

A PERFORMANCE EVALUATION OF A  
CDC 6600 COMPUTER

---

A THESIS

PRESENTED TO  
THE FACULTY OF THE DEPARTMENT OF COMPUTER SCIENCE  
UNIVERSITY OF HOUSTON

.....  
.....  
IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE  
MASTER OF SCIENCE

---

Paula B. Hawthorn

December, 1974

## ACKNOWLEDGEMENT

I wish to gratefully acknowledge the help of George Spix, a fine system programmer and person. Steve Sherman deserves special thanks for his patience and confidence.

ABSTRACT  
A PERFORMANCE EVALUATION OF A  
CDC 6600 COMPUTER

A THESIS  
PRESENTED TO  
THE FACULTY OF THE DEPARTMENT OF COMPUTER SCIENCE  
UNIVERSITY OF HOUSTON

IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE  
MASTER OF SCIENCE

Paula B. Hawthorn

December, 1974

## ABSTRACT

This thesis describes a software probe of a CDC 6600. Included are a description of the Kronos operating system, histograms of total channel wait and holding times, channel wait and holding times by system function, peripheral processor wait and holding times by peripheral processor routine, number of free peripheral processors, total time per job by type, CPU time per job by type, time between roll out, time between I/O request, and wait time for field length changes. An analysis of the data is included.



## INTRODUCTION

This thesis presents a performance evaluation of the CDC 6600 computer, under the Kronos 2.1 operating system. The evaluation was done by use of an event-driven probe imbedded in the operating system. The results of the probe are written to disk and the disk files later analyzed.

In Chapter One we present the goals and some of the previous work done in the field of performance evaluation; Chapter Two is an explanation of the probe, the CDC 6600 computer, and the Kronos operating system. Chapter Three is the data; Chapter Four, an explanation of the data and the conclusions drawn.

## TABLE OF CONTENTS

ACKNOWLEDGEMENT .....	i
ABSTRACT .....	iii
INTRODUCTION .....	iv
CHAPTER ONE: GOALS OF PERFORMANCE EVALUATION .....	I-1
Types of Monitors .....	I-1
Goals of Performance Evaluation .....	I-3
CHAPTER TWO: THE CDC 6600 .....	II-1
Hardware Architecture .....	II-1
Operating System .....	II-3
System Philosophy .....	II-5
The Software Probe .....	II-7
Analysis Program .....	II-8
Structure of the Program .....	II-9
CATCHPP .....	II-12
CHAPTER THREE: DATA .....	III-1
CHAPTER FOUR: ANALYSIS .....	IV-1
Channel Statistics: Histograms 1-52 .....	IV-1
Peripheral Processor Usage .....	IV-6
Process Characteristics .....	IV-9
Day File Statistics .....	IV-9
Conclusion .....	IV-14
GLOSSARY OF TERMS .....	G-1
BIBLIOGRAPHY .....	B-1

## CHAPTER ONE

### GOALS OF PERFORMANCE EVALUATION

Lucas<sup>11</sup> presents three purposes for performance evaluation: selection evaluation (to determine which of a number of machines performs best in order to determine which one to obtain); performance projection (to determine how a system still in the design phase will work); and performance monitoring (to determine how a system is working). This study is concerned with the last: performance monitoring.

#### Types of Monitors

There are two types of system monitors: hardware and software. The hardware monitors are free-standing devices with electronic probes which, when connected to the correct circuiting in the computer, counts and, perhaps, times the events probed.<sup>15</sup> Events so probed may be channel activity<sup>4</sup> or the use of certain registers. Advantages of a hardware probe include portability (the utility to use it on any system) and non-interference with the system being evaluated. The problems include the high cost and general unavailability of the hardware monitor.

A software monitor is a programmed set of instructions that, when in memory, monitor the state of the system. There are two types of software monitors: event-driven and sampling monitors. The event-driven monitors take some action upon a given event occurring; for instance, if the event being monitored is disk accesses, when the disk is accessed the

monitor will either update counters or write information in a file identifying that the event took place. A sampling monitor goes into execution at intervals (timed or random) and observes and records the state of the machine. For instance, if the disk activity is being monitored and the disk is busy 60% of the time the monitor is sampling, then the conclusion is that the disk is busy 60% of the time.

The major disadvantage with either type of software probe is the distortion caused by the probe; the system resources are certainly used by the probe and care must be taken not to distort the system to the extent that the data gathered is inaccurate. An event-driven probe will have its heaviest effect on the system when the system is most used (there being more events to record when more is happening). Software probes offer the advantage of associating events; when a hardware probe detects a read from a disk, it does not record what kind of process read the record (whether teletype or batch job) or whether the process stopped everything, waiting for the record to be read, or continued processing. Each of these associations can be made by a software probe.

The disadvantages of event-driven probes are that they are hard to maintain, not portable, and generate a great deal of data. Programming a sampling probe is very difficult; and extensive knowledge of the operating system and the machine is required, and the probe is frequently not portable from one version of the operating system to the next one, much less from one machine to another.

An event-driven probe will generate less data because of the amount of analysis done in the probe itself; therefore, there is distortion to

the system by the size of the probe. Another problem with sampling probes is that the exact sequence of events that occurred is not available; only the state of the machine at the time the sample is made is available.

The first evaluation of this system that was attempted was with a sampling monitor. The sampling program was written in Fortran and used an assembly language routine to read the system tables in memory at timed intervals. A sampling program was chosen because it is easier to write than an event-driven probe; and because if the event-driven probe, which consists of modifications to the operating system, doesn't work, the operating system doesn't work and the system fails; if the sampling program fails, only the sampling program fails. The reason we switched to using an event-driven probe is that the sampling program could not operate on a fine enough time scale; being in user mode, it could not sample quickly enough to catch those sequences of events which happened very quickly. The probe in its final form is an event-driven monitor. Also, some events of interest are not in the system tables.

#### Goals of Performance Evaluation

Computers and operating systems have grown in complexity since the time that the time that an add instruction took was considered a major factor in the evaluation of a computer.<sup>11</sup> With the current complexity of systems, the data needed to measure the system has grown in volume and the measurements themselves have become very sophisticated. What we monitor and use for our evaluation is dependent upon the goal of the

evaluation and the criteria for performance. Fine, Jackson, and McIsaac<sup>6</sup>, in their 1966 study, were attempting to determine the number of off-page references a program in execution would make if memory were partitioned into pages. So they used a software probe to capture each memory reference and determine if that reference would be off-page.<sup>1</sup> Pinkerton,<sup>13</sup> in his dissertation, was interested in storage algorithms and used a software probe to determine the state of the system before and after improvements suggested by his study. He published statistics dealing with I/O delays, page request delays, CPU intervals, and terminal I/O delays. In Shemer and Heying's study<sup>16</sup> of a system designed for both batch and terminal users, they modelled the system response to an increased number of users. They then validated their model by probing the system to determine if the response function was, in fact, as they had modelled it to be. So they monitored response time to on-line demands, and percentage of CPU time available for batch jobs.

The Fuchs and Jackson<sup>7</sup> study of various systems was to determine if certain functions of teletype users could be fit to standard distribution curves. This is an attempt to characterize the use of the systems and is one of the major reasons for performance evaluation. The statistics they were interested in concerned such measurements as think time and characters per user and computer burst time. These were measured and fit to poisson, gamma, geometric and log-normal distributions. The study by Fuller, Price, and Wilhelm<sup>8</sup> takes this type of analysis one step further by directly addressing the problem: queueing theory models of certain functions of operating systems (like disk service request handlers) make certain

assumptions about the nature of the service requests (usually, that they are exponential). They wanted to find out if those assumptions were valid. The Fuller, Price, and Wilhelm study was concerned with CPU burst times and that is what they monitored.

The Margolin, Parmelee, and Schatzoff<sup>12</sup> study was aimed at discovering what memory sizes the programs running on their system required, so that memory could be pre-partitioned into the more heavily used sizes. So they measured the sizes of buffers, the extant time of buffers, and the number of requests for buffers.

Noe and Nutt<sup>14</sup> were interested in validating a trace-driven model of a CDC 6400. They did this by analyzing the day file provided by the operating system. The day file is a recording of such statistics as program size and job turnaround time. The figures Noe and Nutt believed important were: job dwell time at control point; job dwell time in output queue; job turnaround time, number of control points in use (from a sampling monitor, not the day file); program size, job dwell time in input and staging queues.

In her thesis Eleanor Lester<sup>10</sup> investigated service time distributions: that is, job turnaround time and CPU time. She was interested in these distributions to determine if they fit any of the standard distribution curves. In John Boyse's<sup>2</sup> study of execution characteristics of a page on demand system a more detailed approach is taken: he is interested in such measurements as page waits, number of I/O requests per run, I/O time per run, real and virtual pages per I/O and CPU interval. An attempt was made to fit some of the data to standard distributions.

In each of the above studies there was a narrowing of focus: the primary objective is clearly defined and the data gathered from the monitor to meet that objective.

In our study, however, we have a broader goal: to determine how efficiently the machine is being used. To find where there are bottlenecks, and what can be done to remove them. We want to find out how well the system is performing.

The following four studies are general studies of computer systems: two are published articles, two dissertations. The Badger, Johnson, and Philips<sup>1</sup> study of the Pitt time sharing system on an IBM 360 focused on CPU utilization by job type, time spent in user, supervisor, I/O overhead and idle states and the transition probabilities of moving from one state to another, and time slots given to one user before seeking another.

Bryan's<sup>3</sup> study of the JOSS system focused on number of users per month, interpretation rates for the interpreter, characters input per second per user, output characters per user, user program size, user session time, user compute size, compute bursts, total task turnaround time, and interaction time.

Jalics'<sup>9</sup> dissertation is a performance evaluation of the PDP10. He studies runtime (CPU time) between I/O, realtime between I/O, processor queues, disk wait queues, terminal I/O queues, job queues, swaps, file accesses, terminal interactions and disk interactions.

The dissertation by Schwetman<sup>15</sup> is a performance evaluation of a CDC 6600. In it he studies disk channel availability, pool peripheral processor availability, disk half-track scattering, control point availability and central memory availability.



Both Schwetman and Jalics cite the need for more definitive studies of computer systems. Data is needed about how large-scale systems actually respond to the demands placed on them; data is also needed about the nature of the demand. Schwetman gives three reasons that empirical data about systems in operation are needed:

1. to increase the knowledge of system structure and component interactions, in order to increase productivity and reliability;
2. to verify and calibrate the results of theoretical methods of analysis;
3. to evaluate the cost-effectiveness of changes to the system.

Jalics mentions that the lack of real data on the behavior of systems limits the progress of the development of queueing theory models of aspects of the operating system.

The data that we are interested in can be broken down into two classifications: data corresponding to the user demand upon the system, and data corresponding to the system response to the demand. When Schwetman studies the availability of the channels, central memory, peripheral processors, and control points, he was studying a combination of the system response and the demand. He also introduces the concept of "balance of resources" which is a numerical figure corresponding to the ratio of the holding time of a resource to the sum of the wait time plus hold time. This ratio is an expression of the response plus demand, and we will investigate the balance ratio for each of the system resources that we study.

Jalics separated the demand from the response more clearly in his study. In studying the length of wait queues, he was studying the response of the system. In studying think and type times, disk references per terminal interaction, runtime-between-I/O, job core size per terminal interaction, he is studying the demand upon the system.

So, we are interested in the demand for resources in the system and system response to that demand. Typical large-scale computer systems have three main resources: central memory, I/O channels, and central processing unit. The CDC 6600, subject of this study, has peripheral processors, which are similar to intelligent channels, that are also system resources.

We will study the demand, and system response to that demand, for each of these resources. We will also separate the demand by job type (batch or teletype) so that we can have a precise picture of what an increase in teletype activity will do to the batch system.

## CHAPTER TWO

### THE CDC 6600

#### Hardware Architecture

This explanation is heavily dependent on J. E. Thornton's explanation of the machine in his book, Design of a Computer: The Control Data 6600.

The CDC 6600 under study has a central storage size of 131 K 60-bit (octal) words. It has a single central processing unit, and 10 peripheral processors.

The peripheral processors are an interesting and unique feature of CDC machines. The design philosophy behind the peripheral processors is that the input-output processing can be handled by small, central-processor-unit independent processors. So the only access that the twelve I/O channels have to the central storage is through the peripheral processors.

Each peripheral processor has 4096 12-bit words. There is a separate instruction set for the peripheral processors, and they are loaded, from central memory, by special instructions. They are not actually 10 separate, independently operating devices, but are constructed with their registers in the form of a barrel. The barrel contains 10 positions, one for each peripheral processor. Each position contains space for the 4 peripheral processor registers. The major cycle on the peripheral processors is 1000 nanoseconds; the minor cycle 100 nanoseconds. One position in the barrel is the "slot." The slot has the circuiting to connect

it to the storage for the peripheral processors, the channels, and central memory. Once each minor cycle all the positions in the barrel are shifted one space, so each peripheral processor has control of the slot once each major cycle, which makes the slot a time-shared device among the 10 peripheral processors without degrading the performance of any of them.

The peripheral processors are used mainly, of course, for input/output activity. System subroutines are loaded into them by the system whenever there is I/O work to be done. (This will be further explained in the section about the operating system.) But as small, independent processors they are very useful for other purposes. One is continuously occupied by the monitor that supervises the actions of the other processors and their interaction with the rest of the machine. An interesting use of a peripheral processor was to provide trace data for a trace-driven simulator.<sup>17</sup>

The configuration of the machine under study is as follows:

Channels 0 and 1 are connected to CDC 808 disks. Each device contains 6 million words of storage, with a data rate of 61 K words/sec, 50 millisecond latency time and average seek time of from 50 to 70 milliseconds. Channel 2 is not used. Channel three is connected to a controller for three tape drives. Channels 4 and 5 are connected to two 844 disk subsystems. There are 4 disks per subsystem; each disk holds 11 million words of storage. They have a data rate of 46.4 K words per second; a seek time of from 10 to 60 milliseconds; a latency time of 20 milliseconds.

Channel 6 is connected to a 6671 multiplexor for up to 16 remote batch terminals.

Channel 7 is a 6676 multiplexor for up to 64 teletype terminals.

Channel 10 (octal numbering system) is the display channel for the continuous console display.

Channel 11 is connected to another 6671 multiplexor for up to 16 remote batch terminals.

Channel 12 handles the unit record equipment: 2 printers, a card reader, and a card punch.

Channel 13 is connected to the controller for another 3 tape drives.

### Operating System

The Kronos 2.1 operating system for the CDC 6600 operates under the control of two organizing routines: CPU monitor and PP monitor. PP monitor is resident in one of the 10 peripheral processors: it calls other PP routines, or itself performs the functions of assigning equipment, assigns mass storage space (that is, disk space), assigns channels, processing day file messages (more about the day file follows), interlocks I/O and some other functions, and manages central storage.

The CPU monitor is responsible for assigning the "pool" peripheral processors (that is, those that have been assigned to user functions), moves storage, performs other user functions and is responsible for other interlocks.

The second, unique feature about this system (the peripheral processor being the first) is the organization of the multiprogramming by the

use of "control points." In the system under study there are 20 control points, but this is a variable number, specifiable at system start-up time. The control points are virtual processors. When a job is assigned a control point, it becomes eligible for execution. Each of the system functions for that job then reference the control point. If, for any reason, the job must be "rolled out"--taken out of central storage and written on mass storage, to be put in the "roll out queue" and "rolled in" later, at system or operator discretion--the control point is re-assigned to another job, if there is one waiting.

The last control point (22 in octal numbering system) is assigned to the system. The next to the last is assigned to the system process that monitors the remote data terminals (called the import/export system). The one above that (number 20) is assigned to BATCHIO, the routine that handles I/O requests from the batch process in memory. The one above that one goes to Magnet, the system process that handles the calling of the peripheral processor routines for magnetic tape operation.

Telex, the routine that handles requests from the remote teletype terminals, resides in the first control point.

This leaves 15 control points for user jobs. This is a minimum of 15 because all except the system process are processes that are not used by the associated process unless there is a need for them. There is extensive room for operator control in this system from the console. If the operator decides for any reason to not allow teletype jobs to run on a certain day, he or she can simply not assign the control point for the Telex system and no teletype can "log-on" (establish contact with) the system.

The system is organized around system tables, resident in the lower part of central storage. These tables can be read and updated by either the CPU monitor or the PP (peripheral processor) monitor. The first 100 (octal words) are used for system pointers. The next 10 hold the channel status table, which shows if a channel is busy, if so, which peripheral processor has it, and if there is one or more waiting for it. The next area is for the control points tables. There are 200 (octal) words per control point; included are the exchange package area which includes information about the job status, and register contents, when the execution of this program is stopped and "control" given to another program.

Also information about the job is kept: maximum time allowed, maximum mass storage space, etc. There are two message areas.

After the control point tables, there is the peripheral processor communication area. The contents of the PP input and output registers, the name of the PP program holding that PP, the control point for which the service is being performed, and a message buffer are stored in the PP communications area in areas of 10 words each.

The rest of the tables are fairly standard file directories, file status and library, and day file (accounting) tables.

### System Philosophy

This is a request/acknowledge system, as opposed to the other major computer architecture, the interrupt system. The advantage to a request/acknowledge system is the purity and discipline of design<sup>18</sup> this makes possible. Interrupt-driven systems are usually difficult to debug and

difficult to program. However, the original design purity has been changed to allow for the "exchange jump" by a peripheral processor to interrupt the CPU at any time. Ordinarily, however, requests for service are on a request/acknowledge basis.

The operating sequence of events is as follows:

The PP monitor program is in control. It scans the output registers of the other peripheral processors to determine if any require a service it can perform (the name of the service is in the output register). If so, it performs that service and zeroes the output register, to allow the PP program to know that the service was performed. It also determines if the time-slice for the program that has control of the CPU is up; if so, it initiates the change of control to another program. It also scans the request-service area of the job in control of the CPU to determine if there is a request for service that it can perform. (This area is a word at the location of the starting relative address of the process, plus one. Hence, the term "RA + 1 call"). If so, it performs the service and clears the word to allow the process to know the service has been performed.

Now, let us assume the program that was given its time-slice was the system. It also will scan the relative-address + 1 of the other central points, plus the PP output registers, to determine if there is a need for service. There are services that either the PP or CPU monitor can perform--whoever sees the call first handles it, and clears the register or word.



There is no virtual storage on this machine; the central memory storage space is a contiguous segment per process. Processes are rolled out or moved around in memory to allow space to be used by another process. The space for each process is called its "field length."

#### The Software Probe

The probe consists of modifications to the PP monitor, CPU monitor, SET (system initialization) routines, plus a 3K program that resides at a control point. The modifications to the CPU monitor and PP monitor programs trap requests for certain types of service and write a one or two word entry into one of two buffers, depending on the service request. The buffers are called the file buffer and the channel buffer. The file buffer is for requests trapped in CPU monitor. These include requests for peripheral processors, requests for field length changes, and relocation of the relative address of jobs. If the latter two are detected, two words with special function codes and the information necessary, such as the control point, the old and new field lengths (or relative address), the job CPU time and the realtime are put in the file buffer and the buffer pointers are updated. If the request was for a peripheral processor, the time is recorded. When a processor is assigned, two words are written containing the name of the peripheral processor program requested, the processor assigned, the control point, the job name, and the CPU and real time of the assignment as well as the wait time for the request to be satisfied. There are five system-defined "types"--- these are: 0: system; 1: local batch; 2: remote batch; 3: remote

time sharing; 4: multi-terminal. This type is also written. It is also possible that one peripheral processor will call another one; in that case the number of the processor that called this one is included.

When a peripheral processor is dropped, we have the above information also.

The other buffer, the channel buffer, records information about the requests, assignments, and drops of channels. The real time of the activity, the function code, the channel, and the address of the PP output register. If a field length request is trapped, this is written to the channel buffer also, giving the new field length requested, the real time, the function code (a 21 for a field length request) and the output register address for the peripheral processor requesting the additional field length. The buffer pointer is updated.

The modification to SET initializes the buffer pointers. The program residing at a control point checks these pointers each time-slice it is given control; it empties the buffers to disk or tape files and resets the pointers.

The data from the probe is then analyzed by the analysis program. This program breaks down the information of the two buffers and merges it; the information is threaded on a per-job basis by keeping track of the job name/PP assignments and by noting when the control point changes (due to roll-out). In the next chapter we include the data from the analysis program.

### Analysis Program

The two main features of the analysis program are that (1) everything happens in pairs: for every assign there is a drop; action

(updating of tables) does not take place until the drop, for it is only then that all the requisite information is available--the amount of real time taken, the amount of CPU time used by the job, etc. (2) all data is kept in tabular (histogram) form. This program makes only one pass of the data files; since these files can be as large as a million words, it was thought essential to make this a one-pass program. This design philosophy has the drawback that the histogram tables have a set maximum; a two-pass program could count the occurrences of events and record the maximums involved; then on the second pass make the histograms.

For instance: in the data LMT has several occurrences past the 4.0 second mark; if the scale were larger these would not all be accounted for at "4.0 and above" level but spread out, so the variations would be visible; on the other hand, the scale for CIO could be reduced, to allow the finer variations in the data to be visible. However, the design philosophy of reading the file only once has given a fairly fast execution time; roughly two hours worth of data is processed in about 240 seconds.

#### Structure of the Program

The analysis program is a tree-structured, modular program that reads the files created by the probe and gathers statistics. There is a pre-processor program that reads a file created by the probe at the beginning of the run; this file is a dump of first 2000 words of memory. The pre-processor program analyses this file to set up the three major tables used in the statistical analysis:

JACT: the job accounting table, it contains 13 words per job active (either assigned to a control point or rolled out). These words are (1) job name, (2) control point assigned (0 if rolled out), (3) real time began, (4) peripheral processor wait time, (5) field length, (6) origin, (7) the number of field length changes, (8) the number of I/O calls, (9) last time it was rolled out, (10) total amount of time spent in PP calls, (11), (12), (13) the CPU time of last field change, I/O call, and roll out.

This table has a limit of 100 jobs active at once; it is a self-cleansing file (jobs that end are removed from the file). It is a linear array; jobs are in order only by the time they are first detected by the analysis program; when a job is removed, all the other jobs are moved up in the file, and the end pointer (JLMT) decreased by one.

PPACT: peripheral processor accounting table; it includes 6 words per peripheral processor. These are (1) name of the PP program that holds the processor; if the processor is not in use, this word is zero; (2) job name of the job calling for the service provided by the peripheral processor; (3) real time the PP was assigned; (4) job CPU time the peripheral processor was assigned; (5) the time the PP first asked for a channel; (6) the channel the peripheral processor is using.

CACT: channel table: 2 words per channel: (1) which PP is holding the channel; (2) the real time the channel was assigned.

The pre-processor program reads the file that contains the dump of memory and fills out the above tables; all of the above information is available except past history items (real time began, CPU and real

time PP's were assigned, etc.) These are all assumed to be begun at the time the run started. These tables are then written to a file (PREPR).

When the analysis program begins it reads PREPR to initialize its tables; then calls all the modules to initialize themselves; then reads FDUMP and CDUMP (the peripheral processor activity and channel activity files explained earlier in Chapter Two). The information in these files is handled on a per-entry basis, in time sequence; if the time is the same, the decision of which (FDUMP entry or CDUMP entry) to handle first is made on whether the FDUMP entry is an assign or a drop; if it is an assign PP, frequently the channel activity at the same time is an assign channel to that PP, so we take the assign first, so we will know what PP program is using the channel. If the FDUMP entry is a drop, we will take the channel activity first; frequently the channel activity is a drop for the channel associated with the PP that is dropping, and, again we need to know which PP to post the channel activity to.

If the entry taken is the FDUMP entry, the routine called is CATCHPP. It is determined in that module if the entry is a field change entry; if so, FIELDCH is called. If the entry taken is a CDUMP entry, RDCHAN is called. RDCHAN screens those entries that are requests for field length changes; these it calls FIELDCH to handle.

The program was designed to call JBACCT, the job accounting routine that records data when a job begins or ends, only when the job's field length went from a value to nothing when it was not rolled out (signifying that it had finished) or from zero to something with no previous record

of the job (meaning it was beginning). Therefore, JBACCT was only called through FIELDCH. However, we have discovered that the sequence of events is not that dependable; there are especially variations in job-ending sequences, with the local file manager called from the job's control point after the job's field length has gone to zero, to clean up local files. This has caused us to call JBACCT from CATCHPP as well as FIELDCH.

There are two small modules to keep track of the peripheral processor (PTRACE) and control point (CTRACE) usage. These are called whenever a control point or peripheral processor is assigned or dropped.

There is one service routine that generates most of the histograms (HIST), the end of the job channel program, (CHNWRT), the routine that keeps track of the number of physical record units written per channel (PRUC), and an error routine that prints data errors.

#### CATCHPP

This module takes the two-word PP entry; if it is a field-change, it calls FIELDCH and returns; otherwise, it tests to see if the entry is an assign or a drop PP. If it is an assign, the PPACT tables are updated, PTRACE is called, and the program returns; if a drop, the histogram tables are checked for the name of the PP program; if it is not there, it is added. In every place where the histogram tables are updated, the procedure is the same: for instance, if we had a drop PP, we would read in the drop entry the name of the PP program; we would obtain from the PPACT tables the time that the PP was assigned; in the PP drop we have the time of the drop, so we subtract the two and use the

function routine ICAL to find which position of the histogram table to update. We would then add one to the proper position (as determined by ICAL) of the proper table (determined by the name of the PP program). We also add the actual time difference into the corresponding percent table. These are actually parallel tables, one with the count, the other with the actual value, so that we can tell not only how many times calls of that duration occurred but also what percentage of the entire time was spent in calls of that duration.

CATCHPP updates CPU time, real time, and wait time per PP program name; it also calls PRUC for PP drop, so that the histogram tables for the number of physical record units per channel can be updated.

RDCHAN handles the assigns and drops for the channels; if it is an assign, the CACT (channel accounting) table is updated, and the program returns. If it is a drop, RDCHAN finds the name of the PP program that was in the PP that held the channel (through PPACT) and posts the time to that PP.

The histograms to be generated for channel data are very detailed: there are as many as 18 PP programs that use some of the channels, and with 12 channels, that gives us an extremely large number of histograms. Therefore, the channel activity is filtered and written to several files, one per every two channels. The end of job program CHNWRT then reads these files and generates the histograms. This means that, although we only read the input data once, we are having to make one pass of these intermediary files per channel, which is very time-consuming. A further refinement of this program would be to find out precisely which histograms

are necessary per channel, limit the number of histograms produced, and keep the tables in memory as is done with CATCHPP.

One problem that occurs in posting the time that a channel is held to the calling PP program is that frequently PP's are requested by one PP program and then handed over to another PP program, without going through the request protocol. We especially see this with 1AJ and 1SJ-- (system scheduling program)--1AJ might bring in the loader "over itself," which is not seen by the analysis program until the PP is dropped under another name than it was requested under. This gives CATCHPP no problem, as it charges PP time to the dropping PP name; RDCHAN, however, has available only the requesting name, and that name is, therefore, the name that is charged with the time. It was decided that this was not enough of a problem to us that we would need to do the extensive reprogramming necessary to delineate the time spent in 1AJ and 1SJ and the various service programs that they call; if at any time it becomes necessary to do so, the solution would be to hold the drop of the channel until the PP dropped and then post the times.



## CHAPTER THREE

### DATA

[illegible]

PERCENT BETWEEN 0 AND 40 MILLISECONDS	4.92	OVER 40 AND UNDER 140 MILLISECONDS	20.68
OVER 140 AND UNDER 400 MILLISECONDS	37.60	OVER 400 AND UNDER 1.5 SECONDS	33.34
MAXIMUM TIME	2980	1.5 AND OVER	3.47

## 00 CHANNEL, TOTAL HOLD TIME

11200

10080

8960

7840

6720

5600

4480

3360

2240

1120

0

2

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 2 4 8 6 5 4 9 7 3 3 2 2 6 4 1 0 0 0 1 13 6 0 0 0 0 0

TOTAL OCCURENCES 60620.00

TOTAL TIME 5597045.00

PERCENT BETWEEN 0 AND 40 MILLISECOND 7.46 OVER 40 AND UNDER 140 MILLISECOND 43.47  
OVER 140 AND UNDER 400 MILLISECOND 23.95 OVER 400 AND UNDER 1.5 SECONDS 18.24 1.5 AND OVER 6.88

MAXIMUM TIME 2335

1SP

MCA

## 01 CHANNEL, TOTAL WAIT TIME

1050 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 945 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 840 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 735 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 630 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 525 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 420 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 315 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 210 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 105 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 0 I \*\*\*\*\*  
 0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0  
 PER CENT 0 0 0 0 2 3 4 4 4 4 8 5 4 4 3 3 9 5 4 4 4 5 6 5 0 0 0 0 0  
 TOTAL OCCURENCES 9933.00  
 TOTAL TIME 888889.00

PERCENT BETWEEN 0 AND 40 MILLISECOND 9.07 OVER 40 AND UNDER 140 MILLISECOND 32.06  
 OVER 140 AND UNDER 400 MILLISECOND 29.13 OVER 400 AND UNDER 1.5 SECONDS 29.74 1.5 AND OVER 0.00  
 MAXIMUM TIME 1312

01 CHANNEL, TOTAL HOLO TIME

13450 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

12105 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

10760 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

9415 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

8070 I \

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

6725 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

5360 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

4035 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

2690 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

1345 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

0 I \*\*\*\*  
 0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 3 5 12 8 6 5 12 9 3 2 2 1 5 1 1 1 0 2 6 4 0 0 0 0 0  
 TOTAL OCCURENCES 66698.00  
 TOTAL TIME 4914252.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 10.16 OVER 40 AND UNDER 140 MILLISECONDS 54.43  
 OVER 140 AND UNDER 400 MILLISECONDS 18.02 OVER 400 AND UNDER 1.5 SECONDS 17.19 1.5 AND OVER .20  
 MAXIMUM TIME 1391  
 MAXIMUM TIME 0

# 04 CHANNEL, TOTAL WAIT TIME

5

```

3700 I ****
I ****
I ****
I ****
3330 I ****
I ****
I ****
I ****
2960 I ****
I ****
I ****
I ****
2590 I ****
I ****
I ****
I ****
I ****
2220 I \ ****
I ****
I ****
I ****
I ****
1850 I ****
I ****
I ****
I ****
I ****
1480 I ****
I ****
I ****
I ****
I ****
1110 I ****
I ****
I ****
I ****
I ****
740 I ****
I ****
I ****
I ****
I ****
370 I ****
I ****
I ****
I ****
I ****
0 I ****

```

	0	5	10	15	20	30	40	50	60	70	80	100	120	140	160	180	200	300	400	500	600	700	800	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PER CENT	0	0	1	1	5	5	4	2	2	2	3	2	2	1	1	1	8	4	3	3	4	4	4	24	0	0	0	0	0	0
TOTAL OCCURENCES	22575.00																													
TOTAL TIME	1785928.00																													

PERCENT BETWEEN 0 AND 40 MILLISECONDS 15.01 OVER 40 AND UNDER 140 MILLISECOND 18.78  
 OVER 140 AND UNDER 400 MILLISECOND 20.98 OVER 400 AND UNDER 1.5 SECONDS 44.00 1.5 AND OVER 1.22  
 MAXIMUM TIME 7315

## 04 CHANNEL, TOTAL HOLD TIME

32600 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

29340 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

26080 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

22820 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

19560 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

16300 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

13040 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

9780 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

6520 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

3260 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

0 I

\*\*\*\*\*  
 0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT

0 0 3 6 15 11 9 5 2 1 2 2 2 1 0 0 6 4 1 0 1 1 0 18 0 0 0 0 0 0

TOTAL OCCURENCES 111624.00

TOTAL TIME 4981676.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 37.39 OVER 40 AND UNDER 140 MILLISECONDS 23.79  
 OVER 140 AND UNDER 400 MILLISECONDS 15.73 OVER 400 AND UNDER 1.5 SECONDS 22.75 1.5 AND OVER .33

MAXIMUM TIME 1277

000

7

	0	5	10	15	20	30	40
CENT	0	0	1	1	3	3	3
TOTAL OCCURENCES							31621.
TOTAL TIME							2917175.00

MILLISECO  
LISECOND  
4272

PERCENT BETWEEN 0 AND 40 MILLISECONDS	11.45	OVER 40 AND UNDER 140 MILLISECONDS	18.03
OVER 140 AND UNDER 400 MILLISECONDS	22.34	OVER 400 AND UNDER 1.5 SECONDS	46.04
MAXIMUM TIME	4272	1.5 AND OVER	2.13



g

I ☆☆☆

I

\*\*\*\*

31365 I \*\*\*\*

✱ ✱ ✱ ✱

~~~~~

27080 1  
T \*\*\*\*\*

[illegible]

21.305 T

|   |      |
|---|------|
| 1 | 4444 |
| 2 | 3333 |

[illegible][illegible]

Copyright © 2010 John Wiley & Sons, Ltd. *J. Forecast.* **30**, 1–16 (2011)  
DOI: 10.1002/for

\*\*\*\*\*

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

|       |   |       |
|-------|---|-------|
| 13940 | I | ***** |
|       |   | ***** |

|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|

\_\_\_\_\_

| I | ***** |
|---|-------|
|   |       |

I \*\*\*\*\*

6970 I \*\*\*\*\*

1. 凡在本行开立存款账户的客户，均可向本行申请开立定期存款账户。

I \*\*\*\*\*

**I** \*\*\*\*\*

I \*\*\*\*\*

0 I \*\*\*\*\*

bioRxiv preprint doi: <https://doi.org/10.1101/2019.05.20.246400>; this version posted May 20, 2019. The copyright holder for this preprint (which was not certified by peer review) is the author/funder, who has granted bioRxiv a license to display the preprint in perpetuity. It is made available under aCC-BY-NC-ND 4.0 International license.

|                  |     |
|------------------|-----|
| TOTAL OCCURENCES | 137 |
|------------------|-----|

\_\_\_\_\_

ER 140 AND UNDER 400 MILLISCOND

LY ONE PP ROUTINE FOR THIS CHANN

LY ONE PP ROUTINE FOR THIS CHANN

|                                         |       |                                    |       |
|-----------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS   | 35.51 | OVER 40 AND UNDER 140 MILLISECONDS | 28.25 |
| OVER 140 AND UNDER 400 MILLISECONDS     | 15.28 | OVER 400 AND UNDER 1.5 SECONDS     | 20.83 |
| MAXIMUM TIME                            | 2622  | 1.5 AND OVER                       | .12   |
| ONLY ONE PP ROUTINE FOR THIS CHANNEL 06 |       |                                    |       |

CIO

9

760

665

570

475

380

285

190

95

0 I

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 4.76  | OVER 40 AND UNDER 140 MILLISECONDS | 22.29 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 42.27 | OVER 400 AND UNDER 1.5 SECONDS     | 27.79 |
| MAXIMUM TIME                          | 2423  | 1.5 AND OVER                       | 2.89  |

00 CHANNEL, HOLD TIME FOR PP ROUTINE

CIO

10

9200 I

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

8280 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

7360 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

6440 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

5520 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

4600 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

3680 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

2760 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

1840 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

920 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

0 I \*\*\*\*

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

| PER CENT         | 0          | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |  |  |
|------------------|------------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| TOTAL OCCURENCES | 0          | 0 | 0  | 0  | 3  | 4  | 13 | 8  | 8  | 5  | 12 | 11  | 6   | 5   | 3   | 2   | 5   | 2   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 0   |  |  |
| TOTAL TIME       | 2962598.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 9.65 OVER 40 AND UNDER 140 MILLISECONDS 60.93  
 OVER 140 AND UNDER 400 MILLISECONDS 25.00 OVER 400 AND UNDER 1.5 SECONDS 4.41 1.5 AND OVER 0.00  
 MAXIMUM TIME 1209

01 CHANNEL, WAIT TIME FOR PP ROUTINE

CIO

850 I

I

I

\*\*\*\*

I

\*\*\*\*\*

I

\*\*\*\*\*

765 I

\*\*\*\*\*

I

\*\*\*\*\*

I

\*\*\*\*\*

I

\*\*\*\*\*

I

\*\*\*\*\*

680 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

595 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

510 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

425 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

340 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

255 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

170 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

85 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

0 I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

I

\*\*\*\*\*

\*\*\*\*

| PER CENT         | 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|------------------|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TOTAL OCCURENCES | 0 | 0 | 0  | 0  | 2  | 3  | 4  | 4  | 4  | 4  | 8  | 5   | 4   | 4   | 3   | 3   | 9   | 4   | 4   | 3   | 3   | 4   | 6   | 6   | 0   | 0   | 0   | 0   | 0   | 0   |
| TOTAL TIME       |   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 8.75  | OVER 40 AND UNDER 140 MILLISECONDS | 33.31 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 29.35 | OVER 400 AND UNDER 1.5 SECONDS     | 28.60 |
| 1.5 AND OVER                          | 0.00  |                                    |       |
| MAXIMUM TIME                          | 1312  |                                    |       |

|                  |   |                                                                                                            |       |
|------------------|---|------------------------------------------------------------------------------------------------------------|-------|
| 11650            | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
| 10485            | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
| 9320             | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
| 8155             | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
| 6990             | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | ****                                                                                                       |       |
|                  | I | *****                                                                                                      |       |
|                  | I | *****                                                                                                      |       |
| 5825             | I | *****                                                                                                      |       |
|                  | I | *****                                                                                                      |       |
|                  | I | *****                                                                                                      |       |
|                  | I | *****                                                                                                      |       |
| 4660             | I | *****                                                                                                      |       |
|                  | I | *****                                                                                                      | ****  |
|                  | I | *****                                                                                                      | ****  |
|                  | I | *****                                                                                                      | ****  |
|                  | I | *****                                                                                                      | ****  |
| 3495             | I | *****                                                                                                      | ****  |
|                  | I | *****                                                                                                      | ****  |
|                  | I | *****                                                                                                      | ****  |
|                  | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
| 2330             | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
| 1165             | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
|                  | I | *****                                                                                                      | ***** |
| 0                | I | *****                                                                                                      | ***** |
|                  |   | 0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0 |       |
| PER CENT         |   | 0 0 0 1 4 6 18 11 7 7 14 10 4 2 1 1 3 1 0 0 0 0 0 0 0 0 0 0                                                |       |
| TOTAL OCCURENCES |   | 49718.00                                                                                                   |       |
| TOTAL TIME       |   | 2871221.00                                                                                                 |       |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 13.18 OVER 40 AND UNDER 140 MILLISECONDS 70.20  
OVER 140 AND UNDER 400 MILLISECONDS 15.29 OVER 400 AND UNDER 1.5 SECONDS 1.33 1.5 AND OVER 0.00  
MAXIMUM TIME 966

```

3100 I
      I      ****
      I      ****
      I      ****
      I      ****
2790 I      ****
      I      ****
      I      ****
      I      ****
      I      ****
2480 I      ****
      I      ****
      I      ****
      I      ****
      I      ****
2170 I      ****
      I      ****
      I      ****
      I      ****
      I      ****
1860 I      ****
      I      ****
      I      ****
      I      ****
      I      ****
1550 I      ****
      I      ****
      I      ****
      I      ****
      I      ****
1240 I      ****
      I      ****
      I      ****
      I      ****
      I      ****
930  I      ****
      I      ****
      I      ****
      I      ****
      I      ****
620  I      ****
      I      ****
      I      ****
      I      ****
      I      ****
310  I      ****
      I      ****
      I      ****
      I      ****
      I      ****
      I      ****
0    I      ****

```

|                  | 0          | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |  |  |
|------------------|------------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| PER CENT         | 0          | 0 | 1  | 2  | 5  | 6  | 5  | 3  | 2  | 2  | 3  | 3   | 2   | 1   | 1   | 2   | 7   | 3   | 3   | 2   | 3   | 3   | 3   | 24  | 0   | 0   | 0   | 0   | 0   | 0   |  |  |
| TOTAL OCCURENCES | 18521.00   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |
| TOTAL TIME       | 1352926.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |

PERCENT BETWEEN 0 AND 40 MILLISECOND 16.74 OVER 40 AND UNDER 140 MILLISECOND 20.35  
 OVER 140 AND UNDER 400 MILLISECOND 19.35 OVER 400 AND UNDER 1.5 SECONDS 42.24 1.5 AND OVER 1.33  
 MAXIMUM TIME 7315

CIO

26300 I

14

23670

21040

18410

15780

13150

10520

7890

5260

2630

Q1:

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 61.17 | OVER 40 AND UNDER 140 MILLISECONDS | 33.77 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 3.91  | OVER 400 AND UNDER 1.5 SECONDS     | 1.15  |
| MAXIMUM TIME                          | 860   | 1.5 AND OVER                       | 0.00  |

05 CHANNEL, WAIT TIME FOR PP ROUTINE

CIO

3250 I  
 3185 I \*\*\*\*  
 3120 I \*\*\*\*  
 3055 I \*\*\*\*  
 2990 I \*\*\*\*  
 2925 I \*\*\*\*  
 2860 I \*\*\*\*  
 2795 I \*\*\*\*  
 2730 I \*\*\*\*  
 2665 I \*\*\*\*  
 2600 I \*\*\*\*  
 2535 I \*\*\*\*  
 2470 I \*\*\*\*  
 2405 I \*\*\*\*  
 2340 I \*\*\*\*  
 2275 I \*\*\*\*  
 2210 I \*\*\*\*  
 2145 I \*\*\*\*  
 2080 I \*\*\*\*  
 2015 I \*\*\*\*  
 1950 I \ \*\*\*\*  
 1885 I \*\*\*\*  
 1820 I \*\*\*\*  
 1755 I \*\*\*\*  
 1690 I \*\*\*\*  
 1625 I \*\*\*\*  
 1560 I \*\*\*\*  
 1495 I \*\*\*\*  
 1430 I \*\*\*\*  
 1365 I \*\*\*\*  
 1300 I \*\*\*\*  
 1235 I \*\*\*\*  
 1170 I \*\*\*\*  
 1105 I \*\*\*\*  
 1040 I \*\*\*\*  
 975 I \*\*\*\*  
 910 I \*\*\*\*  
 845 I \*\*\*\*  
 780 I \*\*\*\*  
 715 I \*\*\*\*  
 650 I \*\*\*\*  
 585 I \*\*\*\*  
 520 I \*\*\*\*  
 455 I \*\*\*\*  
 390 I \*\*\*\*  
 325 I \*\*\*\*  
 260 I \*\*\*\*  
 195 I \*\*\*\*  
 130 I \*\*\*\*  
 65 I \*\*\*\*  
 0 I \*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 1 1 4 4 3 2 2 2 4 3 2 2 2 7 4 3 3 4 3 3 26 0 0 0 0 0 0

TOTAL OCCURRENCES 21369.00

TOTAL TIME 1879958.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 12.23 OVER 40 AND UNDER 140 MILLISECONDS 19.29

OVER 140 AND UNDER 400 MILLISECONDS 22.03 OVER 400 AND UNDER 1.5 SECONDS 44.83 1.5 AND OVER 1.57

MAXIMUM TIME 4272



CIO

23600

21240

18880

16520

14160

11800

9440

7080

4720

2360

1

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 53.70 | OVER 40 AND UNDER 140 MILLISECONDS | 40.71 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 4.31  | OVER 400 AND UNDER 1.5 SECONDS     | 1.28  |
| MAXIMUM TIME                          | 861   | 1.5 AND OVER                       | 0.00  |

00 CHANNEL, WAIT TIME FOR PP ROUTINE

1RI

17

50

45

40

35

30

25

20

15

10

5

0

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

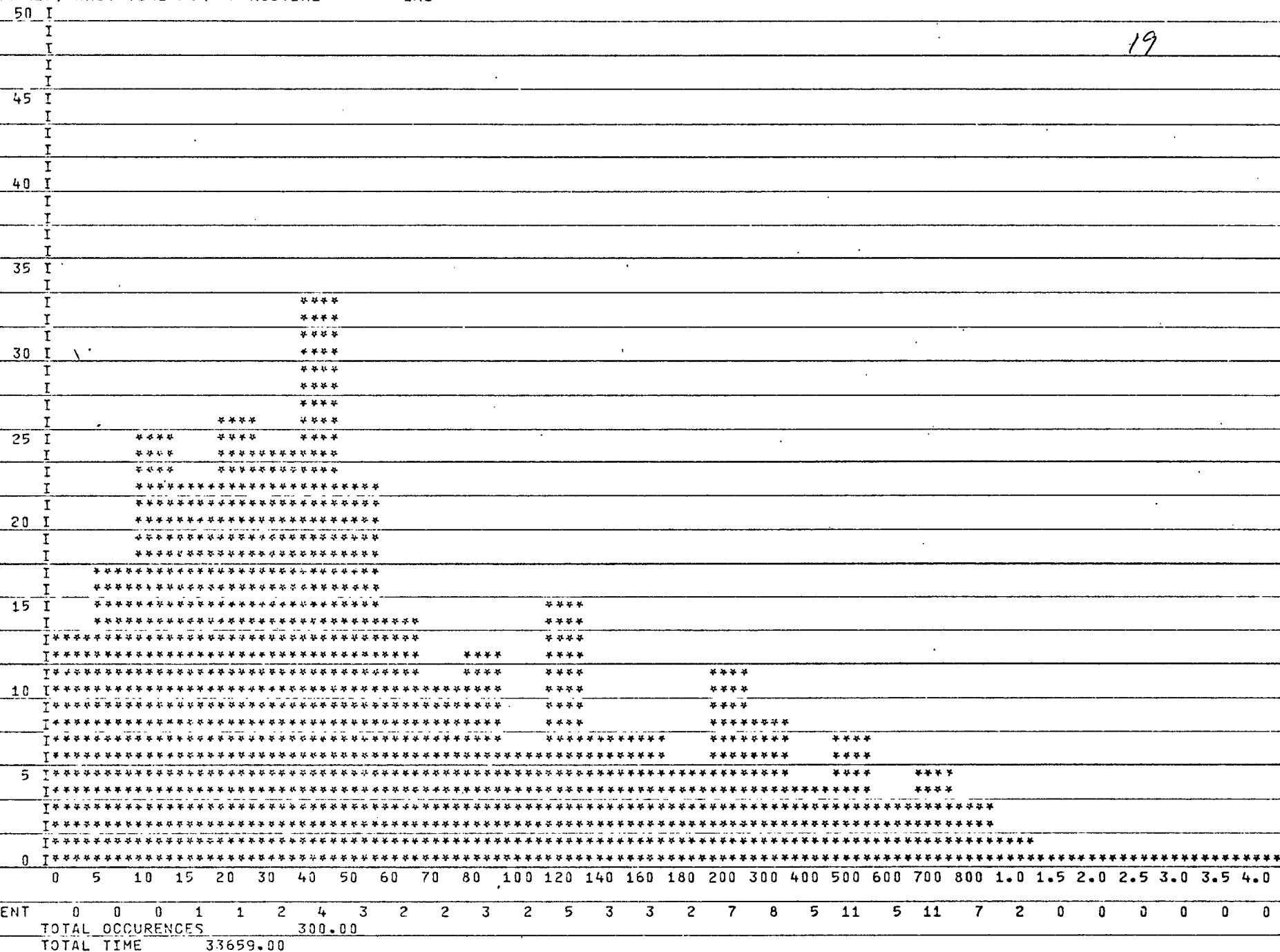
PER CENT 0 0 0 0 0 1 1 1 0 1 1 1 1 1 1 1 4 5 3 4 5 3 7 41 3 0 5 0 0 0

TOTAL OCCURRENCES 377.00

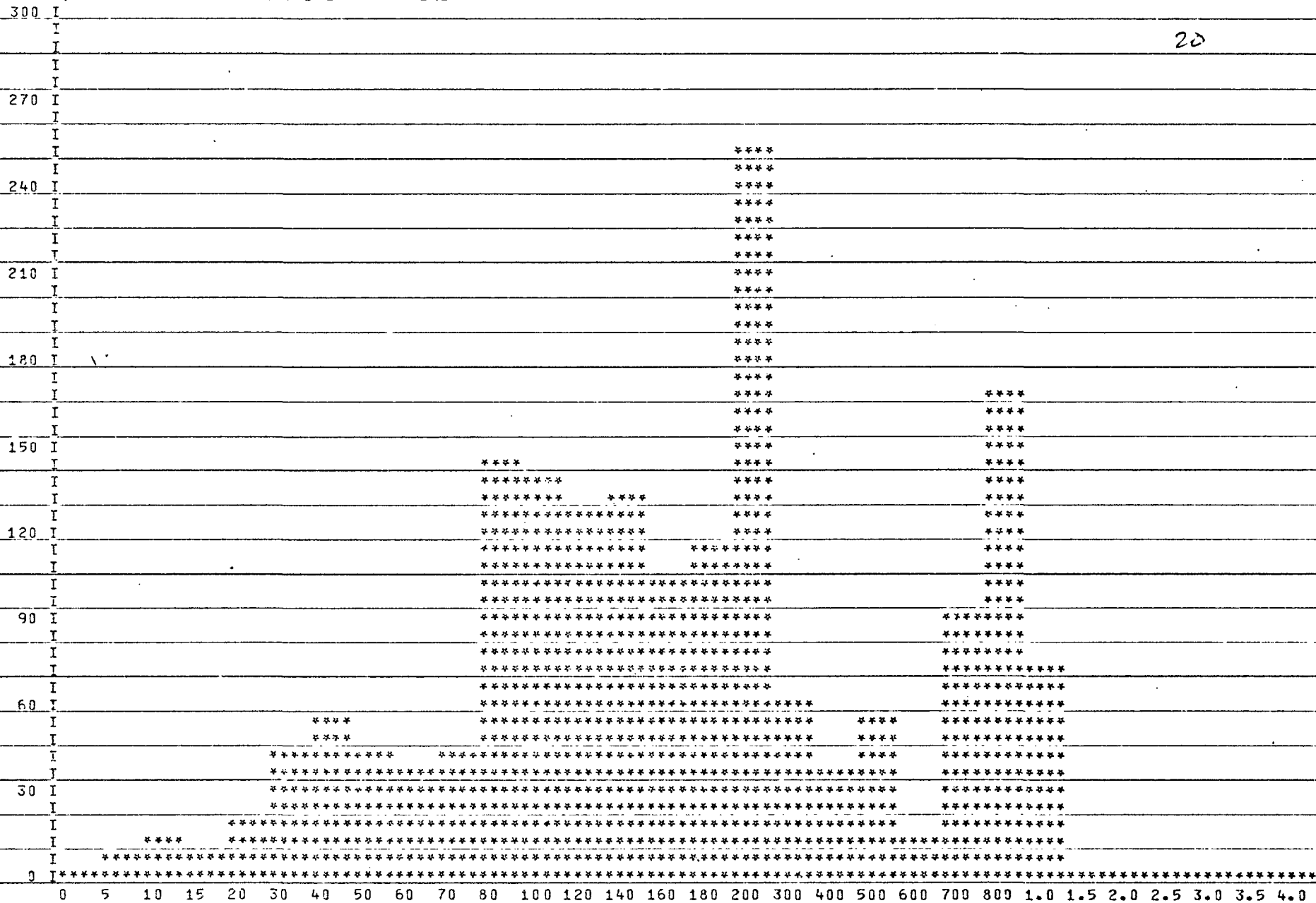
TOTAL TIME 96093.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 2.65 OVER 40 AND UNDER 140 MILLISECONDS 7.87  
 OVER 140 AND UNDER 400 MILLISECONDS 15.09 OVER 400 AND UNDER 1.5 SECONDS 65.31 1.5 AND OVER 9.08  
 MAXIMUM TIME 2980





PERCENT BETWEEN 0 AND 40 MILLISECOND 6.77 OVER 40 AND UNDER 140 MILLISECOND 17.98  
 OVER 140 AND UNDER 400 MILLISECOND 31.16 OVER 400 AND UNDER 1.5 SECONDS 44.09 1.5 AND OVER 0.00  
 MAXIMUM TIME 924



PERCENT BETWEEN 0 AND 40 MILLISECOND 0.43 OVER 40 AND UNDER 140 MILLISECOND 7.20  
 OVER 140 AND UNDER 400 MILLISECOND 28.91 OVER 400 AND UNDER 1.5 SECONDS 63.46 1.5 AND OVER 0.00  
 MAXIMUM TIME 1289

100 I

I

I

I

I

90 I

I

I

I

80 I

I

I

I

70 I

I

I

I

60 I

I

I

I

50 I

I

I

I

I

40 I

I

I

I

I

30 I

I

I

I

20 I

I

I

I

I

10 I

I

I

I

I

0 I

I

I

I

I

I

I

I

I

I

| PER CENT         | 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|------------------|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TOTAL OCCURENCES | 0 | 0 | 0  | 1  | 1  | 1  | 0  | 1  | 0  | 1  | 1  | 2   | 1   | 1   | 0   | 1   | 4   | 7   | 5   | 11  | 4   | 8   | 10  | 29  | 0   | 0   | 0   | 0   | 0   | 0   |
| TOTAL TIME       |   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 5.50 OVER 40 AND UNDER 140 MILLISECONDS 7.67  
 OVER 140 AND UNDER 400 MILLISECONDS 17.24 OVER 400 AND UNDER 1.5 SECONDS 69.59 1.5 AND OVER 0.00  
 MAXIMUM TIME 1202

```

450 I
I
I
I
I
405 I
I
I
I
I
360 I
I
I
I
I
315 I
I
I
I
I
270 I
I
I
I
I
225 I
I
I
I
I
180 I
I
I
I
I
135 I
I
I
I
I
90 I
I
I
I
I
45 I
I
I
I
0 I

```

\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 0 0 0 0 0 0 0 2 4 2 0 0 15 1 1 1 4 3 0 58 0 0 0 0 0

TOTAL OCCURRENCES 2107.00

TOTAL TIME 701543.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 1.47 OVER 40 AND UNDER 140 MILLISECONDS 4.02

OVER 140 AND UNDER 400 MILLISECONDS 24.92 OVER 400 AND UNDER 1.5 SECONDS 69.59 1.5 AND OVER 0.00

MAXIMUM TIME 1243

22

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 5.20  | OVER 40 AND UNDER 140 MILLISECONDS | 8.82  |
| OVER 140 AND UNDER 400 MILLISECONDS   | 15.47 | OVER 400 AND UNDER 1.5 SECONDS     | 64.90 |
| MAXIMUM TIME                          | 1960  | 1.5 AND OVER                       | 5.61  |



450 I

I

I

I

I

405 I

I

I

I

I

360 I

I

I

I

I

315 I

I

I

I

I

270 I

I

I

I

I

225 I

I

I

I

I

180 I

I

I

I

I

135 I

I

I

I

I

90 I

I

I

I

I

45 I

I

I

I

I

0

\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 1 0 0 0 0 0 1 4 2 6 6 11 2 0 1 3 3 0 50 0 0 0 0 0 0

TOTAL OCCURENCES 3479.00

TOTAL TIME 919483.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 2.49 OVER 40 AND UNDER 140 MILLISECONDS 3.81  
 OVER 140 AND UNDER 400 MILLISECONDS 33.24 OVER 400 AND UNDER 1.5 SECONDS 60.46 1.5 AND OVER 0.00  
 MAXIMUM TIME 1402

24

1AJ

25

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 7.52  | OVER 40 AND UNDER 140 MILLISECONDS | 17.31 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 26.98 | OVER 400 AND UNDER 1.5 SECONDS     | 48.19 |
| MAXIMUM TIME                          | 1401  | 1.5 AND OVER                       | 0.00  |

00 CHANNEL, HOLD TIME FOR PP ROUTINE

1AJ

24

```

500 I
490 I
480 I      ****
470 I      ****
460 I      ****
450 I      ****
440 I      ****
430 I      ****
420 I      ****
410 I      ****
400 I      ****
390 I      ****
380 I      ****      ****
370 I      ****      ****
360 I      ****      ****
350 I      ****      ****
340 I      ****      ****
330 I      ****      ****
320 I      ****      ****
310 I      ****      ****
300 I      ****      ****
290 I      ****      ****
280 I      ****      ****
270 I      ****      ****
260 I      ****      ****
250 I      ****      ****
240 I      ****      ****
230 I      ****      ****
220 I      ****      ****
210 I      ****      ****
200 I      ****      ****
190 I      ****      ****
180 I      ****      ****
170 I      ****      ****
160 I      ****      ****
150 I      ****      ****
140 I      ****      ****
130 I      ****      ****
120 I      ****      ****
110 I      ****      ****
100 I      ****      ****
90 I      ****      ****
80 I      ****      ****
70 I      ****      ****
60 I      ****      ****
50 I      ****      ****
40 I      ****      ****
30 I      ****      ****
20 I      ****      ****
10 I      ****      ****
0 I      ****      ****

```

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 0 0 0 1 1 4 3 1 1 3 2 9 7 2 0 0 1 1 28 25 0 0 0 0 0

TOTAL OCCURENCE 3676.00

TOTAL TIME 1029960.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS .92 OVER 40 AND UNDER 140 MILLISECONDS 12.48

OVER 140 AND UNDER 400 MILLISECONDS 25.29 OVER 400 AND UNDER 1.5 SECONDS 35.21 1.5 AND OVER 25.10

MAXIMUM TIME 1918

01 CHANNEL, HOLD TIME FOR PP ROUTINE

1AJ

27

```

600 I
I
I ****
I ****
I ****
540 I ****
I ****
I ****
I ****
480 I ****
I ****
I ****
I ****
I ****
420 I ****
I ****
I ****
I ****
I ****
360 I ****
I ****
I ****
I ****
I ****
300 I ****
I ****
I ****
I ****
I ****
240 I ****
I ****
I ****
I ****
I ****
180 I ****
I ****
I ****
I ****
I ****
120 I ****
I ****
I ****
I ****
I ****
60 I ****
I ****
I ****
I ****
I ****
0 I ****

```

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 0 0 1 1 2 6 6 3 2 2 3 10 2 2 4 2 7 18 18 0 0 0 0 0 0

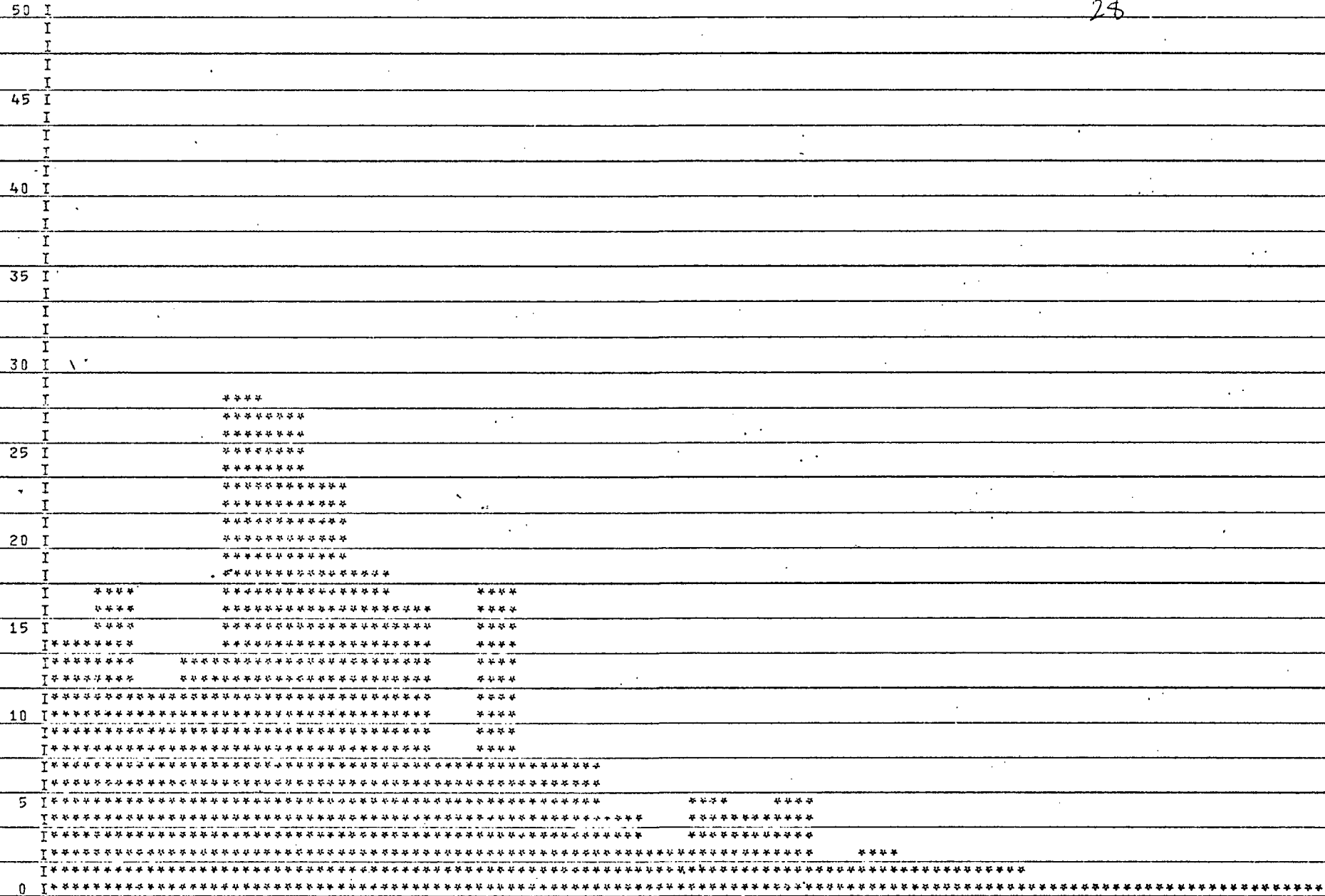
TOTAL OCCURENCES 3602.00

TOTAL TIME 753954.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 1.13 OVER 40 AND UNDER 140 MILLISECONDS 19.18

OVER 140 AND UNDER 400 MILLISECONDS 25.37 OVER 400 AND UNDER 1.5 SECONDS 54.32 1.5 AND OVER 0.00

MAXIMUM TIME 1391



PER CENT 0 0 0 1 3 5 5 5 5 3 8 4 5 3 1 5 5 9 2 6 3 4 4 0 0 0 0 0 0 0

TOTAL OCCURENCS 231.00

TOTAL TIME 17231.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 12.31 OVER 40 AND UNDER 140 MILLISECONDS 33.99

OVER 140 AND UNDER 400 MILLISECONDS 31.26 OVER 400 AND UNDER 1.5 SECONDS 22.44 1.5 AND OVER 0.00

MAXIMUM TIME 855



|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 2.97  | OVER 40 AND UNDER 140 MILLISECONDS | 5.55  |
| OVER 140 AND UNDER 400 MILLISECONDS   | 24.75 | OVER 400 AND UNDER 1.5 SECONDS     | 66.73 |
| MAXIMUM TIME                          | 1277  | 1.5 AND OVER                       | 0.00  |

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 10.35 | OVER 40 AND UNDER 140 MILLISECONDS | 14.66 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 25.47 | OVER 400 AND UNDER 1.5 SECONDS     | 47.61 |
| MAXIMUM TIME                          | 1990  | 1.5 AND OVER                       | 1.90  |



1AJ

◆ ◆ ◆ ◆

32

장부부부

무사부처무사부처

하루하루가 즐겁다

七 卒 卒 卒 卒 卒 卒 卒 卒

부강부강부강부강부강부강부강

\*\*\*\*\*

\* \* \*

✻ ✻ ✻ ✻ ✻ ✻ ✻ ✻ ✻ ✻ ✻ ✻

✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧

[illegible]

|                  |          |
|------------------|----------|
| TOTAL OCCURENCES | 12437.00 |
|------------------|----------|

TOTAL TIME 1190744.00

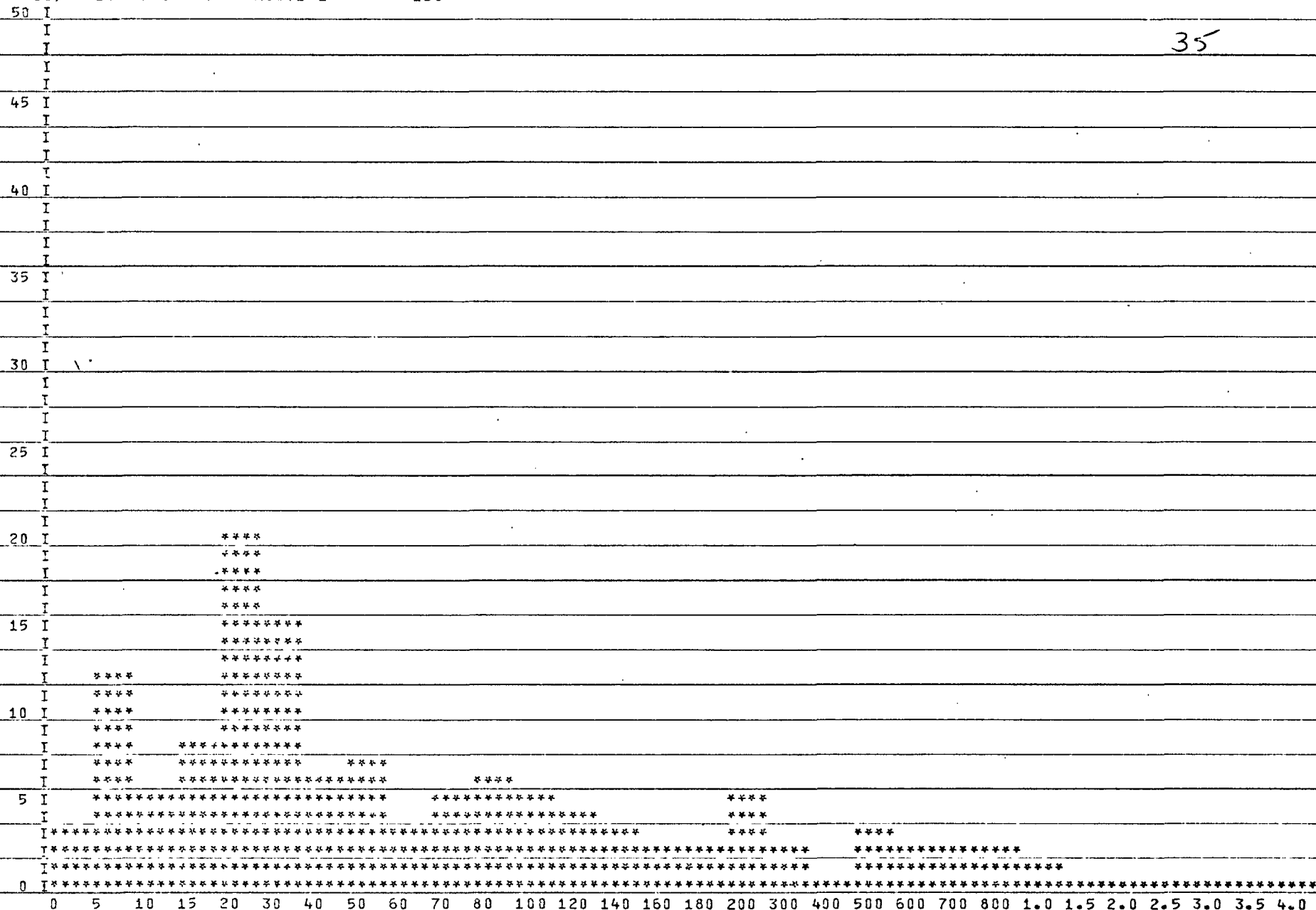
TOTAL FINE 11557 440 00

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 15.65 | OVER 40 AND UNDER 140 MILLISECONDS | 12.75 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 19.68 | OVER 400 AND UNDER 1.5 SECONDS     | 51.91 |
| MAXIMUM TIME                          | 1415  | 1.5 AND OVER                       | 0.00  |

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 4.72  | OVER 40 AND UNDER 140 MILLISECONDS | 8.25  |
| OVER 140 AND UNDER 400 MILLISECONDS   | 25.53 | OVER 400 AND UNDER 1.5 SECONDS     | 61.50 |
| MAXIMUM TIME                          | 1497  | 1.5 AND OVER                       | 0.00  |

| PER CENT         | 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|------------------|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TOTAL OCCURENCES | 0 | 0 | 0  | 0  | 0  | 1  | 2  | 3  | 3  | 3  | 4  | 2   | 1   | 1   | 2   | 1   | 11  | 7   | 0   | 1   | 2   | 0   | 2   | 35  | 8   | 0   | 0   | 0   | 0   | 0   |
| TOTAL TIME       |   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

PERCENT BETWEEN 0 AND 40 MILLISECOND 3.23 OVER 40 AND UNDER 140 MILLISECOND 19.12  
 OVER 140 AND UNDER 400 MILLISECOND 25.30 OVER 400 AND UNDER 1.5 SECONDS 44.27 1.5 AND OVER 8.08  
 MAXIMUM TIME 1764



| PER CENT         | 0        | 0 | 0 | 0 | 3 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 8 | 4 | 0 | 11 | 8 | 10 | 11 | 6 | 0 | 0 | 0 | 0 | 0 |
|------------------|----------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|---|----|----|---|---|---|---|---|---|
| TOTAL OCCURENCES | 123.00   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |    |    |   |   |   |   |   |   |
| TOTAL TIME       | 14299.00 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |    |    |   |   |   |   |   |   |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 9.23 OVER 40 AND UNDER 140 MILLISECONDS 16.02  
 OVER 140 AND UNDER 400 MILLISECONDS 25.38 OVER 400 AND UNDER 1.5 SECONDS 49.37 1.5 AND OVER 0.00  
 MAXIMUM TIME 923

15J

36

36

100 I  
I  
I  
I  
I  
90 I  
I  
I  
I  
I  
80 I  
I  
I  
I  
I  
I  
70 I  
I  
I  
I  
I  
60 I  
I  
I  
I  
I  
50 I  
I  
I  
I  
I  
40 I  
I  
I  
I  
I  
30 I  
I  
I  
I  
I  
20 I  
I  
I  
I  
I  
10 I  
I  
I  
I  
0 I

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

ENT 0 0 0 0 1 2 3 4 5 3 5 4 2 1 2 4 10 3 5 4 4 6 18 4 0 0 0 0 0 0  
TOTAL OCCURENCES 703.00  
TOTAL TIME 91116.00

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 4.80  | OVER 40 AND UNDER 140 MILLISECONDS | 27.88 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 24.27 | OVER 400 AND UNDER 1.5 SECONDS     | 43.05 |
| MAXIMUM TIME                          | 931   | 1.5 AND OVER                       | 0.00  |

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 6.20  | OVER 40 AND UNDER 140 MILLISECONDS | 10.49 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 16.75 | OVER 400 AND UNDER 1.5 SECONDS     | 66.56 |
| MAXIMUM TIME                          | 1044  | 1.5 AND OVER                       | 0.00  |

38

|                                      |       |                                   |       |
|--------------------------------------|-------|-----------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECOND | 3.99  | OVER 40 AND UNDER 140 MILLISECOND | 10.21 |
| OVER 140 AND UNDER 400 MILLISECOND   | 28.29 | OVER 400 AND UNDER 1.5 SECONDS    | 57.51 |
| MAXIMUM TIME                         | 1101  | 1.5 AND OVER                      | 0.00  |

|   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 4.93  | OVER 40 AND UNDER 140 MILLISECONDS | 10.18 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 15.94 | OVER 400 AND UNDER 1.5 SECONDS     | 64.62 |
| MAXIMUM TIME                          | 2130  | 1.5 AND OVER                       | 4.34  |

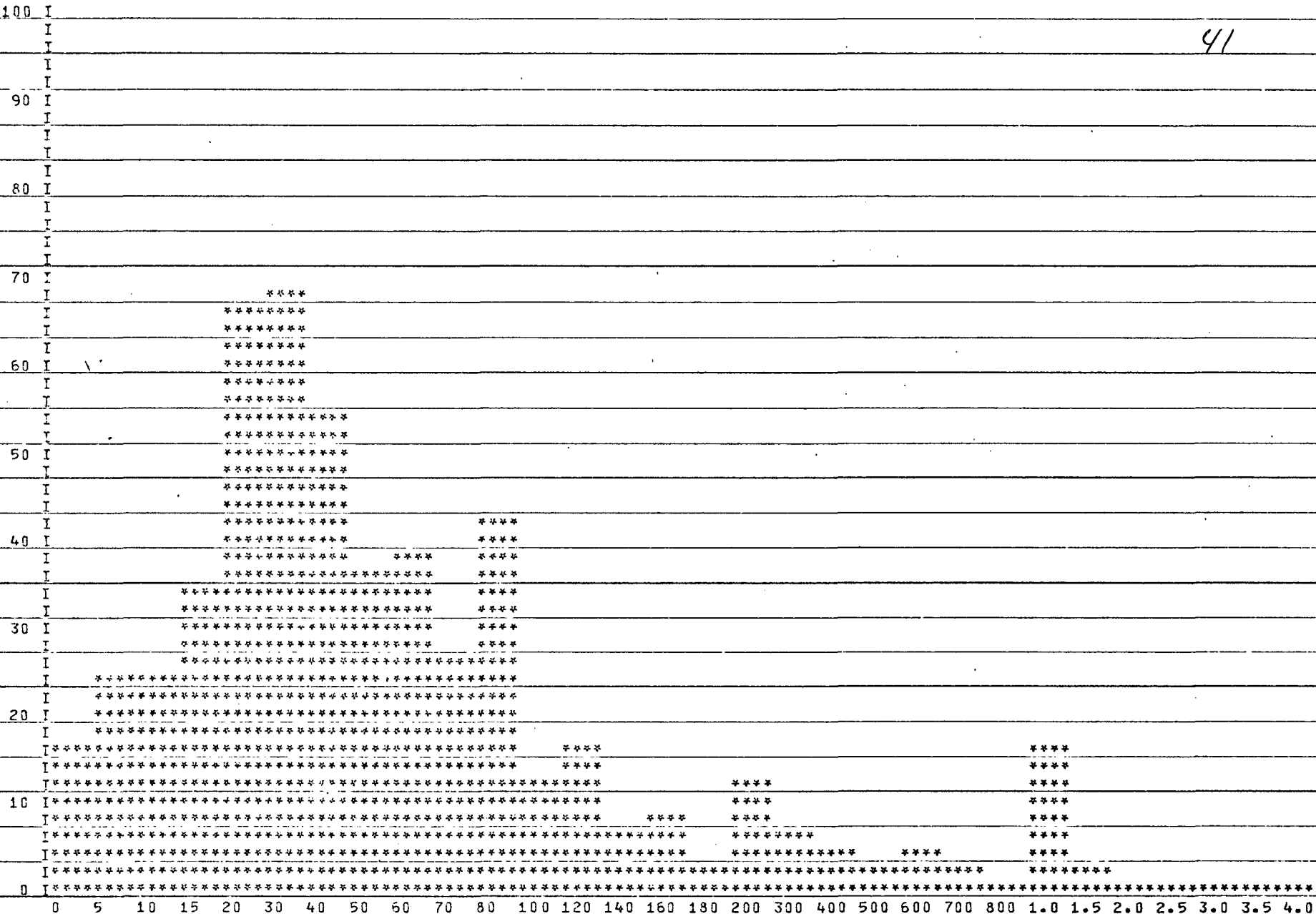




00 CHANNEL, WAIT TIME FOR PP ROUTINE

PFM

41



|                  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |          |   |   |   |   |   |   |   |    |   |   |   |   |   |   |
|------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----------|---|---|---|---|---|---|---|----|---|---|---|---|---|---|
| PER CENT         | 0 | 0 | 0 | 0 | 2 | 3 | 3 | 3 | 4 | 3 | 5 | 2 | 3 | 1 | 2 | 0        | 4 | 3 | 3 | 1 | 5 | 2 | 1 | 31 | 7 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OCCURENCES |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 533.00   |   |   |   |   |   |   |   |    |   |   |   |   |   |   |
| TOTAL TIME       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 62407.00 |   |   |   |   |   |   |   |    |   |   |   |   |   |   |

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 8.12  | OVER 40 AND UNDER 140 MILLISECONDS | 22.23 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 15.92 | OVER 400 AND UNDER 1.5 SECONDS     | 46.05 |
| MAXIMUM TIME                          | 1657  | 1.5 AND OVER                       | 7.68  |

00 CHANNEL, HOLD TIME FOR PP ROUTINE

PFM

1200

I

I

I

I

I

1080

I

I

I

I

I

960

I

I

I

I

I

840

I

I

I

I

I

720

I

I

I

I

I

600

I

I

I

I

I

480

I

I

I

I

I

360

I

I

I

I

I

240

I

I

I

I

I

120

I

I

I

I

I

0

I

I

I

I

I

I

I

I

I

I

I

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

42

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

| PER CENT         | 0 | 5 | 10 | 15 | 20 | 30        | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|------------------|---|---|----|----|----|-----------|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TOTAL OCCURENCES | 0 | 0 | 0  | 0  | 7  | 22        | 12 | 7  | 7  | 8  | 21 | 8   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| TOTAL TIME       |   |   |    |    |    | 182316.00 |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

|                                      |       |                                   |       |
|--------------------------------------|-------|-----------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECOND | 31.71 | OVER 40 AND UNDER 140 MILLISECOND | 65.73 |
| OVER 140 AND UNDER 400 MILLISECOND   | 2.56  | OVER 400 AND UNDER 1.5 SECONDS    | 0.00  |
| 1.5 AND OVER                         | 0.00  |                                   |       |
| MAXIMUM TIME                         | 220   |                                   |       |



PFM

1050

|   |       |
|---|-------|
| I | ***** |
| I | ***** |
| I | ***** |
| I | ***** |

945

|   |     |
|---|-----|
| I | *** |
| I | *** |
| I | *** |
| I | *** |

840

|   |         |
|---|---------|
| I | 4 4 4 4 |
| I | 4 4 4 4 |
| I | 4 4 4 4 |
| I | 4 4 4 4 |

735

|   |       |
|---|-------|
| I | ***** |
| I | ***** |
| I | ***** |
| I | ***** |

630

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| I | * | * | * | * | * |
| Y | * | * | * | * | * |
| I | * | * | * | * | * |
| Y | * | * | * | * | * |

525

[illegible]

420

|   |                 |
|---|-----------------|
| I | 8 8 8 8 8 8 8 8 |
| I | 8 8 8 8 8 8 8 8 |
| I | 8 8 8 8 8 8 8 8 |
| I | 8 8 8 8 8 8 8 8 |

315

|   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| I | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| I | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| I | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| I | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |

210

|   |               |
|---|---------------|
| I | 성 성 성 성 성 성 성 |
| I | 성 성 성 성 성 성 성 |
| I | 성 성 성 성 성 성 성 |
| I | 성 성 성 성 성 성 성 |

105

[illegible]

|   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

[illegible]

TOTAL OCCURENCES 3012.00

|            |           |
|------------|-----------|
| TOTAL TIME | 133419.00 |
|------------|-----------|

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 38.41 | OVER 40 AND UNDER 140 MILLISECONDS | 60.17 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 1.43  | OVER 400 AND UNDER 1.5 SECONDS     | 0.00  |
| 1.5 AND OVER                          | 0.00  |                                    |       |
| MAXIMUM TIME                          | 193   |                                    |       |

P F M

350 I

45

315

280

245

210

175

140

105

79

35

5

PER CENT

|                  |           |
|------------------|-----------|
| TOTAL OCCURENCES | 2482.00   |
| TOTAL TIME       | 233564.00 |

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 10.74 | OVER 40 AND UNDER 140 MILLISECONDS | 16.37 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 31.21 | OVER 400 AND UNDER 1.5 SECONDS     | 40.06 |
| MAXIMUM TIME                          | 2115  | 1.5 AND OVER                       | 1.61  |

4700

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

46

4230

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

3760

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

3290

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

2820

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

2350

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

1880

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

1410

I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*  
 I \*\*\*\*

940

I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*

470

I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*  
 I \*\*\*\*\*

0

I \*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 2 6 19 5 6 9 7 4 5 2 1 2 1 1 7 11 1 0 0 0 0 0 0 0 0 0

TOTAL OCCURENCES 13283.00

TOTAL TIME 569726.00

PERCENT BETWEEN 0 AND 40 MILLISECOND 35.36 OVER 40 AND UNDER 140 MILLISECOND 36.59

OVER 140 AND UNDER 400 MILLISECOND 26.89 OVER 400 AND UNDER 1.5 SECONDS 1.16 1.5 AND OVER 0.00

MAXIMUM TIME 471

05 CHANNEL, WAIT TIME FOR PP ROUTINE

PFM

47

```

500 I
490 I
480 I      ****
470 I      ****
460 I      ****
450 I      ****
440 I      ****
430 I      ****
420 I      ****
410 I      ****
400 I      ****
390 I      ****
380 I      ****
370 I      ****
360 I      ****
350 I      ****
340 I      ****
330 I      ****
320 I      ****
310 I      ****
300 I      ****
290 I      ****
280 I      ****
270 I      ****
260 I      ****
250 I      ****
240 I      ****
230 I      ****
220 I      ****
210 I      ****
200 I      ****
190 I      ****
180 I      ****
170 I      ****
160 I      ****
150 I      ****
140 I      ****
130 I      ****
120 I      ****
110 I      ****
100 I      ****
90 I      ****
80 I      ****
70 I      ****
60 I      ****
50 I      ****
40 I      ****
30 I      ****
20 I      ****
10 I      ****
0 I      ****

```

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

| PER CENT          | 0         | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |  |  |
|-------------------|-----------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| TOTAL OCCURRENCES | 0         | 0 | 1  | 1  | 4  | 4  | 4  | 3  | 3  | 2  | 4  | 3   | 4   | 2   | 3   | 2   | 7   | 6   | 3   | 3   | 5   | 2   | 2   | 19  | 1   | 0   | 0   | 0   | 0   | 0   |  |  |
| TOTAL TIME        | 259056.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 13.26 OVER 40 AND UNDER 140 MILLISECONDS 21.13  
 OVER 140 AND UNDER 400 MILLISECONDS 26.24 OVER 400 AND UNDER 1.5 SECONDS 37.10 1.5 AND OVER 2.27  
 MAXIMUM TIME 2157



P F M

48

|                                       |       |                                    |       |
|---------------------------------------|-------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 47.88 | OVER 40 AND UNDER 140 MILLISECONDS | 45.16 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 6.82  | OVER 400 AND UNDER 1.5 SECONDS     | .14   |
| MAXIMUM TIME                          | 640   | 1.5 AND OVER                       | 0.00  |

03 CHANNEL, HOLD TIME FOR PP ROUTINE

1MT

9000 I

8820 I\*\*\*\*

8640 I\*\*\*\*

8460 I\*\*\*\*

8280 I\*\*\*\*

8100 I\*\*\*\*

7920 I\*\*\*\*

7740 I\*\*\*\*

7560 I\*\*\*\*

7380 I\*\*\*\*

7200 I\*\*\*\*

7020 I\*\*\*\*

6840 I\*\*\*\*

6660 I\*\*\*\*

6480 I\*\*\*\*

6300 I\*\*\*\*

6120 I\*\*\*\*

5940 I\*\*\*\*

5760 I\*\*\*\*

5580 I\*\*\*\*

5400 I\*\*\*\*

5220 I\*\*\*\*

5040 I\*\*\*\*

4860 I\*\*\*\*

4680 I\*\*\*\*

4500 I\*\*\*\*

4320 I\*\*\*\*

4140 I\*\*\*\*

3960 I\*\*\*\*

3780 I\*\*\*\*

3600 I\*\*\*\*

3420 I\*\*\*\*

3240 I\*\*\*\*

3060 I\*\*\*\*

2880 I\*\*\*\*

2700 I\*\*\*\*

2520 I\*\*\*\*

2340 I\*\*\*\*

2160 I\*\*\*\*

1980 I\*\*\*\*

1800 I\*\*\*\*\*

1620 I\*\*\*\*\*

1440 I\*\*\*\*\*

1260 I\*\*\*\*\*

1080 I\*\*\*\*\*

900 I\*\*\*\*\*

720 I\*\*\*\*\*

540 I\*\*\*\*\*

360 I\*\*\*\*\*

180 I\*\*\*\*\*

0 I\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 2 4 2 1 1 10 50 2 0 1 0 14

TOTAL OCCURENCES 13670.00

TOTAL TIME 1743694.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 3.23 OVER 40 AND UNDER 140 MILLISECONDS 2.38

OVER 140 AND UNDER 400 MILLISECONDS 3.06 OVER 400 AND UNDER 1.5 SECONDS 21.59 1.5 AND OVER 69.74

MAXIMUM TIME 30493

49

7550 I

50

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*

6795 I\*\*\*\*

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*

6040 I\*\*\*\*

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*

5285 I\*\*\*\*

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*

4530 I\*\*\*\*

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*

3775 I\*\*\*\*

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*

3020 I\*\*\*\*

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*

2265 I\*\*\*\*

I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*  
I\*\*\*\*\*

1510 I\*\*\*\*\*

I\*\*\*\*\*  
I\*\*\*\*\*  
I\*\*\*\*\*  
I\*\*\*\*\*  
I\*\*\*\*\*

755 I\*\*\*\*\*

I\*\*\*\*\*  
I\*\*\*\*\*  
I\*\*\*\*\*  
I\*\*\*\*\*

\*\*\*\*

\*\*\*\*

0 I\*\*\*\*\*

\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3 1 2 1 9 66 0 1 0 0 3

TOTAL OCCURENCES 10835.00

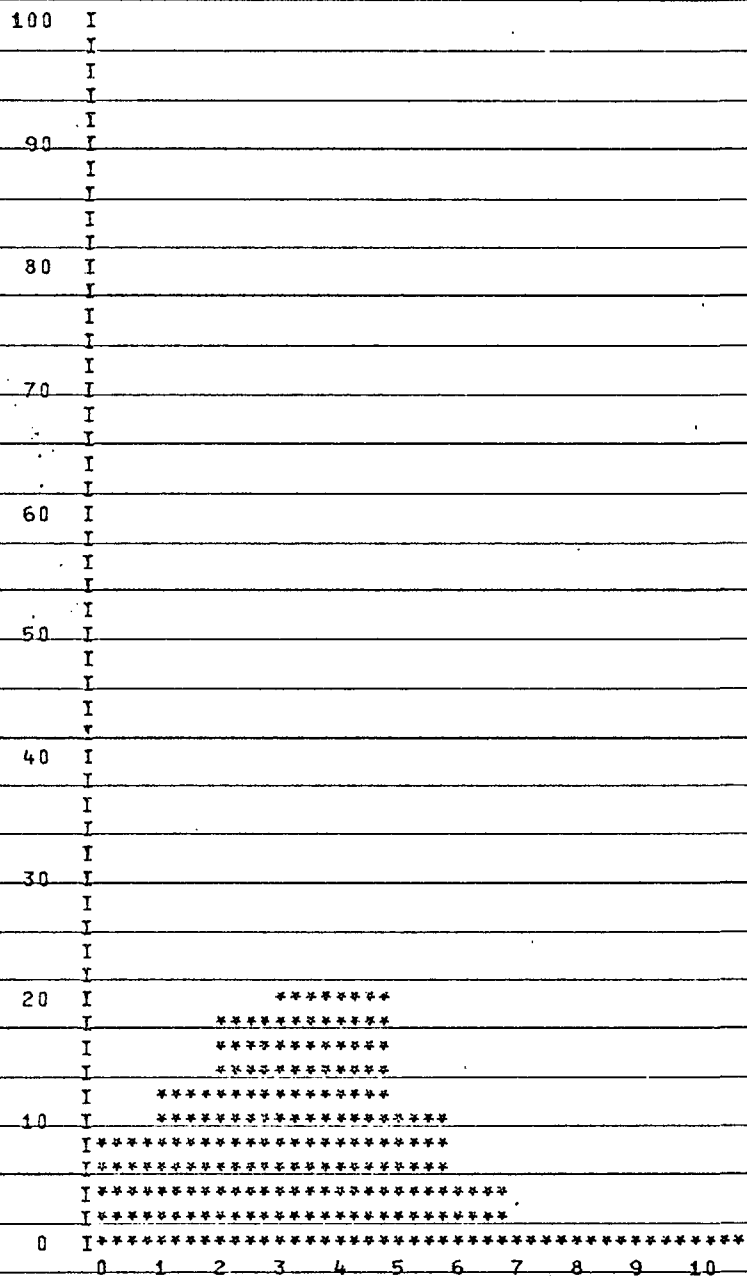
TOTAL TIME 1076036.00

PERCENT BETWEEN 0 AND 40 MILLISECOND 4.12 OVER 40 AND UNDER 140 MILLISECOND .49  
 OVER 140 AND UNDER 400 MILLISECOND 2.71 OVER 400 AND UNDER 1.5 SECONDS 20.48 1.5 AND OVER 72.20  
 MAXIMUM TIME 12836

NUMBER OF FREE PPS

PERCENT OF  
TIME

51



WAIT TIME PER PP ROUTINE

CIO

52

```

9250 I
9065 I****
8880 I****
8695 I****
8510 I****
8325 I****
8140 I****
7955 I****
7770 I****
7585 I****
7400 I****
7215 I****
7030 I****
6845 I****
6660 I****
6475 I****
6290 I****
6105 I****
5920 I****
5735 I****
5550 I****
5365 I****
5180 I****
4995 I****
4810 I****
4625 I****
4440 I****
4255 I****
4070 I****
3885 I****
3700 I****
3515 I****
3330 I****
3145 I****
2960 I****
2775 I****
2590 I****
2405 I****
2220 I*****
2035 I*****
1850 I*****
1665 I*****
1480 I*****
1295 I*****
1110 I*****
925 I*****
740 I*****
555 I*****
370 I*****
185 I*****
0 I*****

```

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

| PER CENT         | 0          | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 5 | 5 | 3 | 2 | 3 | 2 | 2 | 9 | 6 | 6 | 5 | 7 | 0 | 14 |  |
|------------------|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|--|
| TOTAL OCCURENCES | 28358.00   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |  |
| TOTAL TIME       | 2987145.00 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |  |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 7.65 OVER 40 AND UNDER 140 MILLISECONDS 10.92  
 OVER 140 AND UNDER 400 MILLISECONDS 16.74 OVER 400 AND UNDER 1.5 SECONDS 23.77 1.5 AND OVER 40.93

TOTAL NUMBER OF PP DROPS 706923  
 TOTAL NUMBER OF PP DROPS 706923



# REAL TIME PER PP ROUTINE

CIO

58000 I  
56340 I \*\*\*\*  
55680 I \*\*\*\*  
54520 I \*\*\*\*  
53360 I \*\*\*\*  
52200 I \*\*\*\*  
51040 I \*\*\*\*  
49880 I \*\*\*\*  
48720 I \*\*\*\*  
47560 I \*\*\*\*  
46400 I \*\*\*\*  
45240 I \*\*\*\*  
44080 I \*\*\*\*  
42920 I \*\*\*\*  
41760 I \*\*\*\*  
40600 I \*\*\*\*\*  
39440 I \*\*\*\*\*  
38280 I \*\*\*\*\*  
37120 I \*\*\*\*\*  
35960 I \*\*\*\*\*  
34800 I \*\*\*\*\*  
33640 I \*\*\*\*\*  
32480 I \*\*\*\*\*  
31320 I \*\*\*\*\*  
30160 I \*\*\*\*\*  
29000 I \*\*\*\*\*  
27840 I \*\*\*\*\*  
26680 I \*\*\*\*\*  
25520 I \*\*\*\*\*  
24360 I \*\*\*\*\*  
23200 I \*\*\*\*\*  
22040 I \*\*\*\*\*  
20880 I \*\*\*\*\*  
19720 I \*\*\*\*\*  
18560 I \*\*\*\*\*  
17400 I \*\*\*\*\*  
16240 I \*\*\*\*\*  
15080 I \*\*\*\*\*  
13920 I \*\*\*\*\*  
12760 I \*\*\*\*\*  
11600 I \*\*\*\*\*  
10440 I \*\*\*\*\*  
9280 I \*\*\*\*\*  
8120 I \*\*\*\*\*  
6960 I \*\*\*\*\*  
5800 I \*\*\*\*\*  
4640 I \*\*\*\*\*  
3480 I \*\*\*\*\*  
2320 I \*\*\*\*\*  
1160 I \*\*\*\*\*  
0 I \*\*\*\*\*

54

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 2 7 7 8 8 5 4 6 6 4 3 2 2 7 4 2 1 1 1 1 6 0 0 0 0 0 1  
TOTAL OCCURENCES 338105.00  
TOTAL TIME 18785694.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 19.37 OVER 40 AND UNDER 140 MILLISECONDS 39.60  
OVER 140 AND UNDER 400 MILLISECONDS 24.64 OVER 400 AND UNDER 1.5 SECONDS 14.37 1.5 AND OVER 2.02  
TOTAL NUMBER OF PP DROPS 706923

WAIT TIME PER PP ROUTINE

1RI

100 I

I

I

I

I

90 I

I

I

I

I

80 I

I

I

I

I

70 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

60 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

50 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

40 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

30 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

20 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

10 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

0 I\*\*\*\*\*

\*\*\*\*

\*\*\*\*\*

\*\*\*\*

\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

| PER CENT         | 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|------------------|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TOTAL OCCURENCES | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 3  | 2   | 0   | 0   | 0   | 0   | 5   | 3   | 4   | 0   | 0   | 0   | 0   | 11  | 36  | 0   | 0   | 32  | 0   | 0   |
| TOTAL TIME       |   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

PERCENT BETWEEN 0 AND 40 MILLISECONDS .74 OVER 40 AND UNDER 140 MILLISECONDS 5.81  
 OVER 140 AND UNDER 400 MILLISECONDS 9.10 OVER 400 AND UNDER 1.5 SECONDS 15.97 1.5 AND OVER 68.38  
 TOTAL NUMBER OF PP DROPS 706923

55



# REAL TIME PER PP ROUTINE

1RI

1650 I

I

I

I

I

1485 I

I

I

I

I

1320 I

I

I

I

I

1155 I

I

I

I

I

990 I

I

I

I

I

825 I

I

I

I

I

660 I

I

I

I

I

495 I

I

I

I

I

330 I

I

I

I

I

165 I

I

I

I

I

0

I

I

I

I

I

I

I

I

I

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

56

|                                       |        |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |                                    |     |     |     |     |     |     |     |     |     |       |     |     |     |
|---------------------------------------|--------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|-----|-----|-----|
| PER CENT                              | 0      | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200                                | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5   | 3.0 | 3.5 | 4.0 |
| TOTAL OCCURENCES                      | 0      | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0   | 2   | 2   | 2   | 1                                  | 11  | 4   | 2   | 2   | 2   | 5   | 5   | 45  | 8   | 1     | 0   | 0   | 0   |
| TOTAL TIME                            | 0      | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0   | 0   | 0   | 0   | 0                                  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0     | 0   | 0   | 0   |
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .03    |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     | OVER 40 AND UNDER 140 MILLISECONDS |     |     |     |     |     |     |     |     |     | 1.24  |     |     |     |
| OVER 140 AND UNDER 400 MILLISECONDS   | 24.26  |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     | OVER 400 AND UNDER 1.5 SECONDS     |     |     |     |     |     |     |     |     |     | 64.94 |     |     |     |
| TOTAL NUMBER OF PP DROPS              | 706923 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     | 1.5 AND OVER                       |     |     |     |     |     |     |     |     |     | 9.54  |     |     |     |

## WAIT TIME PER PP ROUTINE

1R0

57

```

250 I
245 I
240 I
235 I
230 I
225 I
220 I
215 I
210 I
205 I
200 I      ****
195 I      ****
190 I      ****
185 I      ****
180 I      ****
175 I      ****
170 I      ****
165 I      ****
160 I      ****
155 I      ****
150 I      ****
145 I      ****
140 I      ****
135 I      ****
130 I      ****
125 I      ****
120 I      ****
115 I      ****
110 I      ****
105 I      ****
100 I      ****
95 I      ****
90 I      ****
85 I      ****
80 I      ****
75 I      ****
70 I      ****
65 I      ****
60 I      ****
55 I      ****
50 I      ****
45 I      ****
40 I      ****
35 I      ****
30 I      ****
25 I      ****
20 I      ****
15 I      ****
10 I      ****
5 I      ****
0 I      ****

```

|                  | 0        | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |  |  |
|------------------|----------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| PER CENT         | 0        | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 4  | 19  | 7   | 1   | 2   | 3   | 4   | 14  | 6   | 5   | 5   | 2   | 2   | 1   | 13  | 0   | 0   | 0   | 0   | 0   |  |  |
| TOTAL OCCURENCES | 621.00   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |
| TOTAL TIME       | 93213.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 1.27 OVER 40 AND UNDER 140 MILLISECONDS 34.75  
 OVER 140 AND UNDER 400 MILLISECONDS 32.58 OVER 400 AND UNDER 1.5 SECONDS 31.40 1.5 AND OVER 0.00  
 TOTAL NUMBER OF PP DROPS 706923

1RO

|                                       |        |                                    |       |
|---------------------------------------|--------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .52    | OVER 40 AND UNDER 140 MILLISECONDS | 3.52  |
| OVER 140 AND UNDER 400 MILLISECONDS   | 29.01  | OVER 400 AND UNDER 1.5 SECONDS     | 56.52 |
|                                       |        | 1.5 AND OVER                       | 10.43 |
| TOTAL NUMBER OF PP DROPS              | 706923 |                                    |       |

WAIT TIME PER PP ROUTINE

1AJ

59

```

250 I
245 I
240 I
235 I
230 I
225 I
220 I
215 I
210 I      ****
205 I      ****
200 I      ****
195 I      ****
190 I      ****
185 I      ****
180 I      ****
175 I      ****
170 I      ****
165 I      ****
160 I      ****
155 I      ****
150 I      ****
145 I      ****
140 I      ****
135 I      ****
130 I      ****
125 I      ****
120 I      ****
115 I      ****
110 I      ****
105 I      ****
100 I      ****
95 I      ****
90 I      ****
85 I      ****
80 I      ****
75 I      ****
70 I      ****
65 I      ****
60 I      ****
55 I      ****
50 I      ****
45 I      ****
40 I      ****
35 I      ****
30 I      ****
25 I****
20 I****
15 I****
10 I****
5 I****
0 I*****

```

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 0 0 0 0 0 1 14 4 0 0 3 4 9 4 3 2 19 3 1 13 5 0 4 0 0 2

TOTAL OCCURENCES 590.00

TOTAL TIME 134926.00

PERCENT BETWEEN 0 AND 40 MILLISECOND .29 OVER 40 AND UNDER 140 MILLISECOND 20.91

OVER 140 AND UNDER 400 MILLISECOND 23.58 OVER 400 AND UNDER 1.5 SECONDS 42.89 1.5 AND OVER 12.32

TOTAL NUMBER OF PP DROPS 706923

REAL TIME PER PP ROUTINE

1AJ

60

```

1500 I
1470 I
1440 I
1410 I
1380 I
1350 I
1320 I
1290 I
1260 I
1230 I
1200 I
1170 I
1140 I
1110 I
1080 I
1050 I
1020 I
990 I
960 I
930 I
900 I
870 I
840 I
810 I
780 I
750 I
720 I
690 I
660 I
630 I
600 I
570 I
540 I
510 I
480 I
450 I
420 I
390 I
360 I
330 I
300 I
270 I
240 I
210 I
180 I
150 I
120 I
90 I
60 I
30 I
0 I

```

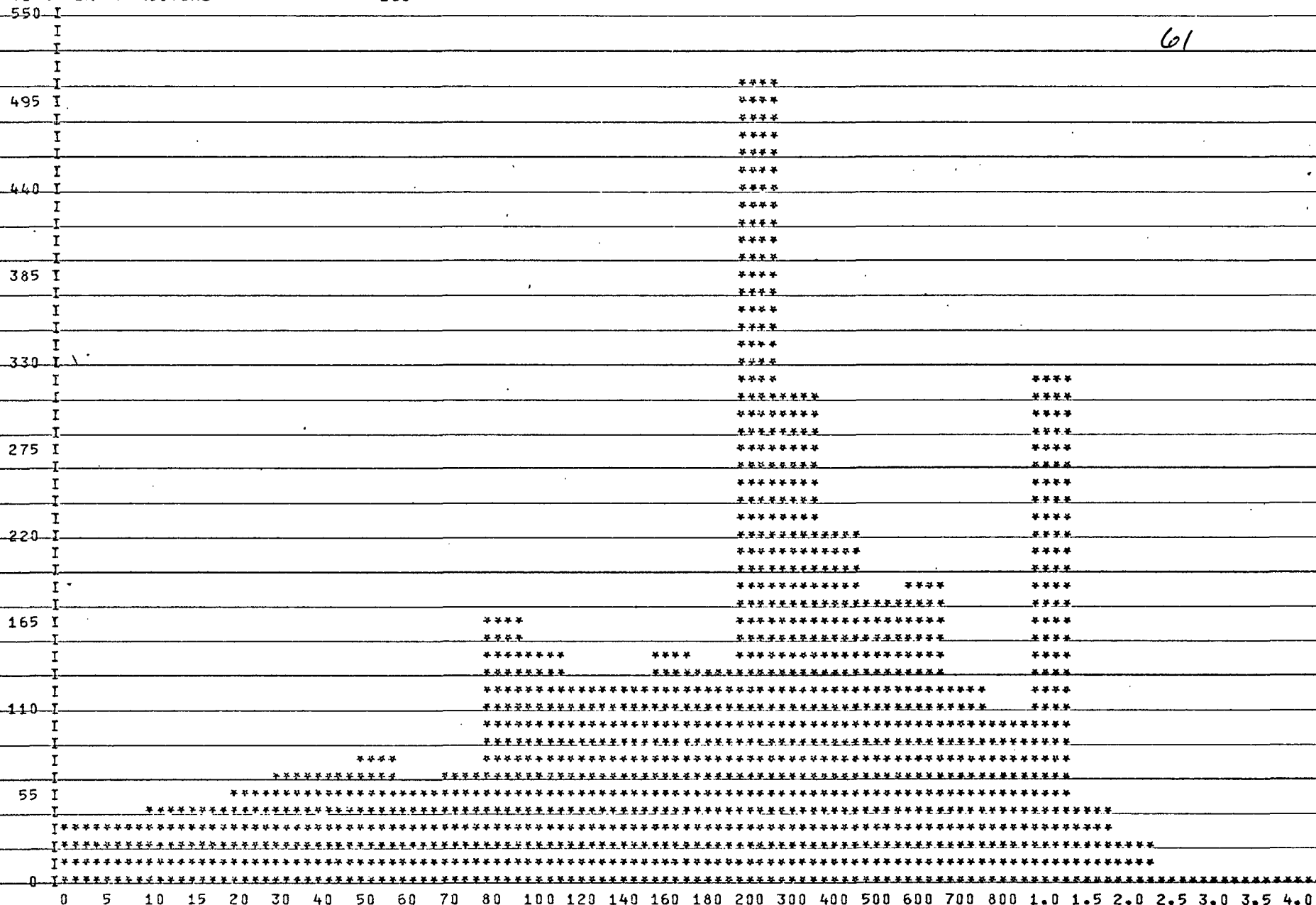
0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 1 3 4 5 4 7 7 5 3 2 1 14 7 3 2 2 1 2 10 1 0 0 0 0 3

TOTAL OCCURENCES 12579.00

TOTAL TIME 1609981.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 2.36 OVER 40 AND UNDER 140 MILLISECONDS 33.25  
OVER 140 AND UNDER 400 MILLISECONDS 35.51 OVER 400 AND UNDER 1.5 SECONDS 23.44 1.5 AND OVER 5.43  
TOTAL NUMBER OF PP DROPS 706923



| PER CENT         | 0          | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |   |  |
|------------------|------------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|--|
| TOTAL OCCURENCES | 0          | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1   | 1   | 1   | 1   | 1   | 1   | 8   | 7   | 7   | 7   | 8   | 6   | 5   | 23  | 6   | 3   | 1   | 0   | 0   | 1 |  |
| TOTAL TIME       | 1415381.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |   |  |

|                                      |        |                                   |       |
|--------------------------------------|--------|-----------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECOND | .40    | OVER 40 AND UNDER 140 MILLISECOND | 3.47  |
| OVER 140 AND UNDER 400 MILLISECOND   | 22.69  | OVER 400 AND UNDER 1.5 SECONDS    | 59.62 |
| 1.5 AND OVER                         | 13.82  |                                   |       |
| TOTAL NUMBER OF PP DROPS             | 706923 |                                   |       |
| TOTAL NUMBER OF PP DROPS             | 706923 |                                   |       |

15J

62

學 學 學

子子子子

~~~~~

學子學子

30680 Y \*\*\*\*

\_\_\_\_\_

下 學 費

I 學 學 學 學

學學學學

23010 I \*\*\*\*\*

I \*\*\*\*\*

I \*\*\*\*

I \_\_\_\_\_ 年 月 日

---

15340 Y \* \* \* \*

~~~~~

\_\_\_\_\_ I \_\_\_\_\_ \* \* \* \*

I \_\_\_\_\_ \* \* \* \*

\_\_\_\_\_

7670 \*\*\*\*\*

\*\*\*\*\*

---

\*\*\*\*\*

中 華 民 國 十 九 年 十 月 十 日  
 中 華 民 國 十 九 年 十 月 十 日

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 104

[illegible]

0 5 10 15

2 CENT 0 0 30

TOTAL TIME

PERCENT BETWEEN 0 AND 1

TOTAL NUMBER OF

|                   |          |
|-------------------|----------|
| TOTAL OCCURRENCES | 71535.00 |
|-------------------|----------|

\_\_\_\_\_

| OVER 140 AND UNDER 400 MILLYSECONDS                                                                    | 6.36 | OVER 400 AND UNDER 1.5 SECONDS | 17.35 | 1.5 AND OVER | 1.11 |
|--------------------------------------------------------------------------------------------------------|------|--------------------------------|-------|--------------|------|
| <p>OVER 140 AND UNDER 400 MILLYSECONDS 6.36 OVER 400 AND UNDER 1.5 SECONDS 17.35 1.5 AND OVER 1.11</p> |      |                                |       |              |      |

PFM

|                                       |        |                                    |       |
|---------------------------------------|--------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 2.36   | OVER 40 AND UNDER 140 MILLISECONDS | 5.58  |
| OVER 140 AND UNDER 400 MILLISECONDS   | 19.29  | OVER 400 AND UNDER 1.5 SECONDS     | 19.20 |
| 1.5 AND OVER                          | 53.57  |                                    |       |
| TOTAL NUMBER OF PP DROPS              | 706923 |                                    |       |





CPU TIME PER PP ROUTINE

1MT

29000 I  
 28420 I\*\*\*\*  
 27840 I\*\*\*\*  
 27260 I\*\*\*\*  
 26680 I\*\*\*\*  
 26100 I\*\*\*\*  
 25520 I\*\*\*\*  
 24940 I\*\*\*\*  
 24360 I\*\*\*\*  
 23780 I\*\*\*\*  
 23200 I\*\*\*\*  
 22620 I\*\*\*\*  
 22040 I\*\*\*\*  
 21460 I\*\*\*\*  
 20880 I\*\*\*\*  
 20300 I\*\*\*\*  
 19720 I\*\*\*\*  
 19140 I\*\*\*\*  
 18560 I\*\*\*\*  
 17980 I\*\*\*\*  
 17400 I\*\*\*\*  
 16820 I\*\*\*\*  
 16240 I\*\*\*\*  
 15660 I\*\*\*\*  
 15080 I\*\*\*\*  
 14500 I\*\*\*\*  
 13920 I\*\*\*\*  
 13340 I\*\*\*\*  
 12760 I\*\*\*\*  
 12180 I\*\*\*\*  
 11600 I\*\*\*\*  
 11020 I\*\*\*\*  
 10440 I\*\*\*\*  
 9860 I\*\*\*\*  
 9280 I\*\*\*\*  
 8700 I\*\*\*\*  
 8120 I\*\*\*\*  
 7540 I\*\*\*\*  
 6960 I\*\*\*\*  
 6380 I\*\*\*\*  
 5800 I\*\*\*\*  
 5220 I\*\*\*\*  
 4640 I\*\*\*\*  
 4060 I\*\*\*\*  
 3480 I\*\*\*\*  
 2900 I\*\*\*\*  
 2320 I\*\*\*\*  
 1740 I\*\*\*\*  
 1160 I\*\*\*\*  
 580 I\*\*\*\*

\*\*\*\*

0 I\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 10 1 1 1 2 3 3 3 11 35 5 1 1 2 14 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TOTAL OCCURENCES 31152.00

TOTAL TIME 145036.00

PERCENT BETWEEN 0 AND 40 MILLISECOND 19.23 OVER 40 AND UNDER 140 MILLISECOND 61.43  
 OVER 140 AND UNDER 400 MILLISECOND 19.34 OVER 400 AND UNDER 1.5 SECONDS 0.00 1.5 AND OVER 0.00  
 TOTAL NUMBER OF PP DROPS 706923

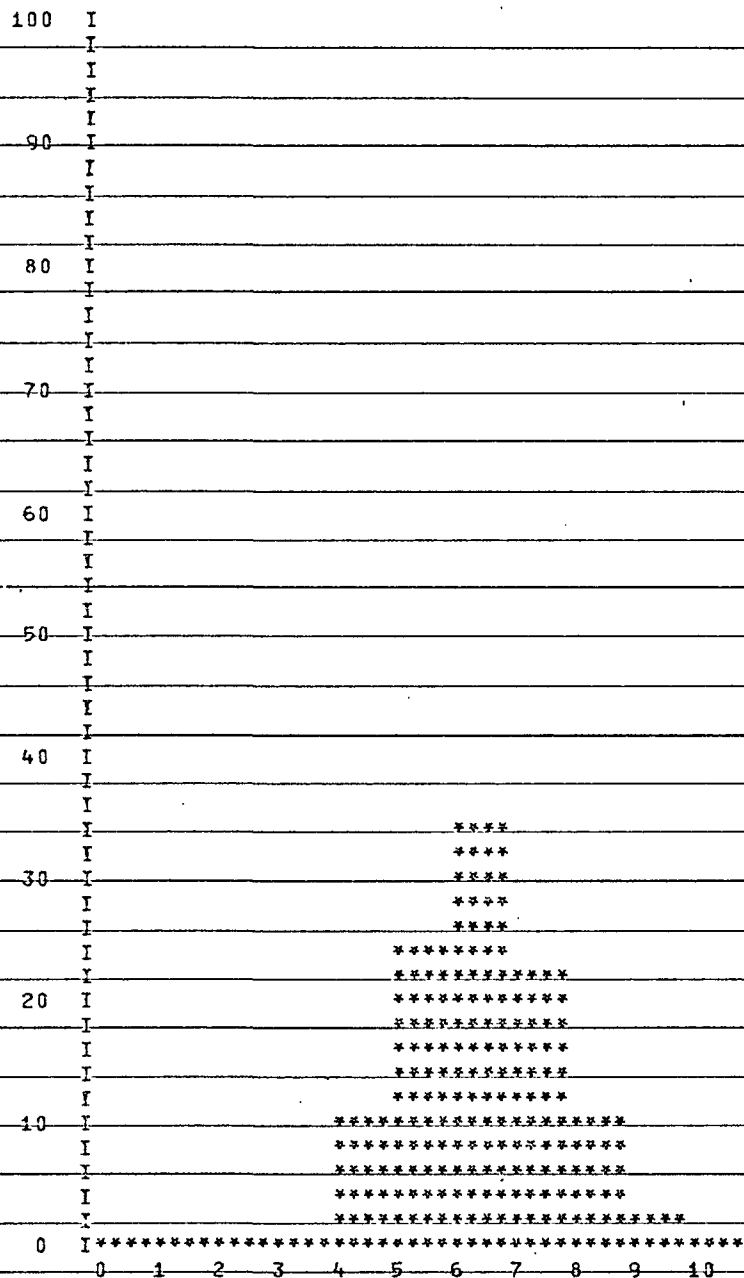


|                                                 |         |                                |
|-------------------------------------------------|---------|--------------------------------|
| PER CENT OF TIME CHANNEL 00 WAS USED BY TYPE 00 | 18.915  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 00 WAS USED BY TYPE 01 | 22.625  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 00 WAS USED BY TYPE 02 | 41.607  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 00 WAS USED BY TYPE 03 | 16.275  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 00 WAS USED BY TYPE 04 | .579    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 01 WAS USED BY TYPE 00 | 21.199  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 01 WAS USED BY TYPE 01 | 18.804  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 01 WAS USED BY TYPE 02 | 32.686  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 01 WAS USED BY TYPE 03 | 26.936  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 01 WAS USED BY TYPE 04 | .375    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 02 WAS USED BY TYPE 00 | 3.704   | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 02 WAS USED BY TYPE 03 | 96.296  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 03 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 04 WAS USED BY TYPE 00 | 13.458  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 04 WAS USED BY TYPE 01 | 16.981  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 04 WAS USED BY TYPE 02 | 50.126  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 04 WAS USED BY TYPE 03 | 19.115  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 04 WAS USED BY TYPE 04 | .320    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 05 WAS USED BY TYPE 00 | 19.617  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 05 WAS USED BY TYPE 01 | 17.081  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 05 WAS USED BY TYPE 02 | 38.894  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 05 WAS USED BY TYPE 03 | 23.512  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 05 WAS USED BY TYPE 04 | .896    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 06 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 07 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 10 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 11 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 12 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 13 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 14 WAS USED BY TYPE 00 | 39.353  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 14 WAS USED BY TYPE 01 | 5.120   | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 14 WAS USED BY TYPE 02 | 17.163  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 14 WAS USED BY TYPE 03 | 37.742  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 14 WAS USED BY TYPE 04 | .618    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 15 WAS USED BY TYPE 00 | 99.606  | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 15 WAS USED BY TYPE 01 | .059    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 15 WAS USED BY TYPE 02 | .191    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 15 WAS USED BY TYPE 03 | .144    | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 16 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 17 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 20 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |
| PER CENT OF TIME CHANNEL 21 WAS USED BY TYPE 00 | 100.000 | PER CENT OF THE TIME IT WAS UP |

PP USE BY ORIGIN 00

PERCENT OF  
TIME

68



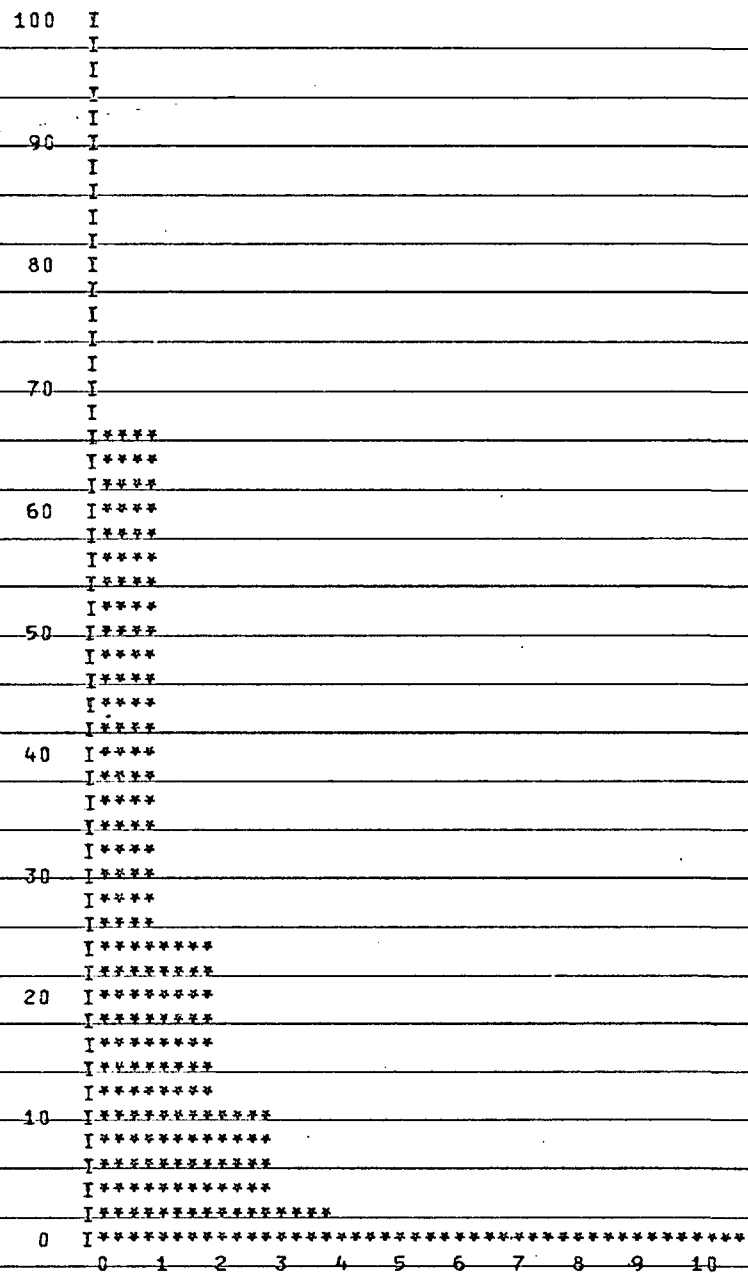
PERCENT OF  
TIME

69

|     |                        |
|-----|------------------------|
| 100 | I                      |
|     | I                      |
|     | I                      |
|     | I                      |
|     | I                      |
| 90  | I                      |
|     | I                      |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 80  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 70  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 60  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 50  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 40  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 30  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 20  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I*****                 |
|     | I*****                 |
| 10  | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
| 0   | I*****                 |
|     | 0 1 2 3 4 5 6 7 8 9 10 |

PERCENT OF  
TIME

70



PERCENT OF  
TIME

71

|     |                        |
|-----|------------------------|
| 100 | I                      |
|     | I                      |
|     | I                      |
|     | I                      |
|     | I                      |
| 90  | I                      |
|     | I                      |
|     | I                      |
|     | I                      |
| 80  | I                      |
|     | I                      |
|     | I                      |
|     | I                      |
| 70  | I                      |
|     | I                      |
|     | I                      |
|     | I****                  |
|     | I****                  |
| 60  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 50  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 40  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I*****                 |
| 30  | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
| 20  | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
| 10  | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
|     | I*****                 |
| 0   | I*****                 |
|     | 0 1 2 3 4 5 6 7 8 9 10 |



PERCENT OF  
TIME

72

|     |                        |
|-----|------------------------|
| 100 | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 90  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 80  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 70  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 60  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 50  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 40  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 30  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 20  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 10  | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
|     | I****                  |
| 0   | I*****                 |
|     | 0 1 2 3 4 5 6 7 8 9 10 |

73

|                                       |                    |                                    |       |
|---------------------------------------|--------------------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .02                | OVER 40 AND UNDER 140 MILLISECONDS | .31   |
| OVER 140 AND UNDER 400 MILLISECONDS   | .79                | OVER 400 AND UNDER 1.5 SECONDS     | 2.59  |
| MAXIMUM REAL TIME                     | 22974 MILLISECONDS | 1.5 AND OVER                       | 96.29 |

## 01 REAL TIME PER TYPE DIVIDED BY 1000

50 I

I

I

I

I

45 I

I

I

I

I

40 I

I

I

I

I

35 I

I

I

I

I

30 I

I

I

I

I

25 I

I

I

I

I

20 I

I

I

I\*\*\*\*

I\*\*\*\*

15 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

10 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

5 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

0 I\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 3 0 0 0 4 5 0 0 0 10 16 22 0 31 0 0

TOTAL OCCURENCES 40.00

TOTAL TIME 9929.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 1.24 OVER 40 AND UNDER 140 MILLISECONDS 4.27  
 OVER 140 AND UNDER 400 MILLISECONDS 3.44 OVER 400 AND UNDER 1.5 SECONDS 20.63 1.5 AND OVER 70.42  
 MAXIMUM REAL TIME 3109 MILLISECONDS

74

## 02 REAL TIME PER TYPE DIVIDED BY 1000

100 I

I

I

I\*\*\*\*

I\*\*\*\*

90 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

80 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

70 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

60 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

50 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

40 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

30 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

20 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

10 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

0 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

| PER CENT         | 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|------------------|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TOTAL OCCURENCES | 0 | 0 | 0  | 0  | 1  | 1  | 1  | 1  | 1  | 2  | 1  | 0   | 2   | 1   | 4   | 0   | 5   | 7   | 2   | 4   | 0   | 4   | 0   | 3   | 5   | 6   | 0   | 0   | 0   | 35  |
| TOTAL TIME       |   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

PERCENT BETWEEN 0 AND 40 MILLISECOND 5.66 OVER 40 AND UNDER 140 MILLISECOND 9.31  
 OVER 140 AND UNDER 400 MILLISECOND 21.68 OVER 400 AND UNDER 1.5 SECONDS 15.35 1.5 AND OVER 48.01

25

## 03 REAL TIME PER TYPE DIVIDED BY 1000

750 I  
 735 I  
 720 I  
 705 I\*\*\*\*  
 690 I\*\*\*\*  
 675 I\*\*\*\*  
 660 I\*\*\*\*  
 645 I\*\*\*\*  
 630 I\*\*\*\*  
 615 I\*\*\*\*  
 600 I\*\*\*\*  
 585 I\*\*\*\*  
 570 I\*\*\*\*  
 555 I\*\*\*\*  
 540 I\*\*\*\*  
 525 I\*\*\*\*  
 510 I\*\*\*\*  
 495 I\*\*\*\*  
 480 I\*\*\*\*  
 465 I\*\*\*\*  
 450 I\*\*\*\*  
 435 I\*\*\*\*  
 420 I\*\*\*\*  
 405 I\*\*\*\*  
 390 I\*\*\*\*  
 375 I\*\*\*\*  
 360 I\*\*\*\*  
 345 I\*\*\*\*  
 330 I\*\*\*\*  
 315 I\*\*\*\*  
 300 I\*\*\*\*  
 285 I\*\*\*\*  
 270 I\*\*\*\*  
 255 I\*\*\*\*  
 240 I\*\*\*\*  
 225 I\*\*\*\*  
 210 I\*\*\*\*  
 195 I\*\*\*\*  
 180 I\*\*\*\*  
 165 I\*\*\*\*  
 150 I\*\*\*\*  
 135 I\*\*\*\*  
 120 I\*\*\*\*  
 105 I\*\*\*\*\*  
 90 I\*\*\*\*\*  
 75 I\*\*\*\*\*  
 60 I\*\*\*\*\*  
 45 I\*\*\*\*\*  
 30 I\*\*\*\*\*  
 15 I\*\*\*\*\*  
 0 I\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 2 3 3 1 3 9 8 3 7 0 0 42  
 TOTAL OCCURENCES 1298.00  
 TOTAL TIME 291661.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 1.14 OVER 40 AND UNDER 140 MILLISECONDS 2.33  
 OVER 140 AND UNDER 400 MILLISECONDS 9.53 OVER 400 AND UNDER 1.5 SECONDS 24.66 1.5 AND OVER 62.35  
 MAXIMUM REAL TIME 11827 MILLISECONDS

76

22

|                                       |       |                                    |      |
|---------------------------------------|-------|------------------------------------|------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .44   | OVER 40 AND UNDER 140 MILLISECONDS | 0.00 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 0.00  | OVER 400 AND UNDER 1.5 SECONDS     | 0.00 |
| 1.5 AND OVER                          | 99.56 |                                    |      |
| XIMUM REAL TIME 4801 MILLISECONDS     |       |                                    |      |

## 00 CPU TIME PER TYPE

50 I

I

I

I

I

45 I

I

I

I

I

40 I

I

I

I

I

35 I

I

I

I

I

30 I

I

I

I

I

25 I

I

I

I

I

20 I

I

I

I

I

15 I

I

I

I

I\*\*\*\*

10 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

5 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

0 I\*\*\*\*\*

0

5

10

15

20

30

40

50

60

70

80

100

120

140

160

180

200

300

400

500

600

700

800

1.0

1.5

2.0

2.5

3.0

3.5

4.0

PER CENT

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

99

TOTAL OCCURENCES

51.00

TOTAL TIME

20233758.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS

.00 OVER 40 AND UNDER 140 MILLISECONDS

.00

OVER 140 AND UNDER 400 MILLISECONDS

.01 OVER 400 AND UNDER 1.5 SECONDS

.04 1.5 AND OVER

99.95

MAXIMUM CPU TIME

0 MILLISECONDS

79

|                                       |                |                                    |       |
|---------------------------------------|----------------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .01            | OVER 40 AND UNDER 140 MILLISECONDS | .01   |
| OVER 140 AND UNDER 400 MILLISECONDS   | 0.00           | OVER 400 AND UNDER 1.5 SECONDS     | .09   |
| MAXIMUM CPU TIME                      | 0 MILLISECONDS | 1.5 AND OVER                       | 99.90 |



80

|                                       |                |                                    |       |
|---------------------------------------|----------------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .02            | OVER 40 AND UNDER 140 MILLISECONDS | .05   |
| OVER 140 AND UNDER 400 MILLISECONDS   | .57            | OVER 400 AND UNDER 1.5 SECONDS     | 1.27  |
| MAXIMUM CPU TIME                      | 0 MILLISECONDS | 1.5 AND OVER                       | 98.09 |

81

81

81

81

81

## 04 CPU TIME PER TYPE

500 I  
 490 I  
 480 I  
 470 I  
 460 I\*\*\*\*  
 450 I\*\*\*\*  
 440 I\*\*\*\*  
 430 I\*\*\*\*  
 420 I\*\*\*\*  
 410 I\*\*\*\*  
 400 I\*\*\*\*  
 390 I\*\*\*\*  
 380 I\*\*\*\*  
 370 I\*\*\*\*  
 360 I\*\*\*\*  
 350 I\*\*\*\*  
 340 I\*\*\*\*  
 330 I\*\*\*\*  
 320 I\*\*\*\*  
 310 I\*\*\*\*  
 300 I\*\*\*\*  
 290 I\*\*\*\*  
 280 I\*\*\*\*  
 270 I\*\*\*\*  
 260 I\*\*\*\*  
 250 I\*\*\*\*  
 240 I\*\*\*\*  
 230 I\*\*\*\*  
 220 I\*\*\*\*  
 210 I\*\*\*\*  
 200 I\*\*\*\*  
 190 I\*\*\*\*  
 180 I\*\*\*\*  
 170 I\*\*\*\*  
 160 I\*\*\*\*  
 150 I\*\*\*\*  
 140 I\*\*\*\*  
 130 I\*\*\*\*  
 120 I\*\*\*\*  
 110 I\*\*\*\*  
 100 I\*\*\*\*  
 90 I\*\*\*\*  
 80 I\*\*\*\*  
 70 I\*\*\*\*  
 60 I\*\*\*\*  
 50 I\*\*\*\*  
 40 I\*\*\*\*  
 30 I\*\*\*\*  
 20 I\*\*\*\*\*  
 10 I\*\*\*\*\*  
 0 I\*\*\*\*\*

42

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 68 10 6 5 2 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
 TOTAL OCCURENCES 535.00  
 TOTAL TIME 1230.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 94.47 OVER 40 AND UNDER 140 MILLISECONDS 5.53  
 OVER 140 AND UNDER 400 MILLISECONDS 0.00 OVER 400 AND UNDER 1.5 SECONDS 0.00 1.5 AND OVER 0.00  
 MAXIMUM CPU TIME 0 MILLISECONDS

43

|                                       |     |                                    |       |
|---------------------------------------|-----|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .01 | OVER 40 AND UNDER 140 MILLISECONDS | .03   |
| OVER 140 AND UNDER 400 MILLISECONDS   | .22 | OVER 400 AND UNDER 1.5 SECONDS     | 1.21  |
|                                       |     | 1.5 AND OVER                       | 98.53 |

78

[illegible]

120

105

50

75

60

45

30

15

100

1

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

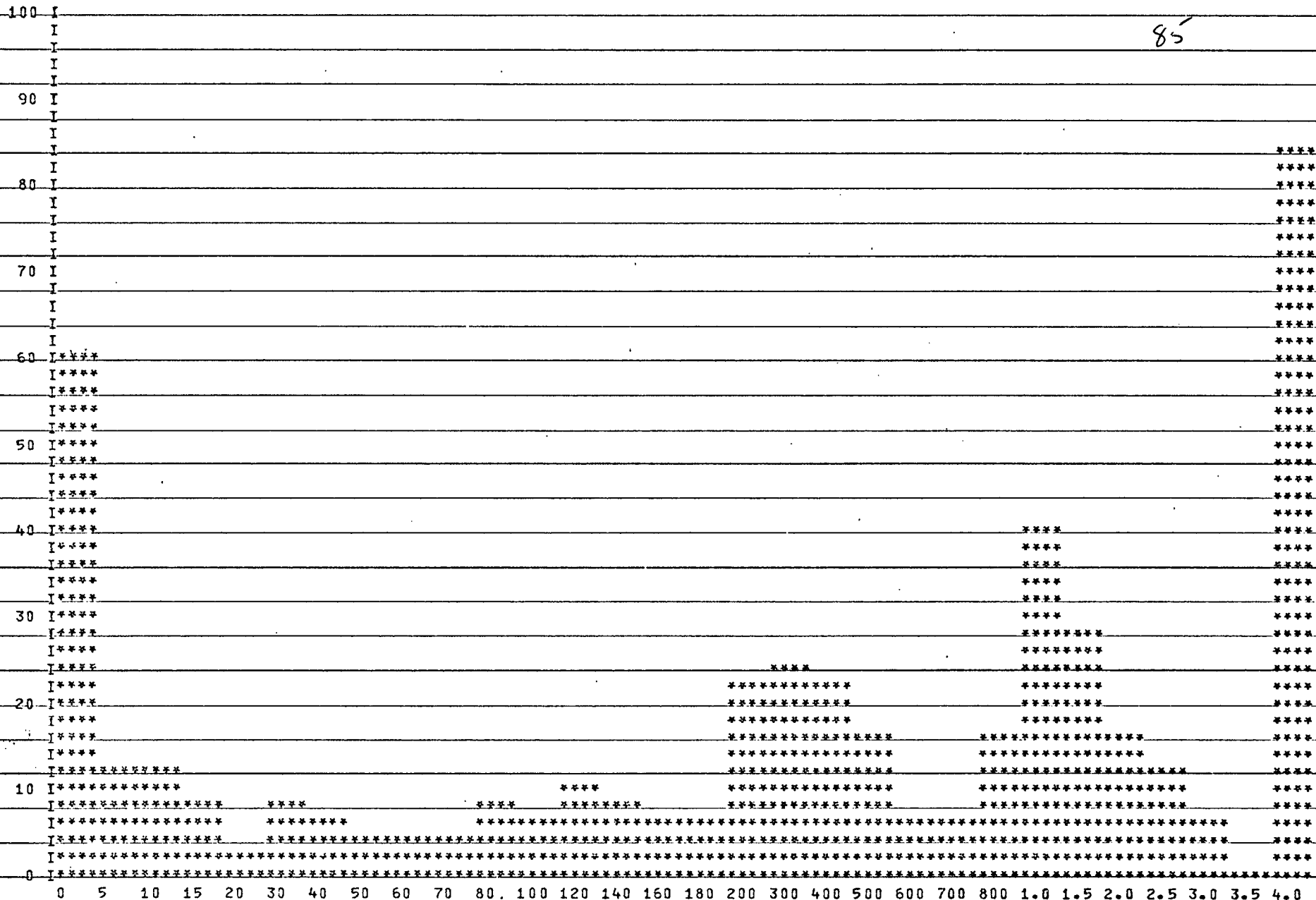
[illegible]

~~TOTAL OCCURENCES~~ ~~227.00~~

TOTAL TIME 2645807.00

|                                       |     |                                    |       |
|---------------------------------------|-----|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .01 | OVER 40 AND UNDER 140 MILLISECONDS | .04   |
| OVER 140 AND UNDER 400 MILLISECONDS   | .18 | OVER 400 AND UNDER 1.5 SECONDS     | 1.30  |
|                                       |     | 1.5 AND OVER                       | 98.47 |

## 02 TIME BETWEEN ROLL OUTS PER TYPE



| PER CENT         | 0          | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |    |  |
|------------------|------------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|--|
| TOTAL OCCURENCES | 0          | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 3   | 3   | 2   | 2   | 1   | 0   | 81 |  |
| TOTAL TIME       | 1372476.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |    |  |

|                                       |      |                                    |       |
|---------------------------------------|------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | .06  | OVER 40 AND UNDER 140 MILLISECONDS | .19   |
| OVER 140 AND UNDER 400 MILLISECONDS   | 1.37 | OVER 400 AND UNDER 1.5 SECONDS     | 6.46  |
|                                       |      | 1.5 AND OVER                       | 91.92 |

84

|                                       |        |                                    |       |
|---------------------------------------|--------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | -21.64 | OVER 40 AND UNDER 140 MILLISECONDS | 2.18  |
| OVER 140 AND UNDER 400 MILLISECONDS   | 3.89   | OVER 400 AND UNDER 1.5 SECONDS     | 13.70 |
|                                       |        | 1.5 AND OVER 101.87                |       |

87

45

40

35

30

25

20

15

10

5



◆◆◆◆

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

|                  |       |   |     |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------------|-------|---|-----|---|---|---|------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PER CENT         | 0     | 0 | 100 | 0 | 0 | 0 | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OCCURENCES |       |   |     |   |   |   | 1.00 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| TOTAL TIME       | 11.00 |   |     |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

|                                       |        |                                    |      |
|---------------------------------------|--------|------------------------------------|------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 100.00 | OVER 40 AND UNDER 140 MILLISECONDS | 0.00 |
| OVER 140 AND UNDER 400 MILLISECONDS   | 0.00   | OVER 400 AND UNDER 1.5 SECONDS     | 0.00 |
|                                       |        | 1.5 AND OVER                       | 0.00 |



48

|          |          |          |          |          |
|----------|----------|----------|----------|----------|
| I        | ✱        | ✱        | ✱        | ✱        |
| <u>I</u> | <u>✱</u> | <u>✱</u> | <u>✱</u> | <u>✱</u> |
| I        | ✱        | ✱        | ✱        | ✱        |
| I        | ✱        | ✱        | ✱        | ✱        |

一 二 三 四  
 一 二 三 四  
 一 二 三 四

|   |   |   |   |   |
|---|---|---|---|---|
| I | 千 | 千 | 千 | 千 |
| I | 千 | 千 | 千 | 千 |
| I | 千 | 千 | 千 | 千 |
| I | 千 | 千 | 千 | 千 |

I 4 4 4 4  
 I 4 4 4 4  
 I 4 4 4 4  
 I 4 4 4 4

I 不 不 不  
 I 不 不 不  
 I 不 不 不  
 I 不 不 不

I ☆ ☆ ☆ ☆  
 I ☆ ☆ ☆ ☆  
 I ☆ ☆ ☆ ☆  
 I ☆ ☆ ☆ ☆

I 不 不 不 不  
 I 不 不 不 不  
 I 不 不 不 不  
 I 不 不 不 不

一 不 不 不  
 一 不 不 不  
 一 不 不 不  
 一 不 不 不

I 子 子 子 子  
 I 子 子 子 子  
 I 子 子 子 子  
 I 子 子 子 子

Y 5 5 5 5 5  
I 5 5 5 5 5  
Y 5 5 5 5 5

\*\*\*\*\*

|   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|---|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

[illegible]

|                  |           |
|------------------|-----------|
| TOTAL OCCURENCES | 265221.00 |
|------------------|-----------|

|            |             |
|------------|-------------|
| TOTAL TIME | 12471889.00 |
|------------|-------------|

|                                       |      |                                    |       |
|---------------------------------------|------|------------------------------------|-------|
| PERCENT BETWEEN 0 AND 40 MILLISECONDS | 7.91 | OVER 40 AND UNDER 140 MILLISECONDS | 2.16  |
| OVER 140 AND UNDER 400 MILLISECONDS   | 96   | OVER 400 AND UNDER 1.5 SECONDS     | 1.07  |
|                                       |      | 1.5 AND OVER                       | 87.91 |

## 01 TIME BETWEEN I/O REQUESTS PER TYPE

22850 I  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 20565 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 18280 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 15995 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 13710 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 11425 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 I\*\*\*\*  
 9140 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 6855 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 4570 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 2285 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 I\*\*\*\*\*  
 0 I\*\*\*\*\*  
 0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0  
 PER CENT 0 1 1 2 4 4 3 3 2 2 6 8 6 5 5 6 14 4 1 0 0 0 0 5 2 0 0 0 0 1  
 TOTAL OCCURENCES 73990.00  
 TOTAL TIME 3347765.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 16.19 OVER 40 AND UNDER 140 MILLISECONDS 26.68  
 OVER 140 AND UNDER 400 MILLISECONDS 43.27 OVER 400 AND UNDER 1.5 SECONDS 9.68 1.5 AND OVER 4.18

## 02 TIME BETWEEN I/O REQUESTS PER TYPE

74300 I

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

66870 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

59440 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

52010 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

44580 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

37150 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

29720 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

22290 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

14860 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\* \*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

7430 I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

I\*\*\*\*\*

0 I\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 3 8 7 7 12 12 10 9 6 4 3 1 1 0 0 0 2 1 1 0 0 0 0 0 0 0 0 0 0 0

TOTAL OCCURENCES 169310.00

TOTAL TIME 2427305.00

PERCENT BETWEEN 0 AND 40 MILLISECONDS 52.25 OVER 40 AND UNDER 140 MILLISECONDS 36.15  
 OVER 140 AND UNDER 400 MILLISECONDS 7.00 OVER 400 AND UNDER 1.5 SECONDS 3.96 1.5 AND OVER .64

## 03 TIME BETWEEN I/O REQUESTS PER TYPE

71500 I  
 70070 I\*\*\*\*  
 58640 I\*\*\*\*  
 67210 I\*\*\*\*  
 55780 I\*\*\*\*  
 64350 I\*\*\*\*  
 62920 I\*\*\*\*  
 61490 I\*\*\*\*  
 60060 I\*\*\*\*  
 58630 I\*\*\*\*  
 57200 I\*\*\*\*  
 55770 I\*\*\*\*  
 54340 I\*\*\*\*  
 52910 I\*\*\*\*  
 51430 I\*\*\*\*  
 50050 I\*\*\*\*  
 48620 I\*\*\*\*  
 47190 I\*\*\*\*  
 45760 I\*\*\*\*  
 44330 I\*\*\*\*  
 42900 I\*\*\*\*  
 41470 I\*\*\*\*  
 40040 I\*\*\*\*  
 38610 I\*\*\*\*  
 37180 I\*\*\*\*  
 35750 I\*\*\*\*  
 34320 I\*\*\*\*  
 32890 I\*\*\*\*  
 31460 I\*\*\*\*  
 30030 I\*\*\*\*  
 28600 I\*\*\*\*  
 27170 I\*\*\*\*  
 25740 I\*\*\*\*  
 24310 I\*\*\*\*  
 22800 I\*\*\*\*  
 21450 I\*\*\*\*  
 20020 I\*\*\*\*  
 18590 I\*\*\*\*  
 17160 I\*\*\*\*  
 15730 I\*\*\*\*  
 14300 I\*\*\*\*  
 12870 I\*\*\*\*  
 11440 I\*\*\*\*\*  
 10010 I\*\*\*\*\*  
 8580 I\*\*\*\*\*  
 7150 I\*\*\*\*\*  
 5720 I\*\*\*\*\*  
 4290 I\*\*\*\*\*  
 2860 I\*\*\*\*\*  
 1430 I\*\*\*\*\*

91

|                  | 0          | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |  |  |
|------------------|------------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| PER CENT         | -25        | 4 | 2  | 3  | 6  | 3  | 2  | 1  | 1  | 2  | 5  | 3   | 5   | 11  | 4   | 3   | 12  | 11  | 4   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 31  |  |  |
| TOTAL OCCURENCES | 111900.00  |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |
| TOTAL TIME       | 2090617.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |

PERCENT BETWEEN 0 AND 40 MILLISECONDS -4.76 OVER 40 AND UNDER 140 MILLISECONDS 17.12  
 OVER 140 AND UNDER 400 MILLISECONDS 48.53 OVER 400 AND UNDER 1.5 SECONDS 7.37 1.5 AND OVER 31.73

## 04 TIME BETWEEN I/O REQUESTS PER TYPE

1750 I  
 1715 I\*\*\*\*  
 1680 I\*\*\*\*  
 1645 I\*\*\*\*  
 1610 I\*\*\*\*  
 1575 I\*\*\*\*  
 1540 I\*\*\*\*  
 1505 I\*\*\*\*  
 1470 I\*\*\*\*  
 1435 I\*\*\*\*  
 1400 I\*\*\*\*  
 1365 I\*\*\*\*  
 1330 I\*\*\*\*  
 1295 I\*\*\*\*  
 1260 I\*\*\*\*  
 1225 I\*\*\*\*  
 1190 I\*\*\*\*  
 1155 I\*\*\*\*  
 1120 I\*\*\*\*  
 1085 I\*\*\*\*  
 1050 I\*\*\*\*  
 1015 I\*\*\*\*  
 980 I\*\*\*\*  
 945 I\*\*\*\*  
 910 I\*\*\*\*  
 875 I\*\*\*\*  
 840 I\*\*\*\*  
 805 I\*\*\*\*  
 770 I\*\*\*\*  
 735 I\*\*\*\*  
 700 I\*\*\*\*  
 665 I\*\*\*\*  
 630 I\*\*\*\*  
 595 I\*\*\*\*  
 560 I\*\*\*\*  
 525 I\*\*\*\*  
 490 I\*\*\*\*  
 455 I\*\*\*\*  
 420 I\*\*\*\*  
 385 I\*\*\*\*  
 350 I\*\*\*\*  
 315 I\*\*\*\*  
 280 I\*\*\*\*  
 245 I\*\*\*\*  
 210 I\*\*\*\*  
 175 I\*\*\*\*  
 140 I\*\*\*\*  
 105 I\*\*\*\*  
 70 I\*\*\*\*  
 35 I\*\*\*\*

92

|                  | 0       | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |  |  |
|------------------|---------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| PER CENT         | 48      | 7 | 11 | 4  | 1  | 0  | 0  | 25 | 0  | 0  | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |  |  |
| TOTAL OCCURENCES | 1778.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |
| TOTAL TIME       | 1047.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |  |

PERCENT BETWEEN 0 AND 40 MILLISECONDS 74.59 OVER 40 AND UNDER 140 MILLISECONDS 25.41  
 OVER 140 AND UNDER 400 MILLISECONDS 0.00 OVER 400 AND UNDER 1.5 SECONDS 0.00 1.5 AND OVER 0.00



## 01 WAIT TIME FOR FIELD CHANGES BY TYPE

250 I  
 245 I\*\*\*\*  
 240 I\*\*\*\*  
 235 I\*\*\*\*  
 230 I\*\*\*\*  
 225 I\*\*\*\*  
 220 I\*\*\*\*  
 215 I\*\*\*\*  
 210 I\*\*\*\*  
 205 I\*\*\*\*  
 200 I\*\*\*\*  
 195 I\*\*\*\*  
 190 I\*\*\*\*  
 185 I\*\*\*\*  
 180 I\*\*\*\*  
 175 I\*\*\*\*  
 170 I\*\*\*\*  
 165 I\*\*\*\*  
 160 I\*\*\*\*  
 155 I\*\*\*\*  
 150 I\*\*\*\*  
 145 I\*\*\*\*  
 140 I\*\*\*\*  
 135 I\*\*\*\*  
 130 I\*\*\*\*  
 125 I\*\*\*\*  
 120 I\*\*\*\*  
 115 I\*\*\*\*  
 110 I\*\*\*\*  
 105 I\*\*\*\*  
 100 I\*\*\*\*  
 95 I\*\*\*\*  
 90 I\*\*\*\*  
 85 I\*\*\*\*  
 80 I\*\*\*\*  
 75 I\*\*\*\*  
 70 I\*\*\*\*  
 65 I\*\*\*\*  
 60 I\*\*\*\*  
 55 I\*\*\*\*  
 50 I\*\*\*\*  
 45 I\*\*\*\*  
 40 I\*\*\*\*  
 35 I\*\*\*\*  
 30 I\*\*\*\*  
 25 I\*\*\*\*  
 20 I\*\*\*\*  
 15 I\*\*\*\*  
 10 I\*\*\*\*  
 5 I\*\*\*\*  
 0 I\*\*\*\*

94

|                   | 0        | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|-------------------|----------|---|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| PER CENT          | 0        | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0   | 0   | 1   | 1   | 1   | 3   | 7   | 5   | 5   | 9   | 8   | 13  | 25  | 3   | 0   | 0   | 0   | 0   | 8   |
| TOTAL OCCURENCES  | 399.00   |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| SUM               | 52688.00 |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| MAXIMUM WAIT TIME | 4626     |   |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

## 02 WAIT TIME FOR FIELD CHANGES BY TYPE

1050 I

I

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

945 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

840 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

735 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

630 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

525 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

420 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

315 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

210 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

105 I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*\*

\*\*\*\*

0 I\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT 0 0 0 0 0 0 0 0 0 0 1 2 1 0 2 2 1 8 6 9 8 5 2 5 26 3 1 0 0 0 6

TOTAL OCCURENCES 1447.00

SUM 130345.00

MAXIMUM WAIT TIME 4537

95



## 03 WAIT TIME FOR FIELD CHANGES BY TYPE

1200 I

I

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

1080

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

960

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

840

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

720

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

600

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

480

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

360

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

240

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

120

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

I\*\*\*\*

0

I\*\*\*\*\*

\*\*\*\*

\*\*\*\*\*

\*\*\*\*

\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

0 5 10 15 20 30 40 50 60 70 80 100 120 140 160 180 200 300 400 500 600 700 800 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PER CENT

0 0 0 0 0 0 0 0 0 0 1 2 0 1 5 4 3 10 8 5 5 6 7 3 15 3 1 5 0 0 5

TOTAL OCCURENCES

1740.00

SUM

160655.00

MAXIMUM WAIT TIME

5518

96

## CHAPTER FOUR

### ANALYSIS

One of the problems of statistical analyses is the tendency of the statistics to be overwhelming. The following 95 histograms and one table are no exception. In order to present them in a comprehensible manner, we shall divide them into three classes: channel statistics, peripheral processor statistics, and job statistics. These are not independent areas. However, the separation is necessary for understanding.

The following data was gathered from approximately six hours of sampling.

#### Channel Statistics: Histograms 1-52

The figure of interest in this section is the balance of utilization. This was developed by Schwetman, and is the ratio of the holding time of a resource to the sum of the wait and holding times. The ideal balance of utilization is 1--the wait time is zero in that case. As the wait time increases, the holding time remaining constant, the balance figure goes to zero. We use the balance of utilization figure to determine where there are bottlenecks in the system. It is not an effective measurement of the efficiency of a device. For instance, the balance of utilization for the card punch is one--very seldom will more than one job be punching cards. Yet, no one would recommend adding more card punches to a configuration because they are efficient output devices. What we are interested in is whether a device is in contention and creating a bottleneck.

The first two channels (0 and 1) are attached to 808 disk subsystems. The balance of utilization for these channels were .77 and .84. The other disk channels (4 and 5) are attached to 844 disk systems; their balance of utilization was .73 for channel 4 and .68 for channel 5. Each of these channels is used for both system and scratch activity, so a strict comparison with the balance figures that Schwetman obtained for the CDC 6600 at the University of Texas is not possible. His figures are from .81 to .83 for the channels for scratch devices and from .55 to .70 for the channel for system use. It is apparent, however, that the two systems are about the same.

It is possible for the system under study to also isolate the system activity to one device. This will be discussed in a later section.

The two peaks in each of the histograms for channel holding time for channel 0 and channel 1 are interesting. These can be seen in histograms 1 and 4. The time between them is from 30 to 60 milliseconds. The 808 disks have a rotational speed of 53 milliseconds per revolution; this double peak represents missed revolutions. There are 49 sectors per track on the 808 disks. These are arranged so that the peripheral processor that is controlling this channel can read one sector, store the data in central memory, and access the next sector before it passes the read/write head. This is done by "half-tracking." This is a CDC feature in which there is a difference between physical addresses and logical addresses. There are two logical tracks for each physical track. The sectors are arranged checkerboard fashion on the physical track, so that, for instance, logical track sector 1 is not contiguous with logical track

1, sector 1, but instead with logical track 2, sector 1. This allows about 1 millisecond between the time logical track 1, sector 1 is read and the time logical track 1, sector 2 comes under the read/write head. The design philosophy is that the PP will have that 1 millisecond to store the data and access the next sector. However, if it takes longer than one millisecond, it will have to wait an entire revolution (50 milliseconds) to obtain the data. This appears to be happening for over one-tenth of the accesses of the 808's.

This is a subject for further investigation. What is taking so long that we miss the data? Another possibility is that these are multi-track accesses, and the disk read/write heads must be repositioned, which could cause a missed revolution. One of the keys to improving this system is to determine the cause of this delay, and improve it.

It is difficult to determine if the 844's have the same problem. They have a rotational speed of one revolution per 20 milliseconds, so the missed revolution may appear in the histogram bar next to the peak bar in histograms 6 and 8. Perhaps a finer scale would show a double peak here, also. They are arranged so that there are more sectors per track, and two intervening sectors between logically contiguous sectors, so that there is still about one millisecond allowed to process the data and return to get the next sector. Therefore, if we have a PP or central memory timing problem, the problem would affect the 844's also. The problem of the missed revolution is most apparent on the 808's.

Another problem area is apparent when the histograms for the PP programs that use these channels are studied. Although the analysis

program produces histograms for all the PP programs that use the channels, the ones we find of particular importance are CIO (histograms 11-16), the general mass storage I/O handler, LRI, the roll in routine, histograms 17-24, LSJ, histograms 33-40, and LAJ, histograms 25-32. LSJ and LAJ are the system schedulers that, among other services, call LRO to roll out jobs, and PFM, the permanent file manager. CIO dominates the figures because it is the greatest user of the disk channels—from 1/2 to 2/3 of the total times a disk channel is requested, it is requested by CIO. But in contrasting the histograms for CIO with the other histograms, we identify another problem: the large amount of time spent rolling jobs in and out. The wait times for CIO precisely mirror the time LRI, LAJ, and LSJ are holding the disk channel.

There are a set of large, interactive (teletype) jobs that use a data base management system. Whenever a teletype job requests input, it is rolled out until the input is received. These 125k jobs are, then, being continually rolled out and in. During the time that they are being rolled out or in, the disk channel is not available to other PP's.

Observe histogram 24. The peak at 100 milliseconds is precisely the transfer time for a 125k job. This leads us to believe the data base management system, which is the only 125k job, has a heavy impact on the system.

It is at this point that we consider moving all roll out activity to one channel, as was done in the system studied by Schwetman. When this is done, the other channels become available for regular I/O. We would see a substantial lessening of turn-around time for batch (local and

remote) jobs. However, the response time would decrease; after an interactive job is rolled out, it would be longer before it could be rolled in again. This is because the system as it stands can roll out and in several jobs at a time--one per channel. If we only use one channel for roll in/roll out activity, only one job can be rolled out or in at once. If we decide to not roll out the large jobs, then we tie up 125k of memory while waiting for input. A reasonable answer may be to limit roll in, roll out activity to one of the disk channels, so that performance is not degraded overall, since we will have the other disks for fast response.

The permanent file manager PFM, clearly shows the missed revolution problem on all disks. This is a service routine that copies one user access file to a location where it can be used for local file work. These are therefore longer accesses than CIO and it is much more likely that there are multi-track accesses. These histograms show double peaks; this would seem to indicate a multi-track problem. If that is our problem, a better track allocation scheme is the solution.

Channels 3 and 13 are the magnetic tape channels. The histograms for LMT, the magnetic tape driver, (numbers 49-50), show the way the tapes are accessed in this system. When a request for a tape is made, LMT gets a PP, then queries the channel to see if the tape is ready yet; if not, LMT releases the channel and the peripheral processor. It is for this reason that the histograms for the tape channels show so many (70 percent) very short channel holding times. When a tape is ready, the controller moves the tape for a usually set distance: about 20 feet. At 150 in/sec,

counting start-up time, this gives us the second peak on the histogram (from 1.5 to 2.0 seconds). The first peak (60 to 70 milliseconds) only appears on the histogram for channel 3 and is a subject for further investigation. It may represent short block reads, or error re-reads.

#### Peripheral Processor Usage

In this system there are 10 peripheral processors. Two are never available to user programs. One is assigned to MTR, the peripheral processor monitor described in Chapter Two, and another is assigned to DSD, the console display driver. Additionally, 10D, the import/export (remote batch) driver usually is holding one peripheral processor. This leaves six peripheral processors for user servicing. These are called the pool processors. Histogram 51 shows that all six are free four percent of the time. Most of the time there are three or four free peripheral processors. However, for eight percent of the time there are no free peripheral processors. This means that for eight percent of the six hours of this sample, a process needing a peripheral processor could not execute.

In order to do any I/O activity, a process must first acquire a peripheral processor. Peripheral processors are used for system functions also, but the most frequent use is for input/output. CIO is the most used input/output routine. Of the 706,923 PP calls of all types that the probe detected, 338,105 were CIO calls. CIO histograms 52 and 53 had a balance of utilization of the peripheral processors of .87. The comparable figure for the University of Texas CDC 6600 system studied by Schwetman was .99. We will now explore the reasons for the difference. The reason we are

interested in this figure is that peripheral processors are one of the central resources of this system. When the balance of utilization for the peripheral processors is low, the system as a whole is seriously affected.

Observe that in the previous data for the channel usage for CIO, that it had a balance of utilization of around .66 for each of the channels. This means that the PP holding time for CIO would be decreased by 34 percent if there were no channel wait time. This would be a decrease of about 8,000 seconds in our sample. We have pointed out that the roll in/roll out activity is what is contributing heavily to the wait time for the channels. The UT system studied by Schwetman had relegated all roll in/roll out activity to one channel. For the system under study, this would mean a substantial increase in wait time for roll out/roll in activity. But IRO, which rolls out jobs, holds a PP only 12 percent of the time that CIO holds a peripheral processor, 3,619 seconds. Therefore, it would take 100 percent increase in roll in/roll out time (twice the holding time of IRO) in order to offset the lessening of the holding time of CIO obtained by relegating all roll in/roll out activity to one channel. Thus, the reason for the better balance of utilization for the peripheral processors on the system that Schwetman studied may be that they allowed the degradation of roll in/roll out times in order to improve total system performance. They had an essentially batch system.

The analysis program produces histograms for the time that a PP program holds a processor (the real time), the time between the time that a request for a PP was made, the time it was assigned (the wait time), and



the overlap time, for every PP program called during the probe period. Only the particular programs of interest are included here. The overlap time is the time that a process keeps on executing after issuing a PP call. The only PP program that exhibited any degree of overlap was CIO (histogram 53). The programs calling CIO continued to execute for 23 percent of the time CIO held the peripheral processor. This time is determined by reading the job's CPU time when the PP is assigned, and again when the PP is dropped. The high amount of overlap for CIO probably results from the installation's heavy use of a standard CDC COBOL sort. This sort is highly efficient. Another example of its efficiency is that it often issued calls for more than one PP at a time.

The histograms for LRI, LRO, and LAJ (numbers 55-62) are included because it is important to see the amount of roll in/roll out activity going on. LAJ frequently brings LRI into the PP that it was occupying, without LRI going through the normal request protocol. Hence, some LRI activity is in the histogram for LAJ. Note that the wait time for LSJ closely resembles the histograms for roll in/roll out activity. This is because LSJ is a system scheduler and is in contention for the peripheral processors at the same time that roll in/roll out activity is taking place. The amount of time spent in LSJ is quite large, and one of the areas that this evaluation shows should be studied.

PFM, histograms 63 and 64, the permanent file manager, was active only .1 percent of the time. The histogram also reveals an area for study. PFM, because it reads and writes permanent files, would be expected to have a long-tailed distribution. The files can be very long,

multi-track, and take a long time to copy. But PFM is taking over 1.5 seconds for 30 percent of the time. This is an area for further investigation.

#### Process Characteristics

In this section we are concerned with the balance of the system load for this system.

The system under study is used by a large educational service center. The local batch processes are concerned with payrolls, student rosters, class scheduling, inventory control, statistical analysis, etc. There are many large sorts that take place; there is very little use made of the CDC 6600's fast arithmetic capabilities. Although Thornton, in his book, Design of a Computer: the CDC 6600, states that the 6600 was designed for scientific work, we find that this machine is being used as a business machine. The remote batch terminals are, for the most part, placed in school districts that use this computer rather than buy one of their own; their work is precisely the same type as the local batch work.

The teletypes are used for three major purposes: the in-house programmers use the teletypes for program development; there are teletypes used by students, for (usually small) student jobs, and there is a large data-base management system. There is a little computer aided instruction, but not much.

#### Day File Statistics

The day file is a system accounting file that can be analyzed to determine the use of the system. In a typical month's work, the day file

showed that this system was used in the following way:

|              | <u>Number<br/>of Jobs</u> | <u>CP Time</u> | <u>PP Time</u> | <u>Disk PRU's<br/>Transferred</u> | <u>Tape PRU's<br/>Transferred</u> |
|--------------|---------------------------|----------------|----------------|-----------------------------------|-----------------------------------|
| Local Batch  | 12%                       | 48%            | 48%            | 52%                               | 98.6%                             |
| Remote Batch | 44%                       | 35%            | 45%            | 46%                               | .6%                               |
| System       | 9%                        | 9%             | 3%             | 1%                                | .7%                               |
| Teletype     | 34%                       | 4%             | 3%             | 1%                                | .01%                              |
| TOTAL        | 44827                     | 2313627        | 5777514        | 1234103                           | 613298                            |

A PRU is a physical record unit: a block of 64 words for a disk, 512 words for a tape.

This shows that the remote batch and local batch have about the same effect on the system. Although the teletype users have many jobs, the impact of the small jobs is very slight.

It is apparent in contrasting the day file analysis and the statistical analysis performed by us that many system functions that are user services are being charged to the user, not the system. This is correct in some cases (i.e., copying files) but incorrect in others (roll in and roll out activity clearly should be charged to the system). Our analysis shows much heavier system impact than the day file does, for this reason.

Histogram 67 shows the use of the channels by type: type 0 is system, type 1 is local batch, type 2 is remote batch, type 3 is the teletype processes, and type 4 is for multiterminal jobs. These are system assigned types which the probe program simply picks up and records. Type 4 is an anomaly---there are no multiterminal jobs. There is currently 1 multiterminal job (type 4). This is the basic sort for the teletype line-editing system.

We show that the main user of the disk channels (0, 1, 4, and 5) was type 2, the remote batch processes. Teletype jobs were the next most significant users of the disk channels, with system and local batch next, and, last, multiterminal jobs.

The magnetic tape drives, on channels 3 and 13, were only used by LMT, which is the magnetic tape driver. This driver is assigned through a system job; therefore, the type we record is type 0, system, although the main user of the tape drives is the local batch type.

The other channels listed do not pertain to this study. Channel 2, while not currently in use, will be the channel for a front-end system. The system was being tested during the period that was probed. Channels 6, 7, and 11 are multiplexors for terminals; channel 10 is the console display channel; channel 12 is the unit record equipment channel. The other channels listed are dummy channels, some are used by the system.

Histograms 68-72 are concerned with peripheral processor usage by type. Origin 0, the system, used 6 peripheral processors most of the time. This makes the system the heaviest user of the peripheral processors, with origin 2, remote batch, next, and then teletype and local batch.

The histograms for real time (73-77) for the jobs by type show the system jobs are the ones with the longest duration. This is understandable, since some system jobs reside at a control point and stay up the whole time the system they are controlling is up. During the time of this probe, there were 5 such jobs at control points: telex, which controls the teletype system; magnet, which handles magnetic tape requests; batchio, which handles the I/O for batch processes; export 2, the remote terminal

handler; and system, the central memory resident monitor discussed in Chapter Two. The last bar on all the time histograms is cumulative--it includes every occurrence from that point on. It is clear that all these histograms are long-tailed. There were 51 system jobs. There were 40 batch jobs; 17 of these had a duration of under 5 seconds. The average batch time was 248 seconds. Type 2, remote batch jobs, showed a surprising number of short-duration jobs. Thirty-three percent of these remote batch jobs were less than 5 seconds in duration. There was a total of 292 remote batch jobs. The teletype jobs show the characteristic high peak of teletype jobs--there were a preponderance of short jobs. The number of long-duration teletype jobs appears only in the percent line because there were fewer than 15 of them most of the time but they are sufficient to give a very fat, long tail to this distribution. It is interesting at this point to contrast the real time and CPU time of the teletype jobs: the CPU time is 15,520 seconds, while the real time is 291,661 seconds.

The time for type 4 (the multiterminal sort) reveals that there were 10 occurrences of teletype sorts that lasted 4 seconds or longer. This is another area that should be investigated.

One of the things we learn from looking at the histograms for CPU (78-82) time per type is that the scale is too fine. There are too many jobs gathered in the cumulative end column to let the true distribution show. We are not really interested in the CPU time for system jobs. The CPU time for local batch jobs follows the distribution for the real time of local batch jobs. The ratio of CPU to real time is .33. The same ratio for remote batch jobs was .08, and for teletype jobs was .05. The

differences are not explainable by charging the unaccounted-for-time to I/O, since teletype and local batch both used the channels less than remote batch. This is an area that also should be investigated further. It is possible that much of this time is roll out time. The analysis program could be modified to give the real time differences between when a job is rolled out and when it is rolled in.

The next set of histograms (83-87) display the CPU time between roll-outs. The histogram for type 3 is of particular interest because it displays a negative percent. This has been investigated, and it was found that the CPU time for a job at roll-out time was frequently one or two milliseconds lower than the CPU time recorded for the job from the last time it was rolled out. It is only teletype jobs that this happens on, and may be a system accounting or probe program bug. Nevertheless, the frequency figures are correct, and show the following:

| <u>Type</u>       | <u>Number<br/>of Jobs</u> | <u>Roll Outs</u> | <u>Roll/Outs<br/>Per Job</u> |
|-------------------|---------------------------|------------------|------------------------------|
| 0 (system)        | 51                        | 832              | 16                           |
| 1 (local batch)   | 40                        | 227              | 5                            |
| 2 (remote batch)  | 292                       | 474              | 2                            |
| 3 (teletype)      | 1298                      | 5838             | 4                            |
| 4 (multiterminal) | 505                       | 1                |                              |

One of the solutions to the low balance figure in the section on channels and in the section on peripheral processors was to slow down the amount it takes for a roll out or roll in, in order to improve the overall system performance. This would affect the system jobs most, because there is more roll-out activity on system jobs. The next most affected would be the local batch jobs, then the teletype, then the remote batch jobs.

The time between I/O requests (histograms 88-92) per type shows that system requests for I/O come between 0 and 5 milliseconds apart most of the time; however, observe the percent line: there are some occurrences of I/O requests more than 4 seconds apart. This means this is a very long-tailed distribution. Forty-three percent of the local batch requests for I/O are between 140 and 400 milliseconds apart, so the local batch programs do more executing between I/O requests than the other types. Type 2, remote batch, shows that the remote batch processes tend to call for I/O quicker, with 52 percent of the calls between 0 and 40 milliseconds apart. Type three, terminal processes, have the negative percent problem. Type 4, multiterminal sorts, had no I/O requests over 60 milliseconds apart.

The last section of the histograms (93-96) displays the wait time for field changes by type. One of the probable bottlenecks of a system is the memory allocation. What we are investigating here is how long after a process requests a field change is the field change granted. The maximum wait time was 7 seconds, for a system job. The ratios of wait time to CPU time for the 4 types that requested field length changes were from .008 for system jobs to .06 for remote batch jobs. In any case, this is not a source of a system bottleneck.

### Conclusion

The main problem with this system is the wait time for the channels. This is caused by two factors: missing revolutions on disk references and long roll-out/roll-in times.

The problem of failing to retrieve information on every revolution of the disk should be investigated and remedied: either a better track

allocation scheme devised; or, if it is a timing problem, the offending subroutine corrected. There is one major drawback to allocating one disk channel to system activity, thus slowing down roll-out/roll-in activity in order to improve system performance. This drawback is that the teletype users will notice a reduced response time, because teletype jobs are often rolled in and out. It is still recommended that one of the 844 disks be used for this, and the analysis probe run again, to determine how much the system improves. Our figures show that teletype users account for from 19 to 36 percent of the usage on the disk channels; therefore, they would benefit from increased general I/O efficiency. We also showed that teletype users are not rolled out substantially more than other users, so they would not be affected more than any other group of users.

There are other ways of minimizing the affect of these long roll-out/roll-ins on the system. One way is to change the lRO and lRI to check the bit in the channel table to determine if the channel they are holding is needed by another PP, and if it is, to give it up. This would also slow down roll-out/roll-in, but it would less consistently do so. If only one channel is allocated for roll-in, roll-out activity, no matter how many free channels there are, only one roll-out or roll-in may happen at one time. With an interruptable roll-in/roll-out discipline, if there are free channels, more roll-outs can happen at once.

Another way of improving roll in/roll out time is to have two different priorities for rolling jobs in. The high priority would be for the teletype jobs, so that their response time would be kept high. The low priority would be for batch jobs, which would slow down their response



time. However, the increase in the efficiency of the system may be enough to overcome the slow-down of the batch jobs and result in a decrease of their total realtime.

A third way of improving the roll in/roll out situation is to write a special track allocation routine for the 808 disks for roll in/roll out activity. This would take advantage of their faster data rate and make more efficient use of the 808 disks.

A management decision needs to be made here, too. If more accounts are to be acquired that use the data base management system, they will seriously degrade the system unless either the data base management program is made smaller, or new devices for roll-out/roll-in activity, such as extended core storage, are also acquired.

The 808 disks have an average holding time of 80 milliseconds, compared to the 844 disks, with an average holding time of 50 milliseconds. It is recommended that the 808 disks be replaced with 844 disks, unless the track allocation for them is changed as suggested above.

The balance of different types of jobs on this system has made it interesting to study. It is apparent that the teletype jobs are not a minor part of the system; even with the roll in/roll out problems discounted, the teletype jobs make a substantial demand on I/O resources. The remote batch jobs, of course, are the heaviest users of the system.

## GLOSSARY OF TERMS

|                         |                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------|
| <u>PP</u>               | peripheral processor                                                                                      |
| <u>roll out/roll in</u> | the temporary transfer of a job from central memory to a disk, and the transfer back into central memory. |
| <u>1AJ, 1SJ</u>         | peripheral processor routines that act as system schedulers.                                              |
| <u>1RO</u>              | the peripheral processor routine that rolls out jobs.                                                     |
| <u>1RI</u>              | the peripheral processor routine that rolls in jobs.                                                      |

## BIBLIOGRAPHY

1. Badger, S. F., Jr., E. A. Johnson and R. W. Phillips "The Pitt Time-Sharing System for the IBM System 360: Two Years Experience," Proceedings Fall Joint Computer Conference (1968), 1-6.
2. Boyse, J. W. "Execution Characteristics of Programs in a Page-on Demand System," Communications of the ACM, Vol. 17, No. 4 (April, 1974), 192-196.
3. Bryan, S. E. "JOSS: 20,000 Hours at a Console--A Statistical Summary," Proceedings Fall Joint Computer Conference, (1967), 769-776.
4. Bussel, B. and R. A. Koster "Instrumenting Computer Systems and Their Programs," Proceedings Fall Joint Computer Conference, (1970), 525-534.
5. Calingaert, P. "System Performance Evaluation: Survey and Appraisal," Communications of the ACM, Vol. 10, No. 1, (January, 1967), 12-18.
6. Fine, S. H., C. W. Jackson, and Paul V. McIsaac "Dynamic Program Behavior Under Paging," Proceedings, ACM National Meeting, 1966, 223-228.
7. Fuchs, E. and P. E. Jackson "Estimates of Distributions of Random Variables for Certain Computer Communications Traffic Models," Communications of the ACM, Vol. 13, No. 12, (Dec., 1970), 752-757.
8. Fuller, S. H., T. G. Price and N. C. Wilhelm "Measurement and Analysis of a Multiprogrammed Computer System," presented, IEEE Workshop on Performance Evaluation, Arzonne National Laboratory (October, 1971).
9. Jalics, P. J. "Measurements of the PDP-10 TOPS-10 Operating System," (Ph.D. thesis), Case Western University (January, 1973).
10. Lester, E. A. "The Investigation of Service Time Distributions," Technical Report CSRG-25, University of Toronto, April, 1973.
11. Lucas, H. C., Jr. "Performance Evaluation and Monitoring," Computing Surveys, Vol. 3, No. 3 (Sep., 1971), 79-91.
12. Margolin, B. H., R. P. Parmelee, and M. Schatzoff "Analysis of Free-Storage Algorithms," IBM Systems Journal, No. 4 (1971), 283-303.

13. Noe, J. D. and B. J. Nutt "Validation of a Trace-Driven CDC 6400 Simulation," Proceedings of the Spring Joint Computer Conference, (1972), 749-757.
14. Pinkerton, T. B. "Program Behavior and Control in Virtual Storage Computer Systems," Technical Report 4, CONCOMP Project, University of Michigan, June, 1968.
15. Schwetman, G. D., Jr. "A Study of Resource Utilization and Performance Evaluation of Large-Scale Computer Systems," (Ph.D. Thesis) University of Texas, July, 1970.
16. Shemer, J. E. and Heying, D. W. "Performance Modeling and Empirical Measurements in a System Designed for Batch and Time-Sharing Users," Proceedings of the Fall Joint Computer Conference, (1969), 17-26.
17. Sherman, S. W. "Trace Driven Modeling Studies of the Performance of Computer Systems," (Ph.D. Thesis), University of Texas, (August, 1972).
18. Thornton, J. E. Design of a Computer: The CDC 6600, Scott, Foresman and Co., Glenview, Illinois, (1970).