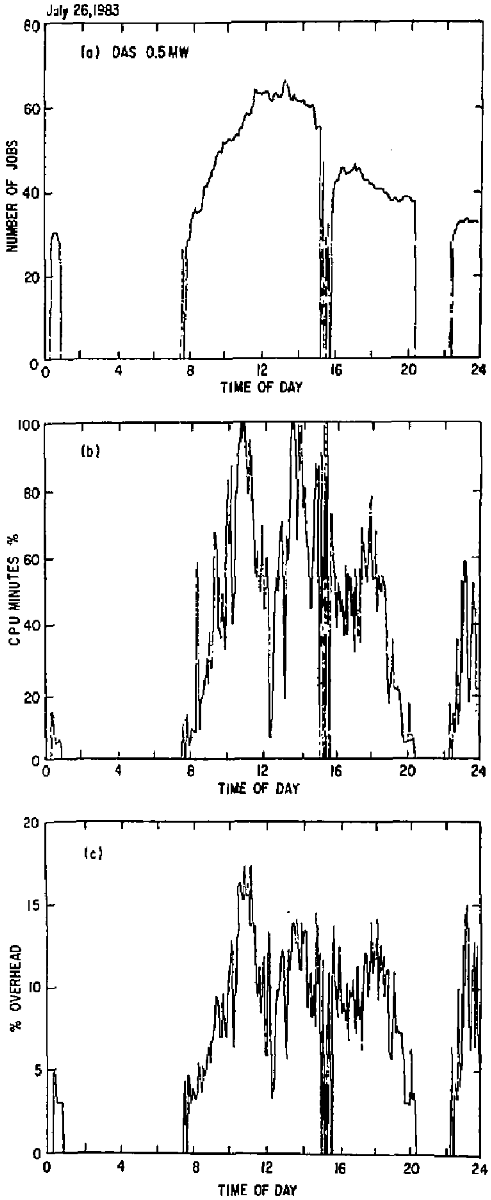


Fig. 5
(a,b,c)

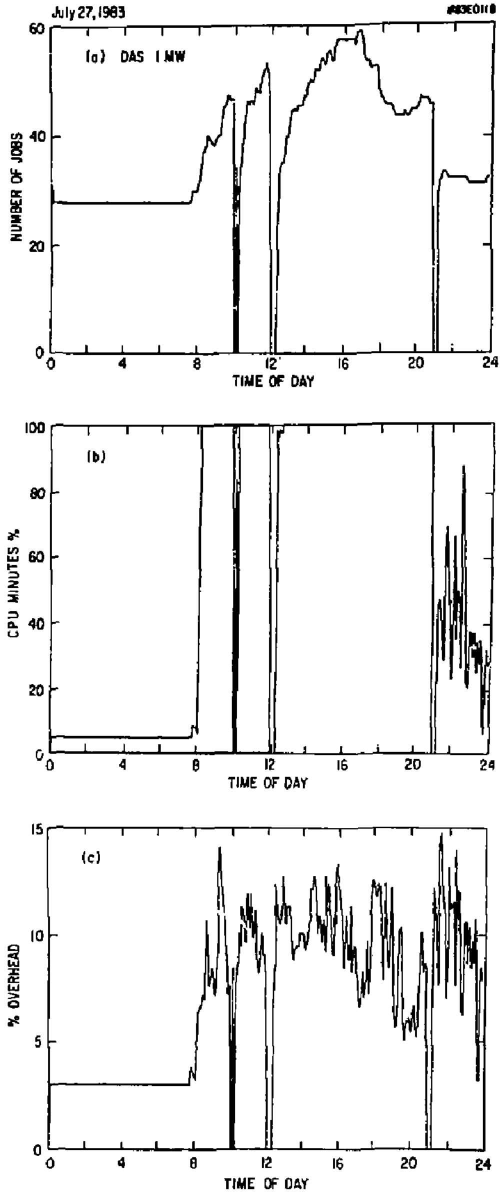


Fig. 6
(a,b,c)

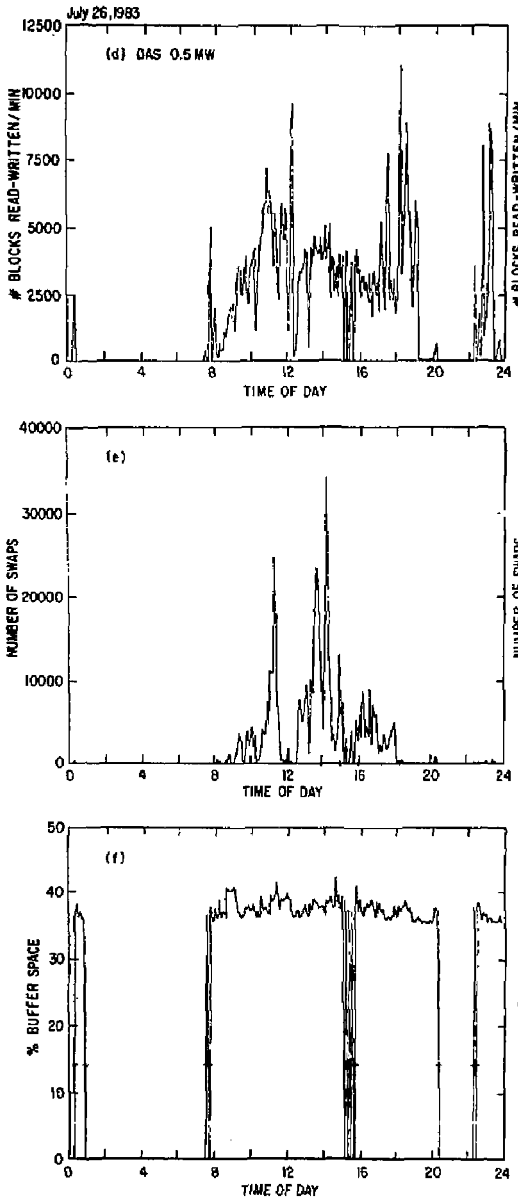


Fig. 5
(d,e,f)

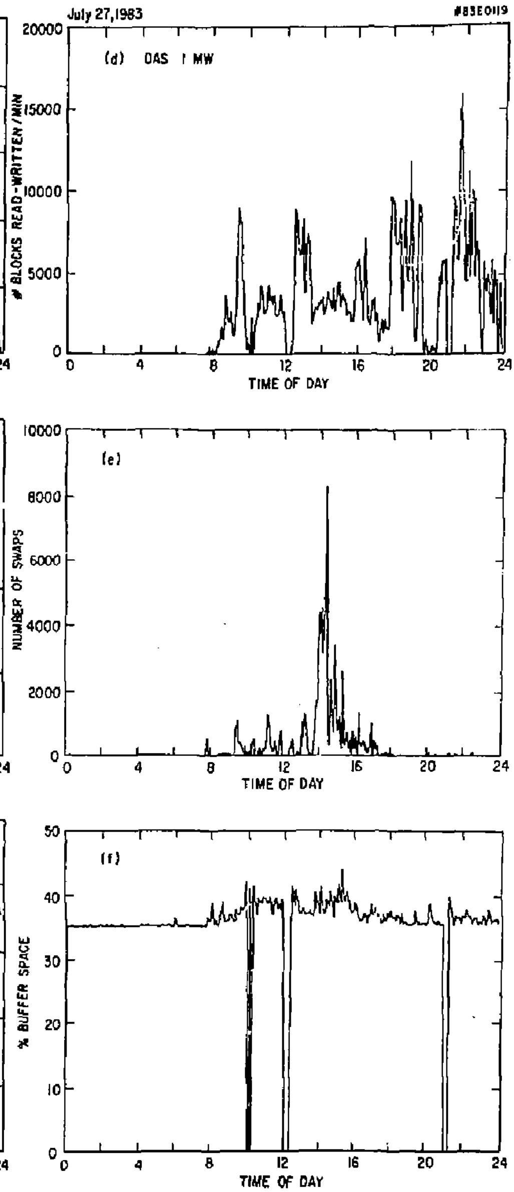


Fig. 6
(d,e,f)

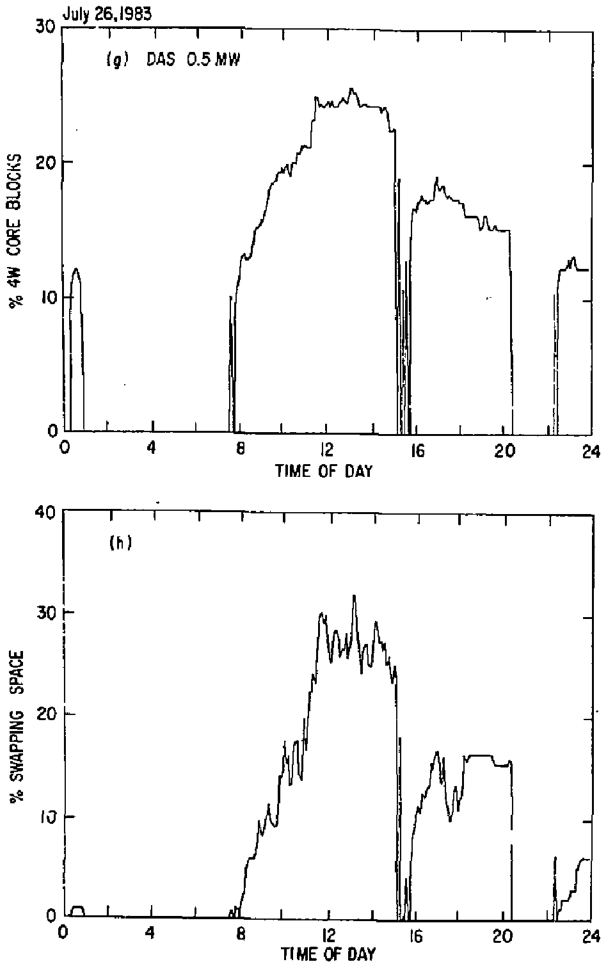


Fig. 5
(g,h)

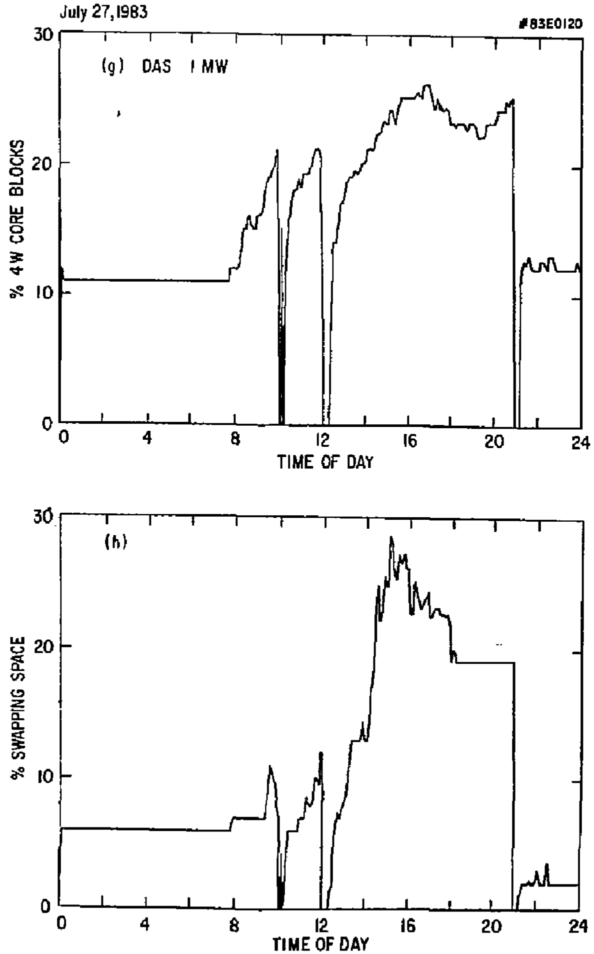


Fig. 6
(g,h)

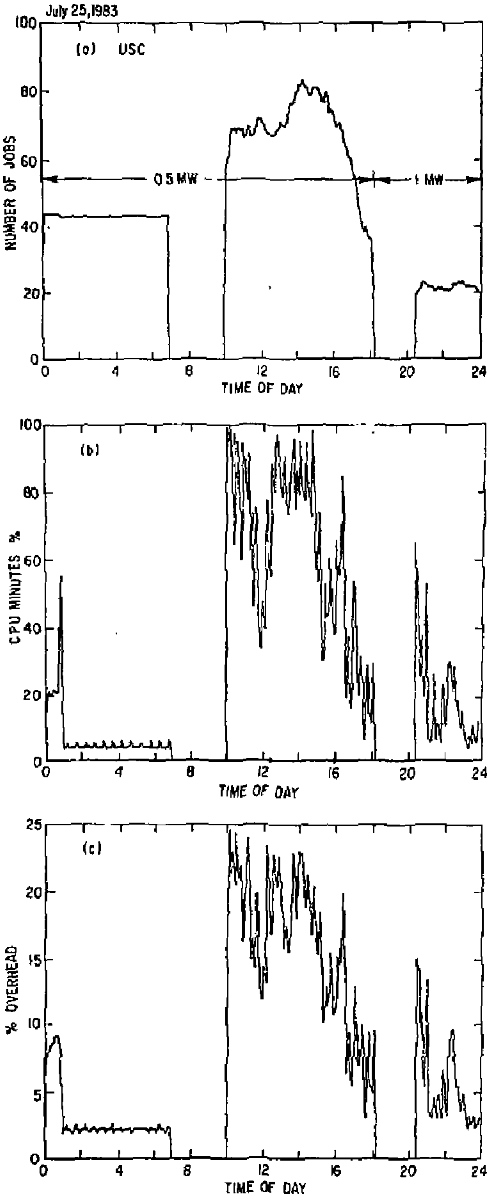


Fig. 7
(a,b,c)

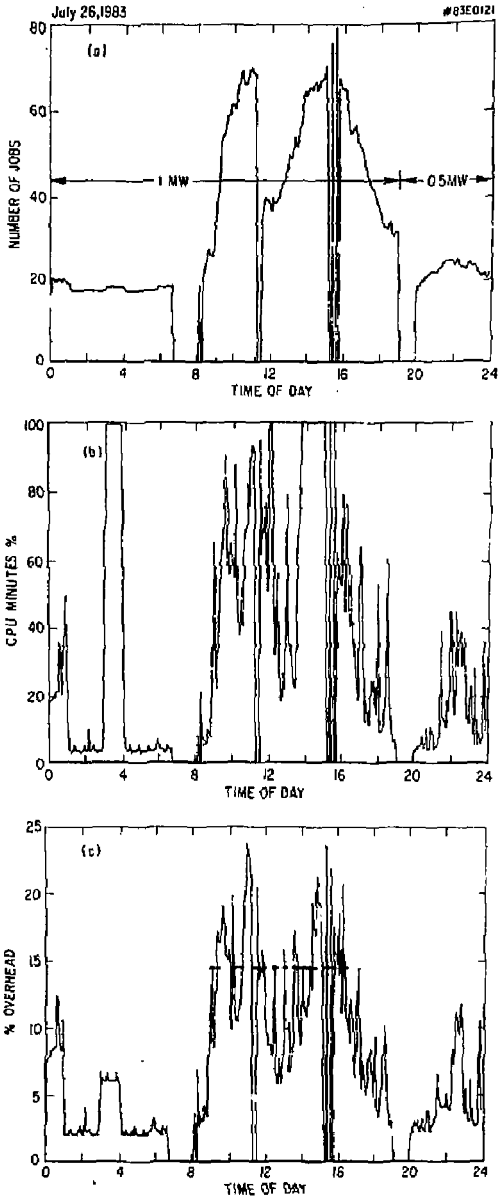


Fig. 8
(a,b,c)

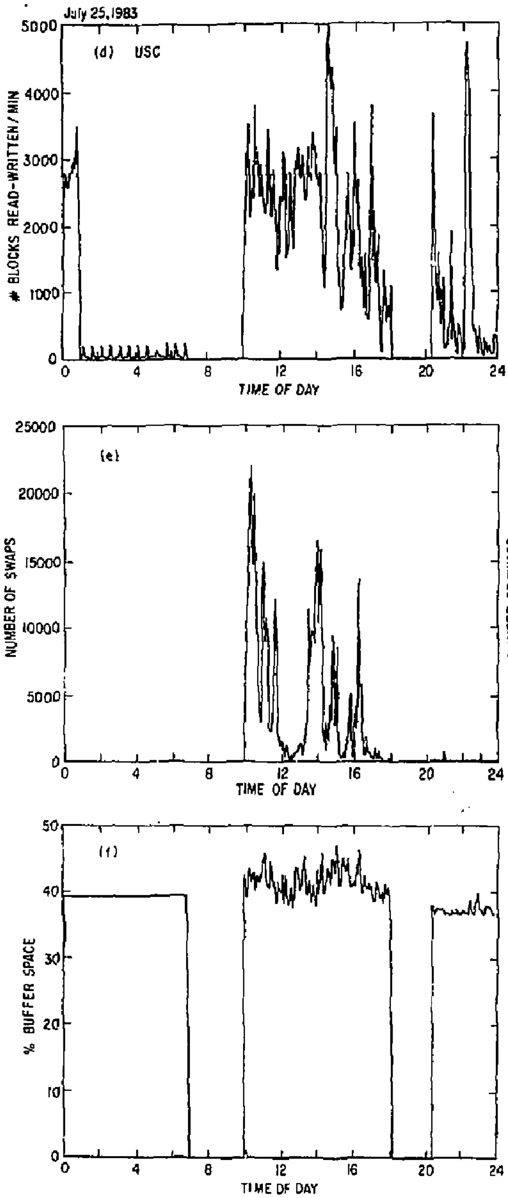


Fig. 7
(d,e,f)

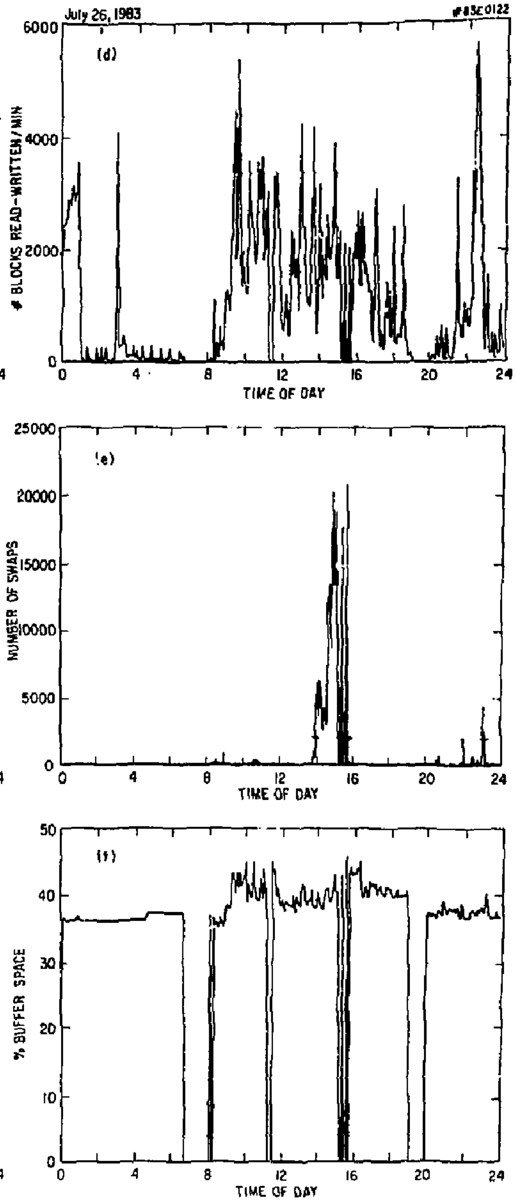


Fig. 8
(d,e,f)

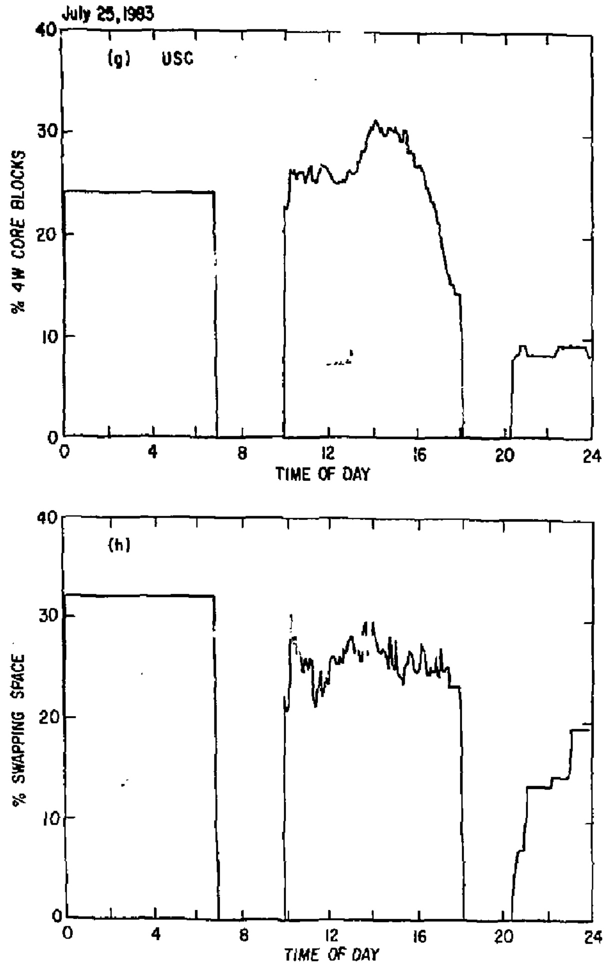


Fig. 7
(g,h)

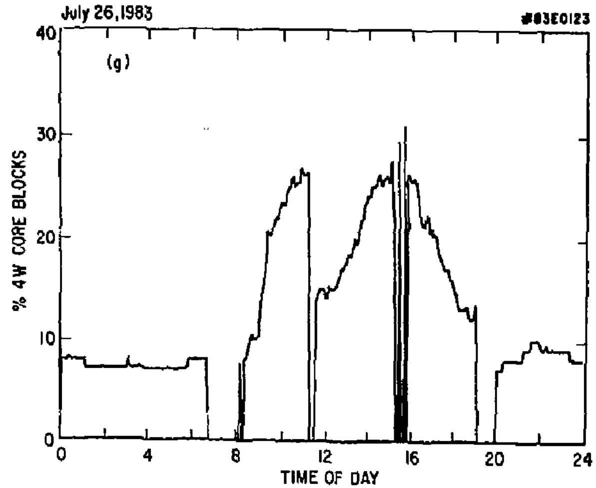


Fig. 8
(g)

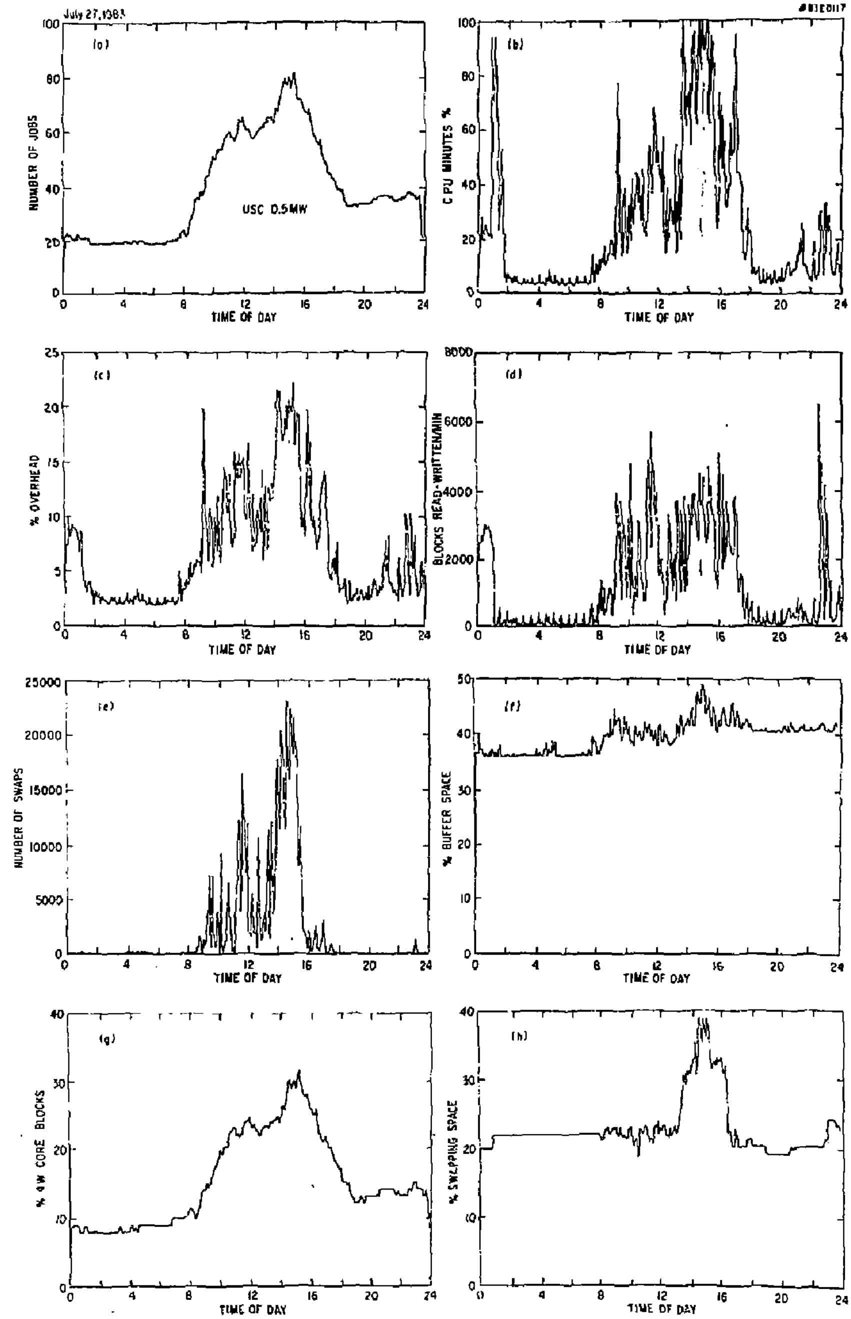
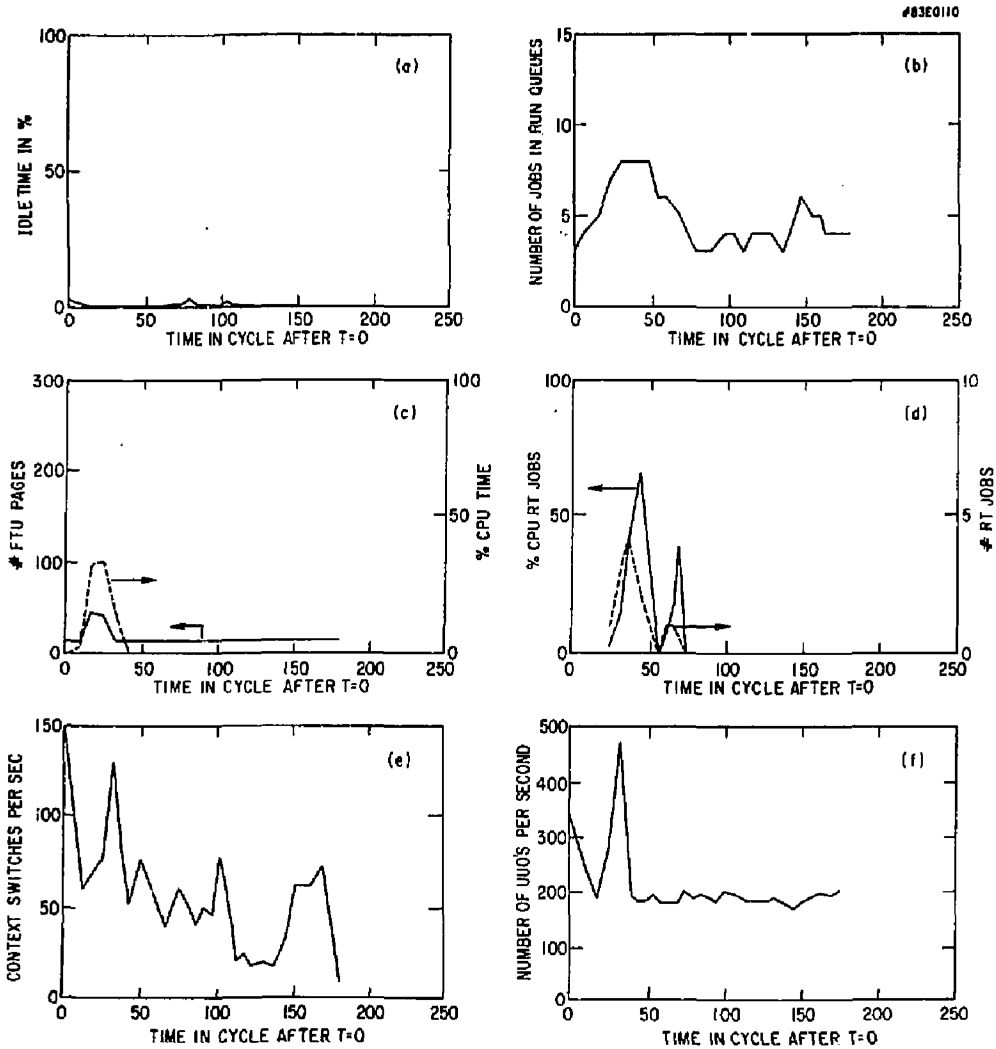
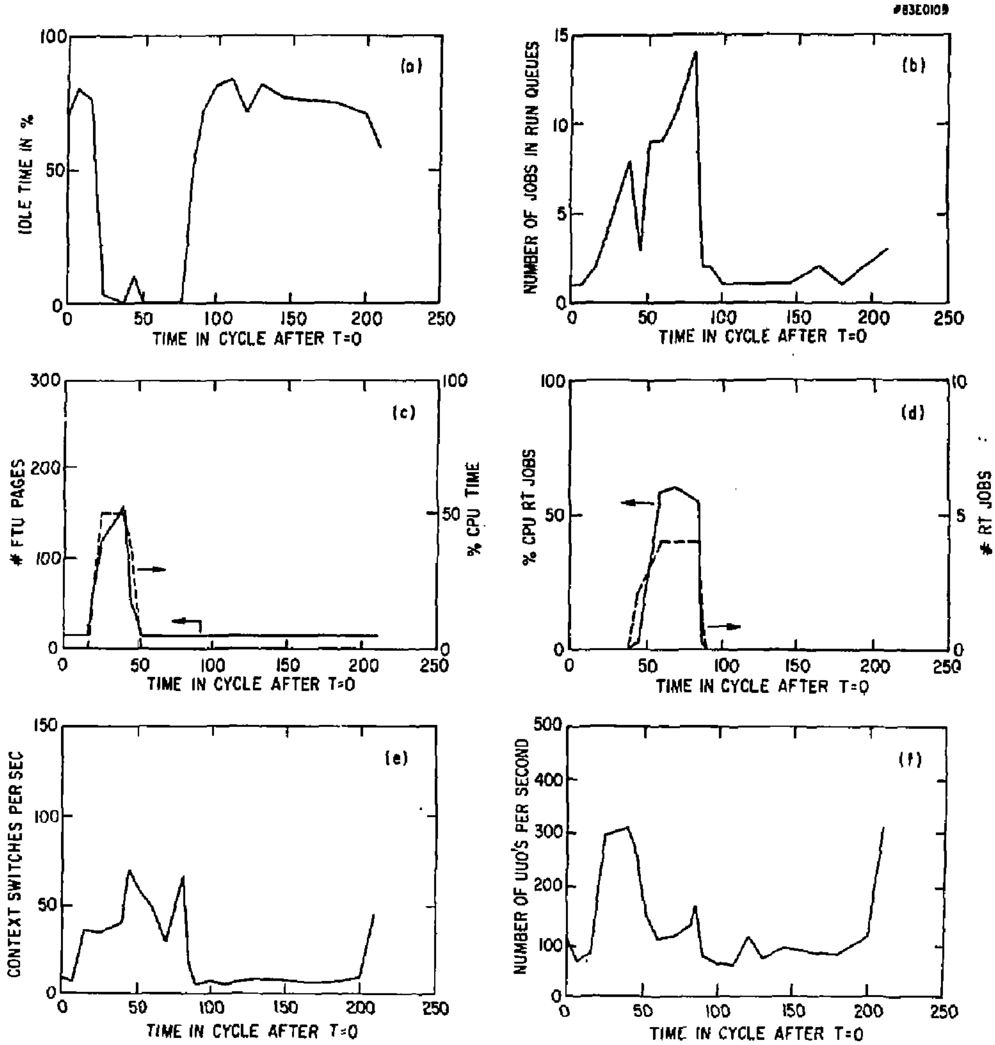

July 27,1983
(a)
NUMBER OF JOBS
USC 0.5MW
TIME OF DAY
(b)
CPU MINUTES %
TIME OF DAY
(c)
% OVERHEAD
TIME OF DAY
(d)
BLOCKS READ-WRITTEN/MIN
TIME OF DAY
(e)
NUMBER OF SWAPS
TIME OF DAY
(f)
% BUFFER SPACE
TIME OF DAY
(g)
% 4W CORE BLOCKS
TIME OF DAY
(h)
% SWAPPING SPACE
TIME OF DAY

Fig. 9



#83E0110
(a)
IDLE TIME IN %
TIME IN CYCLE AFTER T=0
(b)
NUMBER OF JOBS IN RUN QUEUES
TIME IN CYCLE AFTER T=0
(c)
FTU PAGES
% CPU TIME
TIME IN CYCLE AFTER T=0
(d)
% CPU RT JOBS
# RT JOBS
TIME IN CYCLE AFTER T=0
(e)
CONTEXT SWITCHES PER SEC
TIME IN CYCLE AFTER T=0
(f)
NUMBER OF UUO'S PER SECOND
TIME IN CYCLE AFTER T=0

Fig. 10



#83E0109
(a)
IDLE TIME IN %
TIME IN CYCLE AFTER T=0
(b)
NUMBER OF JOBS IN RUN QUEUES
TIME IN CYCLE AFTER T=0
(c)
FTU PAGES
% CPU TIME
TIME IN CYCLE AFTER T=0
(d)
% CPU RT JOBS
# RT JOBS
TIME IN CYCLE AFTER T=0
(e)
CONTEXT SWITCHES PER SEC
TIME IN CYCLE AFTER T=0
(f)
NUMBER OF UUO'S PER SECOND
TIME IN CYCLE AFTER T=0

Fig. 11

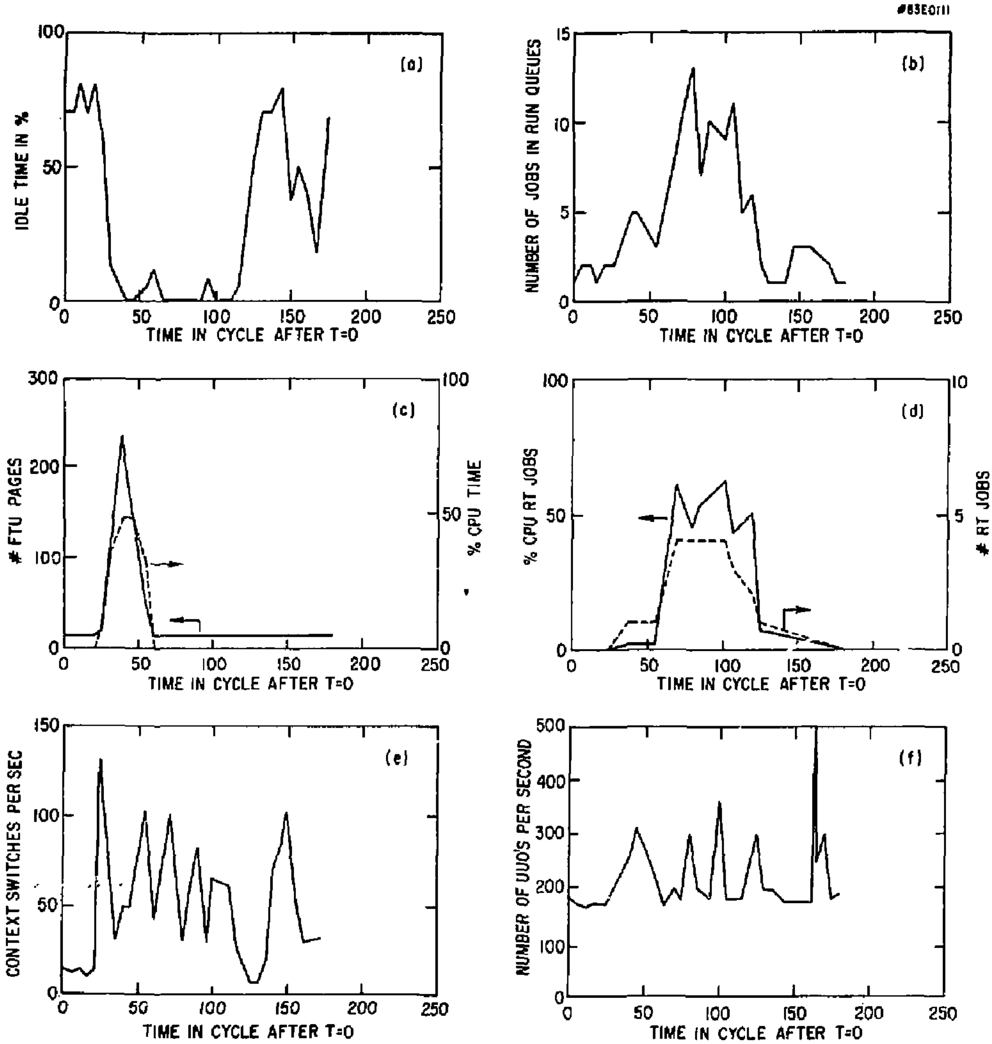

#83E0111
(a)
IDLE TIME IN %
TIME IN CYCLE AFTER T=0
(b)
NUMBER OF JOBS IN RUN QUEUES
TIME IN CYCLE AFTER T=0
(c)
FTU PAGES
% CPU TIME
TIME IN CYCLE AFTER T=0
(d)
% CPU RT JOBS
# RT JOBS
TIME IN CYCLE AFTER T=0
(e)
CONTEXT SWITCHES PER SEC
TIME IN CYCLE AFTER T=0
(f)
NUMBER OF UUO'S PER SECOND
TIME IN CYCLE AFTER T=0

Fig. 12

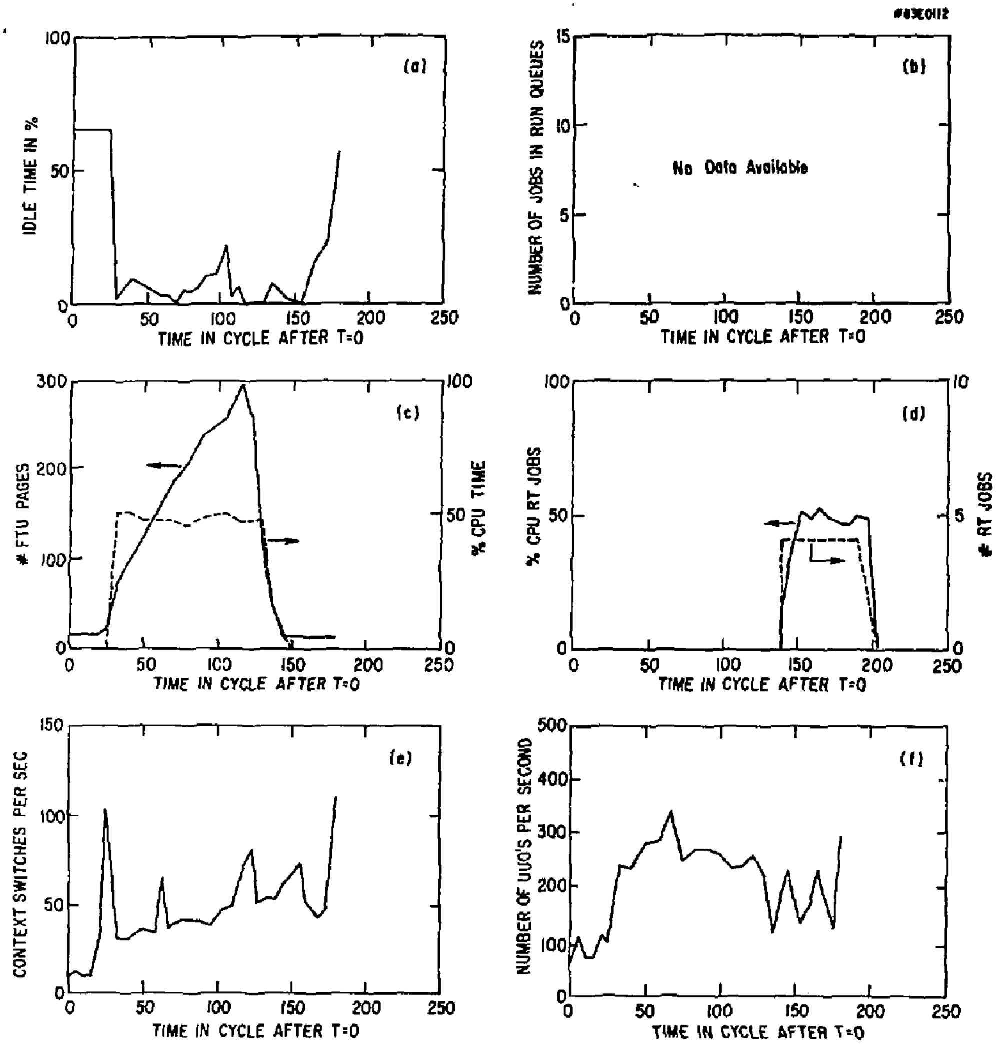

#83E0112
(a)
IDLE TIME IN %
TIME IN CYCLE AFTER T=0
(b)
NUMBER OF JOBS IN RUN QUEUES
No Data Available
TIME IN CYCLE AFTER T=0
(c)
FTU PAGES
% CPU TIME
TIME IN CYCLE AFTER T=0
(d)
% CPU RT JOBS
# RT JOBS
TIME IN CYCLE AFTER T=0
(e)
CONTEXT SWITCHES PER SEC
TIME IN CYCLE AFTER T=0
(f)
NUMBER OF UUO'S PER SECOND
TIME IN CYCLE AFTER T=0

Fig. 13

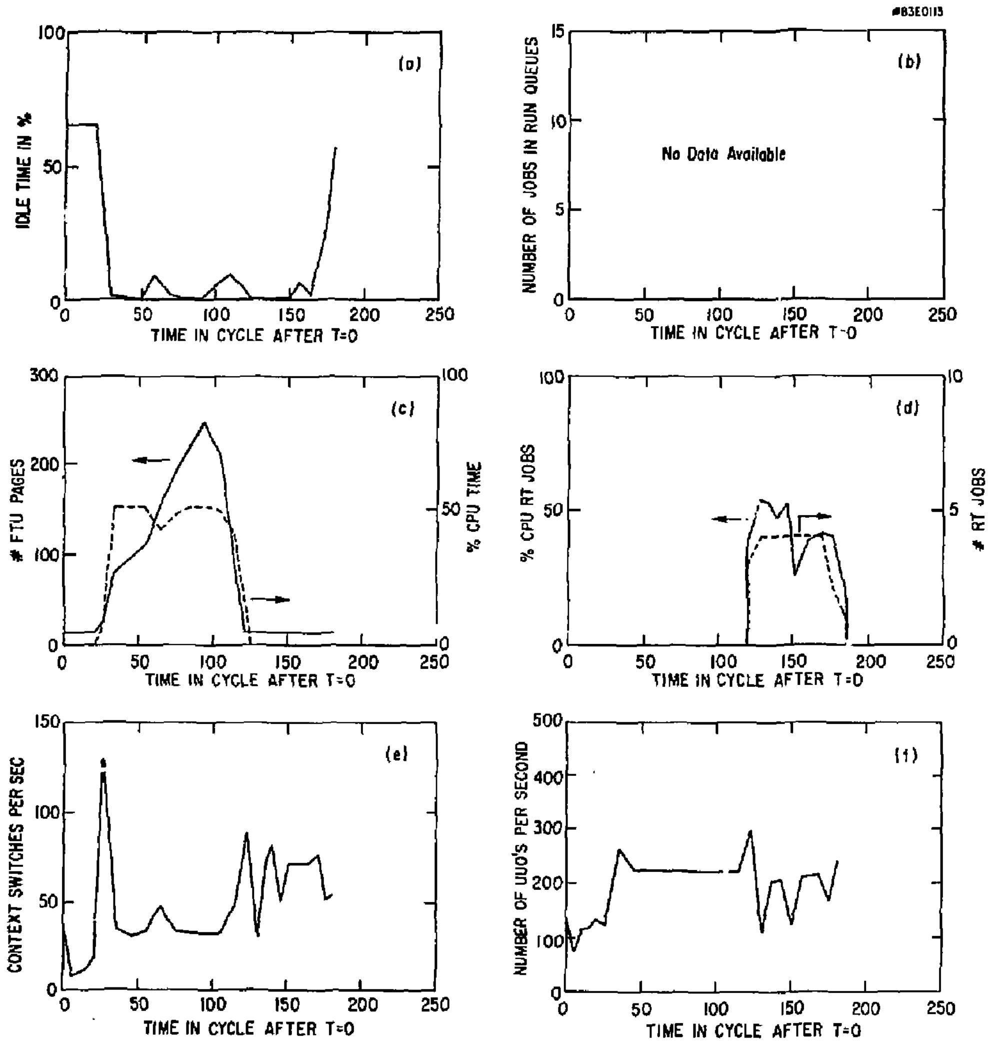

#83E0115
IDLE TIME IN %
(a)
TIME IN CYCLE AFTER T=0
NUMBER OF JOBS IN RUN QUEUES
(b)
No Data Available
TIME IN CYCLE AFTER T=0
FTU PAGES
% CPU TIME
(c)
TIME IN CYCLE AFTER T=0
% CPU RT JOBS
# RT JOBS
(d)
TIME IN CYCLE AFTER T=0
CONTEXT SWITCHES PER SEC
(e)
TIME IN CYCLE AFTER T=0
NUMBER OF UUO'S PER SECOND
(f)
TIME IN CYCLE AFTER T=0

Fig. 14

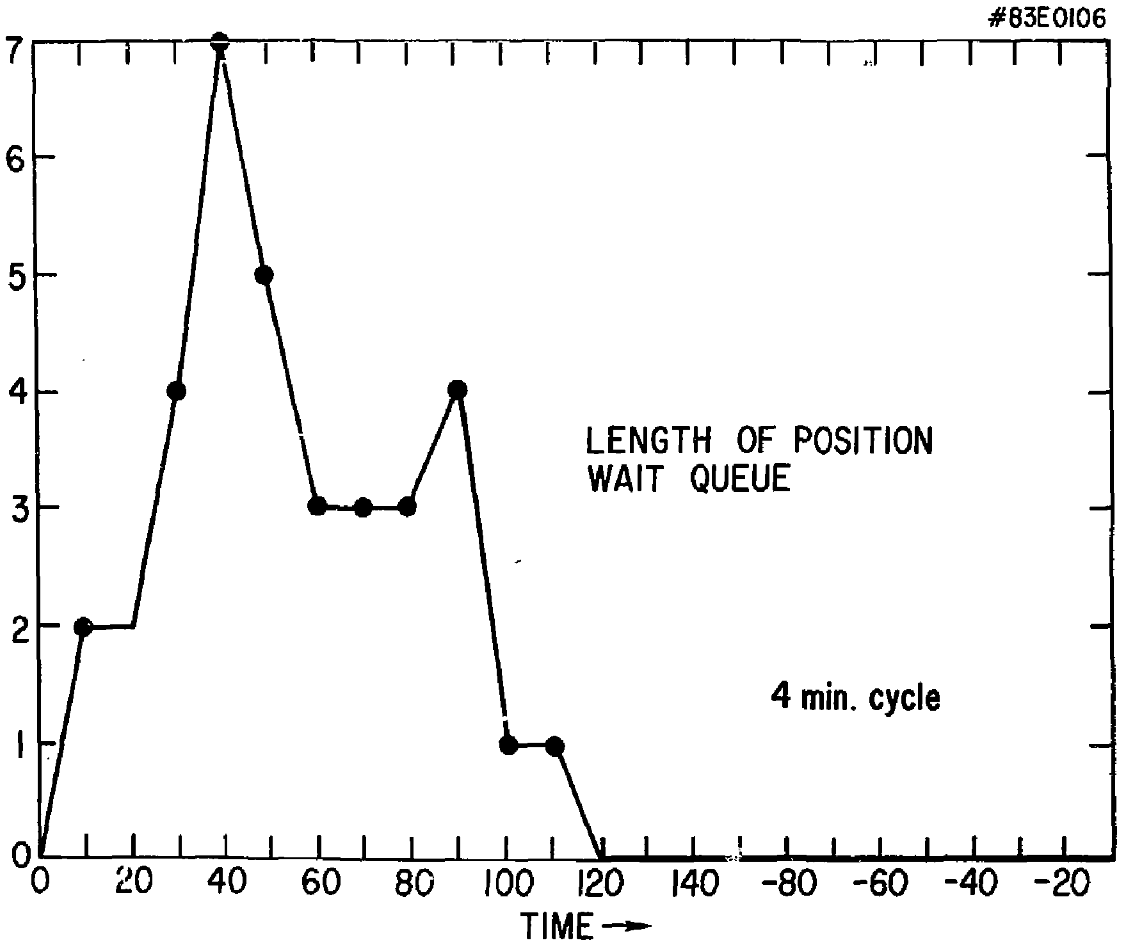

#83E0106
7
6
5
4
3
2
1
0
0
20
40
60
80
100
120
140
-80
-60
-40
-20
TIME →
LENGTH OF POSITION
WAIT QUEUE
4 min. cycle

Fig. 15

#83E0105

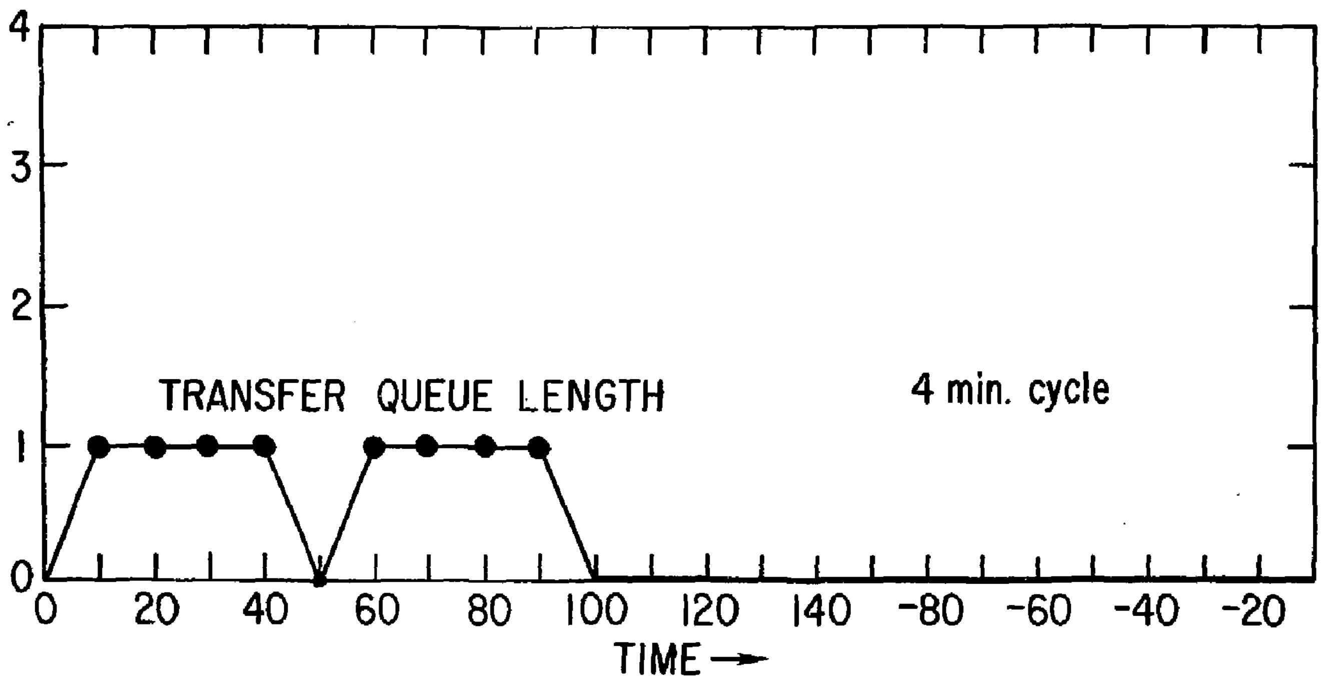


Fig. 16

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