

THE U.B.C. RECORDINGS COLLECTION:

A TRAFFIC FLOW STUDY

by

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ABSTRACT

The U.B.C. Recordings Collection represents a service network with different service centers which include the information desk, the shelves, and the listening room. Arrivals to the system follow a random traffic pattern. The units flowing in the network are defined as jobs requiring service from the service stations. The probabilistic job routings are considered to be a stationary finite-state Markov Chain discrete in time.

Field work was done during the summer school and during the regular winter term. The essential traffic observations were obtained by questionnaires. A first analysis of the operating characteristics was made using a graphical method shown in the diagrams 1 and 2; at this, the recordings collection was considered to be a service facility with a large number of service channels. By this method, knowledge could be gained about the number of arrivals during a day, the number of simultaneous customers in the system and in the listening room, the time spent for service, the regularity and changes in arrival and service statistics, and the regularity of departures. It became evident that the distribution of the interarrival times, both, to the recordings collection (shelves and information desk) and to the listening room as well, fit a negative exponential distribution function.

The distribution of the service times associated with the recordings collection could be identified as exponentially distributed, while the service time distribution of the listening room follows an empirical distribution function (see diagrams 3 to 10).

The basically observed statistics were applied in a simulation. The simulation was performed with the "General Purpose Simulation System/360, (GPSS/360)" in three variations in order to obtain empirical data under modified arrival rates and one or two desk servers, respectively. The data of interest was gathered in tables; the information content of the tables was plotted in graphs (see computer output). Data of significance has been used for the description of the traffic behavior of each single service center and was displayed in the diagrams 11 to 13.

The flow model predicted that congestion may appear at the information desk and in the listening room. The simulation has confirmed this prediction.

Under lasting rush hour conditions, jobs requiring service at the information desk may spend about 3 to 4 times their actual service time in queue waiting for service. This result has been obtained under the general assumption of a first-in first-service order of a 1 1.

arriving desk jobs. However, in practice, the observed rush traffic lasts only about two hours between 12:00 and 2:00. Consequently, arriving jobs related to re-shelving of recordings may be buffered and serviced at times of lower traffic. Thus, the actual waiting time in queue will be lower.

In the case of a second server on duty, the waiting time in queue drops down significantly. It will not exceed the service time (see diagram 11).

The service at the shelves storing the recordings is problemless. The maximum number of jobs at the shelves does not reach the service capacity. The average service times are constant under varied conditions.

In deciding what is an adequate number of turntables, there is a conflict between high utilization rate and satisfied customers. The conflict situation becomes evident under extreme traffic conditions, for instance, when the peak traffic exceeds the provided capacity, or conversely, when the equipment is idle because of low traffic. A satisfying approach depends upon the range and weight of the appearing traffic fluctuations. As it is shown, the intensity of arrivals varies considerably during the interval of a day. However, the range of fluctuating arrival rates still increases by considering different days of a week or different seasons, such as the summer

session or the winter term. An acceptable solution of an adequate number of turntables installed may lead to a compromise between 'perfect' equipment utilization and 'completely' satisfied customers. Depending on the pursued policy, it may favour one or the other interest.

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CHAPTER 1

GENERALITIES: THE SYSTEM UNDER STUDY

The recordings collection of the U.B.C. Library houses more than fifteen thousand recordings of all kinds which may be played in the Wilson Listening Room without charge or may be borrowed for an annual fee.

The traffic flow study of the recordings collection inclusive of the listening room includes:

- a) the analysis of the service system in its operating characteristics,
- b) the presentation of a traffic flow model,
- c) the simulation of the model under changing traffic conditions,
- d) the application of the essential simulation extract to provide a measurement and evaluation method of the achievement of each single service facility.

The recordings collection, as a service system, consists of three facilities offering different customer services:

- a) At the information desk, main services are to provide information concerning the recordings collection, including new applications for membership, and to store all returned records.
- b) The record shelves themselves are an information source and supply the recordings either for taking home or ~~for~~
- c) for listening on the turntables installed in the listening room.

The system's input is a series of arriving jobs represented by the arriving patrons, each requiring a number of service operations at the service facilities. The system's output is comprised of completed services or satisfied customers, respectively. The flow of jobs among the service facilities is illustrated below:

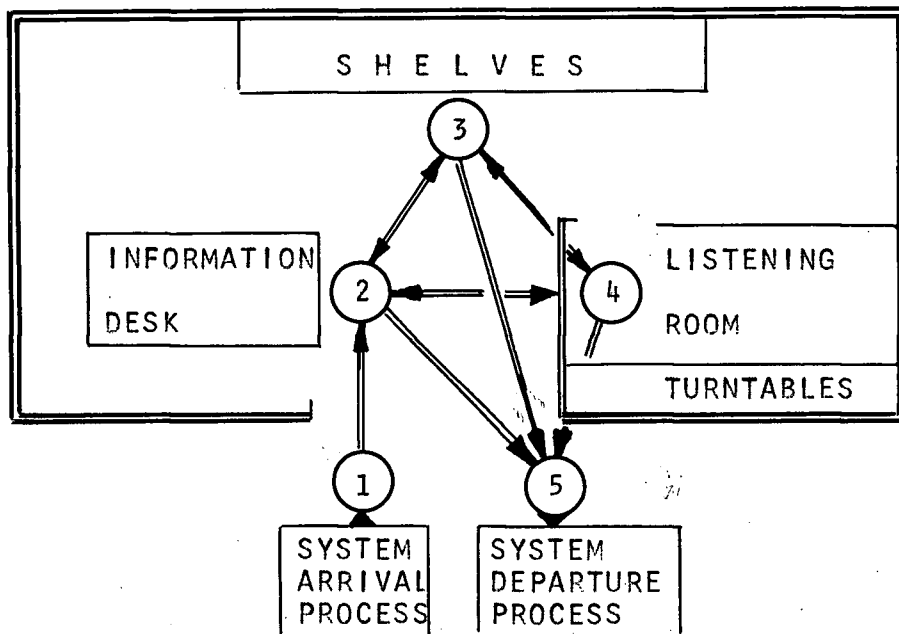


Figure 1: The physical plant of the service facilities of the recordings collection and the corresponding channels of the job flows

CHAPTER 2

ANALYSIS OF THE OPERATING CHARACTERISTICS

The recordings collection is a service facility with a large number of service channels. Simultaneously, a certain number of jobs may be in the system's service occupying its service capacities. For instance, the listening room offers 23 turntables installed, and at the storing shelves, service is self-operated. The only single channel service station is the information desk.

1. Determination of Significant Traffic Characteristics

1.1 Description of the technique employed

The operating Characteristics such as:
the number of arriving customers during a day,
the number of simultaneous customers,
the time spent for service,
the regularity and changes in arrival and service statistics,
the regularity of departures
will be evaluated in a graphical method. We want to use a graph to comprehend the traffic data which was obtained by the numerous answers on the questionnaires. Furthermore, it is our objective to generalize the observed traffic flow in a form, that we might be able to learn an ex-

pected behavior of the service system under study.

The graph used shows on its abscissa the current hours of the daily public access to the recordings collection. The ordinate records the cumulative number of customers going into the system and into the listening room, respectively. The cumulative number of customers may be recorded at any convenient time interval. The smaller the interval between the recordings, the more accurate is the observation that can be made from analysis of the measurements.

The required information was obtained using a questionnaire. This form was presented to each arriving customer at the entrance with the request to return it at the exit. During these events, the arrival and departure time could be noted on the form. Also, if the customer visited the listening room, he filled in the appropriate arrival and exit time. The other items of the questionnaire assisted to determine what kind of service facilities the patrons had used. From the information sheets, all required data could be obtained for further evaluation.

At certain times, the cumulative number of customers who entered the recordings collection and the listening room, respectively, is represented by the arrival curves. Similarly, the departure curves show the cumulat-

ive customers that leave after their service completion. The arrival curve and the departure curve within a coordinate system and the parameters derived from it are outlined in the schematic graph below:

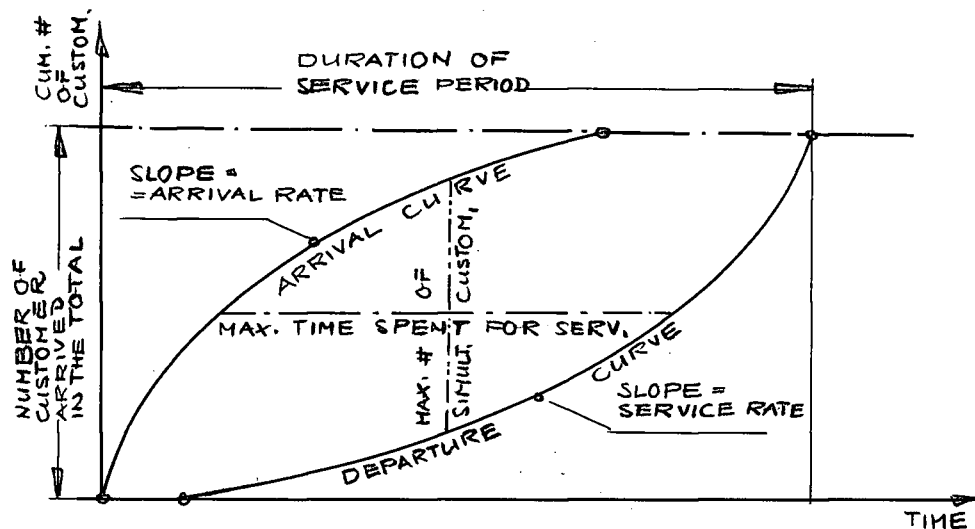


Figure 2: Operating traffic characteristics shown in a schematic graph

The arrival rate is the rate at which customers appear to demand service. It varies during the successive times of a day. The arrival rate may be obtained from the slope of the arrival curve for any time interval under consideration. If a desired time interval is selected, the slope of the entrance curve between the beginning and the end of the interval gives the arrival rate during that interval.

Similarly, the rate of service is the rate with which customers are discharged from the service. It also varies during the daily service period and can be deter-

ined in the same way as the arrival rate.

At a certain time of interest, the simultaneous number of customers in service follows from the vertical distance between the arrival and the exit curve. The arrival curve shows the cumulative number of customers that have entered. The number of customers that have left is given by the exit curve. Thus, the difference between the two values must be the number of customers that remain in service at the moment in question.

An average time spent for service may be obtained by the horizontal distance between the entrance and exit curve. If we keep track graphically of all arrivals (time/cummulative number of customers) and register the time spent for service (t_c) of each customer (n), then we may obtain an average service time associated to those n customers by

$$t_{c, \text{avg.}} = \frac{1}{\text{number of } n \text{ customers}} \sum_{c=1}^n t_c$$

We interconnect all points of arrivals and obtain the arrival curve; the points of average service times lie on the exit curve, such as it is shown in the sketch below:

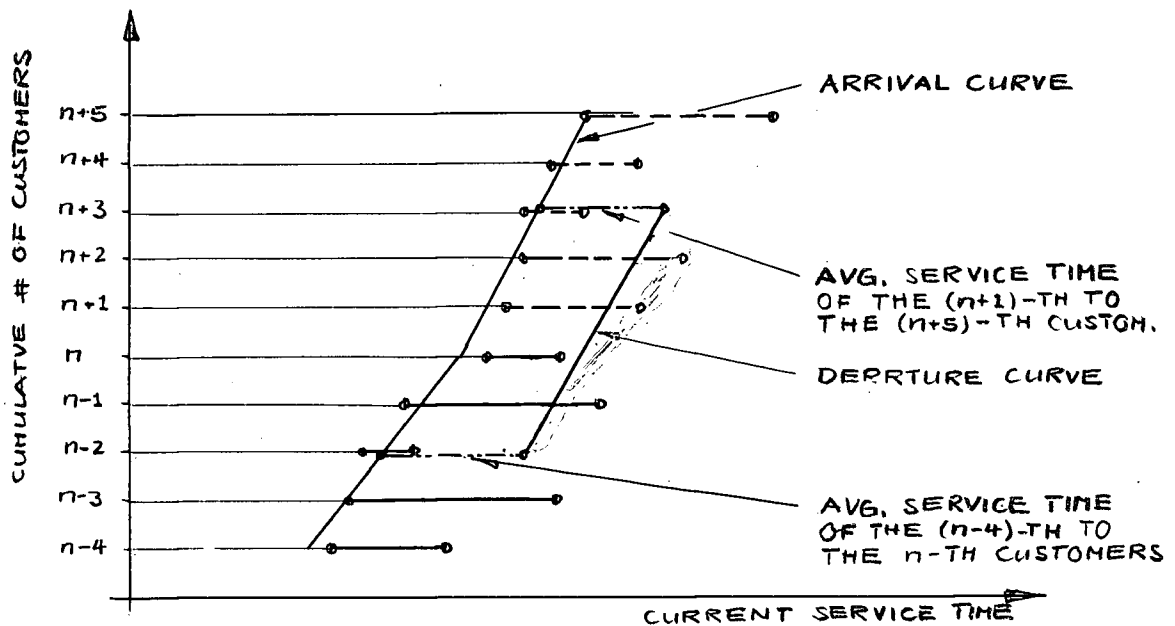


Figure 3: The determination of the representative arrival and departure curve

Thus, the smoothed curves of the arrivals and the exits represent a generalized description of the traffic behavior during the current service time. We compare those traffic characteristics observed on different days of a week and realize a strong similarity in the customer's behavior. The comprehended data of a week's observation is shown in diagram 1. We assume, this generalized graph represents the traffic flow during the summer term, and analogously, the graph shown in diagram 2 may represent the traffic during the winter term.

In proceeding to determine how much time an average customer will spend for service when he arrives at the current time t_c of a day, first we examine the arrival curve. We realize, it will be the n -th customer

on the average. Looking horizontally across to the arrival curve, it can be noted that the n -th customer will leave at time t_{c+n} . Hence, we can expect that the n -th customer will spend a total of $(t_c - t_{c+n}) = t_n$ minutes for service. Generally, the horizontal distance between the arrival and exit curve is a graphical representation of how long customers spend at any single point. The longest and shortest time spent is represented by the longest and shortest horizontal lines between the two curves.

The total number of customers, readily obtained from the curves, is indicated by the highest points on both the arrival and the exit curves, and may be read on the vertical scale. The duration of the daily service period is indicated on the horizontal scale.

1.2 The traffic flow during the summer term

Usually, fewer students attend summer school. But summer school students might have more leisure than students of the regular winter term. Such circumstances may significantly affect the behavior of visits of the recordings collection.

Diagram 1 shows the approximate traffic characteristics during the summer session 1970. The inquiry took place in the first week of July.

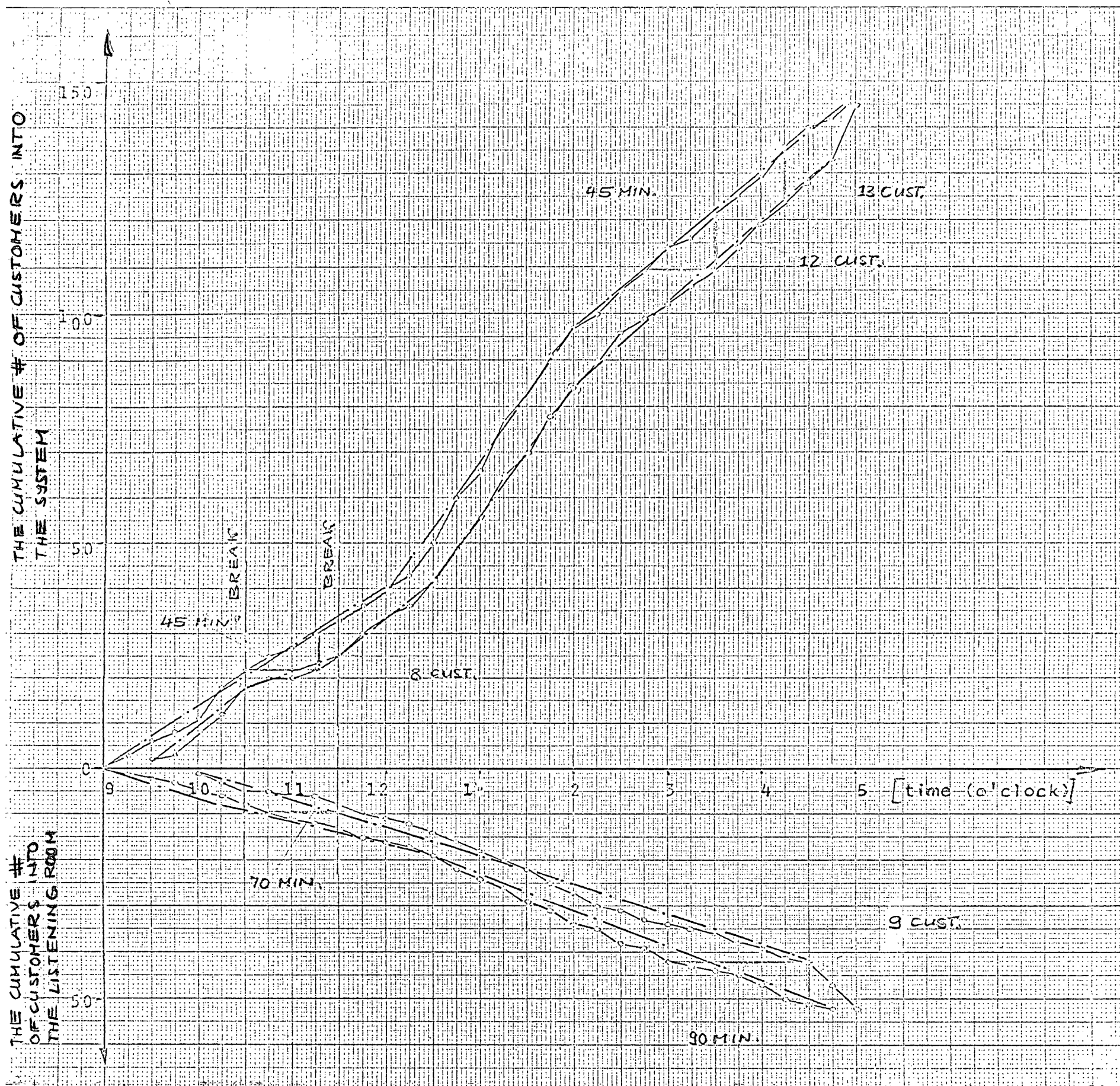


TABLE:

MAXIMUM VALUES				
time interval	number of simultaneous customers in:		time (min.) spent in:	
	system	list. room	system	list. room
10:35-11:20			45	
10:40-11:45				65
2:45- 3:30			45	
3:00- 4:30				90
11:35-11:45	8	6		
<1:30<	13	7		
<3:00<	12	8		
<4:15<	13	9		

DIAGRAM 1: The traffic characteristic curves of the recordings collection during the summer term

From the system arrival curve of diagram 1, we can determine three arrival rates in the time periods between 9:00 and 12:00, 12:00 and 2:00, and 2:00 and 5:00. At 9:00, 12:00, 2:00, and 5:00, there were 0, 40, 97, and 145 cumulative counted customers in the system, as obtained from examination of the arrival curve. Thus, 40, 57, and 48 customers had entered the recordings collection during the corresponding time periods of 180, 120, and 180 minutes. The slope at any point of the system's arrival curve is obtained by dividing the number of customers served by the respective time period. Hence, in the average, there arrived

$$\frac{40}{180} = 1 \text{ customer/4.5 minutes}$$

$$\frac{57}{120} = 1 \text{ customer/2.1 minutes}$$

$$\frac{48}{180} = 1 \text{ customer/3.75 minutes}$$

during the periods examined. The length of the interval must be short when the slope changes rapidly or there will be an averaging of different arrival rates.

The behavior of the exit curve is affected by periodic changes during the morning. The customers are going to leave the recordings collection between 9:30 and the break at 10:30 with an average departure rate

of 1 customer/3.3 minutes.

After the 10:30 break, the departure rate slows down but increases again shortly before the 11:30 break. Obviously, the students either leave for ~~6:30~~ classes or for early lunch starting at 11:30. However, the average departure rate decreases to 1 customer/8.7 minutes between 10:30 and 11:30. This results in a maximum number of simultaneous customers (8) in the system at 11:30, as the average arrival rate does not diminish during the same interval.

After 11:30, the visitors to the recordings collection may leave for lunch. The exit rate increases to 1 customer/4.1 minutes.

From 12:15 till about 2:00, rush hour takes place, the exit rate goes up to 1 customer/2.2 minutes, which is about equivalent to the arrival rate of 1 customer/2.1 minutes during the same interval. This indicates that there is a high traffic flow into and out of the recordings collection. Under these circumstances, of course, the number of simultaneous customers and the time spent in the system are about constant.

After this period, the exit rate decreases again to 1 customer/3.2 minutes. Within the few minutes before

the 5:00 closing time, the remaining customers leave and once again create a kind of rush traffic (1 customer /1.36 minutes).

It can be seen that the maximum number of simultaneous customers appear at 11:30 (8 customers), at 1:30 (13 customers), at 3:00 (12 customers), and at 4:15 (13 customers), respectively.

The longest times are spent between 10:35 and 11:20 (45 minutes) and 2:45 and 3:30 (45 minutes). On the average day in the 197- summer, 145 customers have been serviced.

The graph concerning the listening room can be interpreted in a similar way. It represents the data which was recorded simultaneously under the same conditions.

In the summary, the table outlines the maximum data of the traffic flow into the recordings collection and adjoining listening room:

PARAMETER	TIME INTERVAL	SYSTEM	LISTENING ROOM
1. Arrival Rate (cust./time)	12:00-2:00	1 cust./2.1 min	
	12:00-4:45		1 cust./7.9 min
2. Departure Rate (cust./time)	12:00-2:00	1 cust./2.2 min.	
	4:45-5:00	1 cust./1.4 min.	
	12:00-4:30		1 cust./8.7 min
	4:30-5:00		1 cust./3 min.
3. Number of Simultaneous Customers	11:30	8 customers	
	11:45		6 customers
	1:30	13 customers	7 customers
	3:00	12 customers	8 customers
	4:15	13 customers	9 customers
4. Time Spent = Service Time	10:35-11:20	45 minutes	
	10:40-11:50		70 minutes
	2:45-3:30	45 minutes	
	3:00-4:30		90 minutes
5. Avg. Total # of Cust. Serviced/Day		145 customers	52 customers

Table 1: Maximum values describing the traffic characteristics of the recordings collection during the summer term 1970

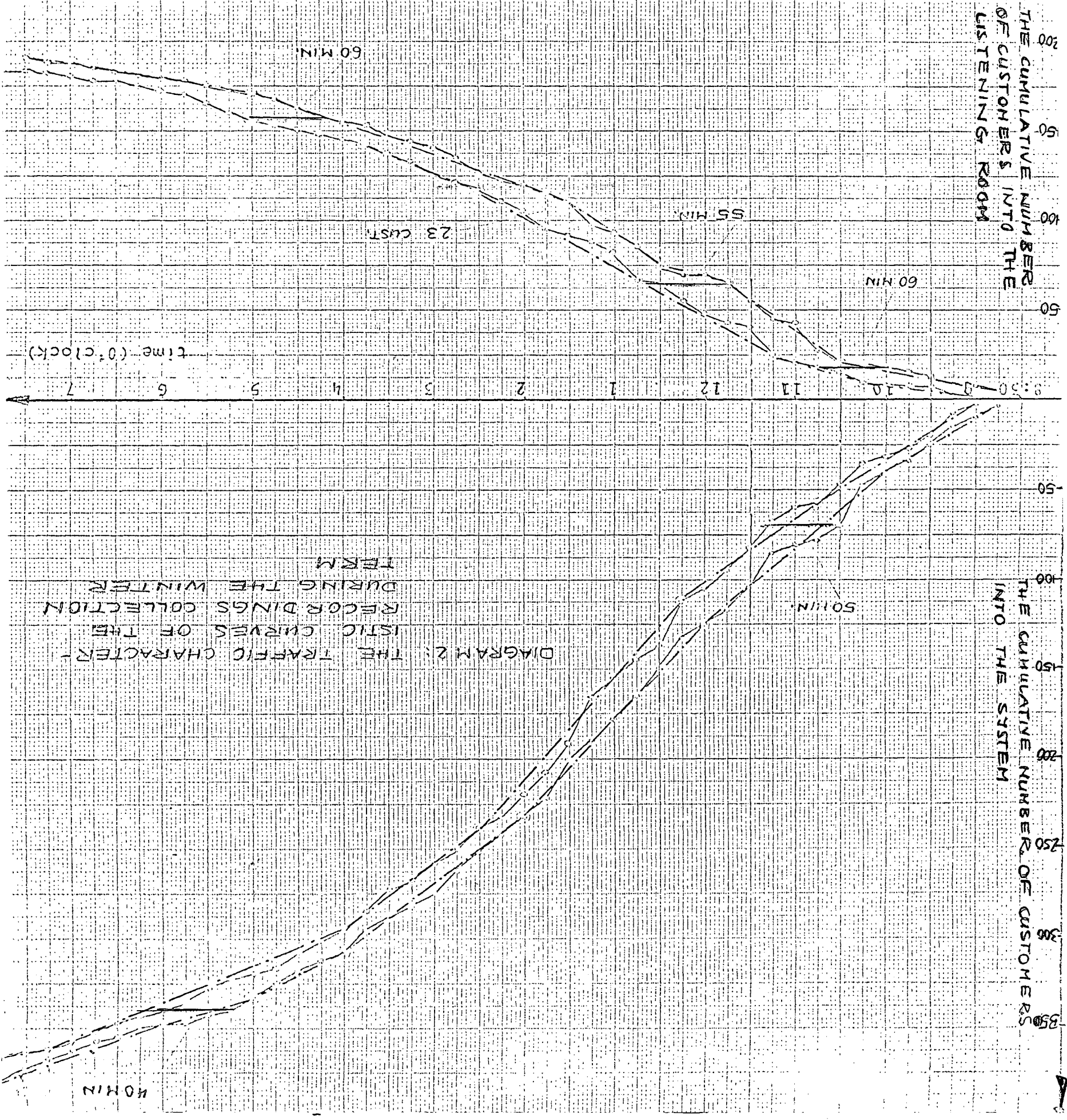


DIAGRAM 2: THE TRAFFIC CHARACTER-
ISTIC CURVES OF THE
RECORDINGS COLLECTION
DURING THE WINTER
TERM

TABLE: MAXIMUM VALUES

time interval	number of simultaneous customers in:	system	list. room	system	listen. room	time (imp.) spent in:
9:45-10:45						60
10:45-11:15				45		
11:50-12:45						55
1:00-5:00						60
4:50-5:30				40		
6:45-7:45						60
<11:00>	21					
<11:45>	24					
<1:45>	25					
						22
						21
						20

1.3 Comparison of the traffic flow observed during the summer session and the winter term

The approximate traffic characteristics are shown in diagram 2 during the winter term 1970. The data results from an inquiry during the last week of September 1970. The corresponding maximum values are:

PARAMETER	TIME INTERVAL	SYSTEM	LISTENING ROOM
1. Arrival Rate (cust./time)	12:00-2:00	1 cust./1.03	
	12:30-1:30		1 cust./1.67 min
	10:30-11:45		1 cust./2.27 min
2. Departure Rate (cust./time)	12:15-2:30	1 cust./1min	
	11:15-2:30		1 cust./2.1 min
3. Number of Simultaneous Customers	11:00	21 customers	20 customers
	11:45	24 customers	21 customers
	1:45	25 customers	22 customers
4. Time Spent =Service Time	9:45-10:45		60 minutes
	10:30-11:15	45 minutes	
	11:50-12:45		55 minutes
	4:00-5:00		60 minutes
	4:50-5:30	40 minutes	
5. Avg. Total Number of Customers Serviced/Day		380 customers	182 customers

Table II: The maximum values describing the traffic characteristics of the recordings collection during the winter term 1970

A comparison of the summer and winter traffic flows revealed the following:

1. The numbers of customers per day demanding service from the recordings collection during the winter term is a multiple of those in the summer session. Consequently, the arrival rate, the departure rate, and the number of simultaneous customers are also multiples. Of course, the utilization rate of the service facilities will be higher during the regular winter term than in the summer. But also, if there is any congestion in the service system, then it will become obvious in the rush hours during the winter term.
2. Despite the different traffic volumes of the summer and winter terms, a fundamental traffic flow behavior can be generalized for both seasons.
 - a) The breaks between the University lessons influence significantly the behavior of the customers arriving or leaving. This can be generally observed, especially during the first half of the day. For instance, the arrival rate decreases shortly before the

breaks but increases distinctly during and shortly after the breaks. In contrast, the departure rate increases some minutes before the break but decreases again after the break. This observation is valid for the traffic flow of the system and of the listening room as well. It indicates that students use the break between two lessons or a following free hour for a visit to the recordings collection. They arrive during and shortly after one break and leave just before or during the next break.

- b) The time interval of the maximum traffic flow, as it is indicated by the maximum arrival rate and departure rate, will appear roughly between 12:00 and 2:00.
- c) The maximum number of simultaneous customers in the recordings collection can be expected at 11:00-11:45 and at 1:30-1:45.
- d) On the average, customers that arrive near 10:30 will spend the most time (45 minutes) of any customers arriving. Those who enter the listening room at that time intend to use the listening units provided for approximately 60 minutes on the average.

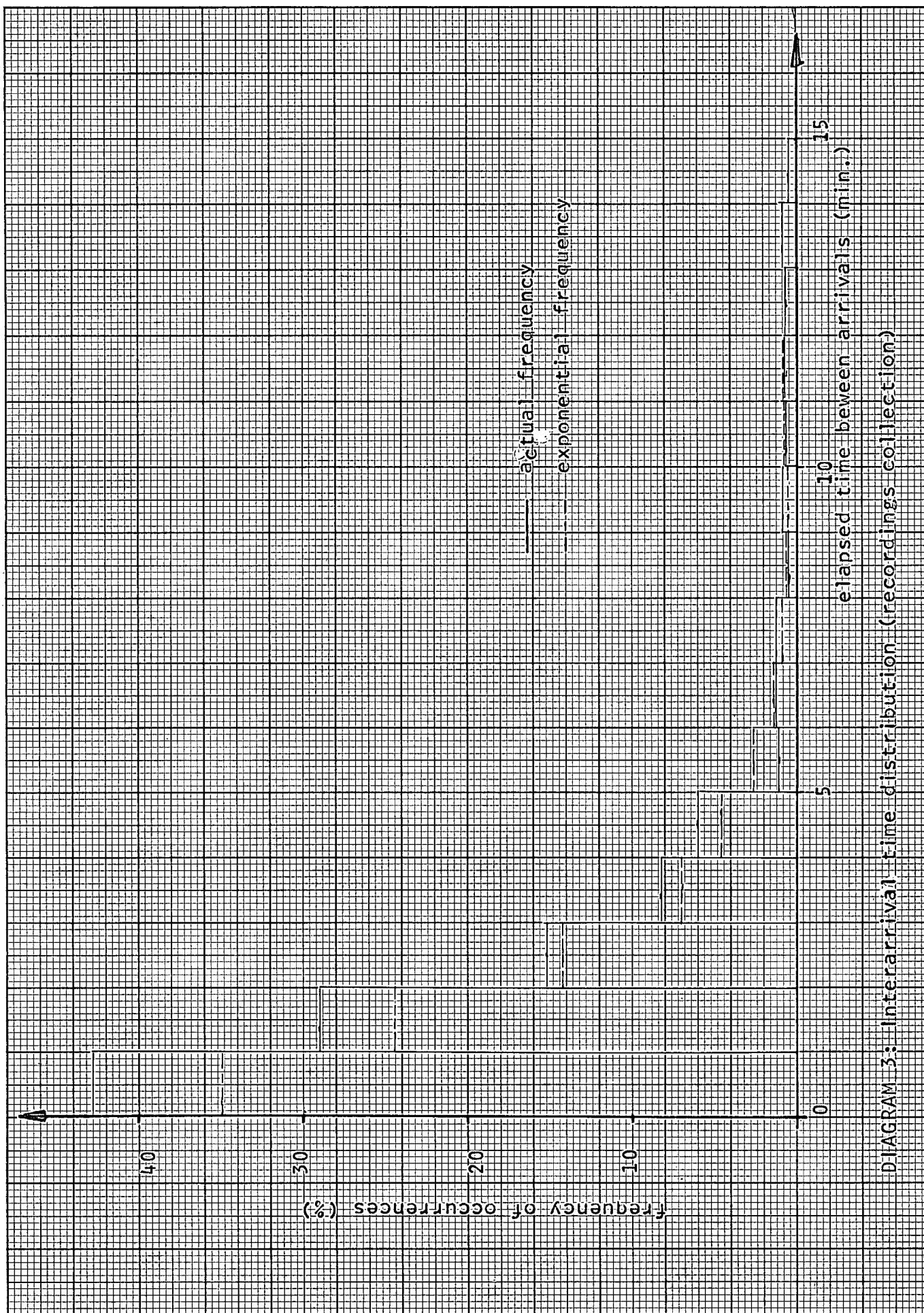


DIAGRAM 3: Interarrival time distribution (recordings collection)

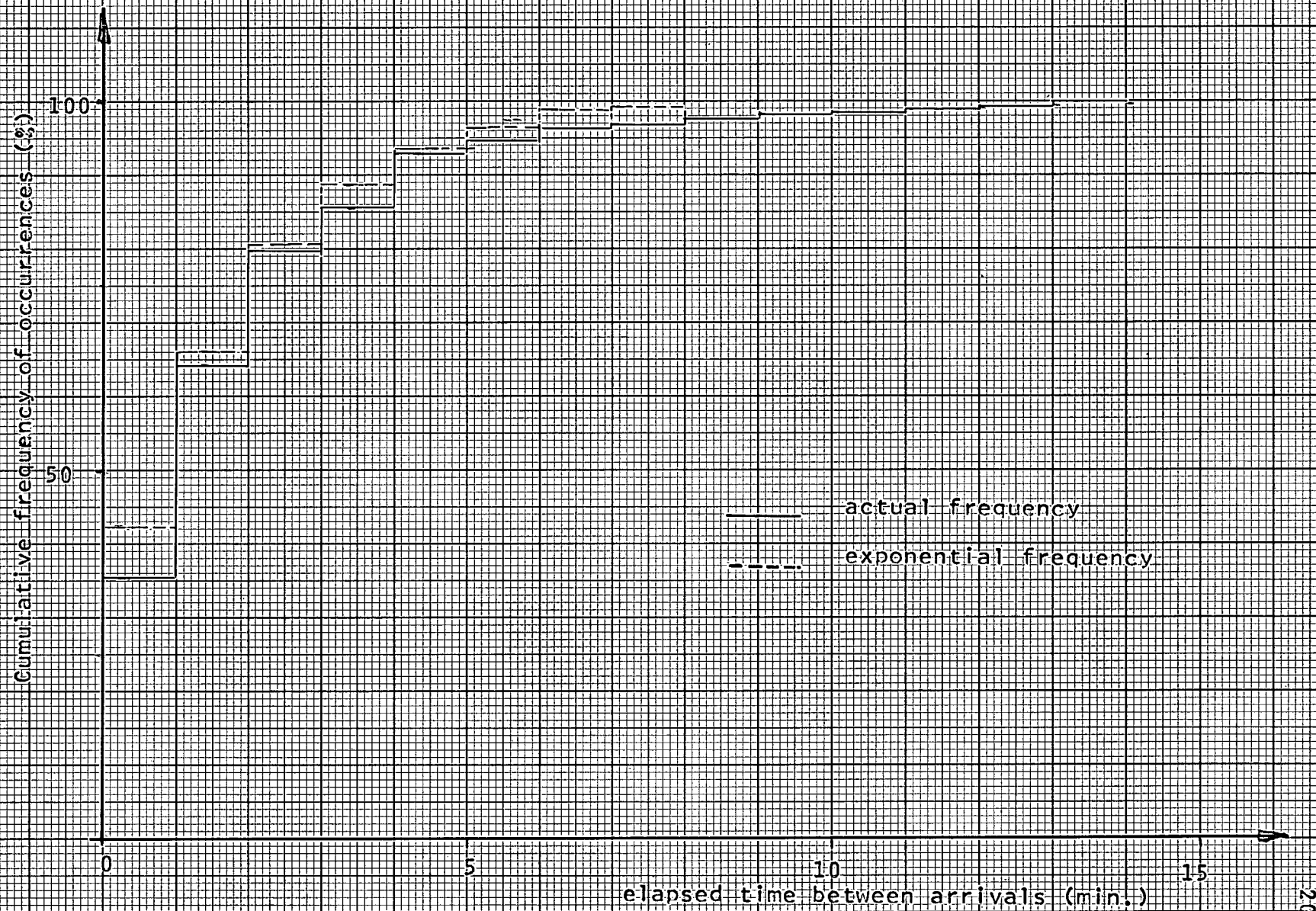


DIAGRAM 4: Cumulative interarrival time distribution (recordings collection)



DIAGRAM 5: Service time distribution of the recordings collection without consideration of the service time in the listening room

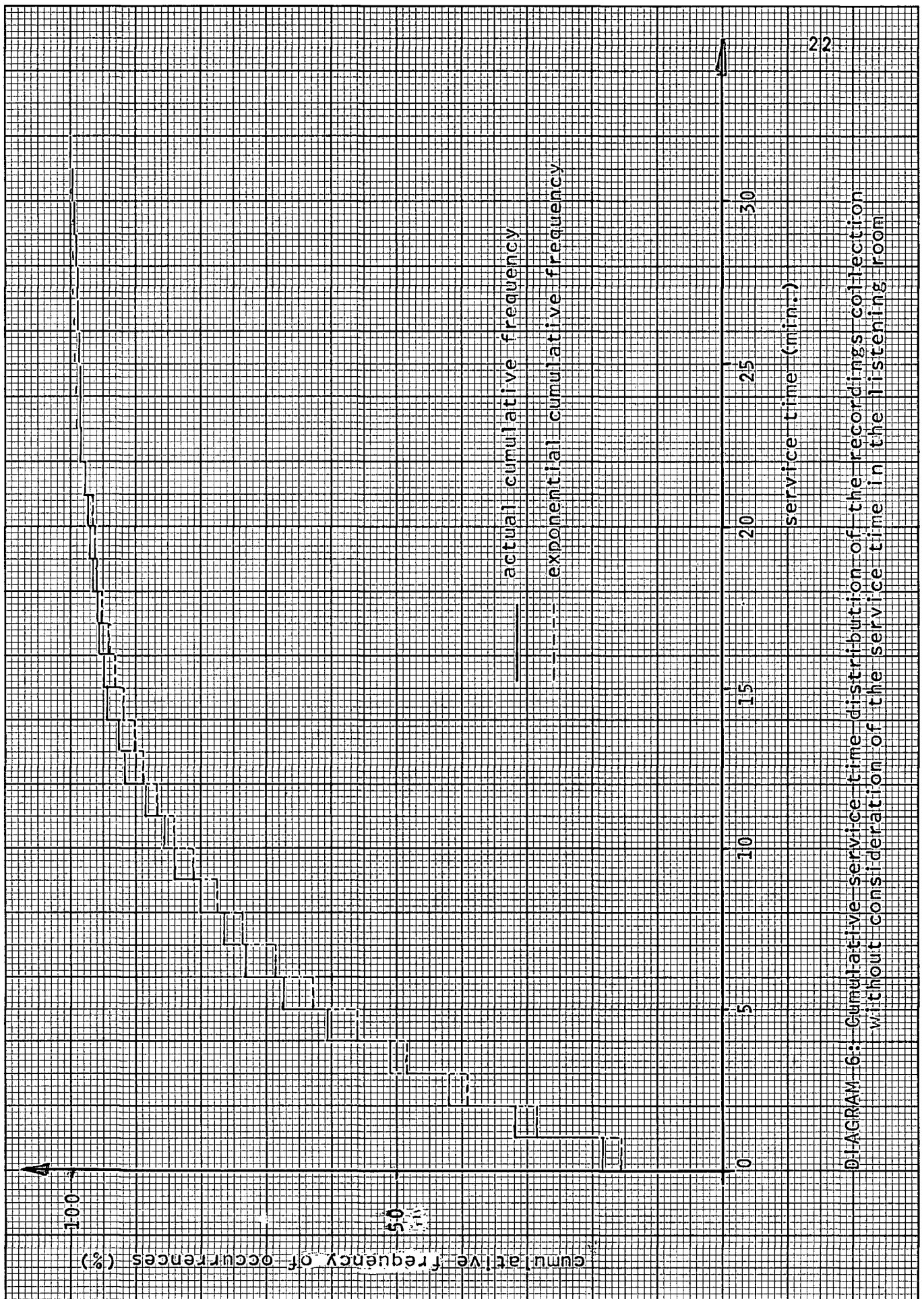
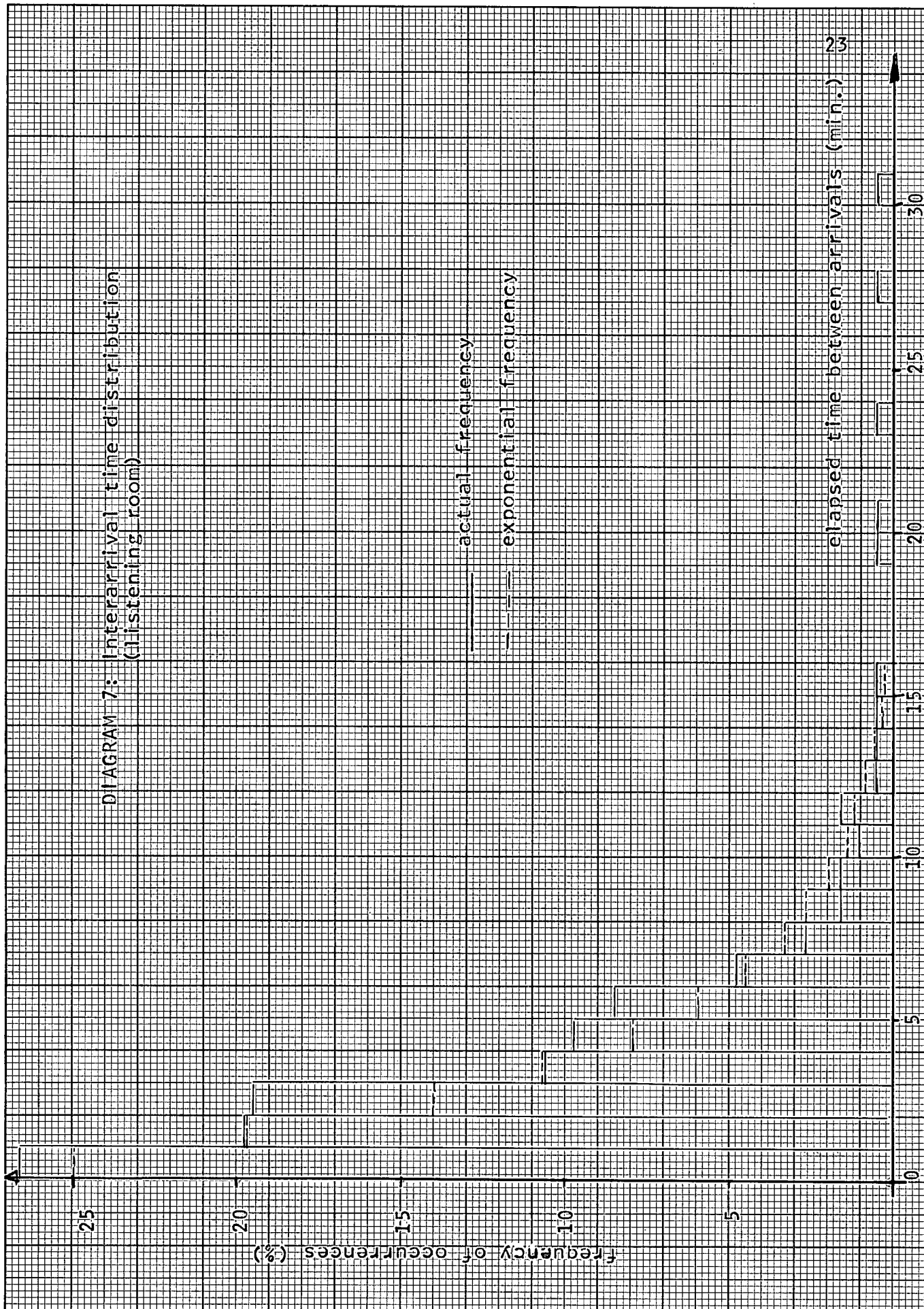


DIAGRAM 6: Cumulative service time distribution of the recordings collection without consideration of the service time in the listening room

DIAGRAM 7: Interarrival time distribution
(listening room)



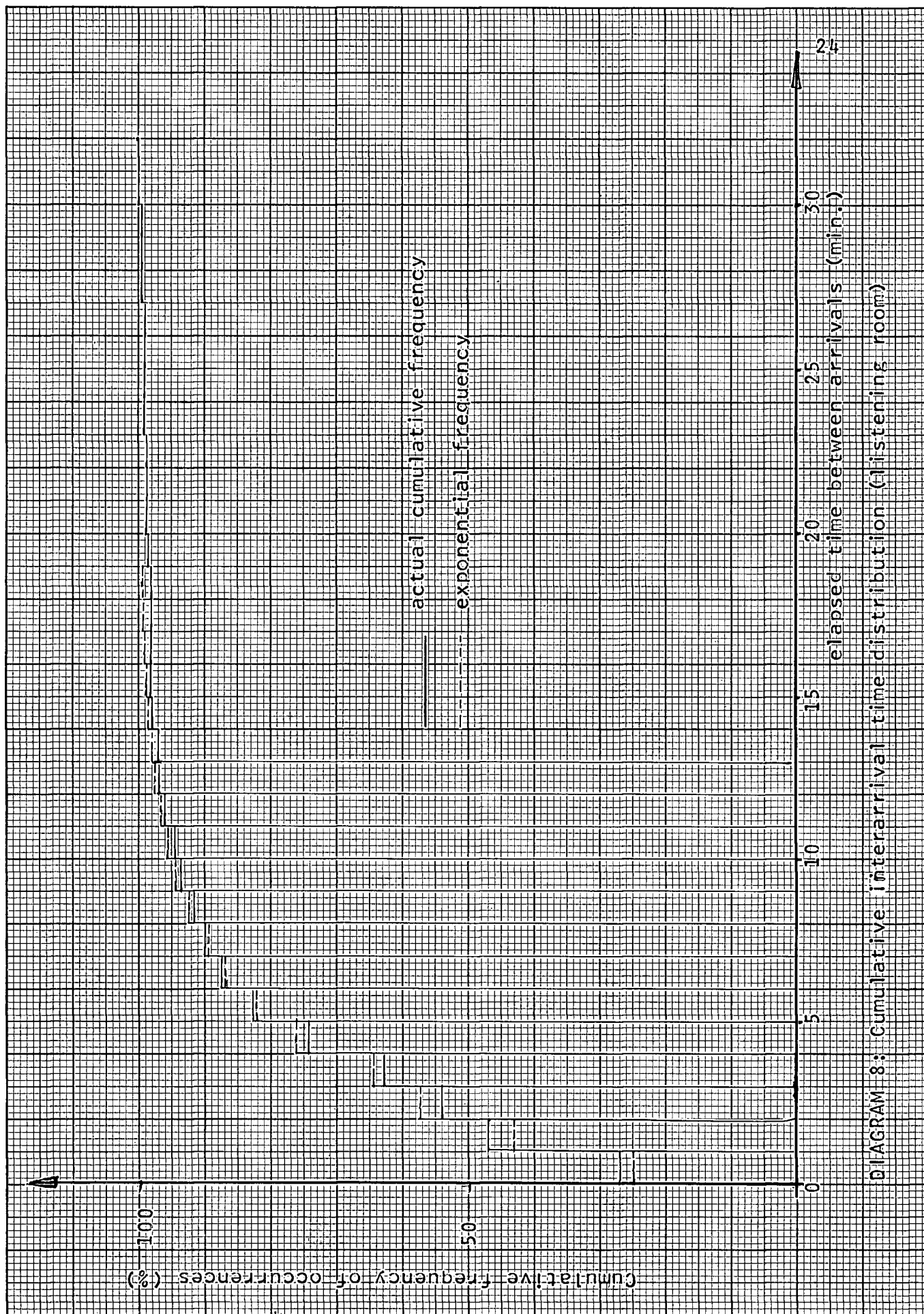


DIAGRAM 8: Cumulative interarrival time distribution (listening room)

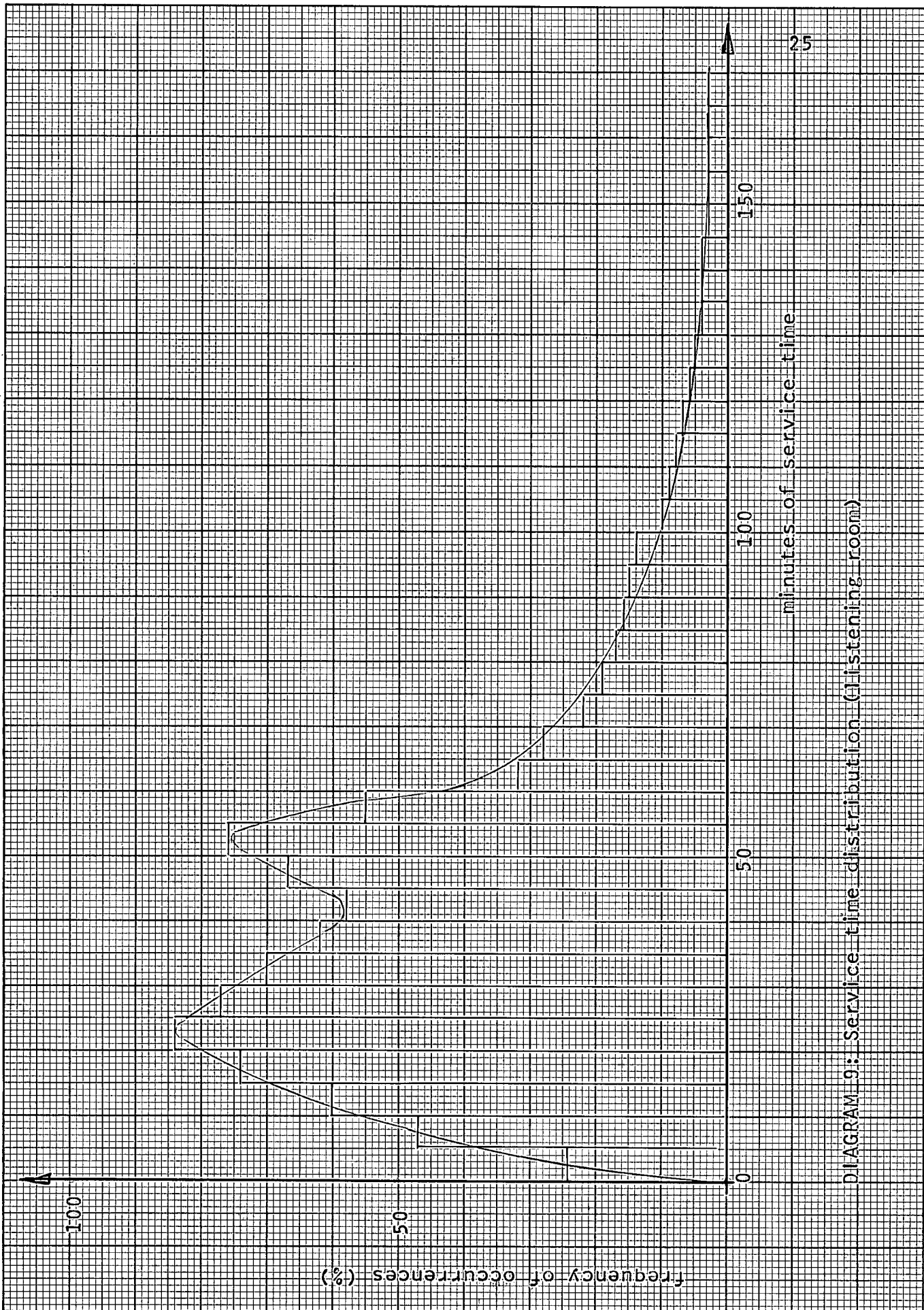
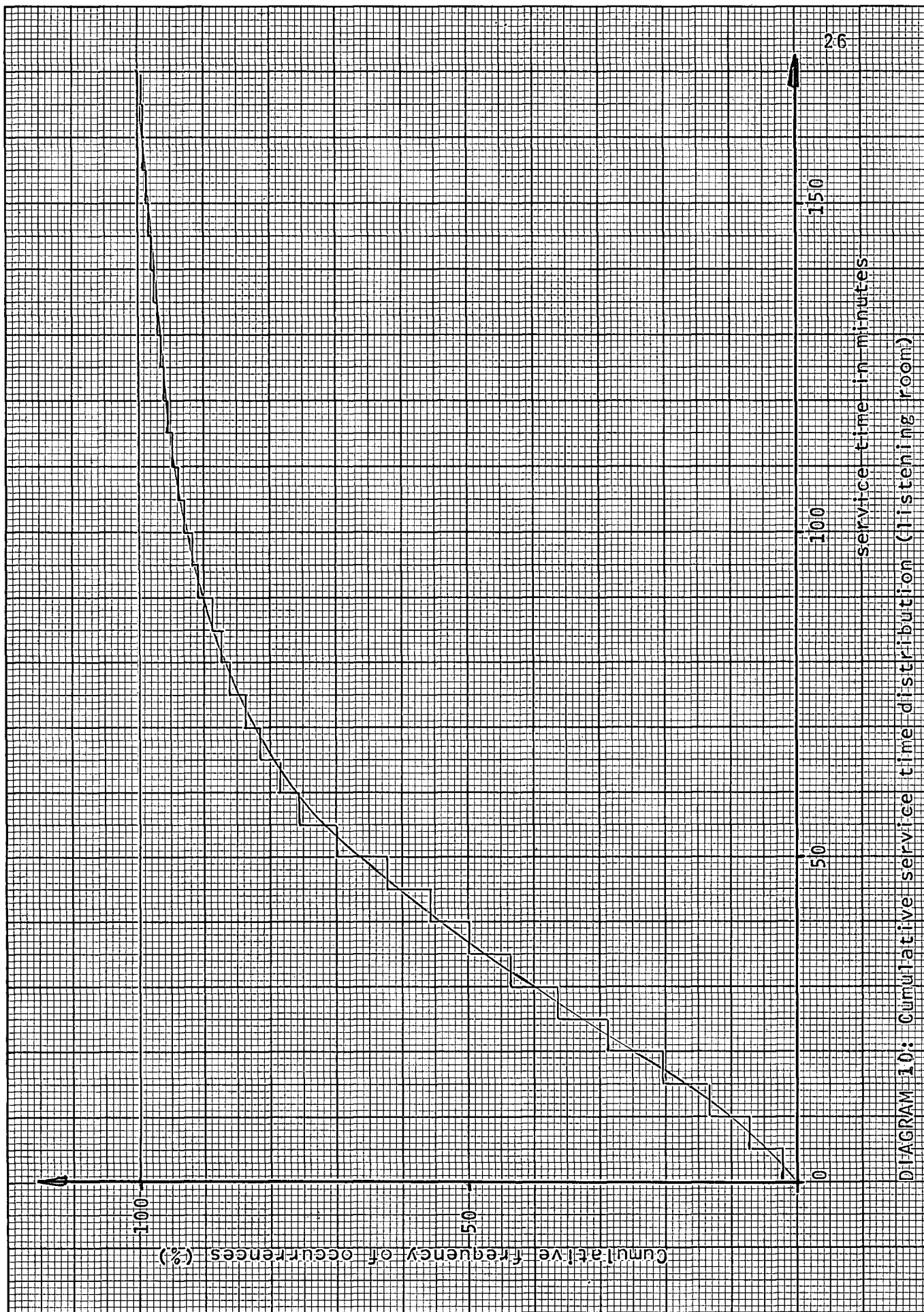


DIAGRAM 9: Service time distribution (listening room)



CHAPTER III

THE TRAFFIC FLOW MODEL

Fundamentally, the service process of the recordings collection can be formulated as a network of service stations with a stochastic input of jobs. Each input is composed of the job departure process from the previous service states. In determining the traffic behavior of the jobs through the network, the customers who require servicing in the different states follow more than one path through the network with a probabilistic behavior. Nevertheless, each arriving job to the system is described by a completely ordered job routing, which specifies the service centers required to completely process the job and the unique sequence in which they must be employed. The job traffic flow of the network can be shown in a continuous flow model. The nodes represent the different service stations with the following notation:

- 1 arrivals to the system
- 2 Information desk
- 3 shelves
- 4 listening room
- 5 departures

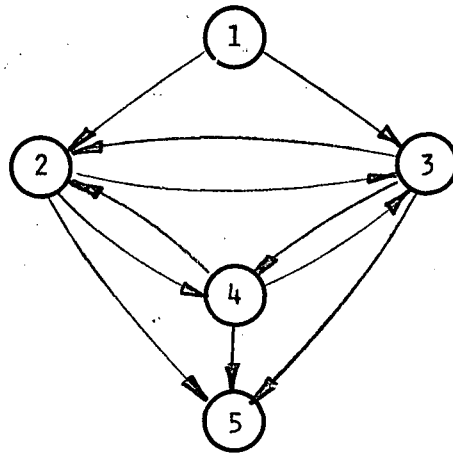


Figure 4: The continuous flow model of the complex service system with five states, numbered 1 to 5

The links connecting the nodes indicate the possible job flows. For instance, some routings through the flow model may be used in a sequence such as:

- | | | |
|----|-------|---------------------------|
| a) | | 1 - 2 - 4 - 5 |
| b) | | 1 - 3 - 4 - 5 |
| c) | | 1 - 2 - 3 - 4 - 5 |
| d) | | 1 - 3 - 2 - 4 - 5 |
| e) | cycle | 1 - /:2 - 4: - 5 |
| f) | cycle | 1 - /:3 - 4:/ - 5 |
| g) | cycle | 1 - /:2 - 3 - 2:/ - 4 - 5 |
| h) | cycle | 1 - /:3 - 2 - 3:/ - 4 - 5 |

etc.

1. The Statistical Properties of the Continuous Flow Model

The flow model is used to study the spread of arriving jobs to different states of the complex service system. The continuous job flow goes from state 1 and ends in state 5. Empirical observations have been made using a questionnaire. For convenience, the approximate behavior generally observed is shown by 100 customers requiring service from the recordings collection in several states. The parameters of the probabilistic flow model are:

- a) The partial flows (F_{ij} 's, number of jobs/time unit) which give the flows through the relevant links, for instance, from state (i) to state (j).
- b) The volumes of service demand during a considered time period (V_i , number of jobs serviced during a time interval) originated by the jobs arrived in each state (i).

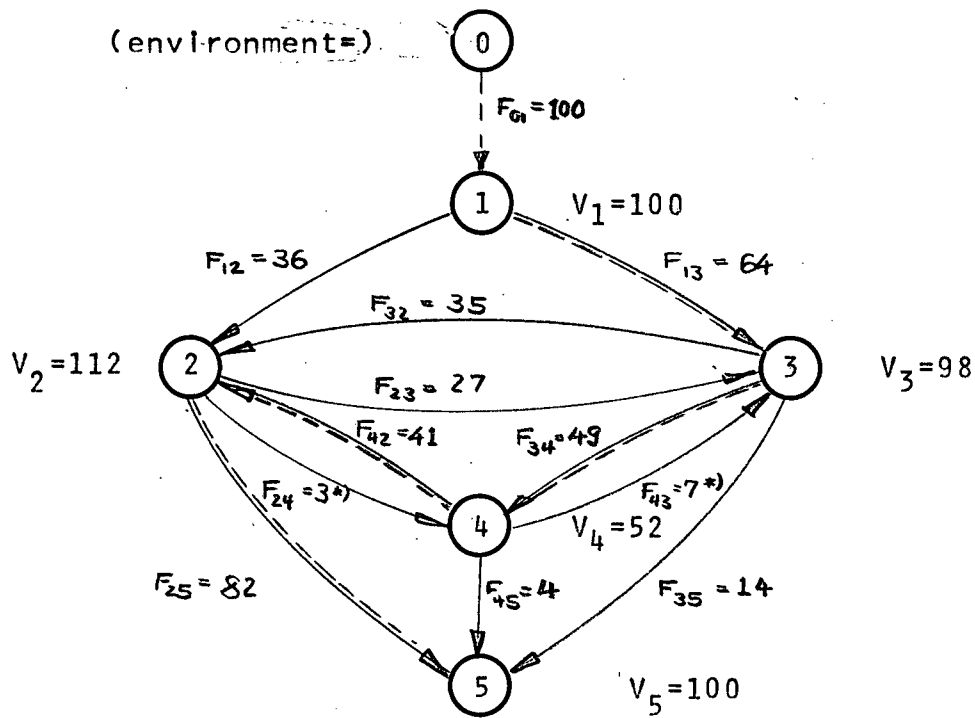


Figure 5: The empirically observed flow of jobs represented by 100 customers requiring service from the system during a time interval of ca. 100 minutes (system's arrival rate = 1 customer/minute).

As the flow model shows, out of 100 patrons arriving within a certain time period (state 1), 36 of them will demand service in the first step from the information desk (state 2), and 64 of those customers will require service from the shelves (state 3). In a second step, customers being serviced either at the information desk or at the shelves, may migrate to alternative accessible service centers if they require additional service from there. A job entering state 5 (departures) means that there is no longer a need for service from the service system. After the departure of all 100 customers, the number of jobs serviced in each state is stated by the volume of the service demand V_i . This demand gives an indication about the relative frequency of the use of each particular service facility, an unbalanced usage of the service units within the service complex, or the origin of congestion.

The observed job flows indicate an approximately balanced service demand for the use of the information desk (112 demands) and the shelves (98 demands). The use of the listening room seems to be relatively light (52 demands). However, it must be taken into account that the capacity of the listening room is limited by the 23 listening units installed. This capacity limitation might be a reason for congestion. For example, if 100

customers will pass through the system for service in a time period of about 2 hours of the top traffic, a demand of 52 services will be created for the listening room. A listening time of ca. 53 minutes on the average will be available for each listening room customer. The playing of one single side of a LP-record takes about 25 minutes. Thus, the time available for each customer may be just sufficient for listening to both sides of one record.

If any congestion will appear within the complex service system, then it will become obvious along the path of maximum job flow which is routing 1-3-4-2-5.

2. The Job Routing Model as a Finite-State Markov Chain

We may consider the job routing model by studying an embedded Markov Chain in the study of the complex service system. The basic concepts of the Markov Chain are determined by the "state" of the system and the "state transition". The state of the system is the particular service facility or the exit and departure state currently occupied by the customer. The system changes its state when the customer transits from one state to the next specified state. There are five states

In the system numbered from 1 to 5. The time between transitions is a random variable determined by the service time distributions related to each single service center. Hence, we may consider the system to be a finite-state, continuous-time process. If the system has an embedded Markov Chain, then the probability of a transition to state (j) at the next transition, given that the system now occupies state (i), is a function only of (i) and (j) and is not altered by additional knowledge concerning its past behavior. In other words, we may specify a set of conditional probabilities p_{ij} that a system which now occupies state (i) will occupy state (j) after its next transition.

A corresponding transition diagram of the system, showing the states and the transition probabilities in the graph below, is derived from the original flow model:

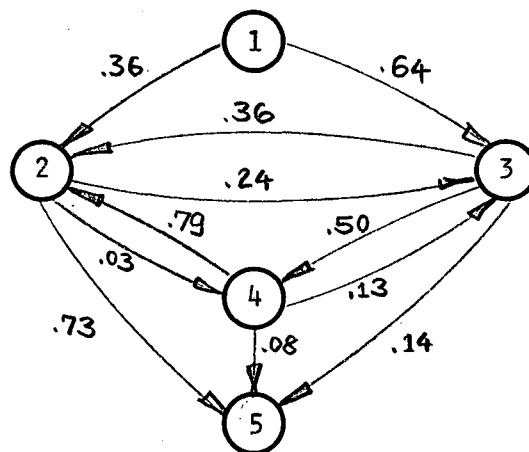


Figure 6: The flow model showing the state transition probabilities

The graph, for instance, makes plain that when a customer is in state (2) there is a 24% chance to go to state (3) after the service completion in the present state, or to migrate to state (4) or to state (5) with the probabilities of 3% and 73%, respectively. A complete description of the process can be stated by the transition matrix P and by the initial probability vector (1) ; the latter determinates the starting state of the process. The rows of the matrix sum to 1:

$$\sum_{j=2}^5 p_{ij} = 1;$$

they are composed of the transition probabilities of a customer in state (i) (row) going to another state (j) (column). The transition to a following state (j) may happen in n steps $(n=1,2,\dots)$. The one-step transition matrix P of the process is given by:

		state after transition $(n+1)$				
		1	2	3	4	5
state after transition (n)	1	0	.36	.64	0	0
	2	0	0	.24	.03	.73
	3	0	.36	0	.50	.14
	4	0	.79	.13	0	.08
	5	0	0	0	0	1

The initial state probability vector (1) is $(1, 0, 0, 0, 0)$.

The transition matrix represents an absorbing chain with transient states from 1 to 4 and an absorbing state denoted by 5. As long as the process is in the transient set of states, it will make state transitions till the absorbing state is reached. Once entered the absorbing state, the process will stay there. The probability that such a state is entered tends to 1 with an increasing number of transition steps.

The matrix version of an absorbing chain aggregating the transient and ergodic set of the states is

$$P = \begin{array}{c} \begin{array}{cc} \overbrace{r-s} & \overbrace{s} \\ \left[\begin{array}{cc} I & 0 \\ R & Q \end{array} \right] \end{array} \begin{array}{l} \left. \vphantom{\begin{array}{cc} I & 0 \\ R & Q \end{array}} \right\} r-s \\ \left. \vphantom{\begin{array}{cc} I & 0 \\ R & Q \end{array}} \right\} s \end{array} \end{array}$$

where the submatrices can be interpreted such as:

1. Region $(r-s).(s)$ = submatrix 0:

The submatrix consists entirely of 0's.

2. Region $(s).(s)$ = submatrix Q:

The process stays in transient states; that means, each state can be reached from each other state, and each state can be left again.

3. Region (s).(r-s) = submatrix R:

represents the process transitions
from transient to ergodic states.

4. Region (r-s).(r-s) = submatrix I:

The process has reached the ergodic
set of states and remains there. The
respective submatrix is represented by
an identity matrix of the appropriate
dimensions.

Thus, we can write our transition matrix P in the
new canonical form:

	5	1	2	3	4
5	1	0	0	0	0
1	0	0	.36	.64	0
2	.73	0	0	.24	.03
3	.14	.0	.36	0	.50
4	.08	0	.79	.13	0

where the regions I, O, R, and Q have been marked off.

Finally, we will make use of the transition probability matrix for the following questions:

2.1 What is the expected number of visits to any state (j) before a customer will leave the service system, given, he is in a present state (i) ?

2.2 What is the probability, a customer ever will visit any state (j) ?

Additionally, we will consider briefly the expected number of transitions up to time t which is represented by a

2.3 Markov Renewal Process.

2.1 The expected number of visits to state (j) before a customer will leave the service system, given, he is in a present state (i)

We say, the mean of the total number of times the process is in a particular transient state (j) is n_{ij} , given, the process starts in state (i).

$$\begin{aligned} n_{ij} &= E[\text{number of visits to (j) | start in state (i)}] \\ &= \sum_{n=0}^{\infty} P[\text{in state (j) on n-th step} | \text{start in state (i)}] \\ &= I_{ij} + Q_{ij} + (Q^2)_{ij} + (Q^3)_{ij} + \dots + \end{aligned}$$

To compute one element n_{ij} , we may add up the original position's contribution, represented by the I-matrix, plus each of the steps' contribution in accordance to the transition probabilities of the Q-matrix. A new entrance to a regarded transient state contributes to our mean of frequency of visits. If the newly occupied state is absorbing, it contributes nothing, since the process will never leave again this state.

We determine all possible n_{ij} 's in the N-matrix:

$$N = I + Q + Q^2 + Q^3 + \dots$$

The expression $I + Q + Q^2 + Q^3 + \dots$ is summable to $(I-Q)^{-1}$; thus

$$N = (I - Q)^{-1} \quad 1)$$

We apply these results to our example:

$$(I-Q) = \begin{matrix} & \begin{matrix} 1 & 2 & 3 & 4 \end{matrix} \\ \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \end{matrix} & \begin{bmatrix} 1 & -0.36 & -0.64 & 0 \\ 0 & 1 & -0.24 & -0.03 \\ 0 & -0.36 & 1 & -0.50 \\ 0 & -0.79 & -0.13 & 1 \end{bmatrix} \end{matrix}$$

1) John Kemeny and Laurie Snell, Finite Markov Chains, Van Nostrand Company, Inc., Nw. York 1963, pg. 45 ff.

The inverse matrix is:

$$N = (I - Q)^{-1} = \begin{array}{c} \begin{matrix} & 1 & 2 & 3 & 4 \end{matrix} \\ \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \end{matrix} \left[\begin{array}{cccc} 1 & 1.125 & 0.978 & 0.523 \\ 0 & 1.283 & 0.335 & 0.206 \\ 0 & 1.036 & 1.340 & 0.701 \\ 0 & 1.148 & 0.438 & 1.253 \end{array} \right] \end{array}$$

In a proof, the multiplication of the $(I - Q)$ matrix with its inverse (N) has to result in the identity matrix I :

We see from the N -matrix that, for instance, if the process starts in state (2), then it will be in the same state (2) an average of 1.283 times, but 0.335 times in state (3) and 0.206 times in state (4), etc. Similar examples easily can be chosen from the N -matrix.

2.2 The probability, a customer ever will visit state (j)

We may wish to know, for example, the probability that the customer will be in state (2) after n transitions if we know he is in state (2) at the beginning of the n -transition process. For this reason, we define a state probability $\pi_j(n)$, the probability that the system will

occupy state (j) after n transitions, or

$$\pi_j(n), (n=1,2,\dots,k) = \text{Prob.} \left[\begin{array}{l} \text{process in state} \\ (j) \text{ at } n\text{-th} \\ \text{transition} \end{array} \right]$$

Considering all possible realizations of the process, we may employ a probability tree which states all possible paths. We obtain the following graphic representation if we assume the process starts in state (2) for example:

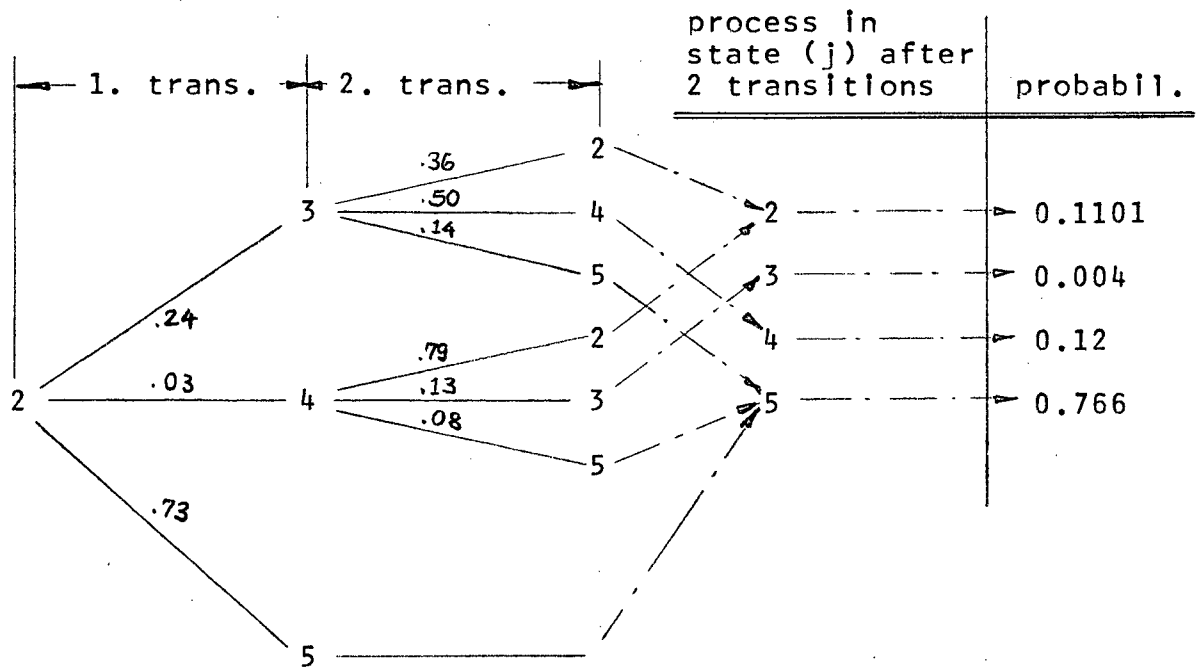


Figure 7: The probability tree showing the possible paths

To find the probability of a certain outcome in n steps ($n=1,2,\dots,k$), we add the weights of all possible paths leading to this result. The n -th power of the one-step transition matrix states the conditional probabilities that, given, the process started in state (i), (rows of the matrix), it will after n steps be in state (j), (columns of the matrix). This follows from

$$\sum_{i=1}^N \pi_i(n) = 1$$

$$\pi_j(n+1) = \sum_{i=1}^N \pi_i(n) p_{ij}, \quad n=0,1,2,\dots$$

If we define a row vector of state probabilities $\overline{\pi}(n)$ with elements $\pi_i(n)$, then

$$\overline{\pi}(n+1) = \overline{\pi}(n)P, \quad n = 0,1,2,\dots$$

Since by recursion

$$\overline{\pi}(1) = \overline{\pi}(0)P$$

$$\overline{\pi}(2) = \overline{\pi}(1)P = \overline{\pi}(0)P^2$$

$$\overline{\pi}(3) = \overline{\pi}(2)P = \overline{\pi}(0)P^3$$

in general,

$$\overline{\pi}(n) = \overline{\pi}(0)P^n, \quad n = 0,1,2,\dots$$

Thus, we find the probability that the system occupies each of its states after n transitions, $\overline{\pi}(n)$, by multiplying the initial state probability vector $\overline{\pi}(1)$

by the n -th power of the transition matrix P .

Let us illustrate these results by applying them to our example. For instance, if the process starts in state (1), it will be in state (4) after 2 transitions with a probability of 0.3308 in accordance to the P^2 -matrix. The calculation is:

$P^1 =$

$$\begin{bmatrix} 0 & .36 & .64 & .0 & .0 \\ 0 & 0 & .24 & .03 & .73 \\ 0 & .36 & 0 & .50 & .14 \\ 0 & .79 & .13 & 0 & .08 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & .36 & .64 & 0 & 0 \\ 0 & 0 & .24 & .03 & .73 \\ 0 & .36 & 0 & .50 & .14 \\ 0 & .79 & .13 & 0 & .08 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$P^1 =$

$$\begin{bmatrix} 0 & .2304 & .089 & .3308 & .3524 \\ 0 & .1101 & .004 & .12 & .766 \\ 0 & .395 & .1514 & .0108 & .4428 \\ 0 & .0467 & .19 & .089 & .6749 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$P^2 =$

Again, the 3-step, or general, the n -step probabilities can be interpreted similarly. With an increasing number of transitions, the process tends to be in the final state (5) without any regard from which original state the process started. This trend can be easily observed by the P^n -matrices such as:

$$p^3 = \begin{bmatrix} 0 & .2924 & .0983 & .0501 & .5591 \\ 0 & .0962 & .0420 & .0053 & .8565 \\ 0 & .0630 & .0962 & .0875 & .7532 \\ 0 & .1383 & .0228 & .0962 & .7427 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$p^4 = \begin{bmatrix} 0 & .0748 & .0766 & .0579 & .7902 \\ 0 & .0193 & .0238 & .0239 & .9330 \\ 0 & .1040 & .0265 & .0499 & .8197 \\ 0 & .0842 & .0457 & .0155 & .8546 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$p^8 = \begin{bmatrix} 0 & .0143 & .0065 & .0065 & .9723 \\ 0 & .0049 & .0022 & .0020 & .9909 \\ 0 & .0090 & .0055 & .0046 & .9811 \\ 0 & .0077 & .0039 & .0045 & .9839 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

We want to know the probabilities, a customer ever will visit any considered state (j) if he starts from a state (i). $f_{ij}^{(n)}$ shall be the probability that, starting from state (i), the first return to state (i) occurs at the n -th transition. We say

$$f_{jj}^{(1)} = p_{jj}$$

$$f_{jj}^{(2)} = p_{jj}^{(2)} - f_{jj}^{(1)} p_{jj}$$

$$f_{jj}^{(n)} = p_{jj}^{(n)} - f_{jj}^{(1)} p_{jj}^{(n-1)} - f_{jj}^{(2)} p_{jj}^{(n-2)} - \dots - f_{jj}^{(n-1)} p_{jj}.$$

In general

$$f_{jj}^{(n)} = \sum_{k=0}^n f_{jj}^{(k)} p_{jj}^{(n-k)}, \quad f_{jj}^{(0)} = 1$$

$$f_{jj}^{(n)} = p_{jj}^{(n)} - \sum_{k=1}^{n-1} f_{jj}^{(n-k)} p_{jj}^{(k)}.$$

If the system starts in state (i), and we are interested in the first passage through state (j), then

$$f_{ij}^{(n)} = p_{ij}^{(n)} - \sum_{k=1}^{n-1} f_{ij}^{(n-k)} p_{jj}^{(k)} \quad 2)$$

Applied to our case, the $f_{ij}^{(1)}$ - probabilities are identical to the p_{ij} 's. We obtain the $f_{ij}^{(n)}$ - probabilities by

2) W. Feller, Introduction to Prob. Theory, Wiley & Sons, Inc., New York 1957, p. 352 f.

$$f_{ij}^{(2)} = \begin{bmatrix} 0 & .2304 & .0890 & .3308 & .3524 \\ 0 & .1101 & .0040 & .1200 & .0360 \\ 0 & .3950 & .1514 & .0108 & .3028 \\ 0 & .0468 & .1896 & .0887 & .5949 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

That means, if the process starts for example in state (1), the first return in 2 steps to state (1) will never occur, however, it will go the first time to the states (2), (3), (4), and (5) with the probabilities of 23%, 9%, 33%, and 35%.

We observe, the process tends to be in the final state (5) after $n > 2$ transitions; the probabilities diminish that the process will be in the states (2), (3) or (4), as it is shown in the $f_{ij}^{(3)}$ and $f_{ij}^{(4)}$ matrices:

$$f_{ij}^{(3)} = p_{ij}^{(3)} - f_{ij}^{(1)} p_{jj}^{(2)} - f_{ij}^{(2)} p_{jj}^{(1)}$$

$$f_{ij}^{(3)} = \begin{bmatrix} 0 & .2528 & .0015 & .0500 & .5591 \\ 0 & .0962 & .0060 & .0050 & .0905 \\ 0 & .0234 & .0962 & .0430 & .3104 \\ 0 & .0514 & .0031 & .0960 & .0678 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$f_{ij}^{(4)} = p_{ij}^{(4)} - f_{ij}^{(1)} p_{jj}^{(3)} - f_{ij}^{(2)} p_{jj}^{(2)} - f_{ij}^{(3)} p_{jj}^{(1)}$$

$$f_{ij}^{(4)} = \begin{bmatrix} 0 & .0149 & .0015 & .0286 & .0720 \\ 0 & .0072 & .0002 & .0105 & .0870 \\ 0 & .0269 & .0035 & .0010 & .1800 \\ 0 & .0031 & .0045 & .0070 & .1119 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Finally, the probabilities that a customer ever will visit a state (j), ($=2,3,\dots,5$) given, he starts from any state (i), ($i=1,2,\dots,5$) is expressed by the sum of $f_{ij} = \sum_{n=1}^{\infty} f_{ij}^{(n)}$. From our results, we may obtain

$$f_{ij} \approx \sum_{n=1}^4 f_{ij}^{(n)}$$

which is

$$f_{ij} \approx \sum_{n=1}^4 f_{ij}^{(n)} = \begin{bmatrix} 0 & .8581 & .7320 & .4094 & .9735 \\ 0 & .2135 & .2503 & .1655 & .9435 \\ 0 & .8035 & .2511 & .5548 & .9332 \\ 0 & .8913 & .3272 & .1923 & .8546 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Because of the negligible contribution of the probability that a customer will visit a state the first time after $n > 4$ transitions, we may obtain

$$f_{ij} = \sum_{n=1}^{\infty} f_{ij}^{(n)} \text{ on the basis of } f_{ij} = \sum_{n=1}^4 f_{ij}^{(n)} .$$

$$f_{ij} = \sum_{n=1}^{\infty} f_{ij}^{(n)} \text{ is in an approximation:}$$

$$f_{ij} \approx \sum_{n=1}^4 f_{ij}^{(n)} = \begin{bmatrix} 0 & .86 & .74 & .41 & 1 \\ 0 & .22 & .26 & .17 & 1 \\ 0 & .81 & .26 & .66 & 1 \\ 0 & .90 & .33 & .20 & 1 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

In our case, every customer will arrive in state (1) as there is no alternative arrival state in the system regarded. Thus, we may consider just the f_{1j} , ($j = 2, 3, 4, 5$) from the first row of the matrix above as here are presented the probabilities of ever going to any state (j), given, the customers start in state (1).

2.3 Markov Renewal Process

We may be interested in the expected number of transitions occurring in each particular state, and in the system as well, up to time T . Our question is described by a Markov renewal process which registers the numbers of transitions into each state in a certain time interval $(0, T)$, when the transition times of the events are independently distributed positive random variables with known probability pattern. A typical sample function of transitions into state (i) is sketched below:

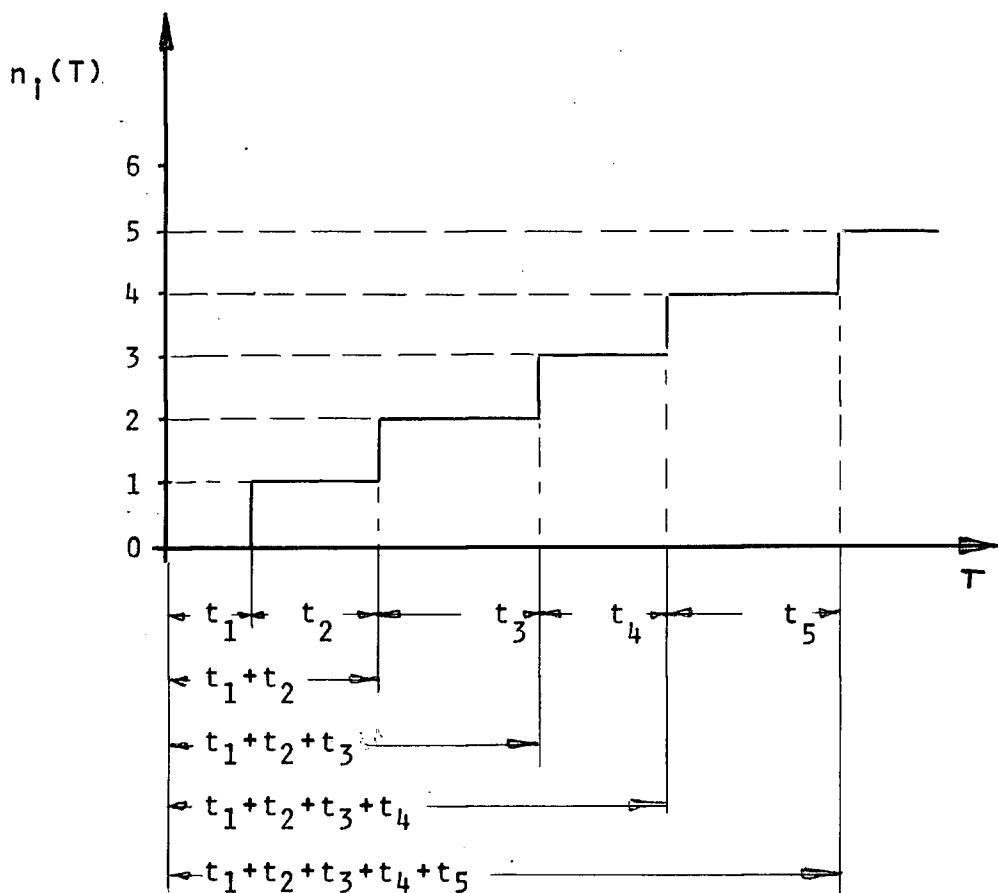


Figure 8: A sample function of transitions into state (i)

In our case, the times between the successive transitions are random variables denoted by $t_{i,k}$, where the index (i) refers to the regarded service state; the second index (k) indicates the k-th successive intertransition time which elapsed between the (k-1)-th and k-th transition.

If $n_i(T)$ represents the number of transitions into state (i), ($i=1,2,\dots,5$) during the time interval 0 to T, then $\{n_i(T), T \geq 0\}$ is a general renewal process (renewals = transitions into the same state) considering the particular state (i).

We want to determine the expected number of transitions into each state (i) up to time T. Therefore, we define first the distribution of the amount of time until the next transition occurs in relation to each service state.

The following sketch shows a state (i) and two alternative successive states $j(1)$ and $j(2)$, or in general $j(x)$, ($x=1,2$). Given, the process occupies state (i) at the present time, from there it will migrate either to state $j(1)$ or to state $j(2)$ with the probabilities of $p_{ij(1)}$ or $p_{ij(2)}$:

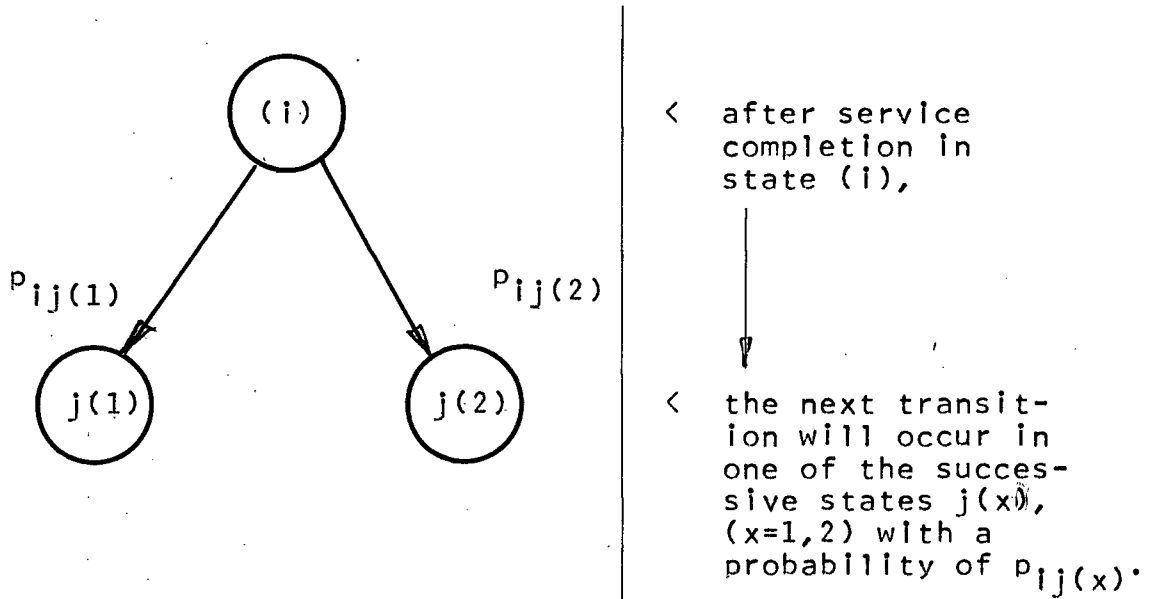


Figure 9: The transition from state (i) to two alternative successive states $j(1)$ and $j(2)$

We define the following:

A transition $---->$ is the job flow from the presently occupied state (i), $(i=1,2,\dots,5)$ to the successive state (j), $(j=2,3,4,5)$; the transition occurs into state (j).

$p_{ij(x)}$ $---->$ is the probability that the next transition will be into state $j(x)$, given that the process has just entered state (i):

$$p_{ij(x)} = p\{i \rightarrow j(x) \mid i\}$$

$p_{ij(x)}^{(T)}$ $---->$ is the probability that after making

a transition into state (i), the process next makes a transition into state $j(x)$ in an amount of time $\leq T$.

$$p_{ij(x)}^{(T)} \geq 0, \quad i, j(x) = 1, 2, \dots, 5, \\ T \geq 0$$

$$\sum_{j(x)=1}^5 p_{ij(x)}^{(\infty)} = 1 \\ i, j(x) = 1, 2, \dots, 5$$

$F_{ij(x)}^{(T)}$ ----> Is the conditional probability that the job will transit within an amount of time (T), given that the process has just entered state (i) and will next enter one of the successive states $j(x)$.

$$F_{ij(x)}^{(T)} = p[\text{time} \leq T \mid i \rightarrow j(x)]$$

$$F_{ij(x)} = \frac{p_{ij(x)}^{(T)}}{p_{ij(x)}}$$

$F_{ij(x)}^{(.)}$ shows the distribution of the intertransition times (= the amount of elapsed time until the next transition occurs in state $j(x)$, given that the process

has just entered state (i)). The intertransition times related to any state (j) are determined by the arrival process and the service process in the previous state (i), the routing probabilities from state (i) to state (j), and by possibly occurring congestion conditions in state (j).

In order to determine the density function of the intertransition times in any state (i), we define $H_i(.)$ by :

$$H_i(T) = \sum_{j=0}^{\infty} F_{ij}(x)(T) \cdot p_{ij}(x) = \sum_{j=0}^{\infty} p_{ij}(x)(T)$$

$$T \geq 0$$

$$i = \text{any state } (1, 2, \dots, 5)$$

$$j(x) = \text{any successive state of } (i), (j(x)=2, 3, 4, 5, \dots)$$

If we regard one particular state (i), to each possible time interval (t) which elapses between two arrivals, we may associate the probability density of its occurrence. We denote the probability by $h_i(t)$:

$$h_i(t) = H_i(t) \frac{d}{dt}, \text{ for } t \geq 0$$

$$\int_{t=0}^{\infty} h_i(t) = 1$$

We obtain the density functions $H_i(t)$'s of the inter-transition times for each service state by simulation (see computer output). Those simulated results consider the service conditions of the preceding states and thus provide the density function of the actual inter-transition times. We assume the simulated density functions in the following.

If we consider all successive transitions of the state (i) during the time interval $(0, T)$ in a chain, the first transition will have been occurred after time interval $t_1(i)$ will have been passed, the second transition after time $t_1(i) + t_2(i)$, and the y-th transition after time $\sum_{j=1}^y t_j(i)$.

Let $N_i(T)$ be the expected number of renewals (transitions) into any particular state (i) up to time T. If the first transition occurs at time t, then the expected number of transitions in the remaining time up to T is $n_i(T-t)$, and summing over all possible values for t, we obtain

$$N_i(T) = \int_{t=0}^T [1 + n_i(T-t)] dh_i(t) + 0 \int_{t=T+1}^{\infty} n_i(t)$$

The term $[1 + N_i(T-t)]$ is the expected number of transitions in the time T if the first transition occurs at

time t ($0 \leq t \leq T$), the probability of this event being $dh_1(t)$. The second sum is the probability that the first transition will exceed T time units.

If we denote the expected number of transitions in the system by $N(T)$ ($= \sum_{i=1}^5$ of expected number of transitions in each state (i) up to time T), we define $\{N(T), T \geq 0\} = \sum_{i=1}^5 n_i(T)$.

It may be of interest to know the state of the process at each time point; this is described by a semi-Markov process. We say:

$S(0) \rightarrow$ is the initial state of the process.

After the n -th transition, the process is in the state $S(n)$. The process with the the transition states $S(n)$, ($n=1,2,\dots,5$) is a Markov Chain with transition probabilities p_{ij} .

$Z(T) \rightarrow$ is the state of the process at time T .

If we know the initial state $S(0)$ of the process and the expected number of visits occurring in each state (i) up to time T which is described by the Markov renewal process, then we can also determine the semi-Markov process $\{Z(T), T \geq 0\}$, or ,

$$\{S(0), N(t), N(t), \dots, N(t), t \geq 0\} = \{Z(T), T \geq 0\} ,$$

where $S(o)$ is the initial state, and the $N_i(t)$'s ,
 $(i=1,2,\dots,5)$ indicate which state (i) is occupied
 at the N -th transition.

3. Restrictions of the Markov Assumptions in the Model

In our example, each single service center is interconnected to a service network. In studying networks, the departure processes from the service centers play an important role. In turn, they are components of arrival processes to other service facilities. For instance, one of the difficulties encountered is statistical dependence in the departure processes from the service stations. A second complication is the presence of time dependent queue lengths at the service stations. The waiting times encountered by a job at the different service stations on its routings are, in general, not independent.

The steady-state departure process from a Poisson-exponential service stage has been studied by Burke.³⁾ Burke proved that the departure process from a Poisson-exponential service state is itself Poisson. The steady-state mean departure rate is the same as the mean arrival rate so that the departure and arrival

3) P.J. Burke, The Output of a Queueing System, Operations Research, 4, 699-704, Dec. 1956

processes are identical. Burke's results apply to n -channel service states with the queue discipline arbitrary except that all customers remain in the system until they have been serviced.

From this follows, the fundamental assumptions of ordinary queuing theory are violated in queuing networks, except when the network definitely shows Poisson-exponential properties. Certainly, whether the dependence phenomena will have an effect on the system flow statistics depends upon the network characteristics and parameters. Intuitively, one would expect that the parameters of the network, such as the number of service stations, the degrees of utilization, as well as the flow structure may be determinants of importance for the degree of dependence of the network characteristics.

Doubtless, our assumptions in respect of the validity of the Markovian properties in continuous time for the service network have to be regarded critically. Certainly, they are violated under a pure theoretical point of view because of at least two reasons:

- a) The service time distribution concerning the listening room does not fit an exponential function. Rather, it seems that the distribution of the listening times is influenced

essentially by the duration of listening for one, two, or more sides of a LP-record.

- b) The queue formation which may occur at the information desk contradicts the assumption of independency of the input process.

However, if we are conscious of those restrictions in our Markov assumptions, under approving circumstances we may accept such an approach as a kind of "practical solution". For instance, as it is shown in the results of the later simulation, the distribution of the service time considering the total service system may still be accepted as exponentially distributed (table 15, computer output). This fact might be considered as a kind of proof that the Markov properties are dominant in terms of the flow characteristics within the service network.

CHAPTER IV

SIMULATION OF THE MODEL

The flow model, developed in its basic properties by observations, was simulated on a computer in three variations in order to obtain more applicable results for evaluation. The flow modifications were performed by the "General Purpose Simulation System/360, (GPSS/360)". They comprised modified system's arrival streams and one or two servers at the information desk, such as in particular:

- a) an interarrival time of 3 minutes and one server equivalent to a low/moderate traffic flow in the morning between 8:30 and 10:00 and in the afternoon after 4 o'clock (winter term),
- b) an interarrival time of 2 minutes and 1 server describing a forced traffic flow approximately between 10:00 and 12:00 and 2:00 and 4:00 o'clock, respectively, and
- c) an interarrival time of 1 minute and two servers representing an extreme rush traffic situation which may appear during the noon hours between 12:00 and 2:00.

The arrivals of customers were generated in state (1) of the flow model. The job routing to the different service stations were determined in a probabilistic sequence as it has been shown in the flow model. A flow chart of the simulation model is outlined on the following page.

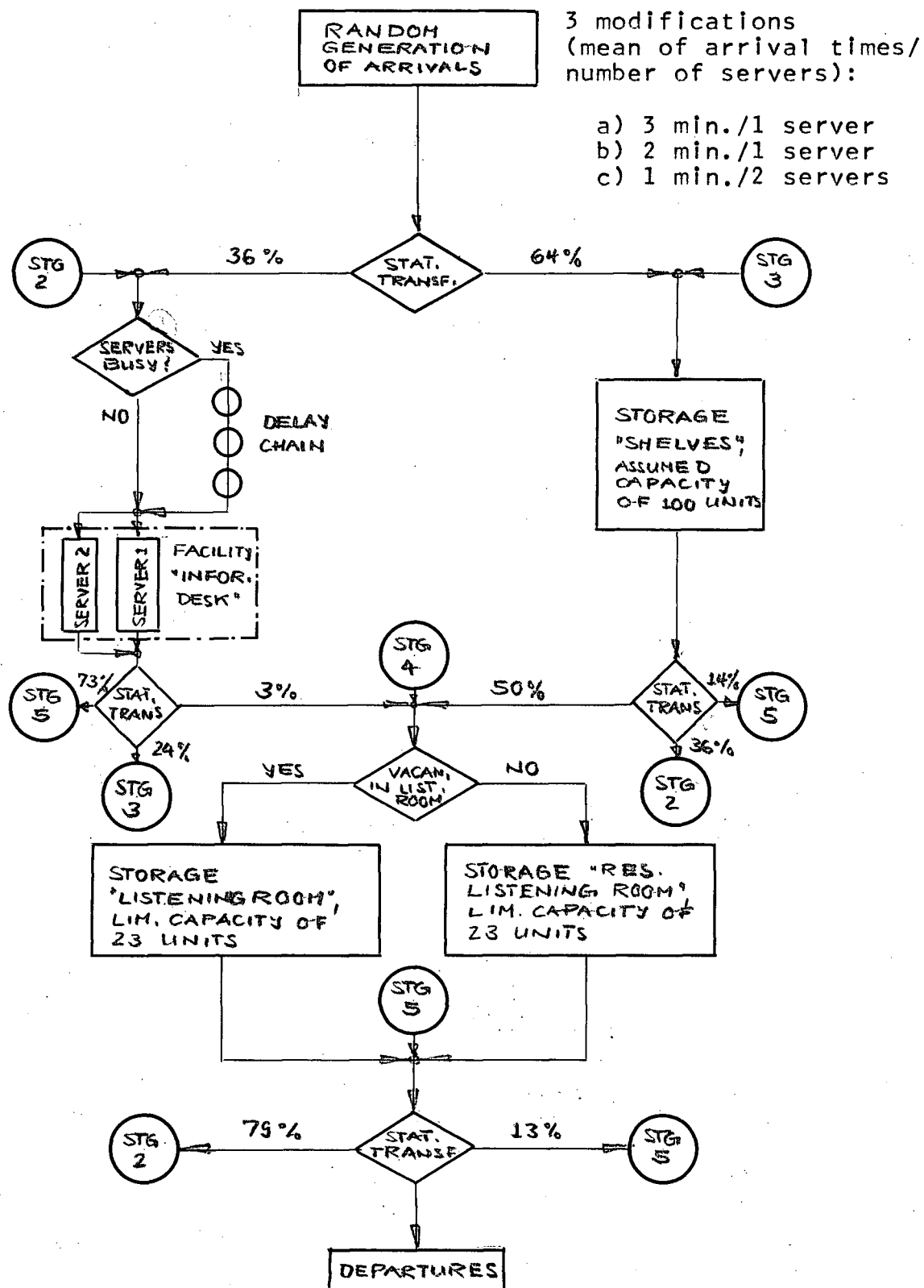
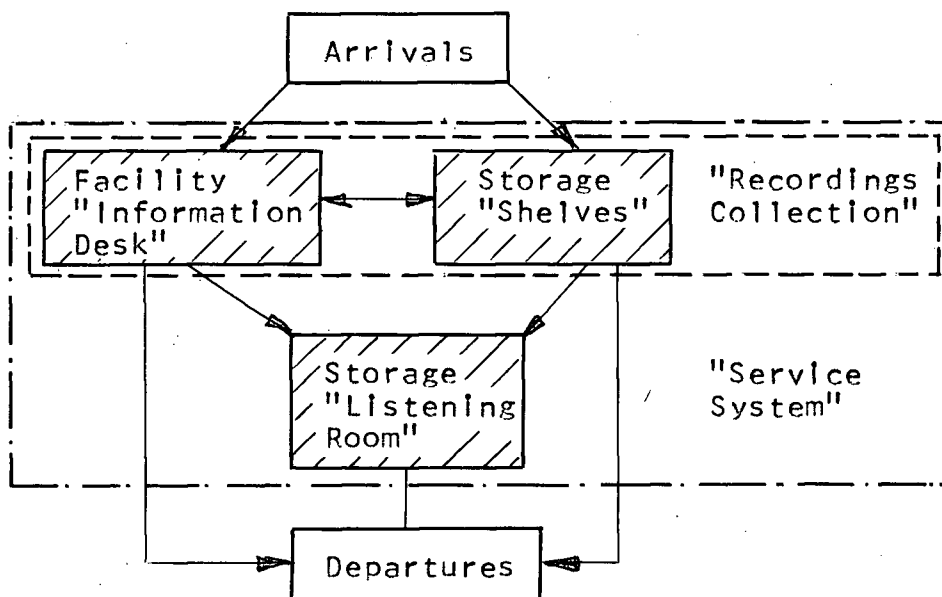
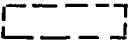
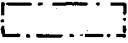


Figure 10: The simulation model

The simulated spread of the job flows and the associated data was saved in tables and presented in a statistical order. The tabulation gathered the number of occurrences in defined frequency classes. General statistics, for instance, the mean, the standard deviation, the percentage of occurrences in each frequency class have been calculated. The information content of those tables included the frequency distributions of the interarrival times, the number of arrivals during an interval of 10 minutes, the transit times, the number of jobs waiting for service, and the number of jobs occupying simultaneously a certain facility. Tables were maintained for each single facility such as the information desk, the shelves, the listening room, but also, the 'recordings collection', and the 'system'. The 'recordings collection' is understood as the combination of the information desk plus the shelves; the 'system' comprised all three facilities. The following sketch may display some interrelationships described above:



Simulated statistics available of

-  each single service center (information desk, shelves, listening room)
-  the recordings collection (information desk plus shelves)
-  the service system (information desk plus shelves plus listening room)

In addition, the simulator maintained general information which pertained to facilities, storages, and queues.

The information contents of the tables have been displayed graphically to achieve a faster and more convenient understanding.

CHAPTER IV

MEASUREMENT AND EFFECTS OF STATISTICAL PROPERTIES
ON THE SERVICE NETWORK UNDER VARIOUS SIMULATION
CONDITIONS

The objective is to gather the analytic results of the simulation for arguments; they will be formulated in graphs as an approach of measurement and evaluation.

1. The Information Desk

Jobs requiring service from the information desk may be concerned with all kind of questions in respect to the recordings collection or the listening room. They include the treatment of new applications, the registrations of loaned records, the acceptance and the reshelving of returned records. All jobs are handled in a first-in first-service order except those dealing with reshelving that can be saved for periods of lower employment. However, in the simulation, a generalized first-in first-service pattern was assumed without any exception for all kind of desk jobs. By this proposition, the simulation could be simplified. This approach involved that returned records were available immediately for the new use, but also,

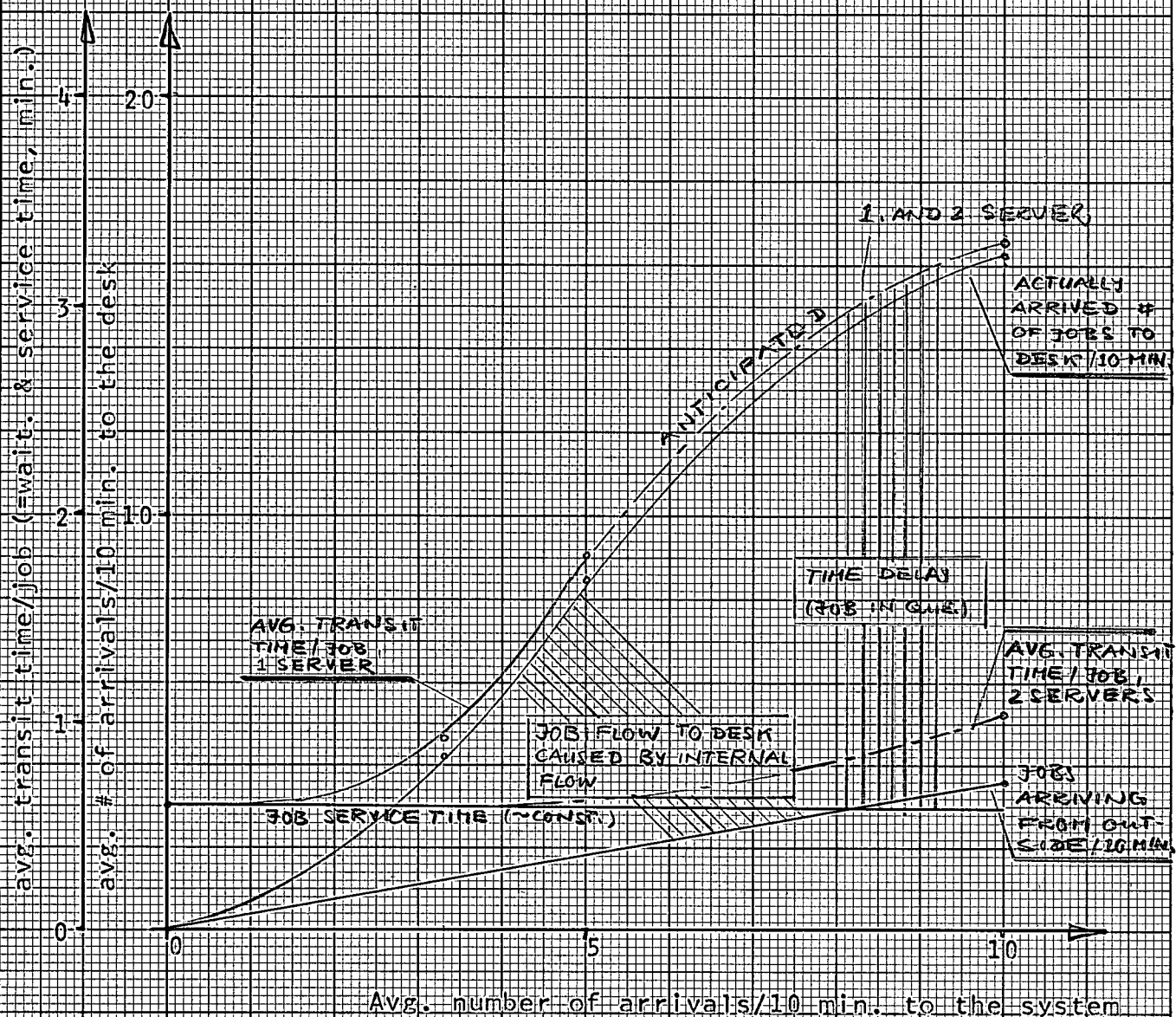


TABLE:

# of arrivals/10 min. to the system			average transit times (min.), 1 server / * 2 servers		
arrival rate	36 % go desk	simulated # of arrivals	service time	time in queue	total transit time
3.33	1.2	4.25	.56	.36	.92
5.00	1.8	8.48	.60	1.22 *	1.82
10.00	3.6	16.16	.57	.48 *	1.06 *

DIAGRAM 11: The average number of arrivals/10 min. to the information desk and the average transit time /job as a function of the number of arrivals to the system/10 minutes

that the waiting times in queue turn out to be slightly larger. Consequently, the assumption made emphasizes congestion of jobs waiting for desk service.

In diagram 11, the average number of job arrivals per 10 minutes to the information desk and likewise, the average transit time of the jobs (waiting time in queue plus service time) is shown in relation to the average number of customers entering the service system during the same interval.

Arrivals to the information desk are originated by the arrivals from outside and by the internal arrivals flowing from the shelves and from the listening room to the desk. The internal share of the total number of desk jobs is a multiple of the external job contribution and causes a non-linear behavior of the desk arrival function.

The waiting time increases considerably with a higher system's arrival rate, while the average desk service time is constant. If there is only one server in action, the waiting time may amount 3-400% of the actual service time; this is valid in the case of the highest system's arrival rate of 1 arrival/minute.

Under same conditions, 2 servers on duty would reduce the waiting time to approximately 100% of the pure service time. There will be no waiting time in queue unless the system's arrival rate is larger than 5 arrivals/10 minutes.

The extent of desk congestion is represented by the area of time delay depicted in diagram 11.

2. The Shelves

In the simulation, the shelves have been considered as a storage with the ability to service a limited number of job requests simultaneously at each time. Job requests may be the selection of recordings for listening, or general interest of information for the recordings available.

Even under conditions of rush traffic, there neither appears congestion in terms of jobs crowding the shelves, nor can there be observed a service time delay.

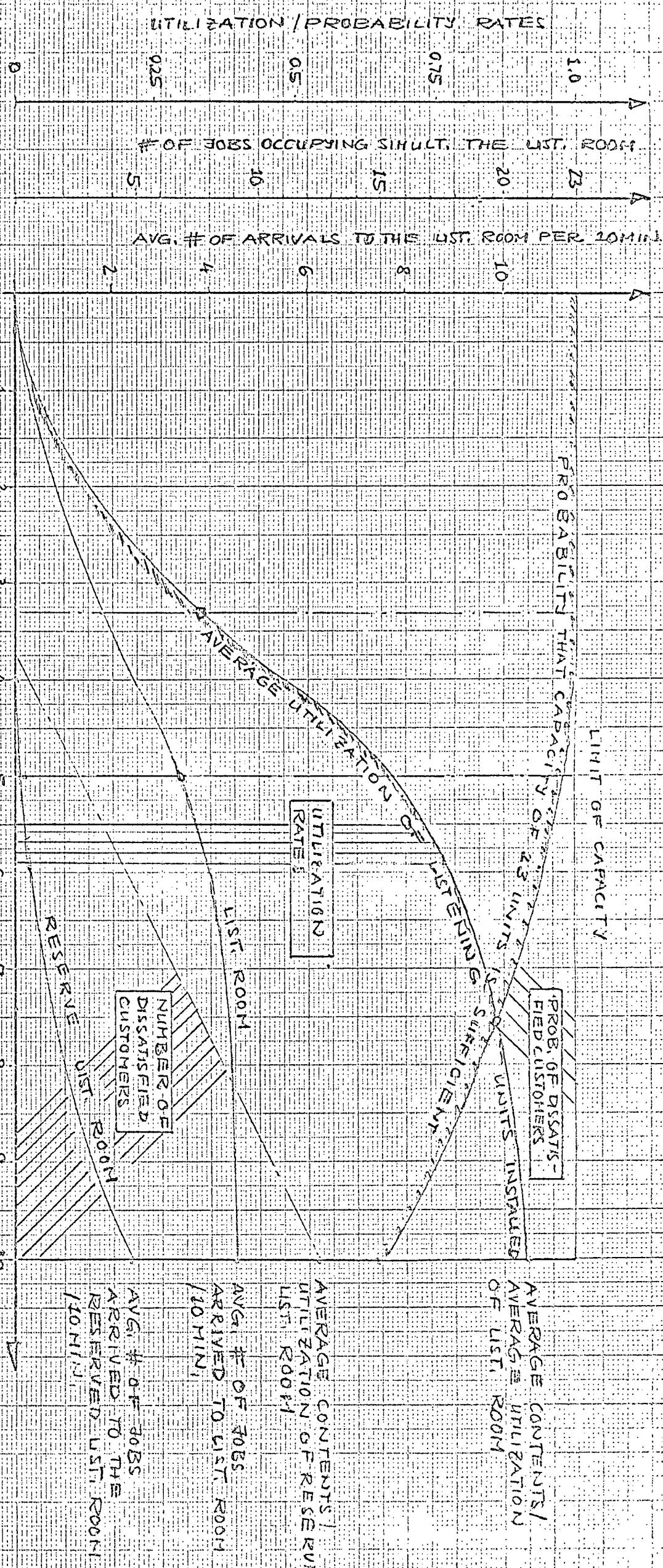


TABLE 1

Average # of arrivals to the		contents of the				prob. of cap. = 25		AVERAGE	
System list. room	res. list. room	list. room	max. room	avg. room	res. list. room	list. units is sufficient (%)	utilization (%)	utilization (%)	utilization (%)
3.3	1.8	0	7.8	23	0	100	.337		
5.0	3.5	.15	15.7	23	2.4	95.9	.69		
10.0	4.5	2.35	20.0	23	12.5	66.0	.909		

Diagram 12: Functional interrelationships concerning the listening room

3. The Listening Room

Jobs arrive to the listening facility with the intention of listening to recordings previously picked up from the shelves. There is a limited number of 23 listening units available. Customers finding no vacancy, usually leave the service system, or they may spend some more time at the shelves waiting for the next vacancy.

The listening room is to be considered as a storage with limited capacity. In the simulation, customers who find no vacancy are described as dissatisfied customers. However, instead of leaving, they will enter an imagined reserve listening room equivalent to the real listening room with the same assumed service features. Thus, under varied system's arrival rates, the traffic flow to the reserve listening room represents dissatisfied customers.

In essence, there appears an interest conflict between a high utilization of the provided facilities and the rate of satisfied customers under changing traffic densities.

If every customer interested in listening shall be able to find a vacancy even during peak traffic periods, relatively many listening units will be unused

during low traffic. Fluctuations of the traffic depend in particular upon the considered time interval of a day, on the specific day of a week, and on the season, and they are unavoidable. In deciding what an adequate capacity of the equipment to be provided will be, the interrelationship between the facility's utilization rate and the satisfaction of the customers has to be considered under varied traffic circumstances.

In diagram 13, the curve of average utilization and the probability curve that the capacity of 23 listening units will be sufficient for every arriving customer is plotted as a function of the average number of the system's arrivals during an interval of 10 minutes. In other words, if there arrive 5 customers on the average during an interval of 10 minutes, the utilization will be 69%, and the probability to find a vacancy will be 95.7%. If the counted number of system's arrivals drops down to 3.3/10 minutes, the associated utilization and probability rates will be 33.7% and 100%, respectively, etc. The utilization curve and probability curve intersect at 85.5% and 7.6 arrivals/10 minutes.

The utilization curve and the probability curve are derived from values obtained by the simulation. The utilization curve represents the average number of occupied listening units at different system's arrival rates relative to the total number of listening units available (23 units).

The probability curve of finding a vacancy is derived from observations related to customers entering the reserve listening room. If no customer will enter the reserve listening room, the provided capacity of 23 turntables will be sufficient by 100%. Overflowing customers to the reserve listening room represent the possibility to find no vacancy in the listening room. The relative share of number of entries into the reserve listening room to the total number of entries that intend to use the listening facility represents a measurement of the probability not to find a vacancy in the listening room.

The utilization rate curve and the curve of the probability of satisfied customers are displayed in dependency of the system's arrivals counted per 10 minutes in a range from 0 to 10 arrivals. This scale represents the actually observed traffic extent of the U.B.C. Recordings Collection. More detailed

data is shown in the table of daily arrival rates observed in the winter term:

S Y S T E M		L I S T E N I N G R O O M	
PERIOD	AVG. ARRIV. RATES/10 MIN.	PERIOD	AVG. ARRIV. RATES/10 MIN.
8:30-10:00	4.4	8:30-10:30	4.0
10:30-12:00	7.0	10:30-11:45	4.4
12:00- 2:00	9.7	11:45-12:30	2.4
2:00- 4:00	5.8	12:30- 1:30	6.0
4:00- 5:00	4.7	1:30- 5:00	2.9
5:00-06:00	1.3	5:00-06:45	1.1
6:00- 8:00	2.9	6:45- 7:30	1.5
day	5.5	day	2.9

Table III: The average arrival rates of the system and of the listening room on an average day in the winter term (see also diagram 2)

The simulation related to the listening room has been performed under the assumption of a constant number of 23 turntables installed in the listening room. From those simulation results, we have formulated two arguments: the probability that the arriving customer will find a vacancy in the listening room versus the utilization rate of the equipment provided. Both functions, as des-

cribed above in more detail, show the characteristics such as:

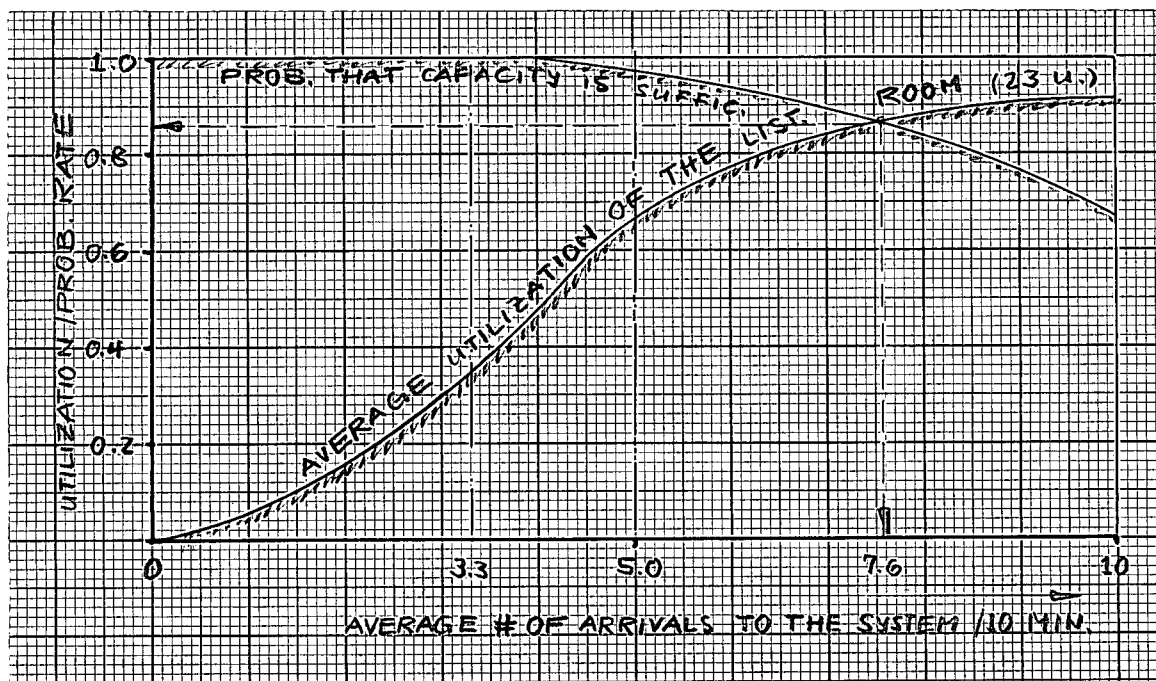
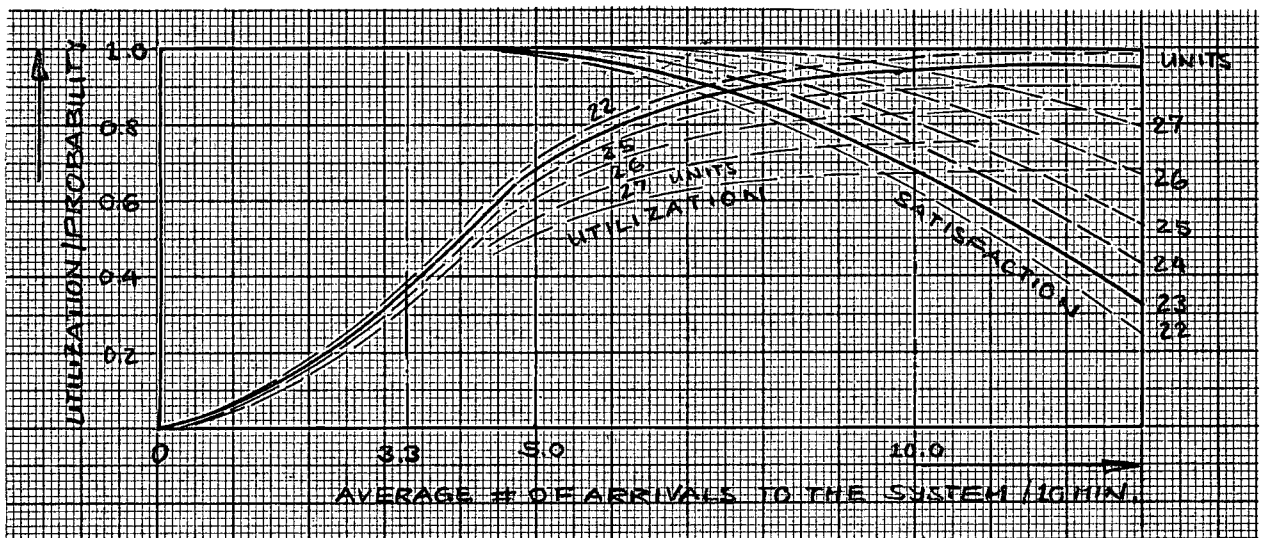


Figure 12: The average utilization rate vs. the probability that every customer will find a vacancy in the listening room

However, in our decision what an adequate number of turntables would be, we may want to obtain more information about the relationship "probability versus utilization" under the conditions of varied numbers of listening units installed. This requirement leads to more simulation in obtaining of reliable data.

Because, we are restricted by the scope of our performed simulation, we want to outline an extended

decision model with anticipated data but on the basis of our results obtained so far. For instance, we may anticipate a simulation map which comprises a number of turntables ranging from 22 to 27 units;



— simulated values,
 ----- anticipated values still to simulate

Figure 13: Anticipated simulation map

In a decision process, such a model might be used in the following ways:

- a) The manager wants to have an average utilization of his equipment of at least 80% on the average. He observes a mean stream of 8 customers per 10 minutes.

In accordance to the assumed decision model, there should be installed no more than 24 turntables. Then, an arriving customer would find a vacancy in the listening room with a probability of approximately 85%.

- b) On the average, there arrive 11 customers during an interval of 10 minutes. A satisfaction of the patrons is required with a probability of at least 90%.

The manager should decide for 27 listening units. However, under this condition, the average utilization rate will be ca. 54% at the most.

Similarly, other arising questions may be answered.

It might be of interest, what combination of a certain number of turntables available related to a given traffic density causes always a utilization rate of, for instance, 80%, or also the same probability rate of 80% of finding a vacancy. From the previously described decision model, the equal-utilization curves and the equal-probability curves can be derived and displayed in a possibly more convenient configuration as shown below:

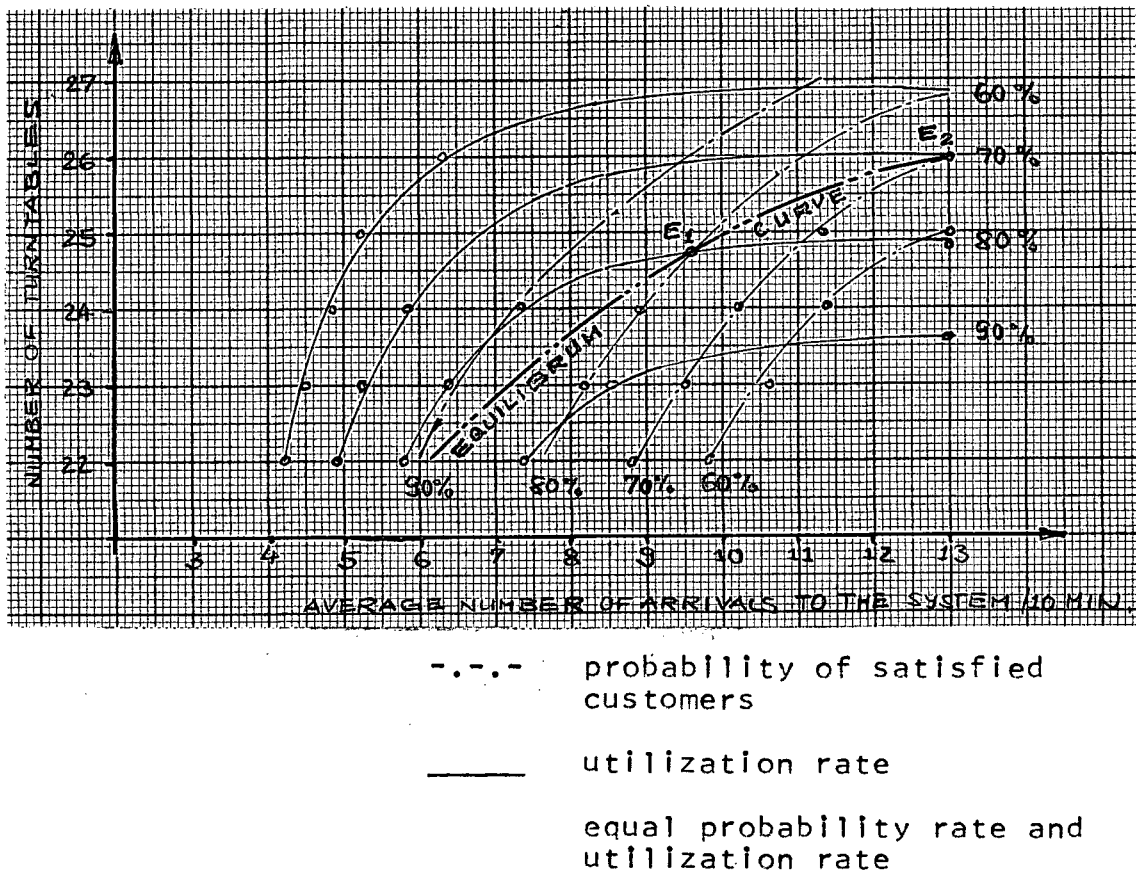


Figure 14: Map of Indifference curves

In the new map of "indifference curves", for instance, the 80%-probability curve and the 80%-utilization curve intersect at the equilibrium E_1 . Corresponding, the 70%-curves intersect at the equilibrium E_2 , etc. The line connecting all those points of equilibrium give the "equilibrium curve". That means, all combinations of both variables (number of turntables, number of arrivals/time interval) which lie along of this curve lead to the same percentage level of the equipment utilization and the probability of customer satisfaction. For instance, a 60% utilization rate corresponds to a 0.6 probability rate.

We may determine the decision field of our model by the coordinates represented by the range of the number of turntables installed in the listening room, and on the other hand, by the range of the average number of system arrivals per 10 minutes. The equilibrium curve divides this decision field in two parts. Decisions which may fall in the upper field emphasize the satisfaction of the customer but lower the utilization of the equipment. The lower decision field favours the equipment utilization at the expense of the customer satisfaction. The equilibrium curve represents the "neutral decisions" without any emphasis of one or the other argument. These relationships are outlined in the graph below:

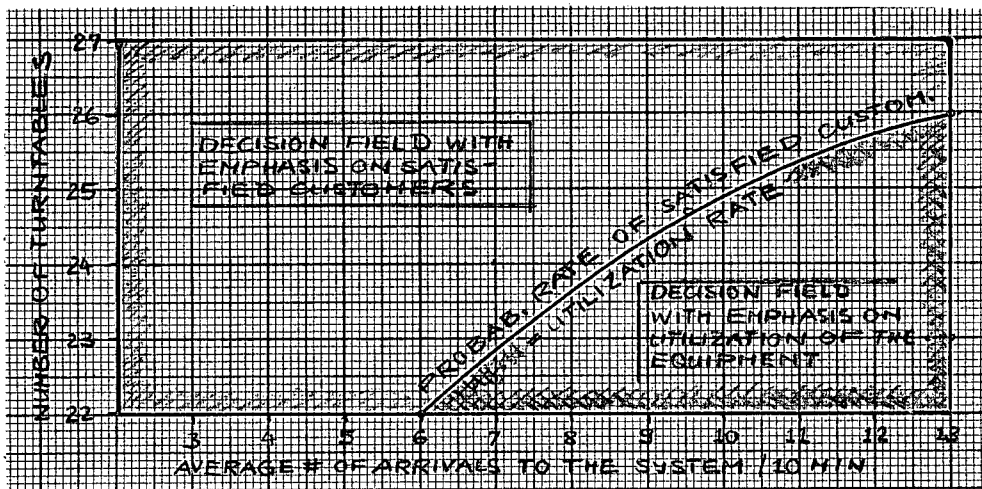


Figure 15: Decision field of the model

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APPENDIX

Table IV: Cumulative number of customers entering or leaving, respectively,
the s y s t e m at certain times during the summer term:

hours min.		9.	10.	11.	12.	1.	2.	3.	4.	5.
.00	(enter.)	0	11	27	40	66	97	114	129	145
	(leav.)	0	8	20	34	56	84	102	119	145
.15	(enter.)	3	18	30	43	77	100	116	136	
	(leav.)	0	12	22	36	65	90	106	123	
.30	(enter.)	6	22	33	50	83	105	121	140	
	(leav.)	2	18	25	42	70	96	109	128	
.45	(enter.)	8	25	36	60	91	106	125	142	
	(leav.)	4	20	30	49	78	97	114	134	
.56	(enter.)								145	

Table V: Cumulative number of customers entering or leaving, respectively,
the l i s t e n i n g r o o m at certain times (summer term):

hours min.		9.	10.	11.	12.	1.	2.	3.	4.	5.
.00	(enter.)	0	5	11	16	24	34	42	47	52
	(leav.)	0	1	6	11	18	27	34	39	52
.15	(enter.)	1	6	12	17	26	35	43	50	
	(leav.)	0	3	6	13	20	30	35	41	
.30	(enter.)	2	8	13	19	29	38	44	51	
	(leav.)	0	5	8	14	22	31	36	42	
.45	(enter.)	3	10	15	22	31	39	45	52	
	(leav.)	0	5	9	16	25	33	38	47	

Table VI: Cumulative number of customers entering or leaving, respectively, the system at certain times (winter term):

[illegible]

Table VII: Cumulative number of customers entering or leaving, respectively,
the l i s t e n i n g r o o m at certain times (winter term):

hours min.		8.	9.	10.	11.	12.	1.	2.	3.	4.	5.	6.	7.	8.
.00	(enter.)	0	5	17	40	67	92	120	140	153	170	176	187	189
	(leav.)	0	0	7	20	48	72	103	125	143	153	170	177	189
.15	(enter.)	0	6	18	43	68	97	123	143	157	173	179	187	
	(leav.)	0	2	9	24	55	79	108	131	147	158	172	181	
.30	(enter.)	0	12	30	56	74	110	127	146	161	174	182	189	
	(leav.)	0	7	15	38	64	90	117	137	149	165	174	182	
.45	(enter.)	3	14	37	63	85	116	136	152	167	176	182	189	
	(leav.)	0	7	17	42	65	94	121	141	151	169	175	182	

Table VIII: Distribution of elapsed time between arrivals to the recordings collection (see diagram 3 and 4)

time interval $t_1 \leq x < t_2$	actual frequency		theoret. frequency	
	prob.(%)	cumulat. prob.(%)	prob.(%)	cumulat. prob.(%)
$0 < x < 1$	35.2	35.2	42.3	42.3
$1 < x < 2$	28.9	64.1	24.4	66.7
$2 \leq x < 3$	15.3	79.4	14.1	80.8
$3 \leq x < 4$	7.2	86.6	8.1	88.9
$4 \leq x < 5$	5.9	92.5	4.7	93.6
$5 \leq x < 6$	1.0	93.5	2.7	96.3
$6 \leq x < 7$	1.3	94.8	1.6	97.9
$7 \leq x < 8$	1.3	96.1	0.9	98.8
$8 \leq x < 9$	0.3	96.4	0.4	99.0
$9 \leq x < 10$	0.8	97.2	.	.
$10 \leq x < 11$	0.5	97.7	$x < 0.2$	.
$11 \leq x < 12$	0.5	98.2	.	.
$12 \leq x < 13$	0.5	98.7		
$13 \leq x < 14$	0.8	99.5		
$14 \leq x < 15$	0.5	100	.	100

$$\lambda_{\text{avg.}} = 0,55 \text{ cust./min.}$$

Table IX: Distribution of service time in the recordings
collection (diagram 5 and 6):

time interval	actual frequency		theoret. frequency of expon. distr.	
$t_1 \leq x < t_2$	prob. %	cumulat. prob. (%)	prob. (%)	cumulat. prob. (%)
0 < x < 1	18.8	18.8	15.4	15.4
1 < x < 2	13.2	32.0	12.7	28.1
2 < x < 3	10.0	42.0	10.9	39.0
3 < x < 4	9.8	51.8	9.3	48.3
4 < x < 5	8.7	60.5	7.9	56.2
5 < x < 6	6.6	67.1	6.7	62.9
6 < x < 7	6.1	73.2	5.6	68.5
7 < x < 8	3.2	76.4	4.8	73.3
8 < x < 9	3.2	79.6	4.1	77.4
9 < x < 10	3.2	82.8	3.4	80.8
10 < x < 11	2.9	85.7	2.9	83.7
11 < x < 12	3.2	88.9	2.5	86.2
12 < x < 13	2.4	91.3	2.1	88.3
13 < x < 14	1.6	92.9	1.7	90.0
14 < x < 15	1.3	94.2	1.6	91.6
15 < x < 16	.8	95.0	1.1	92.7
16 < x < 17	.3	95.3	1.0	93.7
17 < x < 18	.5	95.8	.9	94.6
18 < x < 19	.5	96.3	.7	95.3
19 < x < 20	.5	96.8	.6	95.9
20 < x < 21	.3	97.1	.5	96.4
21 < x < 22	.3	97.4	.	.
22 < x < 23	.3	97.7	.	.
23 < x < 24	.3	98.5	.	.
.	.	.	.	.
31 < x < 32	.2	100	.	100

mean = 2279 cust. min./378 cust. = 6.04 min./cust. = .165 c/min.

Table X: Distribution of elapsed time between arrivals
to the listening room (diagram 7 and 8)

time interval	actual frequency		theor. frequency of expon. distr.	
$t_1 \leq x \leq t_2$	prob. %	cum. prob. (%)	prob. (%)	cumulat. prob. (%)
$0 < x < 1$	26.7	26.7	24.9	24.9
$1 \leq x < 2$	18.7	45.4	18.7	43.6
$2 \leq x < 3$	18.5	53.9	14.0	57.6
$3 \leq x < 4$	10.6	64.5	10.6	68.2
$4 \leq x < 5$	9.7	74.2	7.9	76.1
$5 \leq x < 6$	8.5	82.7	5.9	82.0
$6 \leq x < 7$	4.8	87.5	4.5	86.5
$7 \leq x < 8$	2.7	90.2	3.3	89.8
$8 \leq x < 9$	1.6	91.8	2.6	92.4
$9 \leq x < 10$	1.6	93.4	1.9	94.3
$10 \leq x < 11$	1.0	94.4	1.4	95.7
$11 \leq x < 12$	1.6	96.0	1.1	96.8
$12 \leq x < 13$	.5	96.5	.8	97.6
.	.	.	.	.
$30 \leq x < 31$	.5	100		100

$$\lambda_{\text{avg.}} = 0.286 \text{ cust./min.}$$

Table XI: Distribution of service time concerning the
listening room (diagram 9 and 10)

time interval	actual frequency	
$t_1 \leq x < t_2$	prob. (%)	cumulative probability (%)
0 $\leq x < 5$	2.4	2.4
5 $\leq x < 10$	4.7	7.1
10 $\leq x < 15$	6.0	13.1
15 $\leq x < 20$	7.4	20.5
20 $\leq x < 25$	4.8	28.9
25 $\leq x < 30$	7.7	36.6
30 $\leq x < 35$	7.0	43.6
35 $\leq x < 40$	6.2	49.8
40 $\leq x < 45$	5.8	55.6
45 $\leq x < 50$	6.7	62.3
50 $\leq x < 55$	7.6	69.9
55 $\leq x < 60$	5.5	75.4
60 $\leq x < 65$	3.2	78.6
65 $\leq x < 70$	2.8	81.4
70 $\leq x < 75$	2.2	83.6
75 $\leq x < 80$	1.9	85.5
80 $\leq x < 85$	1.7	87.2
85 $\leq x < 90$	1.6	88.8
90 $\leq x < 95$	1.5	90.3
95 $\leq x < 100$	1.4	91.7
100 $\leq x < 105$	1.0	92.7
105 $\leq x < 110$	.9	93.6
110 $\leq x < 115$	.8	94.4
115 $\leq x < 120$	.7	95.1
120 $\leq x < 125$	.6	95.7
125 $\leq x < 130$	.5	96.2
130 $\leq x < 135$	.4	96.6
135 $\leq x < 140$	.4	97.0
140 $\leq x < 145$	.4	97.4
145 $\leq x < 150$	.3	97.7
150 $\leq x < 155$	.3	98.0
155 $\leq x < 160$	.3	98.3
160 $\leq x < 165$	.3	98.6
165 $\leq x < 170$	.3	98.9
170 $\leq x < 175$	.3	99.2
175 $\leq x < 180$	.2	99.4
180 $\leq x < 185$	.2	99.6
185 $\leq x < 190$	.2	99.8
190 $\leq x < 195$	.2	100.0

①

```
***** THIS JOB SUBMITTED THROUGH FRONT DESK READER *****
$SIGNON WULI T=150 P=400 PRIQ=V COPIES=4
**LAST SIGNON WAS: 00:12:49 12-30-70
USER "WULI" SIGNED ON AT 00:28:20 ON 12-30-70
$RUN *GPSS PAR=SIZE=B
EXECUTION BEGINS
```

BLOCK NUMBER	*LOC	OPERATION A,B,C,D,E,F,G	COMMENTS	CARD NUMBER
		SIMULATE		1
*		SIMULATION OF UBC RECORDINGS COLLECTION BY JOHANNES KRAMAR		2
*				3
*		FUNCTION DEFINITIONS		4
*				5
*		SYSTEM ARRIVAL TIME EXPONENTIALLY DISTRIBUTED		6
		ARRIV FUNCTION RN1,C16	NEG. EXP. DISTR., MEAN=3MIN.	7
		0.0,0.0/.182,.1/.283,.267/.486,.5/.632,.83/.735,1.17/.81,1.5/.865,1.83		8
		.903,2.16/.930,2.5/.95,2.84/.964,3.16/.975,3.5/.982,3.84/.987,4.15		9
		.99,4.5		10
*				11
				12
*		DESK SERVICE TIME EXPONENTIALLY DISTRIBUTED		13
		DESK FUNCTION RN1,C24	NEG. EXP. DISTR.	14
		0.0,0.0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69/.5,.915/.7,1.2/		15
		.75,1.38/.8,1.6/.84,1.83/.88,2.12/.9,2.3/.92,2.52/.94,2.81/.95,2.99		16
		.96,3.2/.97,3.5/.98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7.0/.9997,8.0		17
*				18
*		SHELF SERVICE TIME EXPONENTIALLY DISTRIBUTED		19
		SHELF FUNCTION RN1,C23	NEG. EXP. DISTR.	20
		0.0,0.0/.154,.840/.281,.250/.390,.420/.483,.580/.562,.750/.629,.92/		21
		.685,1.08/.733,1.25/.774,1.42/.808,1.59/.837,1.75/.862,1.92		22
		.883,2.08/.9,2.25/		23
		.915,2.42/.927,2.58/.937,2.75/.946,2.92/.953,3.08/.959,3.25		24
		.964,3.42/1.0,5.27		25
*				26
*		LISTENING ROOM SERVICE TIME GENERALLY DISTRIBUTED		27
		LIST FUNCTION RN1,C25	GEN. DISTRIBUTION	28
		0.0,0.0/.024,.063/.071,.187/.131,.312/.205,.437/.289,.563/.366,.690/		29
		.436,.820/.498,.940/.556,1.06/.623,1.18/.699,1.31/.754,1.44/.786,1.55/		30
		.814,1.69/.835,1.81/.855,1.94/.872,2.06/.888,2.18/.903,2.31/.917,2.44/		31
		.927,2.55/.962,3.19/.989,4.20/1.00,4.820		32
*				33
*		STORAGE DEFINITIONS		34
10		STORAGE 200	DEFINE SIZE OF SYSTEM'S STORAGE	35
11		STORAGE 150	DEFINE SIZE OF REC. COLL.	36
30		STORAGE 100	DEFINE SIZE OF STOR. 30	37
40		STORAGE 23	DEFINE SIZE OF STOR. 40	38
41		STORAGE 23	DEFINE SIZE OF STOR. 41	39
*		TABLE DEFINITIONS		40
TAB1	TABLE	IA,1,1,20	INTERARRIVAL TIME	41
TAB2	TABLE	RT,0,1,30,10	ARRIVAL RATE	42
TAB3	TABLE	M1,1,1,30	TRANSIT TIME TABLE	43
TAB4	QTABLE	2,0,1,30	UNITS IN QUE.	44
TAB5	TABLE	IA,1,1,30	INTERARRIVAL TIME SHELVES	45
TAB6	TABLE	RT,0,1,20,10	ARRIVAL RATE	46
TAB7	TABLE	M1,1,1,60	TRANSIT TIME	47
TAB8	TABLE	S30,0,1,40	STOR. 30 OCCUPANCY	48
TAB9	TABLE	M1,1,1,60	TRANS. TIME SERVI	49
TAB10	TABLE	S11,0,1,60	STORAGE 11 OCCUPANCY	50
TAB11	TABLE	IA,1,1,30	INTERARR. TIME FAC. 40	51
TAB12	TABLE	RT,0,1,15,10	IARRIVALS FAC. 40	52
TAB13	TABLE	M1,0,5,60	TRANS. TIME FAC. 40	53
TAB14	TABLE	S40,0,1,26	STORE 40 OCCUPANCY	54
TAB15	TABLE	M1,0,5,60	TRANS. TIME IN SYSTEM	55
TAB16	TABLE	S10,0,2,60	SYST. OCCUPANCY	56

8	DESK	SEIZE	2	OCC. DESK	68
9		DEPART	2	LEAVE QUE. 2	69
10		ADVANCE	1, FN\$DESK	DESK SERVICE	70
11		RELEASE	2	RELEASE DESK	71
12		UNLINK	2, DESK, 1	UNLINK USER CHAIN 2	72
13		TABULATE	TAB1	TAB. INTERARR. TIME	73
14		TABULATE	TAB2	TAB. ARRIVALS	74
15		TABULATE	TAB3	TAB. TRANS. TIME	75
16		LEAVE	11		76
17		TABULATE	TAB9		77
18		TABULATE	TAB10		78
19		ASSIGN	2, K1	SET PI TO 1	79
20		TEST LE	C1, K3600, FINE	TEST TIME	80
21		TEST E	P3, K1, GEH2		81
22		TEST E	P4, K1, GEH3		82
23		TRANSFER	, EXIT		83
24	GEH2	TEST E	P4, K1, GEH4		84
25		TRANSFER	.75, STG3, EXIT		85
26	GEH3	TRANSFER	.96, STG4, EXIT		86
27	GEH4	TRANSFER	.73, GEH5, EXIT		87
28	GEH5	TRANSFER	.11, STG3, STG4		88
29	STG3	MARK			89
30		ENTER	11	CUM. STORE RC.	90
31		ENTER	30	ENTER STOR. 30	91
32		ADVANCE	6, FN\$SHELF	SHELF SERVICE TIME	92
33		LEAVE	30	LEAVE STOR. 30	93
34		TABULATE	TAB5	INTERARRIVAL TIME	94
35		TABULATE	TAB6	ARRIVAL RATE	95
36		TABULATE	TAB7	TRANSIT TIME	96
37		TABULATE	TAB8	STORE. SHELVES OCCUPANCY	97
38		LEAVE	11	LEAVE STORE 11	98
39		TABULATE	TAB9		99
40		TABULATE	TAB10	STORE RECORD. COLLECT.	100
41		ASSIGN	3, K1	SET P2 TO 1	101
42		TEST LE	C1, K3600, FINE	TEST TIME	102
43		TEST E	P2, K1, GEH7		103
44		TEST E	P4, K1, GEH8		104
45		TRANSFER	, EXIT		105
46	GEH7	TEST E	P4, K1, GEH9		106
47		TRANSFER	.28, STG2, EXIT		107
48	GEH8	TRANSFER	.22, STG4, EXIT		108
49	GEH9	TRANSFER	.14, GEH10, EXIT		109
50	GEH10	TRANSFER	.58, STG2, STG4		110
51	STG4	MARK			111
52		GATE SNF	40, OFLOW		112
53		ENTER	40	ENTER STOR. 40	113
54		ADVANCE	40, FN\$LIST	LIST. ROOM SERVICE TIME	114
55		LEAVE	40	LEAVE STORAGE 40	115
56		TABULATE	TAB11	INTER ARRIVAL TIME FAC. 4	116
57		TABULATE	TAB12	ARRIVAL RATE FAC. 4	117
58		TABULATE	TAB13	TRANSIT TIME FAC. 4	118
59		TABULATE	TAB14	STORE. 40 OCCUPANCY	119
60		TRANSFER	, BEIDE		120
61	OFLOW	ENTER	41		121

62	ADVANCE	40,FN\$LIST	LIST. ROOM SERVICE TIME	122
63	LEAVE	41		123
64	TABULATE	TAB17	OCCUP. OF RESERV. LIST. ROOM	124
65	TRANSFER	,BEIDE		125
66	BEIDE ASSIGN	4,K1	SET P4 TO 1	126
67	TEST E	P3,K1,GEH11		127
68	TRANSFER	.09,STG2,EXIT		128
69	GEH11 TEST LE	C1,K3600,FINE	TEST TIME	129
70	TEST E	P2,K1,GEH13		130
71	TRANSFER	.38,STG3,EXIT		131
72	GEH13 TRANSFER	.08,GEH14,EXIT		132
73	GEH14 TRANSFER	.14,STG2,STG3		133
74	EXIT LEAVE	10	LEAVE SYST. STOR.	134
75	TABULATE	TAB15	TRANS. TIME IN SYSTEM	135
76	TABULATE	TAB16	SYSTEM OCCUPANCY	136
77	TERMINATE			137
78	FINE LEAVE	10	LEAVE SYST. STOR.	138
79	TABULATE	TAB15	TRANS. TIME IN SYSTEM	139
80	TABULATE	TAB16	SYSTEM OCCUPANCY	140
81	TERMINATE	1		141
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	START	1		143
	*			144
	REPORT			145
	EJECT			146
FAC	TITLE	2,STATISTICS CONCERNING THE INFORMATION DESK		147
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QUE	TITLE	2, STATISTICS CONCERNING THE DESK QUEUE		149
	SPACE	3		150
CHA	TITLE	2, STATISTICS CONCERNING THE DESK USER CHAIN		151
	EJECT			152
TAB	TITLE	1,DESK INTERARRIVAL TIMES (MIN.):		153
	EJECT			154
	*			155
	* GRAPH			156
	GRAPH	TP,TAB1		157
	ORIGIN	50,10		158
	X	,2,13,1,1,8		159
	Y	0,4,20,2		160
7	STATEMENT	4,1,%		161
100	STATEMENT	52,24,INTERARRIVAL TIME (MIN.)		162
10	STATEMENT	55,46,FIGURE 1: REL. FREQUENCY OF INTERARRIVAL TIMES		163
	ENDGRAPH			164
	*			165
TAB	TITLE	2,NUMBER OF ARRIVALS TO DESK/10 MIN.		166
	EJECT			167
	*			168
	* GRAPH			169
	GRAPH	TP,TAB2		170
	ORIGIN	50,10		171
	X	,2,2,0,1,30		172
	Y	0,1,21,2		173
7	STATEMENT	4,1,%		174
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.		175

10 STATEMENT 55,64,FIGURE 2: REL. FREQUENCY OF ARRIVALS TO INF. DE1
SK DURING 10 MIN.
ENDGRAPH

176

177

178

* 179

TAB TITLE 3,DESK TRANSIT TIMES (MIN.) (=WAIT. & SERVICE TIME)
EJECT

180

181

* 182

* GRAPH 183

GRAPH TP,TAB3 184

ORIGIN 50,10 185

X ,14,1,1,8 186

Y 0,3,20,2 187

7 STATEMENT 4,1,% 188

100 STATEMENT 52,19,TRANSIT TIME (MIN.) 189

10 STATEMENT 55,60,FIGURE 3: REL. FREQUENCY OF TRANST TIMES AT INF1 190

ORMATION DESK 191

ENDGRAPH 192

* 193

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EJECT 195

* 196

* GRAPH 197

GRAPH TP,TAB4 198

ORIGIN 50,10 199

X ,2,13,0,1,8 200

Y 0,3,20,2 201

7 STATEMENT 4,1,% 202

100 STATEMENT 52,13,JOBS IN QUEUE 203

10 STATEMENT 55,72,FIGURE 4: REL. FREQUENCY OF JOBS WAITING FOR SER 204

RVICE AT INFORMATION DESK 205

ENDGRAPH 206

* 207

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EJECT 211

* 212

* GRAPH 213

GRAPH TP,TAB5 214

ORIGIN 50,10 215

X ,2,18,1,1,6 216

Y 0,4,20,2 217

7 STATEMENT 4,1,% 218

100 STATEMENT 52,24,INTERARRIVAL TIME (MIN.) 219

10 STATEMENT 55,46,FIGURE 5: REL. FREQUENCY OF INTERARRIVAL TIMES 220

ENDGRAPH 221

* 222

TAB TITLE 6,NUMBER OF ARRIVALS TO SHELVES/10 MIN. 223

EJECT 224

* GRAPH 225

GRAPH TP,TAB6 226

ORIGIN 50,10 227

X ,2,4,0,1,20 228

Y 0,1,20,2 229

7	STATEMENT	4,1,%	230
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.	231
10	STATEMENT	55,62,FIGURE 6: REL. FREQUENCY OF ARRIVALS TO SHELVES1	232
	DURING 10 MIN.		233
	ENDGRAPH		234
*			235
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	EJECT		237
*			238
* GRAPH			239
	GRAPH	TP,TAB7	240
	ORIGIN	50,10	241
	X	,,5,1,1,15	242
	Y	0,1,24,2	243
7	STATEMENT	4,1,%	244
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	245
10	STATEMENT	55,52,FIGURE 7: REL. FREQUENCY OF TRANSIT TIMES AT SH1	246
ELVES			247
	ENDGRAPH		248
*			249
TAB	TITLE	8,OCCUPANCY OF SHELVES	250
	EJECT		251
*			252
* GRAPH			253
	GRAPH	TP,TAB8	254
	ORIGIN	50,10	255
	X	,2,6,0,1,15	256
	Y	0,1,24,2	257
7	STATEMENT	4,1,%	258
100	STATEMENT	52,9,OCCUPANCY	259
10	STATEMENT	55,79,FIGURE 8: REL. FREQUENCY OF NUMBER OF JOBS OCCU1	260
PYING	SIMULTANEOUSLY THE SHELVES		261
	ENDGRAPH		262
*			263
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RAGE			265
	SPACE	3	266
TAB	TITLE	9,TRANSIT TIMES THROUGH REC. COLL. (MIN.) , (=DESK & 1	267
SHELVES)			268
	EJECT		269
*			270
* GRAPH			271
	GRAPH	TP,TAB9	272
	ORIGIN	50,10	273
	X	,,7,1,1,15	274
	Y	0,1,45,1	275
7	STATEMENT	4,1,%	276
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	277
10	STATEMENT	55,75,FIGURE 9: REL. FREQUENCY OF TRANSIT TIMES THROU1	278
GH	THE RECORDINGS COLLECTION		279
	ENDGRAPH		280
*			281
TAB	TITLE	10,OCCUPANCY OF RECORD. COLLECT. (=DESK & SHELVES)	282
	EJECT		283

*			284
* GRAPH			285
	GRAPH	TP,TAB10	286
	ORIGIN	50,10	287
	X	,2,4,0,1,20	288
	Y	0,1,15,3	289
7	STATEMENT	4,1,%	290
100	STATEMENT	52,9,OCCUPANCY	291
10	STATEMENT	55,85,FIGURE 10: REL. FREQUENCY OF NUMBER OF JOBS OCC1	292
UPYING	SIMULTANEOUSLY DESK AND SHELVES		293
	ENDGRAPH		294
*			295
STD	TITLE	40,THE LISTENING ROOM AS STORAGE	296
	SPACE	3	297
TAB	TITLE	11,LISTENING ROOM INTERARRIVAL TIMES (MIN.)	298
	EJECT		299
*			300
* GRAPH			301
	GRAPH	TP,TAB11	302
	ORIGIN	50,10	303
	X	,,7,1,1,15	304
	Y	0,4,15,3	305
7	STATEMENT	4,1,%	306
100	STATEMENT	52,25,INTERARRIVAL TIME (MIN.)	307
10	STATEMENT	55,64,FIGURE 11: REL. FREQUENCY OF INTERARRIVAL TIMES1	308
TO LISTENING ROOM			309
	ENDGRAPH		310
*			311
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	EJECT		313
*			314
* GRAPH			315
	GRAPH	TP,TAB12	316
	ORIGIN	50,10	317
	X	,2,6,0,1,15	318
	Y	0,1,24,2	319
7	STATEMENT	4,1,%	320
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.	321
10	STATEMENT	55,70,FIGURE 12: REL. FREQUENCY OF ARRIVALS TO LISTEN1	322
ING ROOM DURING 10 MIN.			323
	ENDGRAPH		324
*			325
TAB	TITLE	13,LIST. ROOM SERVICE TIMES (MIN.)	326
	EJECT		327
*			328
* GRAPH			329
	GRAPH	TP,TAB13	330
	ORIGIN	50,10	331
	X	,,3,5,1,30	332
	Y	0,1,21,2	333
7	STATEMENT	4,1,%	334
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	335
10	STATEMENT	55,58,FIGURE 13: REL. FREQUENCY OF TRANSIT TIME OF LI1	336
STENING ROOM			337

	ENDGRAPH		338
*			339
TAB	TITLE	14, OCCUPANCY OF LIST. ROOM	340
	EJECT		341
*			342
* GRAPH			343
	GRAPH	TP, TAB14	344
	ORIGIN	50,10	345
	X	,2,4,6,1,18	346
	Y	0,1,16,3	347
7	STATEMENT	4,1,%	348
100	STATEMENT	52,9, OCCUPANCY	349
10	STATEMENT	55,87, FIGURE 14: REL. FREQUENCY OF NUMBER OF JOBS OCC1	350
UPYING	SIMULTANEOUSLY THE LISTENING ROOM		351
	ENDGRAPH		352
*			353
STO	TITLE	41, THE RESERV. LISTENING ROOM AS STORAGE	354
	SPACE	3	355
TAB	TITLE	17, OCCUPANCY OF RESERVE LIST. ROOM	356
	EJECT		357
*			358
* GRAPH			359
	GRAPH	TP, TAB17	360
	ORIGIN	50,10	361
	X	,2,6,0,1,15	362
	Y	0,1,35,1	363
7	STATEMENT	4,1,%	364
100	STATEMENT	52,9, OCCUPANCY	365
10	STATEMENT	55,96, FIGURE 14A: REL. FREQUENCY OF NUMBER OF JOBS OC1	366
COPYING	SIMULTANEOUSLY THE LISTENING ROOM		367
	ENDGRAPH		368
*			369
STO	TITLE	10, THE SYSTEM AS STORAGE	370
	SPACE	3	371
TAB	TITLE	15, SYSTEM TRANSIT TIMES (MIN.) (=SERVICE & WAIT. TIME1	372
)			373
	EJECT		374
*			375
* GRAPH			376
	GRAPH	TP, TAB15	377
	ORIGIN	50,10	378
	X	,,3,5,1,30	379
	Y	0,5,20,2	380
7	STATEMENT	4,1,%	381
100	STATEMENT	52,19, TRANSIT TIME (MIN.)	382
10	STATEMENT	55,49, FIGURE 15: REL. FREQUENCY OF SYSTEM TRANSIT TIME1	383
ES			384
	ENDGRAPH		385
*			386
TAB	TITLE	16, OCCUPANCY OF SYSTEM (=DESK, SHELVES, LIST. ROOM)	387
	EJECT		388
*			389
* GRAPH			390
	GRAPH	TP, TAB16	391

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	ORIGIN	50,10	392
	X	,2,4,2,2,20	393
	Y	0,2,20,2	394
7	STATEMENT	4,1,%	395
100	STATEMENT	52,9,OCCUPANCY	396
10	STATEMENT	55,79,FIGURE 16: REL. FREQUENCY OF NUMBER OF JOBS DCC1	397
UPYING	SIMULTANEOUSLY THE SYSTEM		398
	ENDGRAPH		399
*			400
	END		401

BLOCK NUMBER	SYMBOL	REFERENCES BY CARD NUMBER						
--------------	--------	---------------------------	--	--	--	--	--	--

66	BEIDE	120	125					
8	DESK	67	72					
74	EXIT	83	85	86	87	105	107	108
		109	128	131	132			
78	FINE	80	102	129				
50	GEH10	109						
69	GEH11	127						
72	GEH13	130						
73	GEH14	132						
24	GEH2	81						
26	GEH3	82						
27	GEH4	84						
28	GEH5	87						
46	GEH7	103						
48	GEH8	104						
49	GEH9	106						
61	DFLOW	112						
4	STG2	63	107	110	128	133		
29	STG3	63	85	88	131	133		
51	STG4	86	88	108	110			

TABLE SYMBOLS AND CORRESPONDING NUMBERS

1	TAB1
10	TAB10
11	TAB11
12	TAB12
13	TAB13
14	TAB14
15	TAB15
16	TAB16
17	TAB17
2	TAB2
3	TAB3
4	TAB4
5	TAB5
6	TAB6
7	TAB7
8	TAB8
9	TAB9

FUNCTION SYMBOLS AND CORRESPONDING NUMBERS

1	ARRIV
2	DESK
4	LIST
3	SHELF

*
* FUNCTION DEFINITIONS
*

* SYSTEM ARRIVAL TIME EXPONENTIALLY DISTRIBUTED

1	FUNCTION	RN1	C16		
0.0	0.0	.182	.1	.283	.267
.486	.5	.632	.83	.736	1.17
.81	1.5	.865	1.83	.903	2.16
.930	2.5	.95	2.84	.964	3.15
.975	3.5	.982	3.84	.987	4.15
.99	4.5				

*
* DESK SERVICE TIME EXPONENTIALLY DISTRIBUTED

2	FUNCTION	RN1	C24		
0.0	0.0	.1	.104	.2	.222
.3	.355	.4	.509	.5	.69
.6	.915	.7	1.2	.75	1.38
.8	1.6	.84	1.83	.88	2.12
.9	2.3	.92	2.52	.94	2.81
.95	2.99	.96	3.2	.97	3.5
.98	3.9	.99	4.6	.995	5.3
.998	6.2	.999	7.0	.9997	8.0

*
* SHELF SERVICE TIME EXPONENTIALLY DISTRIBUTED

3	FUNCTION	RN1	C23		
0.0	0.0	.154	.840	.281	.250
.390	.420	.483	.580	.562	.750
.629	.92	.685	1.08	.733	1.25
.774	1.42	.808	1.59	.837	1.75
.862	1.92	.883	2.08	.9	2.25
.916	2.42	.927	2.58	.937	2.75
.946	2.92	.953	3.08	.959	3.25
.964	3.42	1.0	5.27		

*
* LISTENING ROOM SERVICE TIME GENERALLY DISTRIBUTED

4	FUNCTION	RN1	C25		
0.0	0.0	.024	.063	.071	.187
.131	.312	.205	.437	.289	.563
.366	.690	.436	.820	.498	.940
.556	1.05	.623	1.18	.699	1.31
.754	1.44	.786	1.56	.814	1.69
.836	1.81	.855	1.94	.872	2.06
.888	2.18	.903	2.31	.917	2.44
.927	2.55	.962	3.19	.989	4.20
1.00	4.820				

*
* STORAGE DEFINITIONS

10	STORAGE	200
11	STORAGE	150
30	STORAGE	100
40	STORAGE	23
41	STORAGE	23

* TABLE DEFINITIONS

1	TABLE	IA	1	1	20
2	TABLE	RT	0	1	30 10
3	TABLE	M1	1	1	30
4	QTABLE	2	0	1	30
5	TABLE	IA	1	1	30

6	TABLE	RT	0	1	20	10
7	TABLE	M1	1	1	60	
8	TABLE	S30	0	1	40	
9	TABLE	M1	1	1	60	
10	TABLE	S11	0	1	60	
11	TABLE	IA	1	1	30	
12	TABLE	RT	0	1	15	10
13	TABLE	M1	0	5	60	
14	TABLE	S40	0	1	26	
15	TABLE	M1	0	5	60	
16	TABLE	S10	0	2	60	
17	TABLE	S41	0	1	26	

*
* GPSS PROGRAM
*

1	GENERATE	3	FN1		
2	ENTER	10			
3	TRANSFER	.360	29	4	

4	MARK				
5	ENTER	11			
6	QUEUE	2			
7	LINK	2	FIFO	8	
8	SEIZE	2			
9	DEPART	2			

10	ADVANCE	1	FN2		
11	RELEASE	2			
12	UNLINK	2	8	1	
13	TABULATE	1			
14	TABULATE	2			
15	TABULATE	3			

16	LEAVE	11			
17	TABULATE	9			
18	TABULATE	10			
19	ASSIGN	2	K1		
20	TEST LE	C1	K3600	78	
21	TEST E	P3	K1	24	
22	TEST E	P4	K1	26	
23	TRANSFER		74		
24	TEST E	P4	K1	27	
25	TRANSFER	.750	29	74	
26	TRANSFER	.960	51	74	
27	TRANSFER	.730	28	74	

28	TRANSFER	.110	29	51	
29	MARK				
30	ENTER	11			
31	ENTER	30			
32	ADVANCE	6	FN3		
33	LEAVE	30			

34	TABULATE	5			
35	TABULATE	6			
36	TABULATE	7			
37	TABULATE	8			
38	LEAVE	11			
39	TABULATE	9			

40	TABULATE	10			
41	ASSIGN	3	K1		
42	TEST LE	C1	K3600	78	
43	TEST E	P2	K1	46	
44	TEST E	P4	K1	48	
45	TRANSFER		74		

46	TEST E	P4	K1	49
47	TRANSFER	.280	4	74
48	TRANSFER	.220	51	74
49	TRANSFER	.140	50	74
50	TRANSFER	.580	4	51
51	MARK			

52	GATE SNF	40	51
53	ENTER	40	
54	ADVANCE	40	EN4

55	LEAVE	40
56	TABULATE	11
57	TABULATE	12

58	TABULATE	13
59	TABULATE	14

60 TRANSFER 66

61	ENTER	41	
62	ADVANCE	40	FN4
63	LEAVE	41	

64 TABULATE 17

65 TRANSFER 66

66 ASSIGN 4 K1

67 TEST E P3 K1 69

68	TRANSFER	.090	4	74
----	----------	------	---	----

69 TEST LE C1 K3600 78

70 TEST E P2 K1 72

71	TRANSFER	.380	29	74
----	----------	------	----	----

72 TRANSFER .080 73 74

73	TRANSFER	.140	4	29
----	----------	------	---	----

74	LEAVE	10
----	-------	----

75 TABULATE 15

76 TABULATE 16

77 TERMINATE

78 LEAVE 10

79 TABULATE 15

80 TABULATE 16

81 TERMINATE 1

* CONTROL CARD
START 1

STATISTICS CONCERNING THE INFORMATION DESK

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
2	.239	1531	.564		

STATISTICS CONCERNING THE DESK QUEUE

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
2	7	.154	1532	1245	81.2	.362	1.937	4	1
AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES									

STATISTICS CONCERNING THE DESK USER CHAIN

USER CHAIN	TOTAL ENTRIES	AVERAGE TIME/TRANS	CURRENT CONTENTS	AVERAGE CONTENTS	MAXIMUM CONTENTS
2	447	1.243		.154	7

DESK INTERARRIVAL TIMES (MIN.)

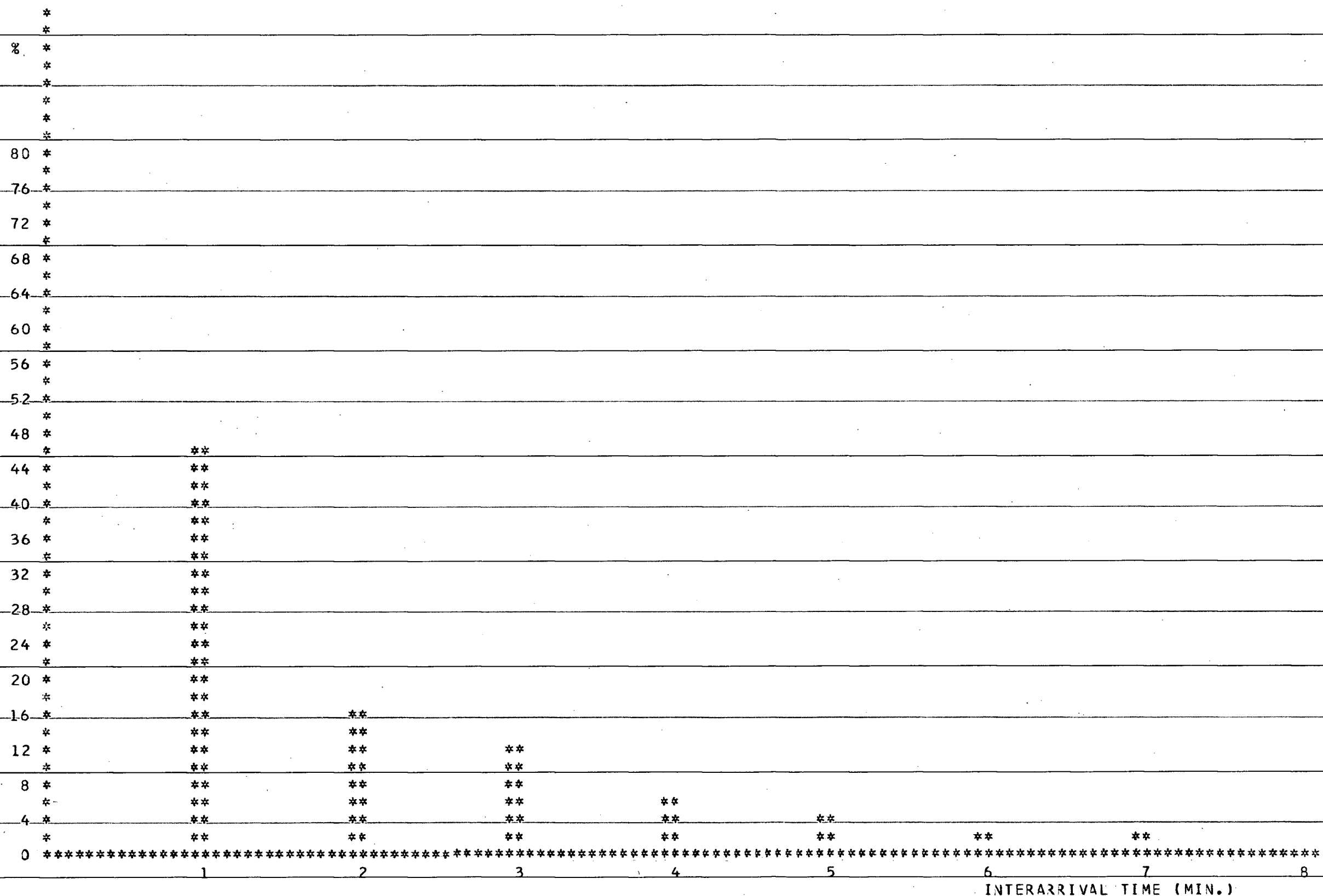
TABLE TAB1
ENTRIES IN TABLE
1530MEAN ARGUMENT
2.350STANDARD DEVIATION
2.574SUM OF ARGUMENTS
3597.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	720	47.05	47.0	52.9	.425	-.524
2	255	16.66	63.7	36.2	.850	-.136
3	209	13.66	77.3	22.6	1.276	.252
4	108	7.05	84.4	15.5	1.701	.640
5	77	5.03	89.4	10.5	2.126	1.029
6	42	2.74	92.2	7.7	2.552	1.417
7	41	2.67	94.9	5.0	2.977	1.805
8	27	1.76	96.6	3.3	3.402	2.194
9	19	1.24	97.9	2.0	3.828	2.582
10	13	.84	98.7	1.2	4.253	2.971
11	3	.19	98.9	1.0	4.678	3.359
12	4	.26	99.2	.7	5.104	3.748
13	4	.26	99.4	.5	5.529	4.136
14	3	.19	99.6	.3	5.954	4.525
15	2	.13	99.8	.1	6.380	4.913
16	0	.00	99.8	.1	6.805	5.302
17	0	.00	99.8	.1	7.231	5.690
18	3	.19	100.0	.0	7.656	6.079

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



INTERARRIVAL TIME (MIN.)

FIGURE 1: REL. FREQUENCY OF INTERARRIVAL TIMES

NUMBER OF ARRIVALS TO DESK/10 MIN.

TABLE TAB2
ENTRIES IN TABLE

MEAN ARGUMENT 4.250
STANDARD DEVIATION 2.257
SUM OF ARGUMENTS 1530.000
NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	10	2.77	2.7	97.2	-.000	-1.882
1	24	6.66	9.4	90.5	.235	-1.439
2	49	13.61	23.0	76.9	.470	-.996
3	63	17.49	40.5	59.4	.705	-.553
4	61	16.94	57.4	42.5	.941	-.110
5	52	14.44	71.9	28.0	1.176	.332
6	45	12.50	84.4	15.5	1.411	.775
7	34	9.44	93.8	6.1	1.647	1.217
8	7	1.94	95.8	4.1	1.882	1.660
9	7	1.94	97.7	2.2	2.117	2.103
10	3	.83	98.6	1.3	2.352	2.546
11	2	.55	99.1	.8	2.588	2.989
12	3	.83	100.0	.0	2.823	3.432

REMAINING FREQUENCIES ARE ALL ZERO

%

21

20

19

18

17

16

15

14

13

12

11

10

9

8

7

6

5

4

3

2

1

0

ARRIVAL RATE/10 MIN.

FIGURE 2: REL. FREQUENCY OF ARRIVALS TO INF. DESK DURING 10 MIN.

DESK TRANSIT TIMES (MIN.) (=WAIT. & SERVICE TIME)

TABLE TAB3		MEAN ARGUMENT		STANDARD DEVIATION		SUM OF ARGUMENTS	
ENTRIES IN TABLE						NON-WEIGHTED	
1531		.926		1.265		1419.000	
UPPER	OBSERVED	PER CENT	CUMULATIVE	CUMULATIVE	MULTIPLE	DEVIATION	
LIMIT	FREQUENCY	OF TOTAL	PERCENTAGE	REMAINDER	OF MEAN	FROM MEAN	
1	1160	75.76	75.7	24.2	1.078	.057	
2	207	13.52	89.2	10.7	2.157	.847	
3	94	6.13	95.4	4.5	3.236	1.638	
4	38	2.48	97.9	2.0	4.315	2.428	
5	17	1.11	99.0	.9	5.394	3.218	
6	8	.52	99.5	.4	6.473	4.008	
7	4	.25	99.8	.1	7.552	4.798	
8	3	.19	100.0	.0	8.631	5.588	

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

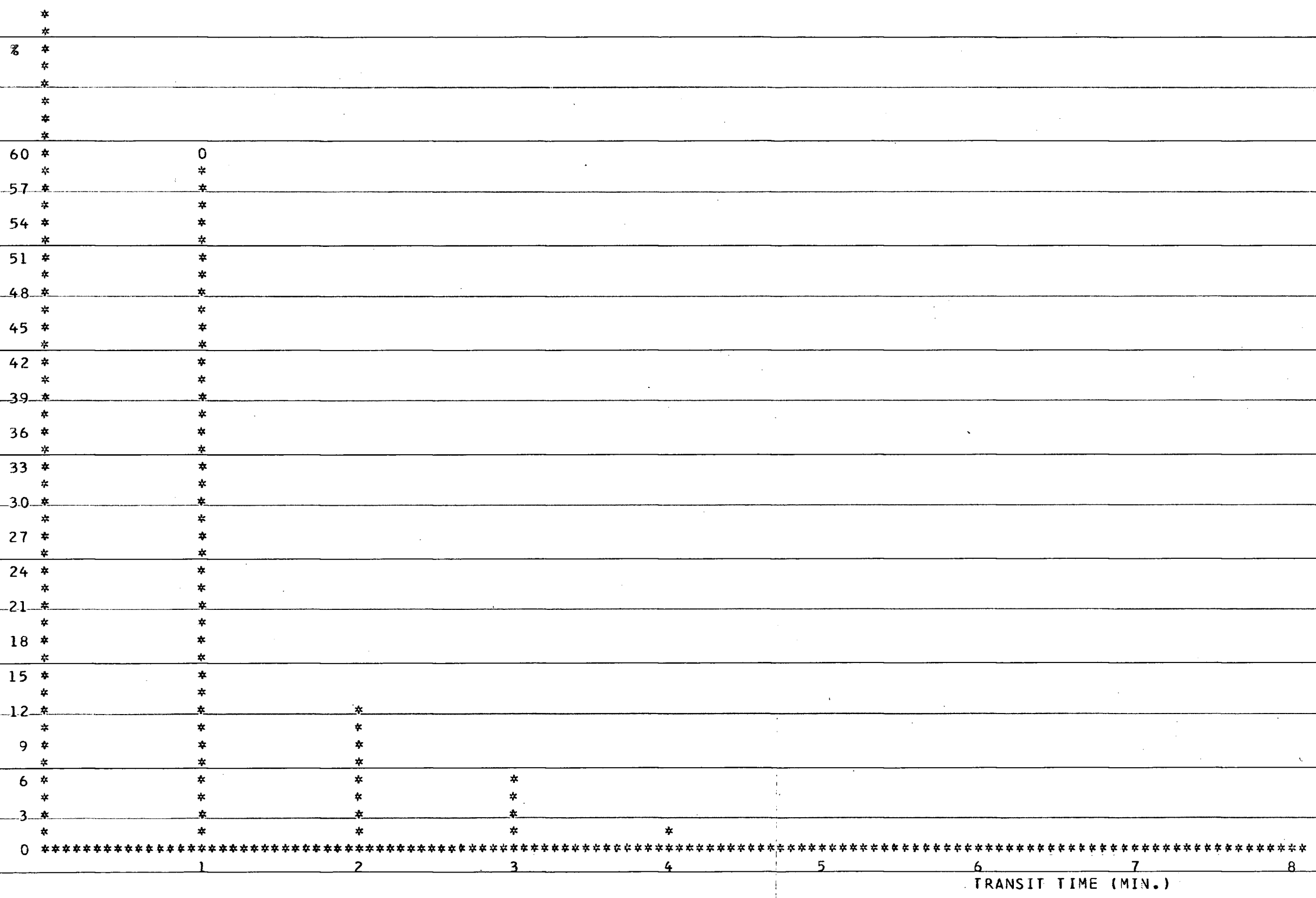


FIGURE 3: REL. FREQUENCY OF TRANST TIMES AT INFORMATION DESK

NUMBER OF JOBS WAITING FOR SERVICE AT DESK

TABLE TAB4

ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

NON-WEIGHTED

1531

.362

.932

555.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	1245	81.31	81.3	18.6	-.000	-.388
1	142	9.27	90.5	9.4	2.758	.683
2	78	5.09	95.6	4.3	5.517	1.755
3	34	2.22	97.9	2.0	8.275	2.827
4	13	.84	98.7	1.2	11.034	3.899
5	12	.78	99.5	.4	13.792	4.971
6	6	.39	99.9	.0	16.551	6.043
7	1	.06	100.0	.0	19.309	7.115

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

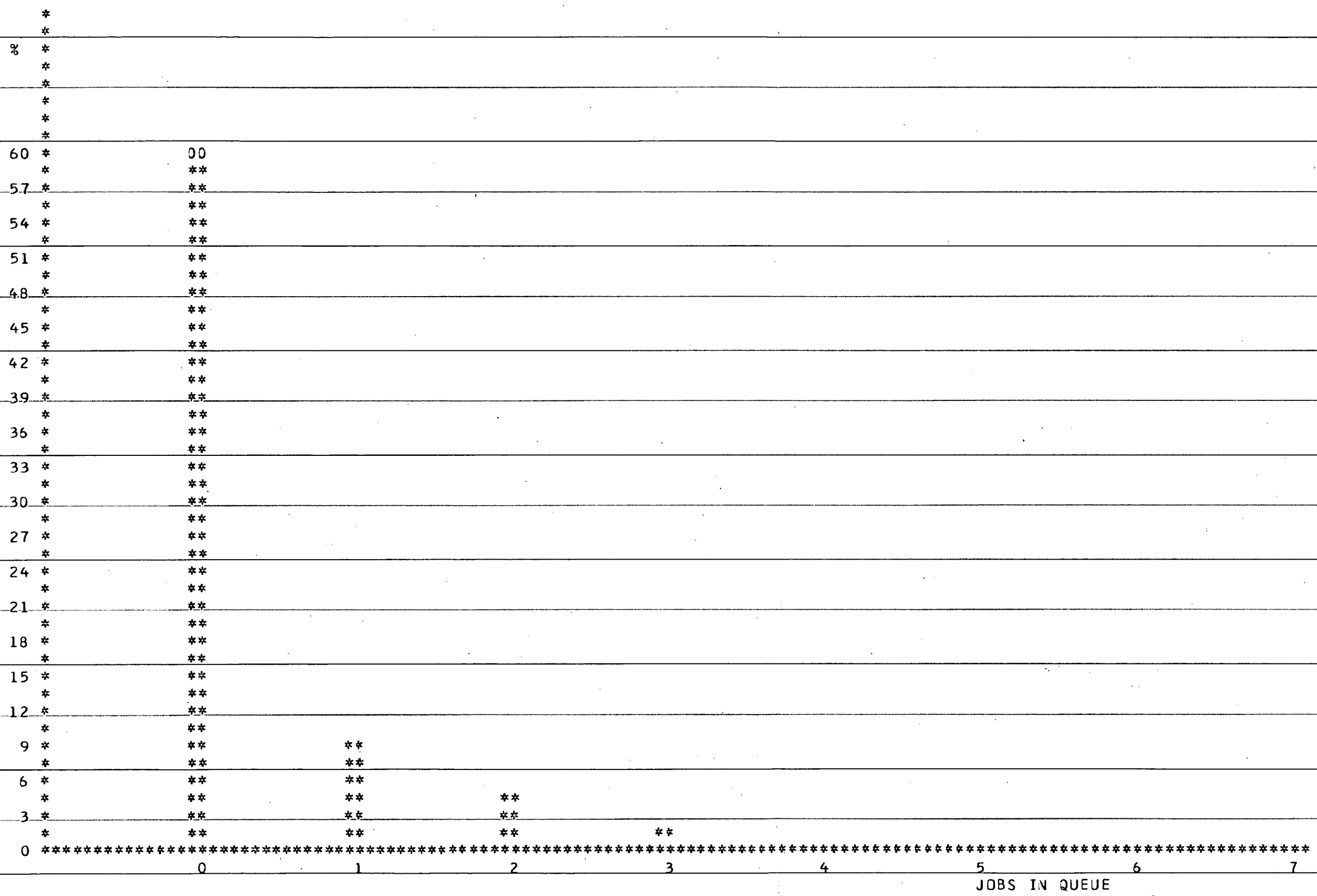


FIGURE 4: REL. FREQUENCY OF JOBS WAITING FOR SERVICE AT INFORMATION DESK

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
30	100	1.876	.018	1195	5.656		9

TABLE	TAB5			
ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION	SUM OF ARGUMENTS	
1194	3.011	3.078	3596.000	NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	499	41.79	41.7	58.2	.332	-.653
2	196	16.41	58.2	41.7	.664	-.328
3	110	9.21	67.4	32.5	.996	-.003
4	104	8.71	76.1	23.8	1.328	.321
5	88	7.37	83.5	16.4	1.660	.645
6	39	3.26	86.7	13.2	1.992	.970
7	42	3.51	90.2	9.7	2.324	1.295
8	30	2.51	92.7	7.2	2.656	1.620
9	27	2.26	95.0	4.9	2.988	1.945
10	17	1.42	96.4	3.5	3.320	2.270
11	13	1.03	97.5	2.4	3.652	2.595
12	14	1.17	98.7	1.2	3.984	2.920
13	5	.41	99.1	.8	4.316	3.244
14	4	.33	99.4	.5	4.648	3.569
15	3	.25	99.7	.2	4.980	3.894
16	1	.08	99.8	.1	5.312	4.219
17	0	.00	99.8	.1	5.644	4.544
18	0	.00	99.8	.1	5.976	4.869
19	0	.00	99.8	.1	5.308	5.194
20	2	.16	100.0	.0	6.640	5.519

~~REMAINING FREQUENCIES ARE ALL ZERO.~~

GRAPH

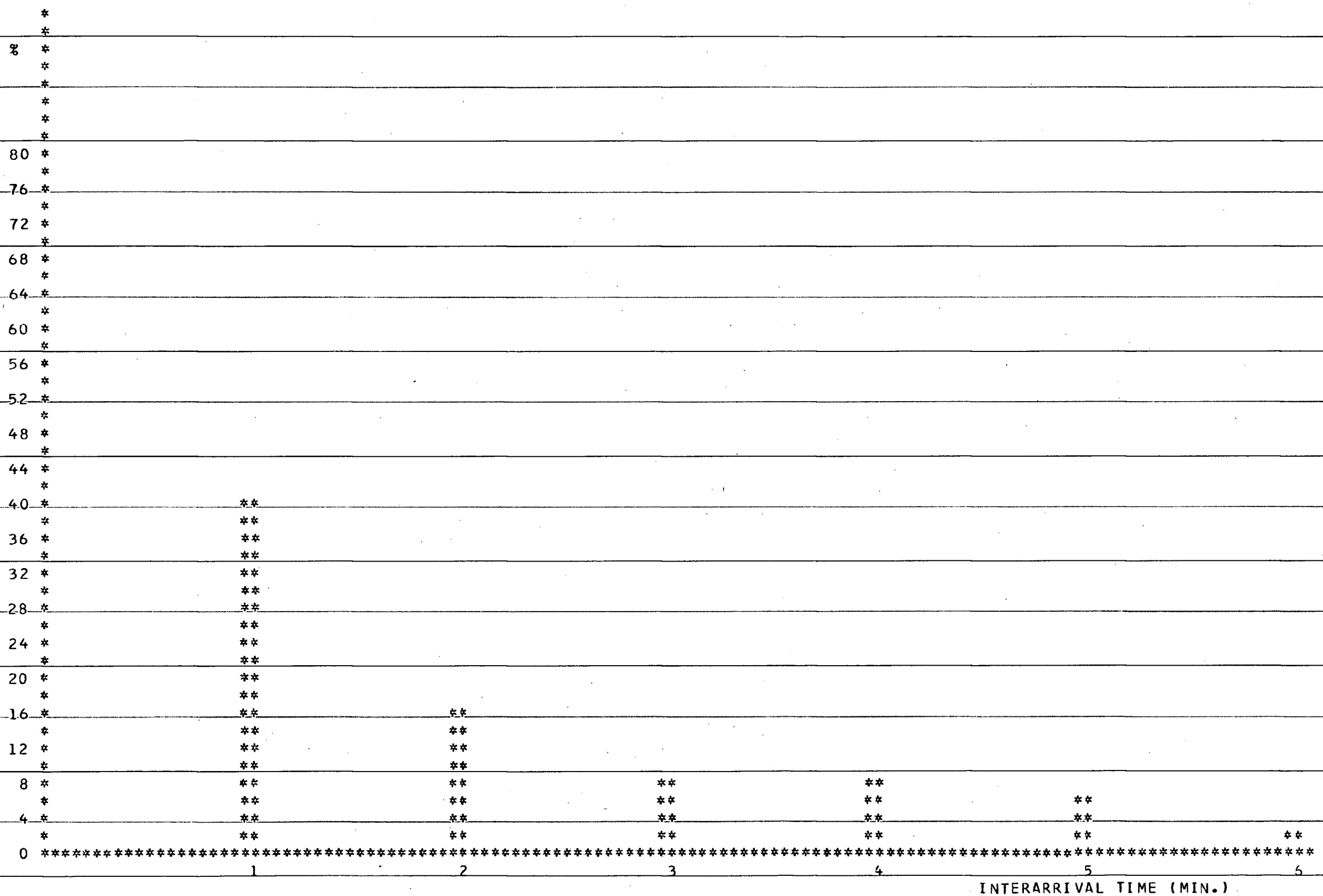


FIGURE 5: REL. FREQUENCY OF INTERARRIVAL TIMES

NUMBER OF ARRIVALS TO SHELVES/10 MIN.

TABLE TAB6

ENTRIES IN TABLE		MEAN ARGUMENT	STANDARD DEVIATION	SUM OF ARGUMENTS		
360		3.316	2.074	1194.000 NON-WEIGHTED		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	8	2.22	2.2	97.7	-.000	-1.598
1	59	16.38	18.6	81.3	.301	-1.116
2	78	21.66	40.2	59.7	.603	-.634
3	82	22.77	63.0	36.9	.904	-.152
4	48	13.33	76.3	23.6	1.206	.329
5	30	8.33	84.7	15.2	1.507	.811
6	21	5.83	90.5	9.4	1.809	1.293
7	20	5.55	96.1	3.8	2.110	1.775
8	7	1.94	98.0	1.9	2.412	2.257
9	5	1.38	99.4	.5	2.713	2.739
10	0	.00	99.4	.5	3.015	3.222
11	1	.27	99.7	.2	3.316	3.704
12	0	.00	99.7	.2	3.618	4.186
13	1	.27	100.0	.0	3.919	4.668

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

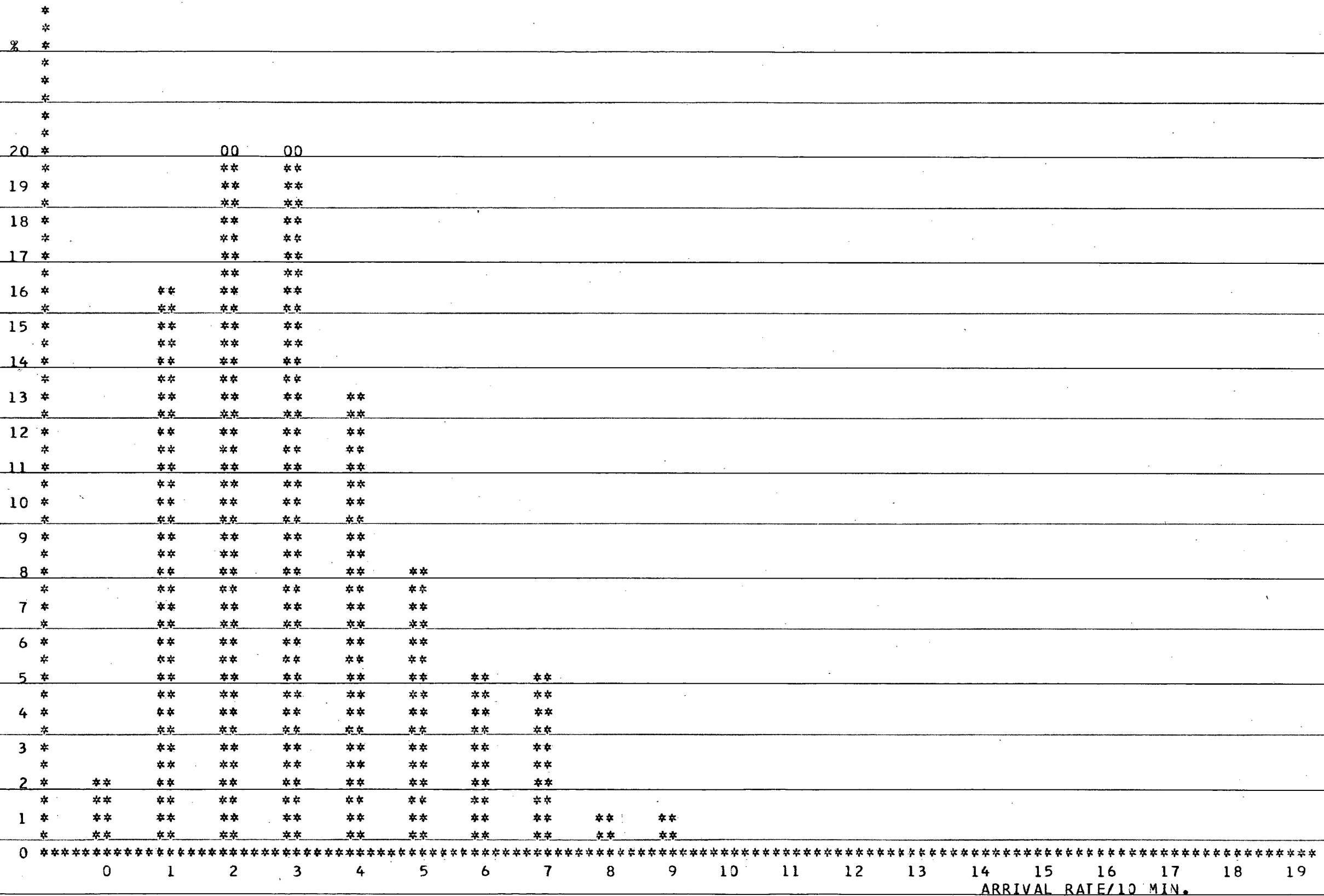


FIGURE 6: REL. FREQUENCY OF ARRIVALS TO SHELVES DURING 10 MIN.

SHELF TRANSIT TIMES (MIN)

TABLE TAB7

ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

1195

5.656

5.457

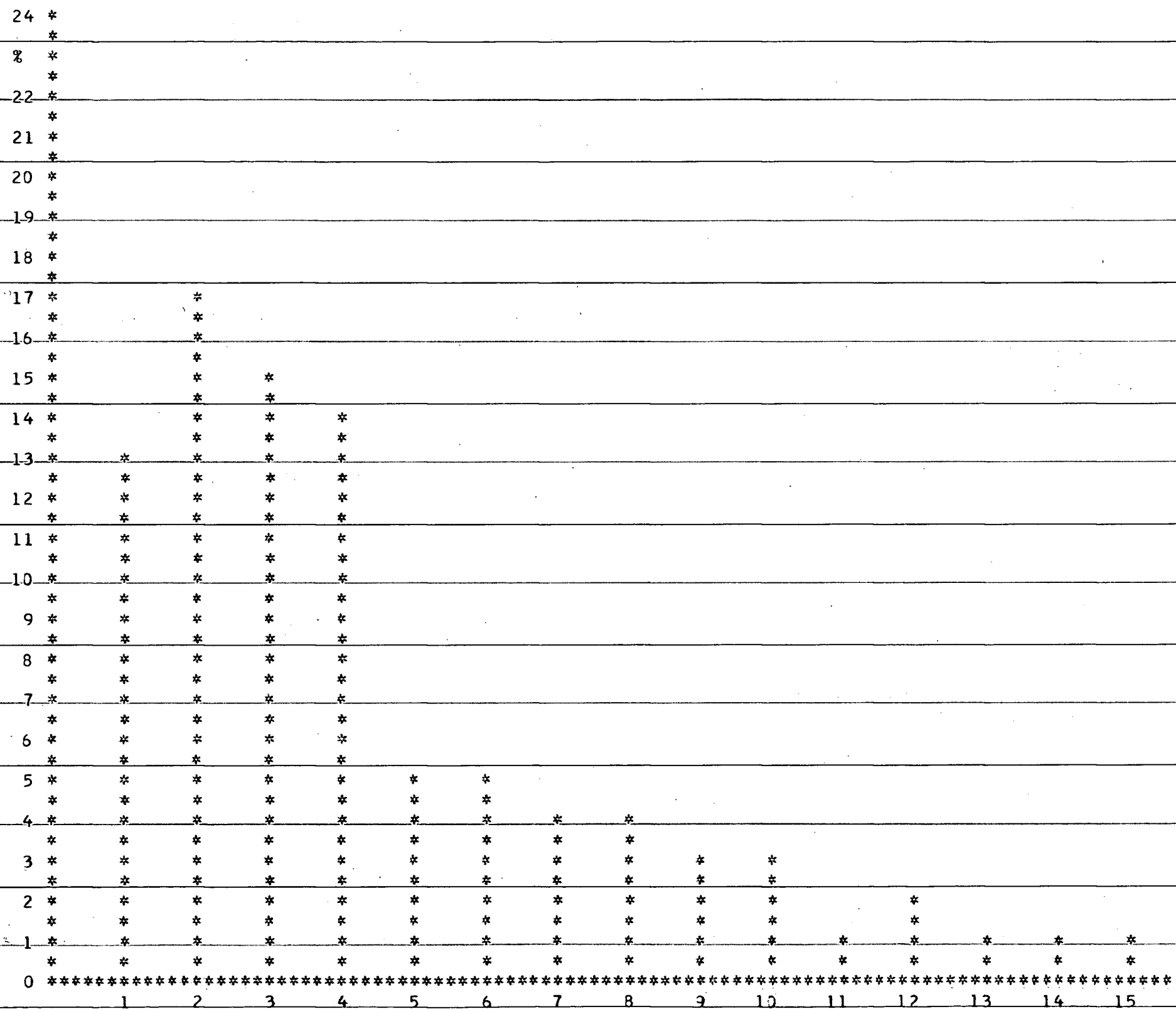
6759.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	157	13.13	13.1	86.8	.176	-.853
2	209	17.43	30.6	69.3	.353	-.669
3	182	15.23	45.8	54.1	.530	-.486
4	178	14.89	60.7	39.2	.707	-.303
5	60	5.02	65.7	34.2	.884	-.120
6	67	5.60	71.3	28.6	1.060	.063
7	50	4.18	75.5	24.4	1.237	.246
8	50	4.18	79.7	20.2	1.414	.429
9	37	3.09	82.8	17.1	1.591	.612
10	39	3.26	86.1	13.8	1.768	.796
11	20	1.67	87.7	12.2	1.944	.979
12	25	2.09	89.8	10.1	2.121	1.162
13	20	1.67	91.5	8.4	2.298	1.345
14	14	1.17	92.7	7.2	2.475	1.529
15	16	1.33	94.0	5.9	2.652	1.712
16	10	.83	94.8	5.1	2.828	1.895
17	6	.50	95.3	4.6	3.005	2.078
18	5	.41	95.8	4.1	3.182	2.262
19	5	.41	96.2	3.7	3.359	2.445
20	3	.25	96.4	3.5	3.536	2.628
21	4	.33	96.8	3.1	3.712	2.811
22	6	.50	97.3	2.6	3.889	2.995
23	6	.50	97.8	2.1	4.066	3.178
24	5	.41	98.2	1.7	4.243	3.361
25	2	.16	98.4	1.5	4.420	3.544
26	3	.25	98.6	1.3	4.596	3.728
27	3	.25	98.9	1.0	4.773	3.911
28	4	.33	99.2	.7	4.950	4.094
29	4	.33	99.5	.4	5.127	4.277
30	4	.33	99.9	.0	5.304	4.461
31	1	.08	100.0	.0	5.480	4.644

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



TRANSIT TIME (MIN.)

FIGURE 7: REL. FREQUENCY OF TRANSIT TIMES AT SHELVES

OCCUPANCY OF SHELVES

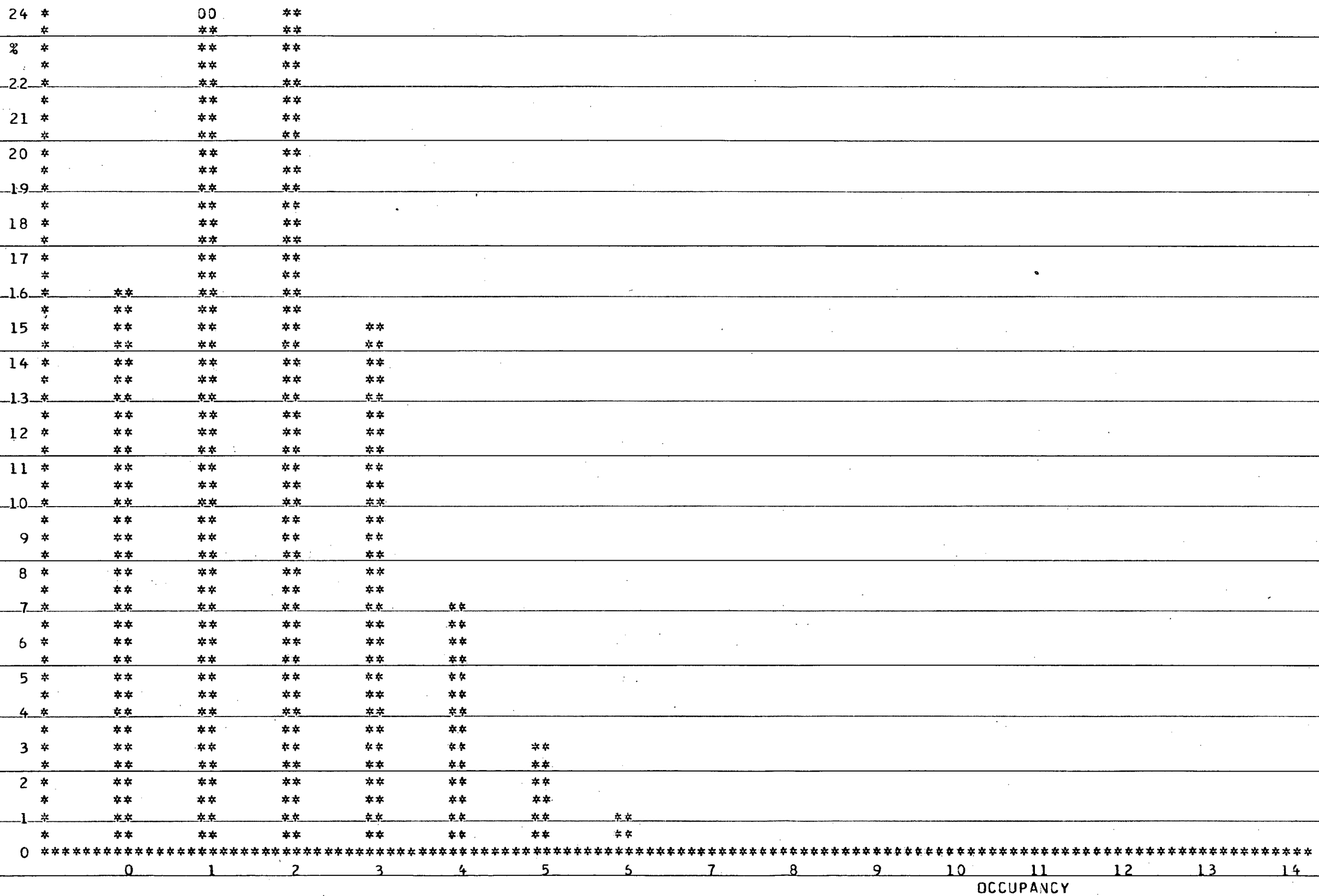
TABLE TAB8
ENTRIES IN TABLE

MEAN ARGUMENT 1.911
STANDARD DEVIATION 1.476
SUM OF ARGUMENTS 2284.000
NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	195	16.31	16.3	83.6	-.000	-1.294
1	347	29.03	45.3	54.6	.523	-.617
2	298	24.93	70.2	29.7	1.046	.060
3	189	15.81	86.1	13.8	1.569	.737
4	91	7.61	93.7	6.2	2.092	1.414
5	47	3.93	97.6	2.3	2.616	2.091
6	22	1.84	99.4	.5	3.139	2.769
7	5	.41	99.9	.0	3.662	3.446
8	1	.03	100.0	.0	4.185	4.123

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



OCCUPANCY

FIGURE 8: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE SHELVES

THE RECORDINGS COLLECTION (=DESK & SHELVES) AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
11	150	2.271	.015	2727	2.999	1	10

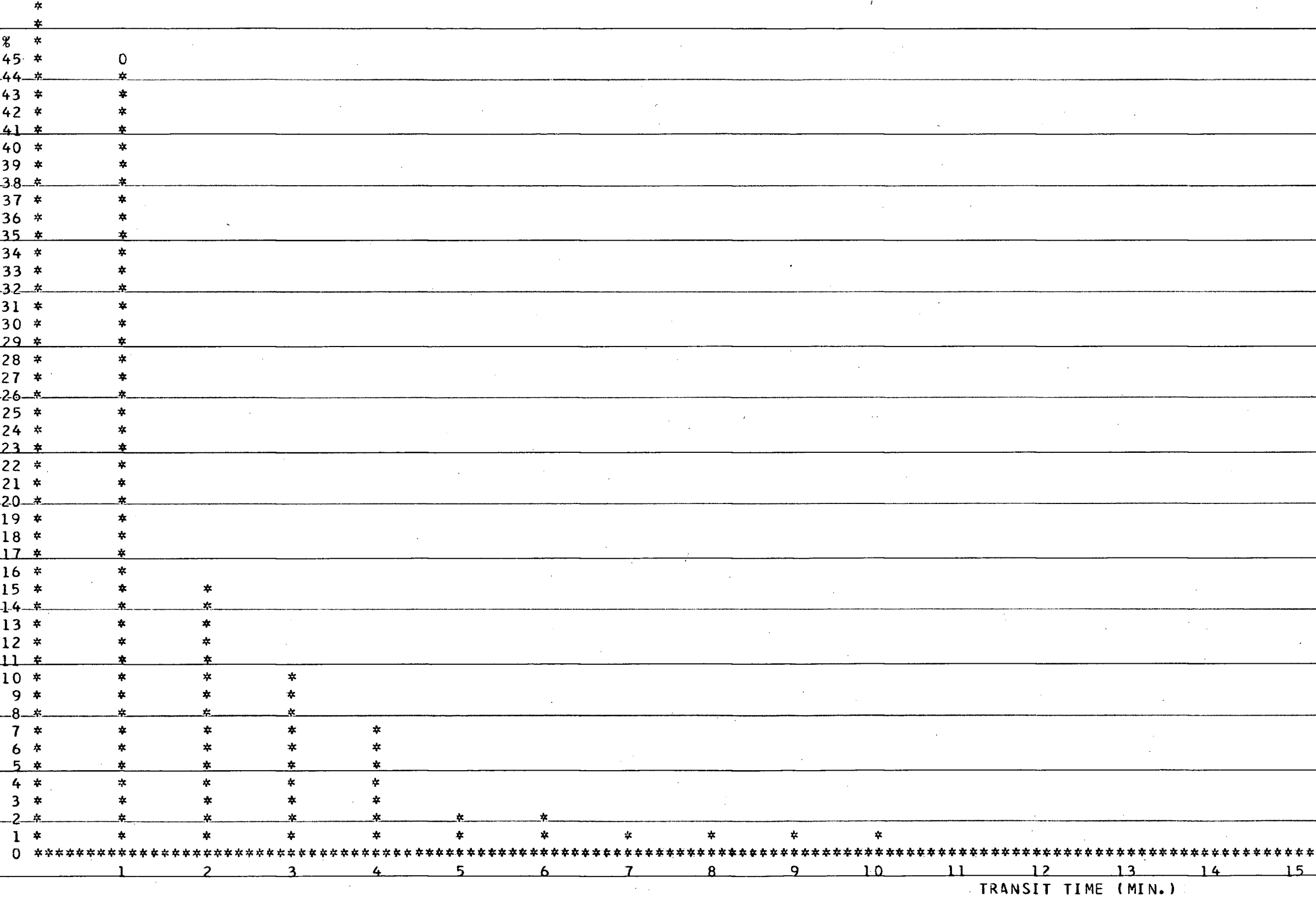
TRANSIT TIMES THROUGH REC. COLL. (MIN.) , (=DESK & SHELVES)

TABLE TAB9	MEAN ARGUMENT	STANDARD DEVIATION	SUM OF ARGUMENTS	NON-WEIGHTED
ENTRIES IN TABLE 2726	3.000	4.410	8178.000	

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	1317	48.31	48.3	51.6	.333	-.453
2	416	15.26	63.5	36.4	.666	-.226
3	276	10.12	73.6	26.3	1.000	-.000
4	216	7.92	81.6	18.3	1.333	.226
5	77	2.82	84.4	15.5	1.666	.453
6	75	2.75	87.1	12.8	2.000	.680
7	54	1.98	89.1	10.8	2.333	.906
8	53	1.94	91.1	8.8	2.666	1.133
9	37	1.35	92.4	7.5	3.000	1.360
10	39	1.43	93.9	6.0	3.333	1.587
11	20	.73	94.6	5.3	3.666	1.813
12	25	.91	95.5	4.4	4.000	2.040
13	20	.73	96.2	3.7	4.333	2.267
14	14	.51	96.8	3.1	4.666	2.494
15	16	.58	97.3	2.6	5.000	2.720
16	10	.36	97.7	2.2	5.333	2.947
17	6	.22	97.9	2.0	5.666	3.174
18	5	.13	98.1	1.8	6.000	3.401
19	5	.18	98.3	1.6	6.333	3.627
20	3	.11	98.4	1.5	6.666	3.854
21	4	.14	98.6	1.3	7.000	4.081
22	6	.22	98.8	1.1	7.333	4.308
23	6	.22	99.0	.9	7.666	4.534
24	5	.18	99.2	.7	8.000	4.761
25	2	.07	99.3	.6	8.333	4.988
26	3	.11	99.4	.5	8.666	5.215
27	3	.11	99.5	.4	9.000	5.441
28	4	.14	99.6	.3	9.333	5.668
29	4	.14	99.8	.1	9.666	5.895
30	4	.14	99.9	.0	10.000	6.122
31	1	.03	100.0	.0	10.333	6.348

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



TRANSIT TIME (MIN.)

FIGURE 9: REL. FREQUENCY OF TRANSIT TIMES THROUGH THE RECORDINGS COLLECTION

OCCUPANCY OF RECORD. COLLECT. (=DESK & SHELVES)

TABLE TAB10

ENTRIES IN TABLE

2726

MEAN ARGUMENT

2.372

STANDARD DEVIATION

1.753

SUM OF ARGUMENTS

6468.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	330	12.10	12.1	87.8	-.000	-1.352
1	633	23.22	35.3	64.6	.421	-.782
2	679	24.90	60.2	39.7	.842	-.212
3	466	17.09	77.3	22.6	1.264	.357
4	297	10.89	88.2	11.7	1.685	.927
5	147	5.39	93.6	6.3	2.107	1.497
6	86	3.15	96.7	3.2	2.528	2.068
7	65	2.33	99.1	.8	2.950	2.638
8	22	.80	99.9	.0	3.371	3.208
9	1	.03	100.0	.0	3.793	3.778

~~REMAINING FREQUENCIES ARE ALL ZERO.~~

GRAPH

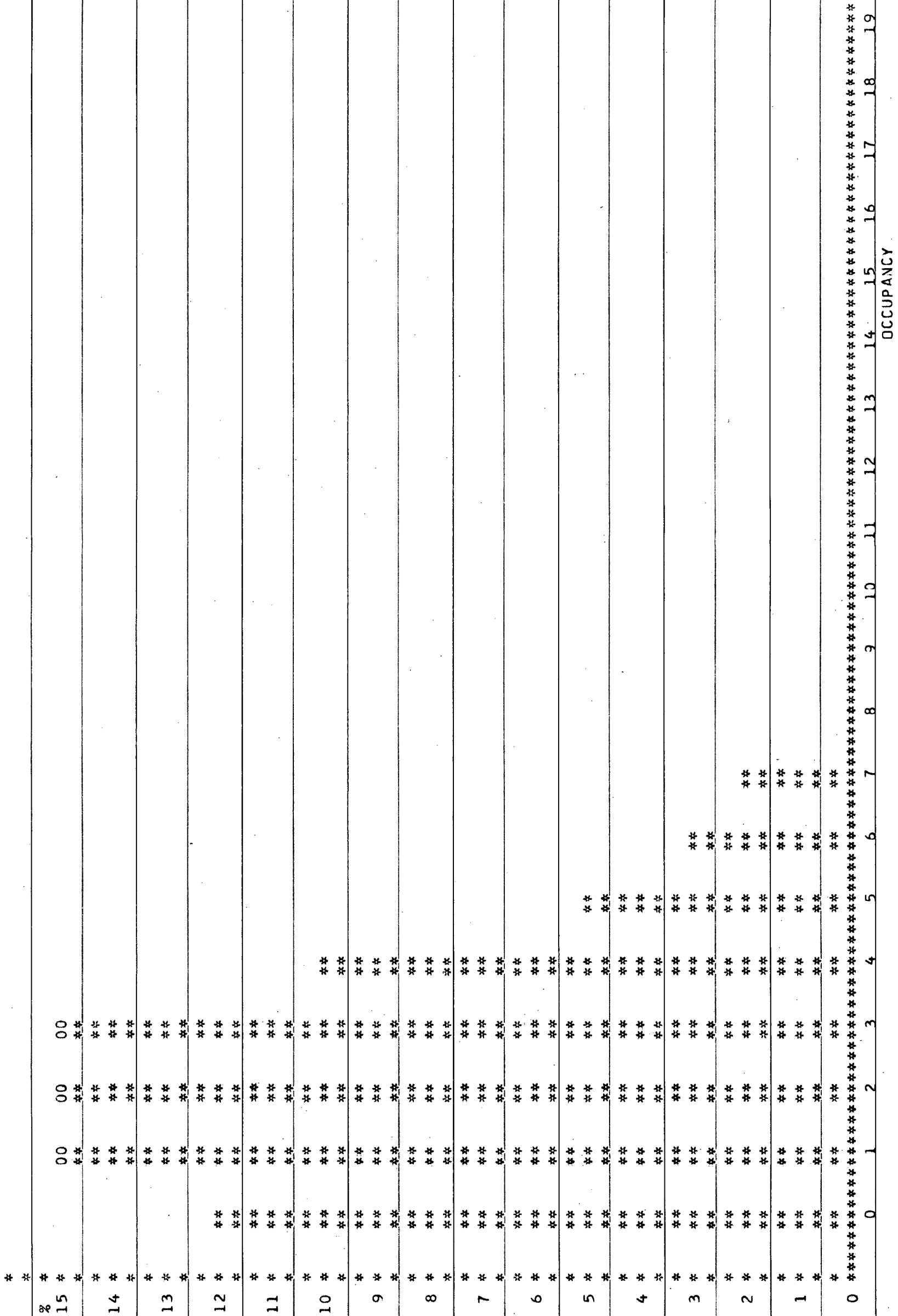


FIGURE 10: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY DESK AND SHELVES

THE LISTENING ROOM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
40	23	7.751	.337	660	42.290	9	23

LISTENING ROOM INTERARRIVAL TIMES (MIN.)

TABLE TAB11 ENTRIES IN TABLE		MEAN ARGUMENT	STANDARD DEVIATION	SUM OF ARGUMENTS		
650		5.496	5.402	3573.000 NON-WEIGHTED		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	140	21.53	21.5	78.4	.181	-.832
2	80	12.30	33.8	66.1	.363	-.647
3	80	12.30	46.1	53.8	.545	-.462
4	53	8.15	54.3	45.6	.727	-.277
5	54	8.30	62.6	37.3	.909	-.091
6	41	6.30	68.9	31.0	1.091	.093
7	44	6.75	75.6	24.3	1.273	.278
8	29	4.46	80.1	19.8	1.455	.463
9	28	4.30	84.4	15.5	1.637	.648
10	15	2.30	86.7	13.2	1.819	.833
11	14	2.15	88.9	11.0	2.001	1.018
12	9	1.38	90.3	9.6	2.183	1.203
13	9	1.38	91.6	8.3	2.364	1.388
14	11	1.69	93.3	6.6	2.546	1.573
15	4	.61	93.9	6.0	2.728	1.759
16	8	1.23	95.2	4.7	2.910	1.944
17	4	.61	95.8	4.1	3.092	2.129
18	4	.61	96.4	3.5	3.274	2.314
19	3	.46	96.9	3.0	3.456	2.499
20	2	.30	97.2	2.7	3.638	2.684
21	3	.46	97.6	2.3	3.820	2.869
22	3	.46	98.1	1.8	4.002	3.054
23	1	.15	98.3	1.6	4.184	3.239
24	1	.15	98.4	1.5	4.366	3.425
25	2	.30	98.7	1.2	4.547	3.610
26	1	.15	98.9	1.0	4.729	3.795
27	1	.15	99.0	.9	4.911	3.980
28	1	.15	99.2	.7	5.093	4.165
29	2	.30	99.5	.4	5.275	4.350
OVERFLOW	3	.45	100.0	.0		
AVERAGE VALUE OF OVERFLOW		32.00				

GRAPH

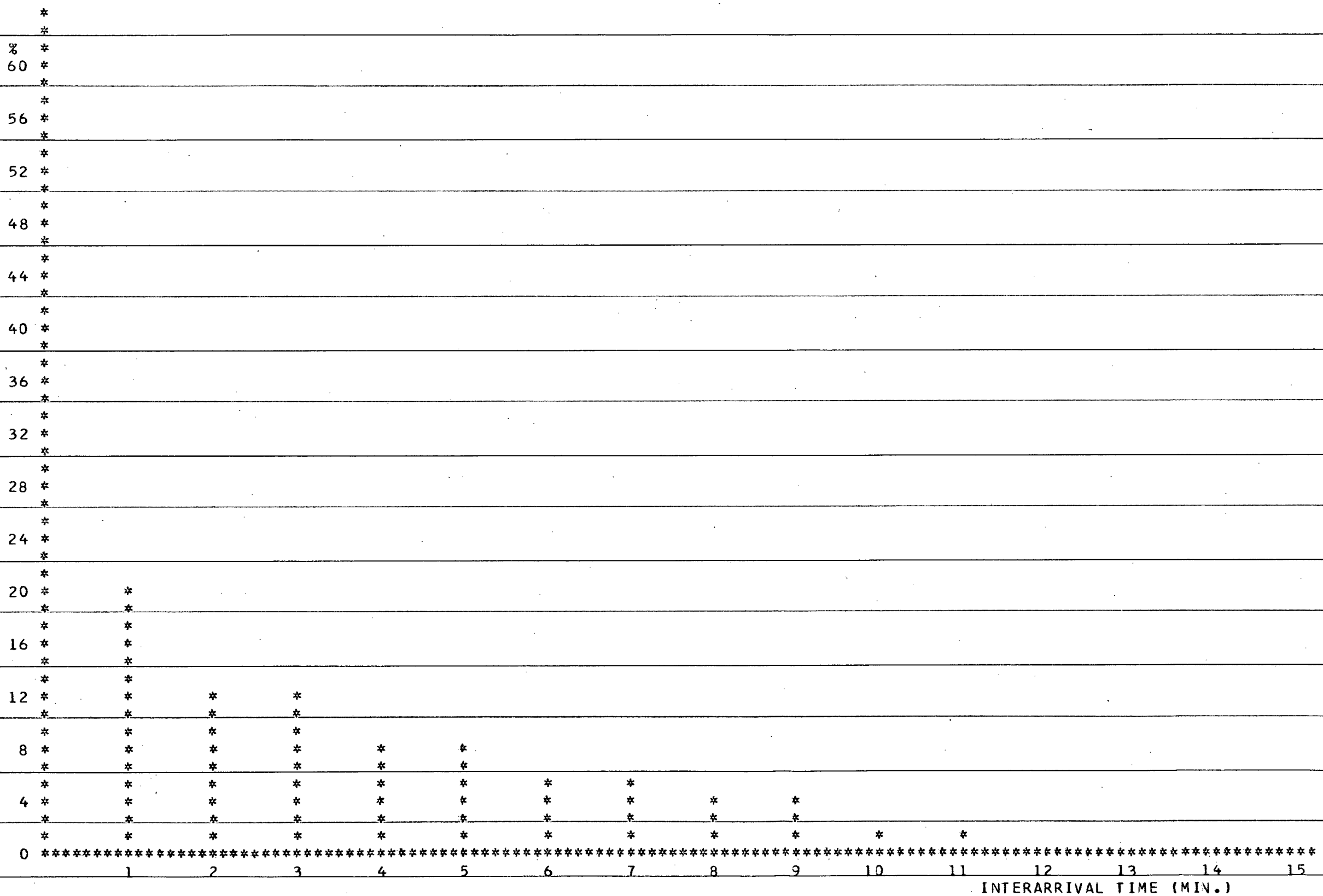


FIGURE 11: REL. FREQUENCY OF INTERARRIVAL TIMES TO LISTENING ROOM

NUMBER OF ARRIVALS TO LIST. ROOM/10 MIN

TABLE TAB12
ENTRIES IN TABLE

MEAN ARGUMENT 1.805
STANDARD DEVIATION 1.351
SUM OF ARGUMENTS 650.000
NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	61	16.94	16.9	83.0	-.000	-1.335
1	106	29.44	46.3	53.6	.553	-.596
2	95	26.38	72.7	27.2	1.107	.143
3	56	15.55	88.3	11.6	1.661	.883
4	27	7.49	95.8	4.1	2.215	1.623
5	12	3.33	99.1	.8	2.769	2.363
6	3	.83	100.0	.0	3.323	3.103

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

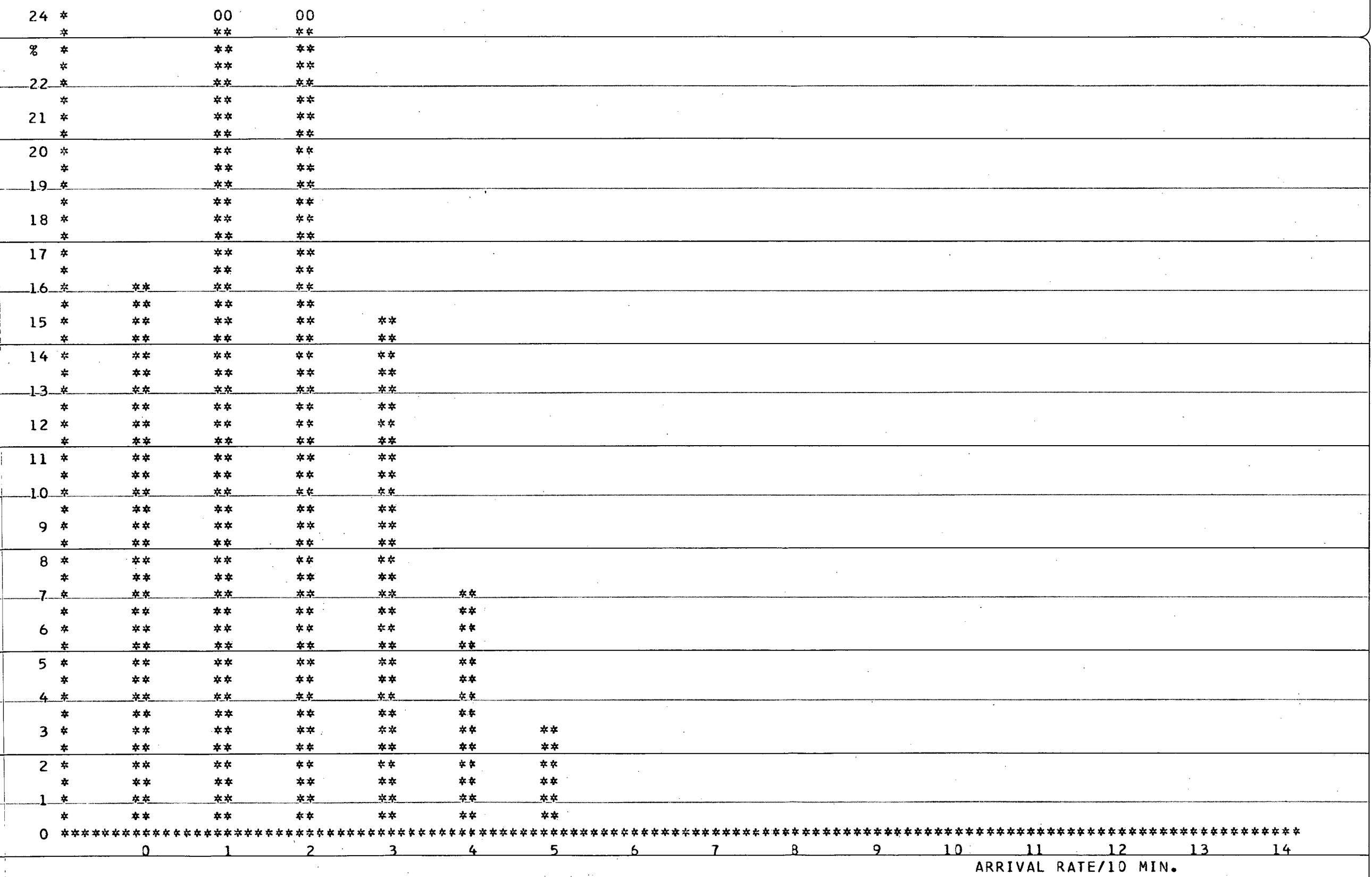


FIGURE 12: REL. FREQUENCY OF ARRIVALS TO LISTENING ROOM DURING 10 MIN.

LIST. ROOM SERVICE TIMES (MIN.)

TABLE TAB13
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

651

42.181

31.437

27460.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	4	.61	.6	99.3	-.000	-1.341
5	38	5.83	5.4	93.5	.118	-1.182
10	34	5.22	11.6	88.3	.237	-1.023
15	49	7.52	19.2	80.7	.355	-.864
20	49	7.52	26.7	73.2	.474	-.705
25	49	7.52	34.2	65.7	.592	-.546
30	46	7.06	41.3	58.6	.711	-.387
35	42	6.45	47.7	52.2	.829	-.228
40	32	4.91	52.6	47.3	.948	-.069
45	47	7.21	59.9	40.0	1.066	.089
50	52	7.93	67.8	32.1	1.185	.248
55	48	7.37	75.2	24.7	1.303	.407
60	32	4.91	80.1	19.8	1.422	.566
65	25	3.84	84.0	15.9	1.540	.725
70	20	3.07	87.0	12.9	1.659	.884
75	10	1.53	88.6	11.3	1.778	1.043
80	10	1.53	90.1	9.8	1.896	1.202
85	11	1.68	91.8	8.1	2.015	1.362
90	6	.92	92.7	7.2	2.133	1.521
95	6	.92	93.7	6.2	2.252	1.680
100	5	.75	94.4	5.5	2.370	1.839
105	6	.92	95.3	4.6	2.489	1.998
110	2	.30	95.6	4.3	2.607	2.157
115	4	.61	96.3	3.6	2.726	2.316
120	4	.61	96.9	3.0	2.844	2.475
125	1	.15	97.0	2.9	2.963	2.634
130	2	.30	97.3	2.6	3.081	2.793
135	2	.30	97.6	2.3	3.200	2.952
140	2	.30	98.0	1.9	3.319	3.111
145	3	.46	98.4	1.5	3.437	3.270
150	2	.30	98.7	1.2	3.556	3.429
155	1	.15	98.9	1.0	3.674	3.588
160	1	.15	99.0	.9	3.793	3.747
165	2	.30	99.3	.6	3.911	3.906
170	1	.15	99.5	.4	4.030	4.065
175	1	.15	99.6	.3	4.148	4.224
180	1	.15	99.8	.1	4.267	4.383
185	1	.15	100.0	.0	4.385	4.542

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

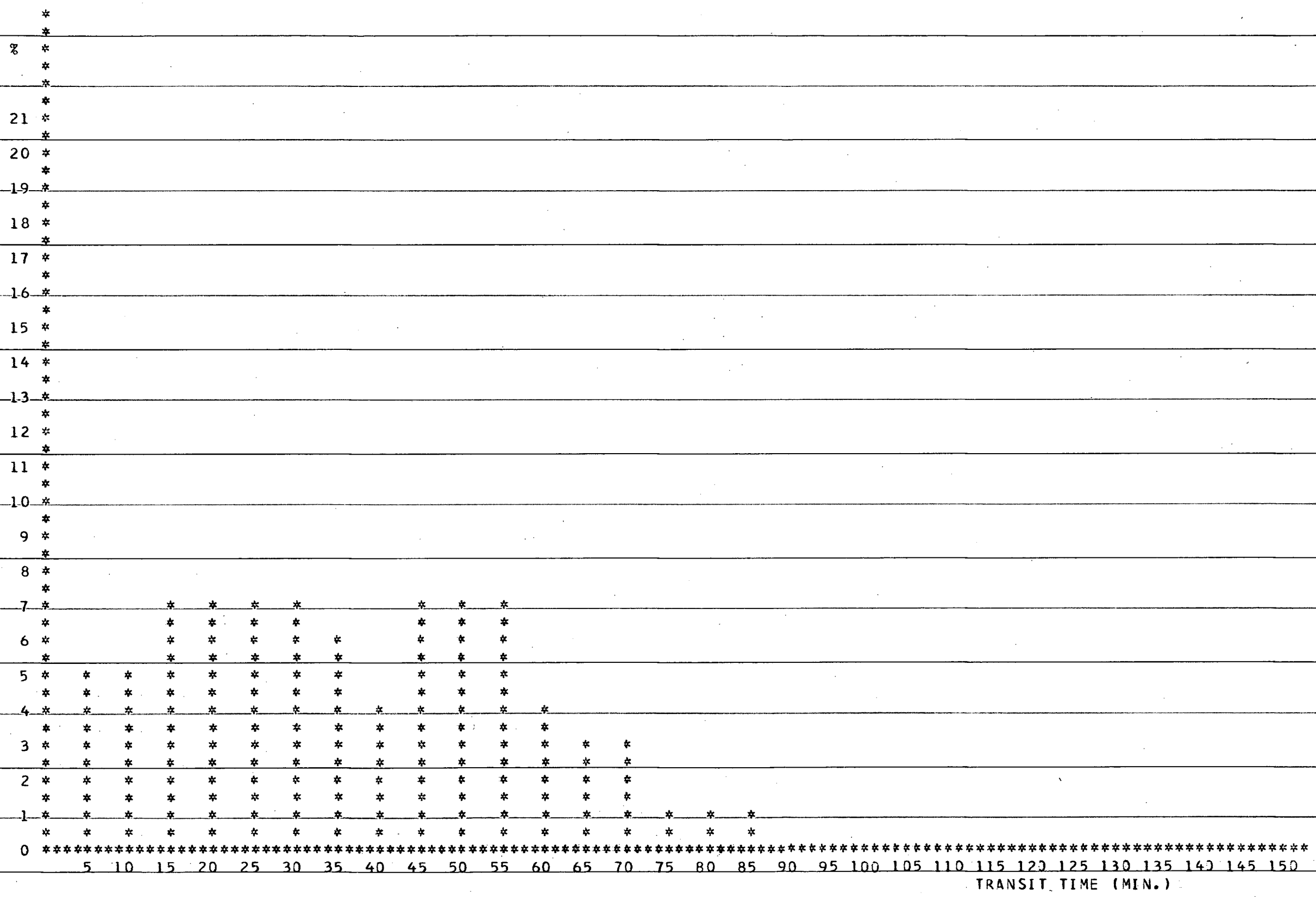


FIGURE 13: REL. FREQUENCY OF TRANSIT TIME OF LISTENING ROOM

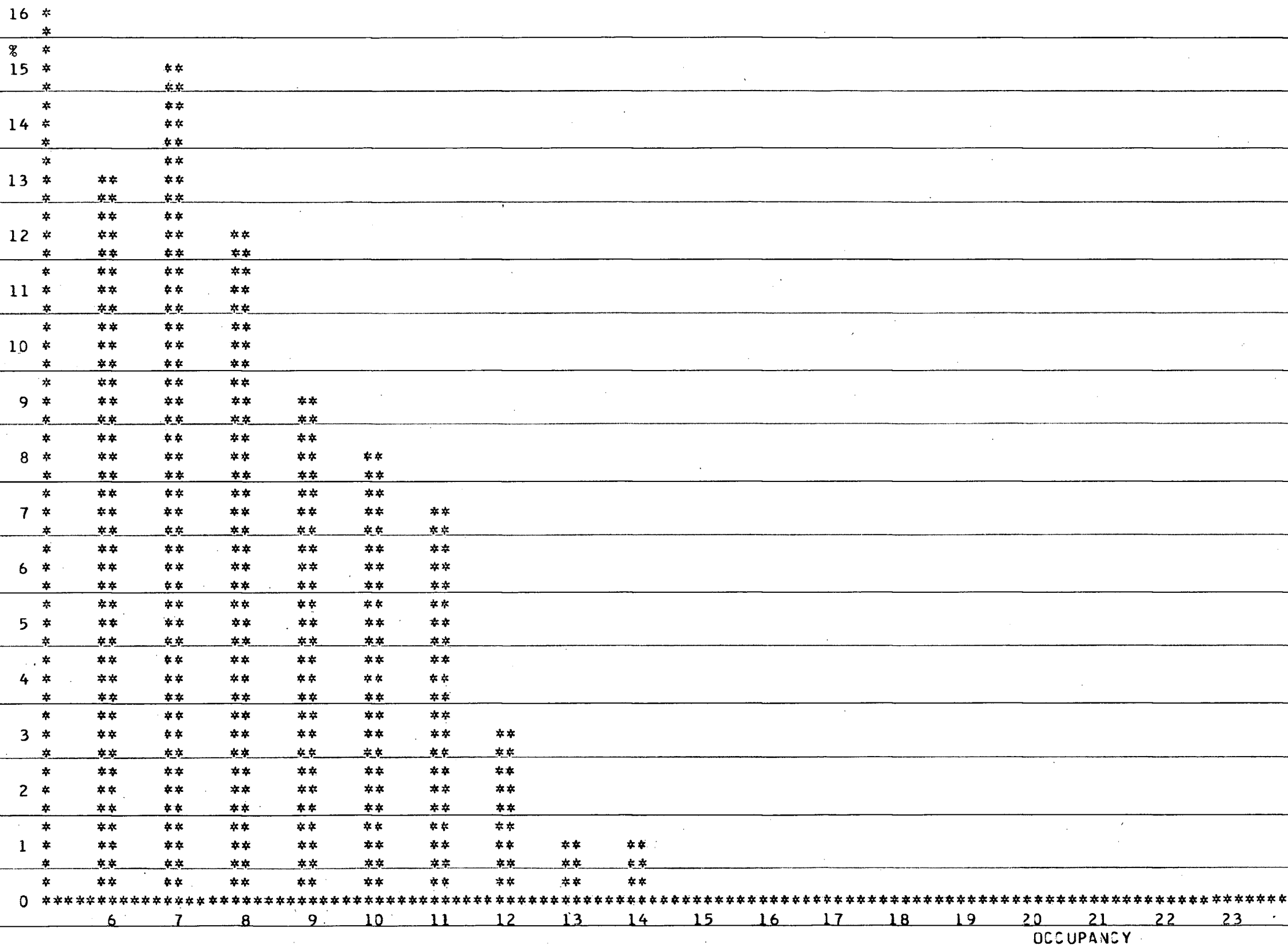
OCCUPANCY OF LIST. ROOM

TABLE TAB14
ENTRIES IN TABLE

651		MEAN ARGUMENT	STANDARD DEVIATION		SUM OF ARGUMENTS		NON-WEIGHTED
		7.774	3.085		5061.000		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN	
0	0	.00	.0	100.0	-.000	-2.519	
1	1	.15	.1	99.8	.128	-2.195	
2	4	.61	.7	99.2	.257	-1.871	
3	17	2.61	3.3	96.6	.385	-1.547	
4	47	7.21	10.5	89.4	.514	-1.223	
5	87	13.36	23.9	76.0	.643	-.898	
6	89	13.67	37.6	62.3	.771	-.574	
7	101	15.51	53.1	46.8	.900	-.250	
8	79	12.13	65.2	34.7	1.029	.073	
9	63	9.67	74.9	25.0	1.157	.397	
10	55	8.44	83.4	16.5	1.286	.721	
11	50	7.68	91.0	8.9	1.414	1.045	
12	22	3.37	94.4	5.5	1.543	1.369	
13	9	1.38	95.8	4.1	1.672	1.693	
14	7	1.07	96.9	3.0	1.800	2.017	
15	2	.30	97.2	2.7	1.929	2.341	
16	4	.61	97.8	2.1	2.058	2.665	
17	2	.30	98.1	1.8	2.186	2.989	
18	5	.76	98.9	1.0	2.315	3.313	
19	2	.30	99.2	.7	2.443	3.637	
20	3	.46	99.6	.3	2.572	3.961	
21	1	.15	99.8	.1	2.701	4.285	
22	1	.15	100.0	.0	2.829	4.609	

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



OCCUPANCY

FIGURE 14: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE LISTENING ROOM

GRAPH

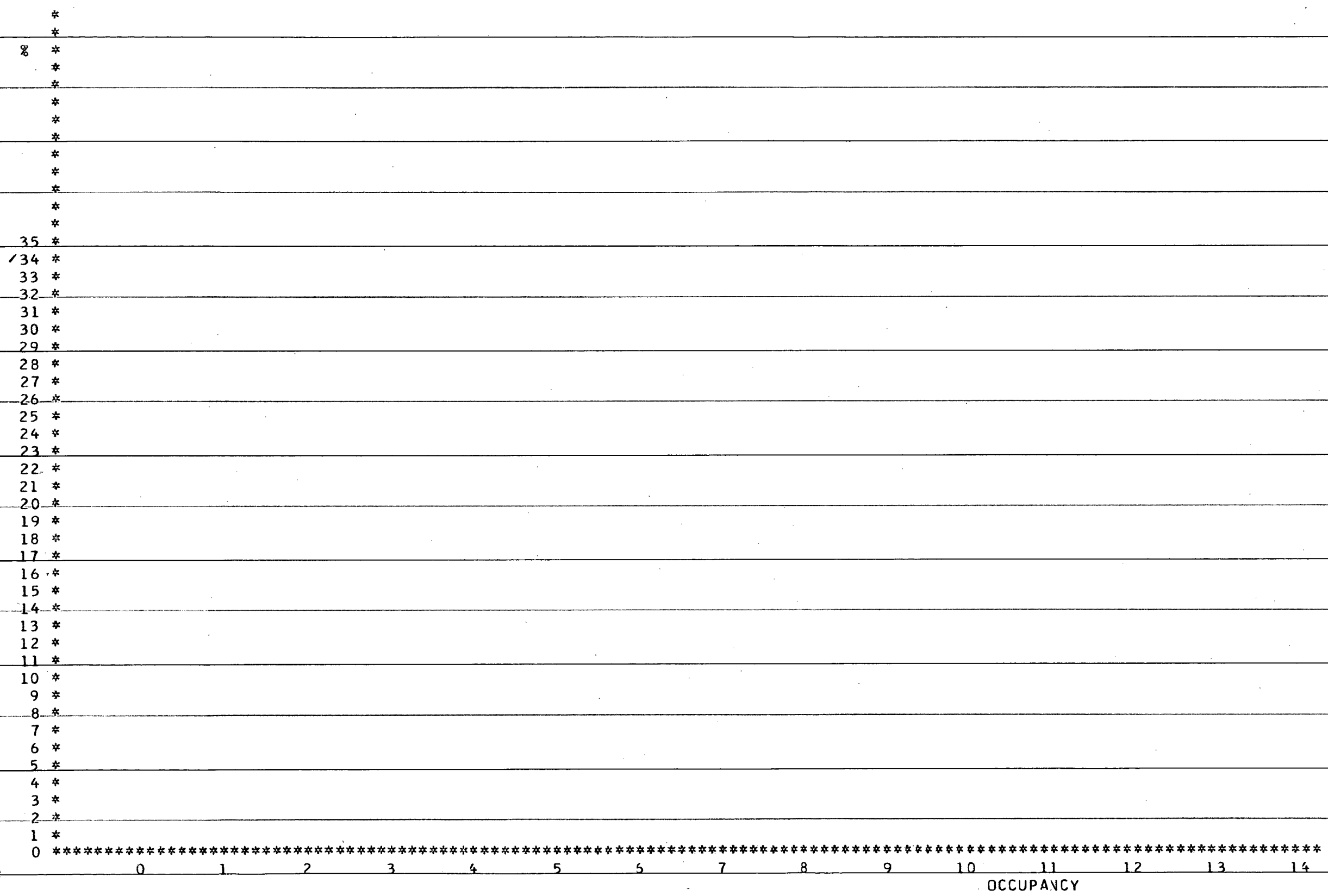


FIGURE 14A: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE LISTENING ROOM

THE SYSTEM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
10	200	10.022	.050	1613	22.375	10	26

SYSTEM TRANSIT TIMES (MIN.) (=SERVICE & WAIT. TIME)

TABLE TAB15	MEAN ARGUMENT	STANDARD DEVIATION	SUM OF ARGUMENTS	NON-WEIGHTED
ENTRIES IN TABLE 1603	3.085	10.210	4946.000	

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	695	43.35	43.3	56.6	-.000	-.302
5	771	48.09	91.4	8.5	1.620	.187
10	54	3.36	94.8	5.1	3.241	.677
15	23	1.43	96.2	3.7	4.861	1.166
20	9	.56	96.8	3.1	6.482	1.656
25	7	.43	97.2	2.7	8.102	2.146
30	6	.37	97.6	2.3	9.723	2.635
35	3	.19	97.8	2.1	11.343	3.125
40	3	.18	98.0	1.9	12.964	3.615
45	5	.31	98.3	1.6	14.584	4.104
50	6	.37	98.6	1.3	16.205	4.594
55	7	.43	99.1	.8	17.825	5.084
60	2	.12	99.2	.7	19.446	5.573
65	2	.12	99.3	.6	21.066	6.063
70	1	.06	99.4	.5	22.687	6.553
75	2	.12	99.5	.4	24.307	7.042
80	2	.12	99.6	.3	25.928	7.532
85	0	.00	99.6	.3	27.548	8.022
90	0	.00	99.6	.3	29.169	8.511
95	1	.06	99.7	.2	30.789	9.001
100	0	.00	99.7	.2	32.410	9.491
105	1	.06	99.8	.1	34.030	9.980
110	0	.00	99.8	.1	35.651	10.470
115	1	.06	99.8	.1	37.271	10.960
120	1	.06	99.9	.0	38.892	11.449
125	0	.00	99.9	.0	40.512	11.939
130	0	.00	99.9	.0	42.133	12.429
135	0	.00	99.9	.0	43.753	12.918
140	0	.00	99.9	.0	45.374	13.408
145	0	.00	99.9	.0	46.994	13.898
150	1	.06	100.0	.0	48.615	14.387

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

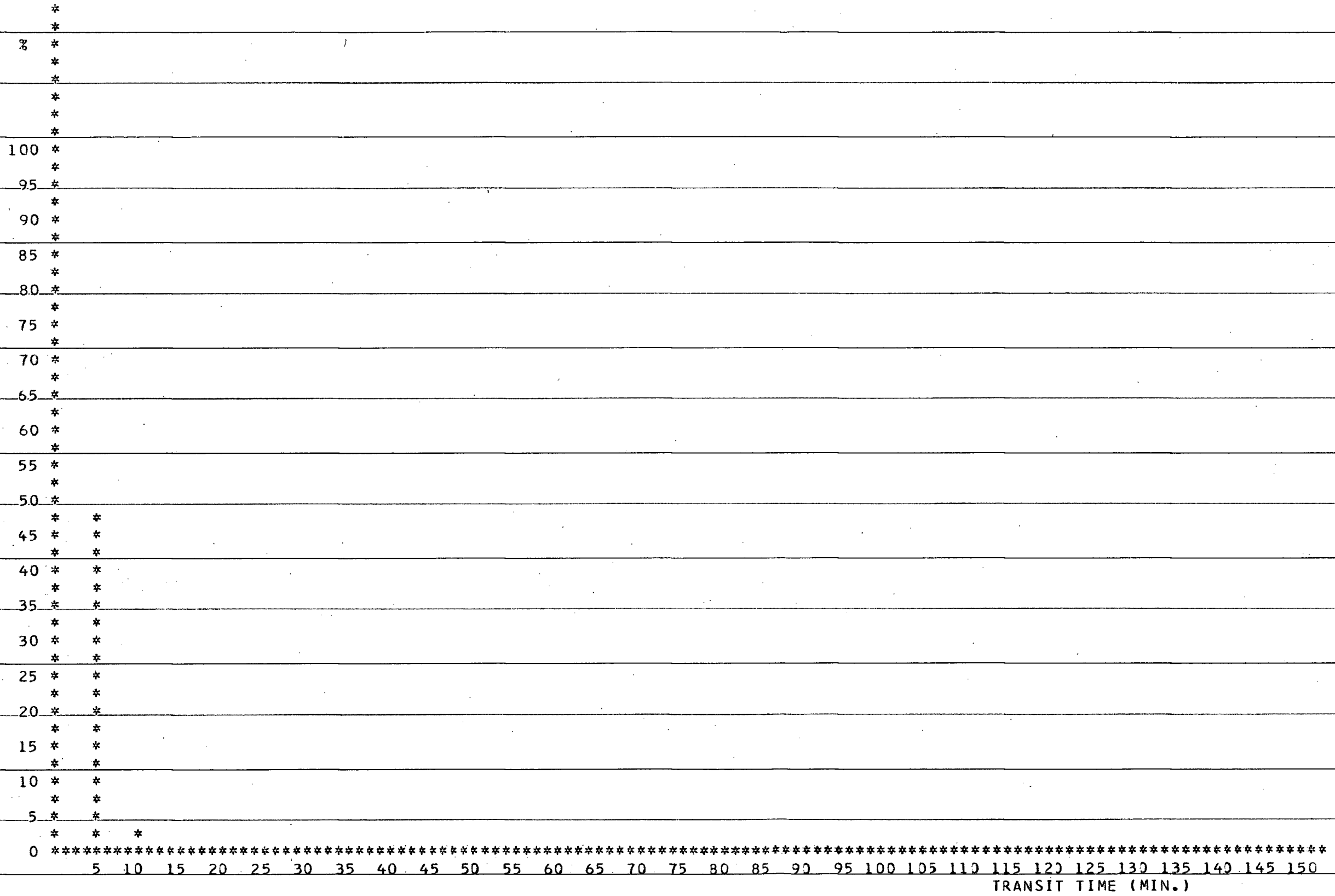


FIGURE 15: REL. FREQUENCY OF SYSTEM TRANSIT TIMES

OCCUPANCY OF SYSTEM (=DESK,SHELVES,LIST. ROOM)

TABLE TAB16

ENTRIES IN TABLE
1603

MEAN ARGUMENT
10.212

STANDARD DEVIATION
3.429

SUM OF ARGUMENTS
16371.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-2.977
2	4	.24	.2	99.7	.195	-2.394
4	30	1.87	2.1	97.8	.391	-1.811
6	158	9.85	11.9	88.0	.587	-1.228
8	347	21.64	33.6	66.3	.783	-.645
10	391	24.39	58.0	41.9	.979	-.062
12	319	19.90	77.9	22.0	1.175	.521
14	189	11.79	89.7	10.2	1.370	1.104
16	94	5.86	95.5	4.4	1.566	1.687
18	36	2.24	97.8	2.1	1.762	2.270
20	16	.99	98.8	1.1	1.958	2.853
22	11	.68	99.5	.4	2.154	3.436
24	6	.37	99.8	.1	2.350	4.019
26	2	.12	100.0	.0	2.545	4.603

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

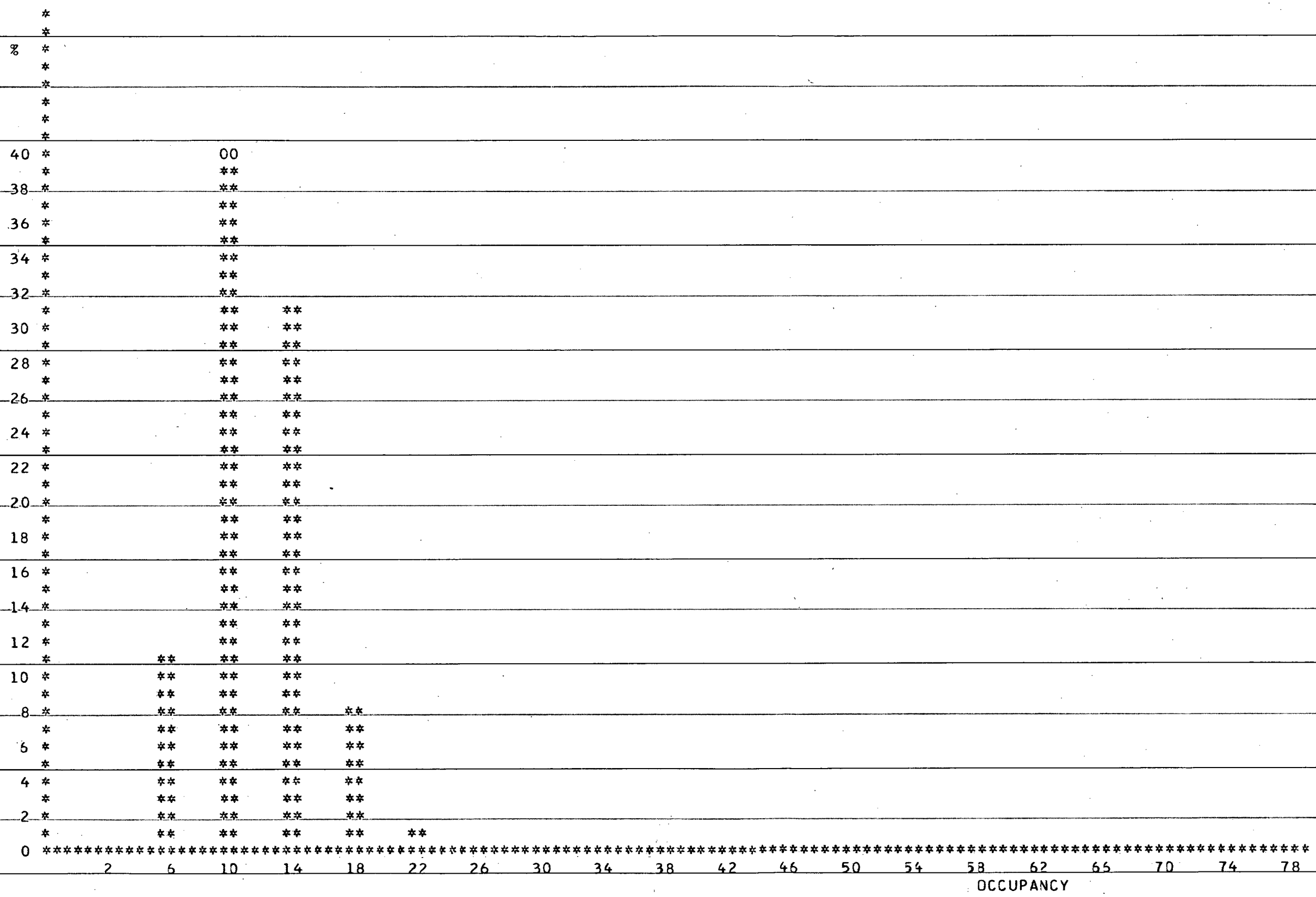


FIGURE 16: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEDUSLY THE SYSTEM

END

CPU TIME USED:

ASSEMBLY: 3.145 SECONDS

EXECUTION: 35.850 SECONDS

EXECUTION TERMINATED

\$\$SIGNOFF

**LAST SIGNON WAS: 00:12:49 12-30-70

MMMMM		MMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSS
MMMMMM		MMMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSSSSSS
MMMMMMM		MMMMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSSSSSSSSSS
MMMMMMMM		MMMMMMMM	TTTTT	SSSSSS
MMMMMMMMM		MMMMMMMMM	TTTTT	SSSSS
MMMMMMMMMM		MMMMMMMMMM	TTTTT	SSSSS
MMMMM	MMMMM	MMMMM	MMMMM	TTTTT
MMMMM	MMMMM	MMMMM	MMMMM	TTTTT
MMMMM	MMMMM	MMMMM	MMMMM	TTTTT
MMMMM	MMMMMMMMMMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSS
MMMMM	MMMMMMMMMM	MMMMM	TTTTT	SSSSSSSS
MMMMM	MMMMMMM	MMMMM	TTTTT	SSSSS
MMMMM	MMMMM	MMMMM	TTTTT	SSSSS
MMMMM	MMM	MMMMM	TTTTT	SSSSS
MMMMM		MMMMM	TTTTT	SSSSSSS
MMMMM		MMMMM	TTTTT	SSSSSSSSSSSSSSSSSS
MMMMM		MMMMM	TTTTT	SSSSSSSSSSSSSS
MMMMM		MMMMM	TTTTT	SSSSSSSSS

***** THIS JOB SUBMITTED THROUGH FRONT DESK READER *****
\$SIGNON WULI T=150 P=400 PRIO=V COPIES=4
**LAST SIGNON WAS: 10:54:13 12-29-70
USER "WULI" SIGNED ON AT 00:12:49 ON 12-30-70
\$RUN *GPSS PAR=SIZE=B
EXECUTION BEGINS

BLOCK NUMBER	*LOC	OPERATION	A,B,C,D,E,F,G	COMMENTS	CARD NUMBER
		SIMULATE			1
	*	SIMULATION OF UBC RECORDINGS COLLECTION BY JOHANNES KRAMAR			2
	*				3
	*	FUNCTION DEFINITIONS			4
	*				5
	*	SYSTEM ARRIVAL TIME EXPONENTIALLY DISTRIBUTED			6
		ARRIV FUNCTION	RN1,C11	NEG. EXP. DISTR.	7
		0.0,0.0/.423,.25/.667,.75/.808,1.25/.889,1.75/.936,2.25/.963,2.75/			8
		.979,3.25/.988,3.75/.990,4.25/1.0,7.25			9
	*				10
					11
	*	DESK SERVICE TIME EXPONENTIALLY DISTRIBUTED			12
		DESK FUNCTION	RN1,C24	NEG. EXP. DISTR.	13
		0.0,0.0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69/.6,.915/.7,1.2/			14
		.75,1.38/.8,1.6/.84,1.83/.88,2.12/.9,2.3/.92,2.52/.94,2.81/.95,2.99			15
		.96,3.2/.97,3.5/.98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7.0/.9997,8.0			16
	*				17
	*	SHELF SERVICE TIME EXPONENTIALLY DISTRIBUTED			18
		SHELF FUNCTION	RN1,C23	NEG. EXP. DISTR.	19
		0.0,0.0/.154,.840/.281,.250/.390,.420/.483,.580/.562,.750/.629,.92/			20
		.685,1.08/.733,1.25/.774,1.42/.808,1.59/.837,1.75/.862,1.92			21
		.883,2.08/.9,2.25/			22
		.916,2.42/.927,2.58/.937,2.75/.946,2.92/.953,3.08/.959,3.25			23
		.964,3.42/1.0,5.27			24
	*				25
	*	LISTENING ROOM SERVICE TIME GENERALLY DISTRIBUTED			26
		LIST FUNCTION	RN1,C25	GEN. DISTRIBUTION	27
		0.0,0.0/.024,.063/.071,.187/.131,.312/.205,.437/.289,.563/.366,.690/			28
		.436,.820/.498,.940/.556,1.06/.623,1.18/.699,1.31/.754,1.44/.786,1.56/			29
		.814,1.69/.836,1.81/.855,1.94/.872,2.06/.888,2.18/.903,2.31/.917,2.44/			30
		.927,2.55/.962,3.19/.989,4.20/1.00,4.820			31
	*				32
	*	STORAGE DEFINITIONS			33
	10	STORAGE	200	DEFINE SIZE OF SYSTEM,S STORAGE	34
	11	STORAGE	150	DEFINE SIZE OF REC. COLL.	35
	30	STORAGE	100	DEFINE SIZE OF STOR. 30	36
	40	STORAGE	23	DEFINE SIZE OF STOR. 40	37
	41	STORAGE	23	DEFINE SIZE OF STOR. 41	38
	*	TABLE DEFINITIONS			39
	TAB1	TABLE	IA,1,1,20	INTERARRIVAL TIME	40
	TAB2	TABLE	RT,0,1,30,10	ARRIVAL RATE	41
	TAB3	TABLE	M1,1,1,30	TRANSIT TIME TABLE	42
	TAB4	QTABLE	2,0,1,30	UNITS IN QUE.	43
	TAB5	TABLE	IA,1,1,30	INTERARRIVAL TIME SHELVES	44
	TAB6	TABLE	RT,0,1,20,10	ARRIVAL RATE	45
	TAB7	TABLE	M1,1,1,60	TRANSIT TIME	46
	TAB8	TABLE	S30,0,1,40	STOR. 30 OCCUPANCY	47
	TAB9	TABLE	M1,1,1,60	TRANS. TIME SERVI	48
	TAB10	TABLE	S11,0,1,60	STORAGE 11 OCCUPANCY	49
	TAB11	TABLE	IA,1,1,30	INTERARR. TIME FAC. 40	50
	TAB12	TABLE	RT,0,1,15,10	ARRIVALS FAC. 40	51
	TAB13	TABLE	M1,0,5,60	TRANS. TIME FAC. 40	52
	TAB14	TABLE	S40,0,1,26	STORE 40 OCCUPANCY	53
	TAB15	TABLE	M1,0,5,60	TRANS. TIME IN SYSTEM	54
	TAB16	TABLE	S10,0,2,60	SYST. OCCUPANCY	55
	TAB17	TABLE	S41,0,1,26	STOR. 41 OCCUPANCY	56

*
* GPSS PROGRAM
*

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1		GENERATE	2, FN\$ARRIV	ARRIVALS TO SYSTEM
2		ENTER	10	CUM. STOR. SYSTEM
3		TRANSFER	.36, STG3, STG2	GO TO 3 OR 2
4	STG2	MARK		SET TRANS. TIME = 0
5		ENTER	11	CUM. STORE RC.
6		QUEUE	2	JOIN QUE. 2
7		LINK	2, FIFO, DESK	LINK USER CHAIN 2

8	DESK	SEIZE	2	OCC. DESK	67
9		DEPART	2	LEAVE QUE. 2	68
10		ADVANCE	1, FN\$DESK	DESK SERVICE	69
11		RELEASE	2	RELEASE DESK	70
12		UNLINK	2, DESK, 1	UNLINK USER CHAIN 2	71
13		TABULATE	TAB1	TAB. INTERARR. TIME	72
14		TABULATE	TAB2	TAB. ARRIVALS	73
15		TABULATE	TAB3	TAB. TRANS. TIME	74
16		LEAVE	11		75
17		TABULATE	TAB9		76
18		TABULATE	TAB10		77
19		ASSIGN	2, K1	SET PI TO 1	78
20		TEST LE	C1, K3600, FINE	TEST TIME	79
21		TEST E	P3, K1, GEH2		80
22		TEST E	P4, K1, GEH3		81
23		TRANSFER	, EXIT		82
24	GEH2	TEST E	P4, K1, GEH4		83
25		TRANSFER	.75, STG3, EXIT		84
26	GEH3	TRANSFER	.96, STG4, EXIT		85
27	GEH4	TRANSFER	.73, GEH5, EXIT		86
28	GEH5	TRANSFER	.11, STG3, STG4		87
29	STG3	MARK			88
30		ENTER	11	CUM. STORE RC.	89
31		ENTER	30	ENTER STOR. 30	90
32		ADVANCE	6, FN\$SHELF	SHELF SERVICE TIME	91
33		LEAVE	30	LEAVE STOR. 30	92
34		TABULATE	TAB5	INTERARRIVAL TIME	93
35		TABULATE	TAB6	ARRIVAL RATE	94
36		TABULATE	TAB7	TRANSIT TIME	95
37		TABULATE	TAB8	STORE. SHELVES OCCUPANCY	96
38		LEAVE	11	LEAVE STORE 11	97
39		TABULATE	TAB9		98
40		TABULATE	TAB10	STORE RECORD. COLLECT.	99
41		ASSIGN	3, K1	SET P2 TO 1	100
42		TEST LE	C1, K3600, FINE	TEST TIME	101
43		TEST E	P2, K1, GEH7		102
44		TEST E	P4, K1, GEH8		103
45		TRANSFER	, EXIT		104
46	GEH7	TEST E	P4, K1, GEH9		105
47		TRANSFER	.28, STG2, EXIT		106
48	GEH8	TRANSFER	.22, STG4, EXIT		107
49	GEH9	TRANSFER	.14, GEH10, EXIT		108
50	GEH10	TRANSFER	.58, STG2, STG4		109
51	STG4	MARK			110
52		GATE SNF	40, OFLOW		111
53		ENTER	40	ENTER STOR. 40	112
54		ADVANCE	40, FN\$LIST	LIST. ROOM SERVICE TIME	113
55		LEAVE	40	LEAVE STORAGE 40	114
56		TABULATE	TAB11	INTER ARRIVAL TIME FAC 4	115
57		TABULATE	TAB12	ARRIVAL RATE FAC. 4	116
58		TABULATE	TAB13	TRANSIT TIME FAC. 4	117
59		TABULATE	TAB14	STORE. 40 OCCUPANCY	118
60		TRANSFER	, BEIDE		119
61	OFLOW	ENTER	41		120

62		ADVANCE	40,FN\$LIST	LIST. ROOM SERVICE TIME	121
63		LEAVE	41		122
64		TABULATE	TAB17	OCCUP. OF RESERV. LIST. ROOM	123
65		TRANSFER	,BEIDE		124
66	BEIDE	ASSIGN	4,K1	SET P4 TO 1	125
67		TEST E	P3,K1,GEH11		126
68		TRANSFER	.09,STG2,EXIT		127
69	GEH11	TEST LE	C1,K3600,FINE	TEST TIME	128
70		TEST E	P2,K1,GEH13		129
71		TRANSFER	.38,STG3,EXIT		130
72	GEH13	TRANSFER	.08,GEH14,EXIT		131
73	GEH14	TRANSFER	.14,STG2,STG3		132
74	EXIT	LEAVE	10	LEAVE SYST. STOR.	133
75		TABULATE	TAB15	TRANS. TIME IN SYSTEM	134
76		TABULATE	TAB16	SYSTEM OCCUPANCY	135
77		TERMINATE			136
78	FINE	LEAVE	10	LEAVE SYST. STOR.	137
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80		TABULATE	TAB16	SYSTEM OCCUPANCY	139
81		TERMINATE	1		140
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	*				143
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		EJECT			145
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	QUE	TITLE	2, STATISTICS CONCERNING THE DESK QUEUE		148
		SPACE	3		149
	CHA	TITLE	2, STATISTICS CONCERNING THE DESK USER CHAIN		150
		EJECT			151
	TAB	TITLE	1, DESK INTERARRIVAL TIMES (MIN.)		152
		EJECT			153
	*				154
	*	GRAPH			155
		GRAPH	TP,TAB1		156
		ORIGIN	50,10		157
		X	,2,13,1,1,8		158
		Y	0,4,20,2		159
	7	STATEMENT	4,1,%		160
	100	STATEMENT	52,24,INTERARRIVAL TIME (MIN.)		161
	10	STATEMENT	55,46,FIGURE 1: REL. FREQUENCY OF INTERARRIVAL TIMES		162
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	*				164
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		EJECT			166
	*				167
	*	GRAPH			168
		GRAPH	TP,TAB2		169
		ORIGIN	50,10		170
		X	,2,2,0,1,30		171
		Y	0,1,21,2		172
	7	STATEMENT	4,1,%		173
	100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.		174

10	STATEMENT	55,64,FIGURE 2: REL. FREQUENCY OF ARRIVALS TO INF. DE1	175
	SK DURING 10 MIN.		176
	ENDGRAPH		177
*			178
TAB	TITLE	3,DESK TRANSIT TIMES (MIN.) (=WAIT. & SERVICE TIME)	179
	EJECT		180
*			181
* GRAPH			182
	GRAPH	TP,TAB3	183
	ORIGIN	50,10	184
	X	,,14,1,1,8	185
	Y	0,3,20,2	186
7	STATEMENT	4,1,%	187
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	188
10	STATEMENT	55,60,FIGURE 3: REL. FREQUENCY OF TRANST TIMES AT INF1	189
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	ENDGRAPH		191
*			192
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	EJECT		194
*			195
* GRAPH			196
	GRAPH	TP,TAB4	197
	ORIGIN	50,10	198
	X	,2,13,0,1,8	199
	Y	0,3,20,2	200
7	STATEMENT	4,1,%	201
100	STATEMENT	52,13,JOBS IN QUEUE	202
10	STATEMENT	55,72,FIGURE 4: REL. FREQUENCY OF JOBS WAITING FOR SEI	203
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	EJECT		210
*			211
* GRAPH			212
	GRAPH	TP,TAB5	213
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	X	,2,18,1,1,6	215
	Y	0,4,20,2	216
7	STATEMENT	4,1,%	217
100	STATEMENT	52,24,INTERARRIVAL TIME (MIN.)	218
10	STATEMENT	55,46,FIGURE 5: REL. FREQUENCY OF INTERARRIVAL TIMES	219
	ENDGRAPH		220
*			221
TAB	TITLE	6,NUMBER OF ARRIVALS TO SHELVES/10 MIN.	222
	EJECT		223
* GRAPH			224
	GRAPH	TP,TAB6	225
	ORIGIN	50,10	226
	X	,2,4,0,1,20	227
	Y	0,1,20,2	228

7	STATEMENT	4,1,%	229
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.	230
10	STATEMENT	55,62,FIGURE 6: REL. FREQUENCY OF ARRIVALS TO SHELVES1	231
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*			234
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	EJECT		236
*			237
* GRAPH			238
	GRAPH	TP,TAB7	239
	ORIGIN	50,10	240
	X	,,5,1,1,15	241
	Y	0,1,24,2	242
7	STATEMENT	4,1,%	243
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	244
10	STATEMENT	55,52,FIGURE 7: REL. FREQUENCY OF TRANSIT TIMES AT SHI	245
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	ENDGRAPH		247
*			248
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	EJECT		250
*			251
* GRAPH			252
	GRAPH	TP,TAB8	253
	ORIGIN	50,10	254
	X	,2,6,0,1,15	255
	Y	0,1,24,2	256
7	STATEMENT	4,1,%	257
100	STATEMENT	52,9,OCCUPANCY	258
10	STATEMENT	55,79,FIGURE 8: REL. FREQUENCY OF NUMBER OF JOBS OCCU1	259
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TAB	TITLE	9,TRANSIT TIMES THROUGH REC. COLL. (MIN.) , (=DESK & 1	266
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	EJECT		268
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* GRAPH			270
	GRAPH	TP,TAB9	271
	ORIGIN	50,10	272
	X	,,7,1,1,15	273
	Y	0,1,45,1	274
7	STATEMENT	4,1,%	275
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	276
10	STATEMENT	55,75,FIGURE 9: REL. FREQUENCY OF TRANSIT TIMES THROU1	277
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*			280
TAB	TITLE	10,OCCUPANCY OF RECORD. COLLECT. (=DESK & SHELVES)	281
	EJECT		282

*			283
* GRAPH			284
	GRAPH	TP,TAB10	285
	ORIGIN	50,10	286
	X	,2,4,0,1,20	287
	Y	0,1,15,3	288
7	STATEMENT	4,1,%	289
100	STATEMENT	52,9,OCCUPANCY	290
10	STATEMENT	55,85,FIGURE 10: REL. FREQUENCY OF NUMBER OF JOBS OCC1	291
UPYING	SIMULTANEOUSLY	DESK AND SHELVES	292
	ENDGRAPH		293
*			294
STO	TITLE	40,THE LISTENING ROOM AS STORAGE	295
	SPACE	3	296
TAB	TITLE	11,LISTENING ROOM INTERARRIVAL TIMES (MIN.)	297
	EJECT		298
*			299
* GRAPH			300
	GRAPH	TP,TAB11	301
	ORIGIN	50,10	302
	X	,,7,1,1,15	303
	Y	0,4,15,3	304
7	STATEMENT	4,1,%	305
100	STATEMENT	52,25,INTERARRIVAL TIME (MIN.)	306
10	STATEMENT	55,64,FIGURE 11: REL. FREQUENCY OF INTERARRIVAL TIMES1	307
	TO LISTENING ROOM		308
	ENDGRAPH		309
*			310
TAB	TITLE	12,NUMBER OF ARRIVALS TO LIST. ROOM/10 MIN	311
	EJECT		312
*			313
* GRAPH			314
	GRAPH	TP,TAB12	315
	ORIGIN	50,10	316
	X	,2,6,0,1,15	317
	Y	0,1,24,2	318
7	STATEMENT	4,1,%	319
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.	320
10	STATEMENT	55,70,FIGURE 12: REL. FREQUENCY OF ARRIVALS TO LISTEN1	321
	ING ROOM DURING 10 MIN.		322
	ENDGRAPH		323
*			324
TAB	TITLE	13,LIST. ROOM SERVICE TIMES (MIN.)	325
	EJECT		326
*			327
* GRAPH			328
	GRAPH	TP,TAB13	329
	ORIGIN	50,10	330
	X	,,3,5,1,30	331
	Y	0,1,21,2	332
7	STATEMENT	4,1,%	333
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	334
10	STATEMENT	55,58,FIGURE 13: REL. FREQUENCY OF TRANSIT TIME OF LII	335
	STENING ROOM		336

	ENDGRAPH		337
*			338
TAB	TITLE	14, OCCUPANCY OF LIST. ROOM	339
	EJECT		340
*			341
* GRAPH			342
	GRAPH	TP, TAB14	343
	ORIGIN	50,10	344
	X	,2,4,6,1,18	345
	Y	0,1,16,3	346
7	STATEMENT	4,1,%	347
100	STATEMENT	52,9,OCCUPANCY	348
10	STATEMENT	55,87,FIGURE 14: REL. FREQUENCY OF NUMBER OF JOBS OCC1	349
UPYING	SIMULTANEOUSLY THE LISTENING ROOM		350
	ENDGRAPH		351
*			352
STO	TITLE	41, THE RESERV. LISTENING ROOM AS STORAGE	353
	SPACE	3	354
TAB	TITLE	17, OCCUPANCY OF RESERVE LIST. ROOM	355
	EJECT		356
*			357
* GRAPH			358
	GRAPH	TP, TAB17	359
	ORIGIN	50,10	360
	X	,2,6,0,1,15	361
	Y	0,1,35,1	362
7	STATEMENT	4,1,%	363
100	STATEMENT	52,9,OCCUPANCY	364
10	STATEMENT	55,96,FIGURE 14A: REL. FREQUENCY OF NUMBER OF JOBS OC1	365
CUPYING	SIMULTANEOUSLY THE LISTENING ROOM		366
	ENDGRAPH		367
*			368
STO	TITLE	10, THE SYSTEM AS STORAGE	369
	SPACE	3	370
TAB	TITLE	15, SYSTEM TRANSIT TIMES (MIN.) (=SERVICE & WAIT. TIME1	371
)			372
	EJECT		373
*			374
* GRAPH			375
	GRAPH	TP, TAB15	376
	ORIGIN	50,10	377
	X	,,3,5,1,30	378
	Y	0,5,20,2	379
7	STATEMENT	4,1,%	380
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	381
10	STATEMENT	55,49,FIGURE 15: REL. FREQUENCY OF SYSTEM TRANSIT TIM1	382
ES			383
	ENDGRAPH		384
*			385
TAB	TITLE	16, OCCUPANCY OF SYSTEM (=DESK, SHELVES, LIST. ROOM)	386
	EJECT		387
*			388
* GRAPH			389
	GRAPH	TP, TAB16	390

	ORIGIN	50,10	391
	X	,2,4,2,2,20	392
	Y	0,2,20,2	393
7	STATEMENT	4,1,%	394
100	STATEMENT	52,9,OCCUPANCY	395
10	STATEMENT	55,79,FIGURE 16: REL. FREQUENCY OF NUMBER OF JOBS OCC1	396
UPYING	SIMULTANEOUSLY THE SYSTEM		397
	ENDGRAPH		398
*			399
	END		400

BLOCK NUMBER

SYMBOL

REFERENCES BY CARD NUMBER

66	BEIDE	119	124					
8	DESK	66	71					
74	EXIT	82	84	85	86	104	106	107
		108	127	130	131			
78	FINE	79	101	128				
50	GEH10	108						
69	GEH11	126						
72	GEH13	129						
73	GEH14	131						
24	GEH2	80						
26	GEH3	81						
27	GEH4	83						
28	GEH5	86						
46	GEH7	102						
48	GEH8	103						
49	GEH9	105						
61	CFLOW	111						
4	STG2	62	106	109	127	132		
29	STG3	62	84	87	130	132		
51	STG4	85	87	107	109			

TABLE SYMBOLS AND CORRESPONDING NUMBERS

1	TAB1
10	TAB10
11	TAB11
12	TAB12
13	TAB13
14	TAB14
15	TAB15
16	TAB16
17	TAB17
2	TAB2
3	TAB3
4	TAB4
5	TAB5
6	TAB6
7	TAB7
8	TAB8
9	TAB9

FUNCTION SYMBOLS AND CORRESPONDING NUMBERS

1	ARRIV
2	DESK
4	LIST
3	SHELF

*
 * FUNCTION DEFINITIONS
 *
 * SYSTEM ARRIVAL TIME EXPONENTIALLY DISTRIBUTED

1	FUNCTION	RN1	C11			
0.0	0.0	.423	.25	.667	.75	
.808	1.25	.889	1.75	.936	2.25	
.963	2.75	.979	3.25	.988	3.75	
.990	4.25	1.0	7.25			

*
 * DESK SERVICE TIME EXPONENTIALLY DISTRIBUTED

2	FUNCTION	RN1	C24			
0.0	0.0	.1	.104	.2	.222	
.3	.355	.4	.509	.5	.69	
.6	.915	.7	1.2	.75	1.38	
.8	1.6	.84	1.83	.88	2.12	
.9	2.3	.92	2.52	.94	2.81	
.95	2.99	.96	3.2	.97	3.5	
.98	3.9	.99	4.6	.995	5.3	
.998	6.2	.999	7.0	.9997	8.0	

*
 * SHELF SERVICE TIME EXPONENTIALLY DISTRIBUTED

3	FUNCTION	RN1	C23			
0.0	0.0	.154	.840	.281	.250	
.390	.420	.483	.580	.562	.750	
.629	.92	.685	1.08	.733	1.25	
.774	1.42	.808	1.59	.837	1.75	
.862	1.92	.883	2.08	.9	2.25	
.916	2.42	.927	2.58	.937	2.75	
.946	2.92	.953	3.08	.959	3.25	
.964	3.42	1.0	5.27			

*
 * LISTENING ROOM SERVICE TIME GENERALLY DISTRIBUTED

4	FUNCTION	RN1	C25			
0.0	0.0	.024	.063	.071	.187	
.131	.312	.205	.437	.289	.563	
.366	.690	.436	.820	.498	.940	
.556	1.06	.623	1.18	.699	1.31	
.754	1.44	.786	1.56	.814	1.69	
.836	1.81	.855	1.94	.872	2.06	
.888	2.18	.903	2.31	.917	2.44	
.927	2.55	.962	3.19	.989	4.20	
1.00	4.820					

*
 * STORAGE DEFINITIONS

10	STORAGE	200
11	STORAGE	150
30	STORAGE	100
40	STORAGE	23
41	STORAGE	23

* TABLE DEFINITIONS

1	TABLE	IA	1	1	20	
2	TABLE	RT	0	1	30	10
3	TABLE	M1	1	1	30	
4	QTABLE	2	0	1	30	
5	TABLE	IA	1	1	30	
6	TABLE	RT	0	1	20	10
7	TABLE	M1	1	1	60	

8	TABLE	S30	0	1	40	
9	TABLE	M1	1	1	60	
10	TABLE	S11	0	1	60	
11	TABLE	IA	1	1	30	
12	TABLE	RT	0	1	15	10
13	TABLE	M1	0	5	60	
14	TABLE	S40	0	1	26	
15	TABLE	M1	0	5	60	
16	TABLE	S10	0	2	60	
17	TABLE	S41	0	1	26	

*
* GPSS PROGRAM

1	GENERATE	2	FN1		
2	ENTER	10			
3	TRANSFER	.360	29	4	
4	MARK				
5	ENTER	11			
6	QUEUE	2			
7	LINK	2	FIFO	8	
8	SEIZE	2			
9	DEPART	2			
10	ADVANCE	1	FN2		
11	RELEASE	2			
12	UNLINK	2	8	1	
13	TABULATE	1			
14	TABULATE	2			
15	TABULATE	3			
16	LEAVE	11			
17	TABULATE	9			
18	TABULATE	10			
19	ASSIGN	2	K1		
20	TEST LE	C1	K3600	78	
21	TEST E	P3	K1	24	
22	TEST E	P4	K1	26	
23	TRANSFER		74		
24	TEST E	P4	K1	27	
25	TRANSFER	.750	29	74	
26	TRANSFER	.960	51	74	
27	TRANSFER	.730	28	74	
28	TRANSFER	.110	29	51	
29	MARK				
30	ENTER	11			
31	ENTER	30			
32	ADVANCE	6	FN3		
33	LEAVE	30			
34	TABULATE	5			
35	TABULATE	6			
36	TABULATE	7			
37	TABULATE	8			
38	LEAVE	11			
39	TABULATE	9			
40	TABULATE	10			
41	ASSIGN	3	K1		
42	TEST LE	C1	K3600	78	
43	TEST E	P2	K1	46	
44	TEST E	P4	K1	48	
45	TRANSFER		74		
46	TEST E	P4	K1	49	
47	TRANSFER	.280	4	74	

48	TRANSFER	.220	51	74
49	TRANSFER	.140	50	74
50	TRANSFER	.580	4	51
51	MARK			
52	GATE SNF	40	61	
53	ENTER	40		
54	ADVANCE	40	FN4	
55	LEAVE	40		
56	TABULATE	11		
57	TABULATE	12		
58	TABULATE	13		
59	TABULATE	14		
60	TRANSFER		66	
61	ENTER	41		
62	ADVANCE	40	FN4	
63	LEAVE	41		
64	TABULATE	17		
65	TRANSFER		66	
66	ASSIGN	4	K1	
67	TEST E	P3	K1	69
68	TRANSFER	.090	4	74
69	TEST LE	C1	K3600	78
70	TEST E	P2	K1	72
71	TRANSFER	.380	29	74
72	TRANSFER	.080	73	74
73	TRANSFER	.140	4	29
74	LEAVE	10		
75	TABULATE	15		
76	TABULATE	16		
77	TERMINATE			
78	LEAVE	10		
79	TABULATE	15		
80	TABULATE	16		
81	TERMINATE	1		
* CONTROL CARD				
START		1		

STATISTICS CONCERNING THE INFORMATION DESK

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
2	.509	3055	.600		

STATISTICS CONCERNING THE DESK QUEUE

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
2	16	1.034	3055	1637	53.5	1.219	2.627	4	
AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES									

STATISTICS CONCERNING THE DESK USER CHAIN

USER CHAIN	TOTAL ENTRIES	AVERAGE TIME/TRANS	CURRENT CONTENTS	AVERAGE CONTENTS	MAXIMUM CONTENTS
2	1826	2.040		1.034	16

DESK INTERARRIVAL TIMES (MIN.)

TABLE TAB1
ENTRIES IN TABLE
3054

MEAN ARGUMENT
1.178

STANDARD DEVIATION
1.527

SUM OF ARGUMENTS
3598.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	2136	69.94	69.9	30.0	.848	-.116
2	439	14.37	84.3	15.6	1.697	.538
3	234	7.66	91.9	8.0	2.546	1.192
4	135	4.42	96.3	3.6	3.395	1.847
5	52	1.70	98.1	1.8	4.244	2.502
6	23	.75	98.8	1.1	5.092	3.157
7	16	.52	99.3	.6	5.941	3.811
8	7	.22	99.6	.3	6.790	4.466
9	7	.22	99.8	.1	7.639	5.121
10	2	.06	99.9	.0	8.488	5.775
11	1	.03	99.9	.0	9.336	6.430
12	1	.03	99.9	.0	10.185	7.085
13	1	.03	100.0	.0	11.034	7.740

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

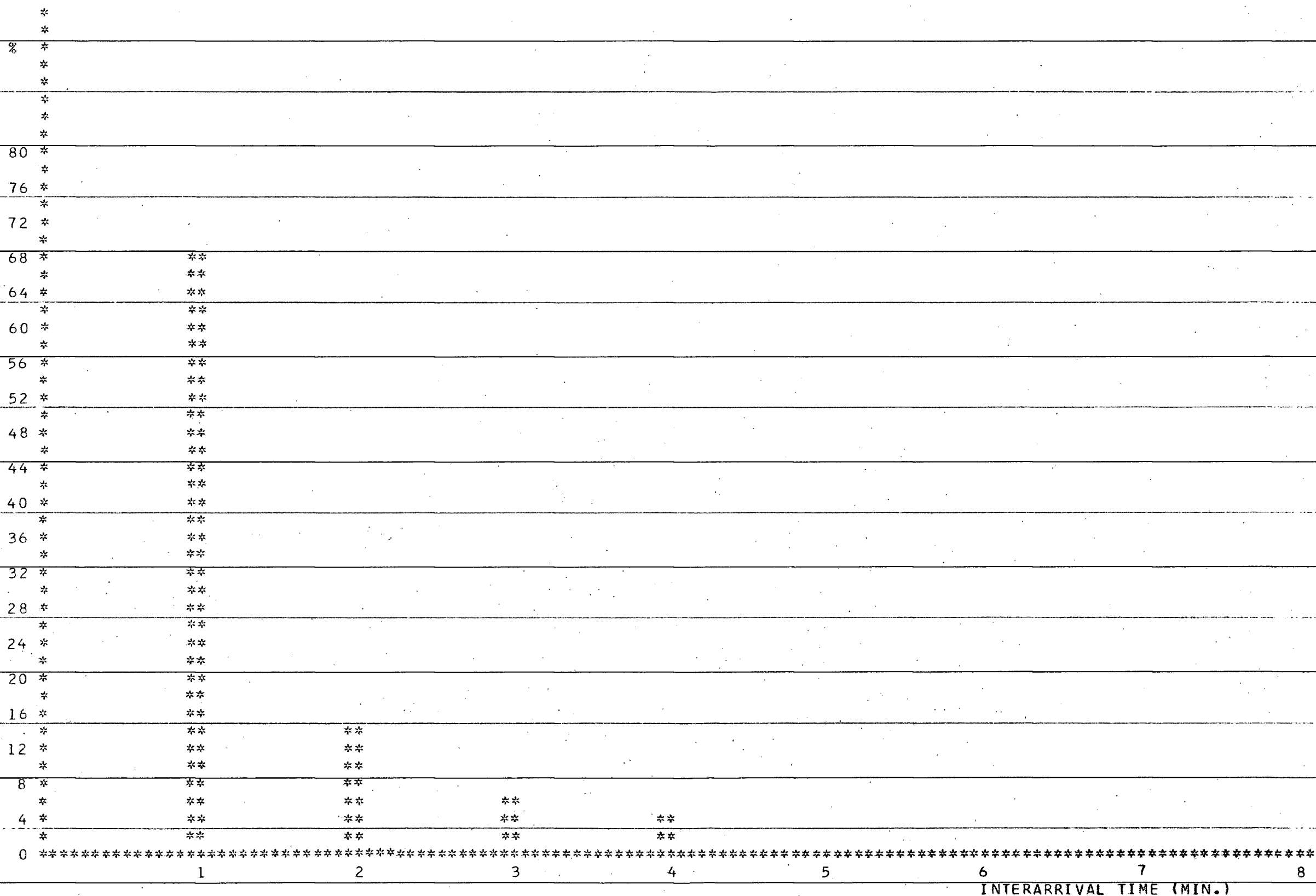


FIGURE 1: REL. FREQUENCY OF INTERARRIVAL TIMES

NUMBER OF ARRIVALS TO DESK/10 MIN.

TABLE TAB2
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

NON-WEIGHTED

360

8.480

3.953

3053.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	2	.55	.5	99.4	-.000	-2.145
1	2	.55	1.1	98.8	.117	-1.892
2	5	1.38	2.4	97.5	.235	-1.639
3	21	5.83	8.3	91.6	.353	-1.386
4	15	4.16	12.4	87.5	.471	-1.133
5	31	8.61	21.1	78.8	.589	-.880
6	44	12.22	33.3	66.6	.707	-.627
7	47	13.05	46.3	53.6	.825	-.374
8	44	12.22	58.6	41.3	.943	-.121
9	29	8.05	66.6	33.3	1.061	.131
10	24	6.66	73.3	26.6	1.179	.384
11	22	6.11	79.4	20.5	1.297	.637
12	19	5.27	84.7	15.2	1.415	.890
13	15	4.16	88.8	11.1	1.532	1.143
14	12	3.33	92.2	7.7	1.650	1.396
15	7	1.94	94.1	5.8	1.768	1.649
16	5	1.38	95.5	4.4	1.886	1.902
17	4	1.11	96.6	3.3	2.004	2.155
18	9	2.49	99.1	.8	2.122	2.408
19	1	.27	99.4	.5	2.240	2.661
20	0	.00	99.4	.5	2.358	2.914
21	0	.00	99.4	.5	2.476	3.166
22	0	.00	99.4	.5	2.594	3.419
23	0	.00	99.4	.5	2.712	3.672
24	1	.27	99.7	.2	2.830	3.925
25	0	.00	99.7	.2	2.947	4.178
26	1	.27	100.0	.0	3.065	4.431

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

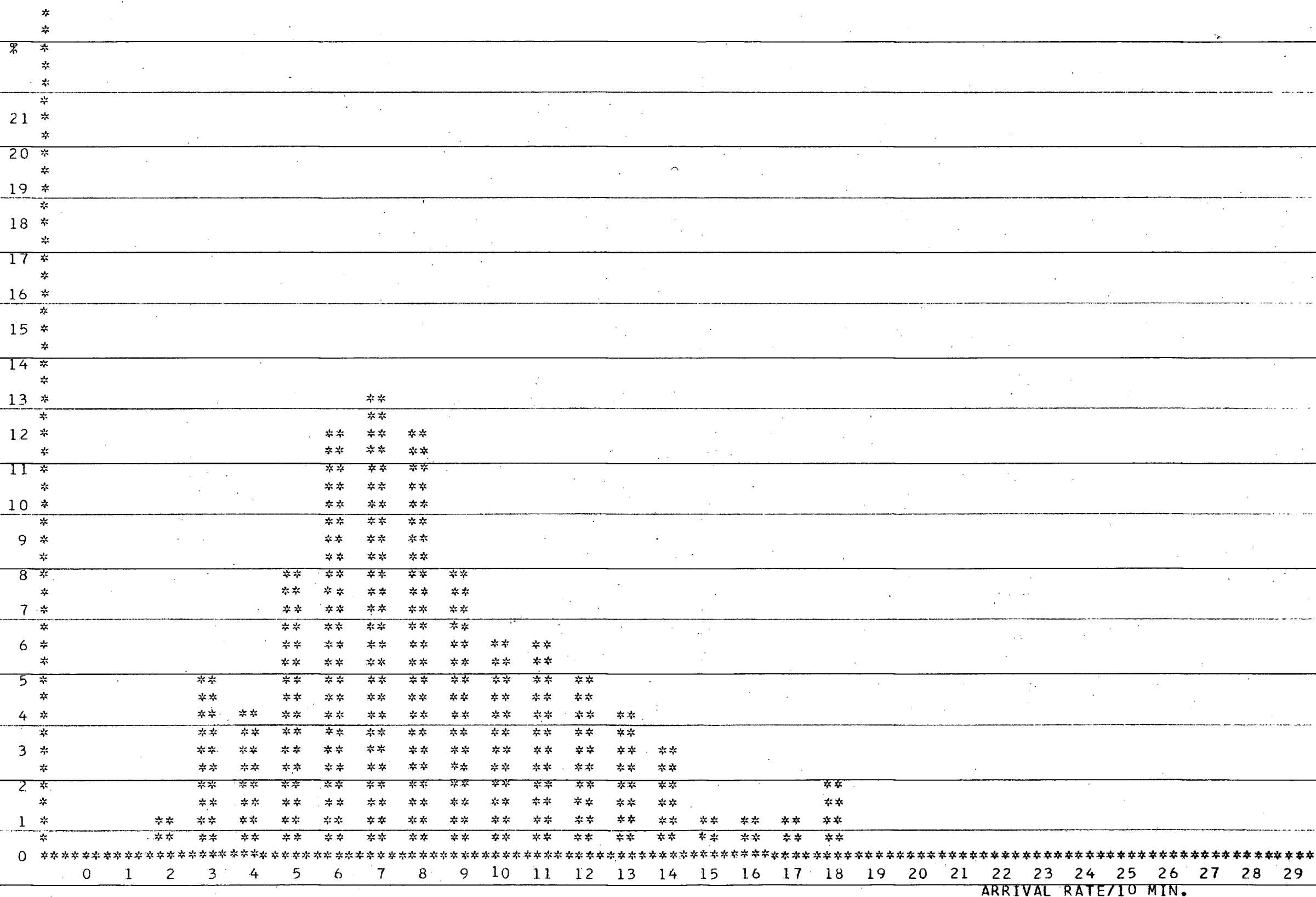


FIGURE 2: REL. FREQUENCY OF ARRIVALS TO INF. DESK DURING 10 MIN.

DESK TRANSIT TIMES (MIN.) (=WAIT. & SERVICE TIME)

TABLE TAB3
ENTRIES IN TABLE
3055MEAN ARGUMENT
1.820STANDARD DEVIATION
2.035SUM OF ARGUMENTS
5561.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	1715	56.13	56.1	43.8	.549	-.403
2	473	15.48	71.6	28.3	1.098	.088
3	327	10.70	82.3	17.6	1.648	.579
4	218	7.13	89.4	10.5	2.197	1.071
5	135	4.41	93.8	6.1	2.746	1.562
6	82	2.68	96.5	3.4	3.296	2.053
7	49	1.60	98.1	1.8	3.845	2.545
8	19	.62	98.7	1.2	4.394	3.036
9	13	.42	99.2	.7	4.944	3.527
10	14	.45	99.6	.3	5.493	4.019
11	6	.19	99.8	.1	6.042	4.510
12	2	.06	99.9	.0	6.592	5.001
13	2	.06	100.0	.0	7.141	5.493

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

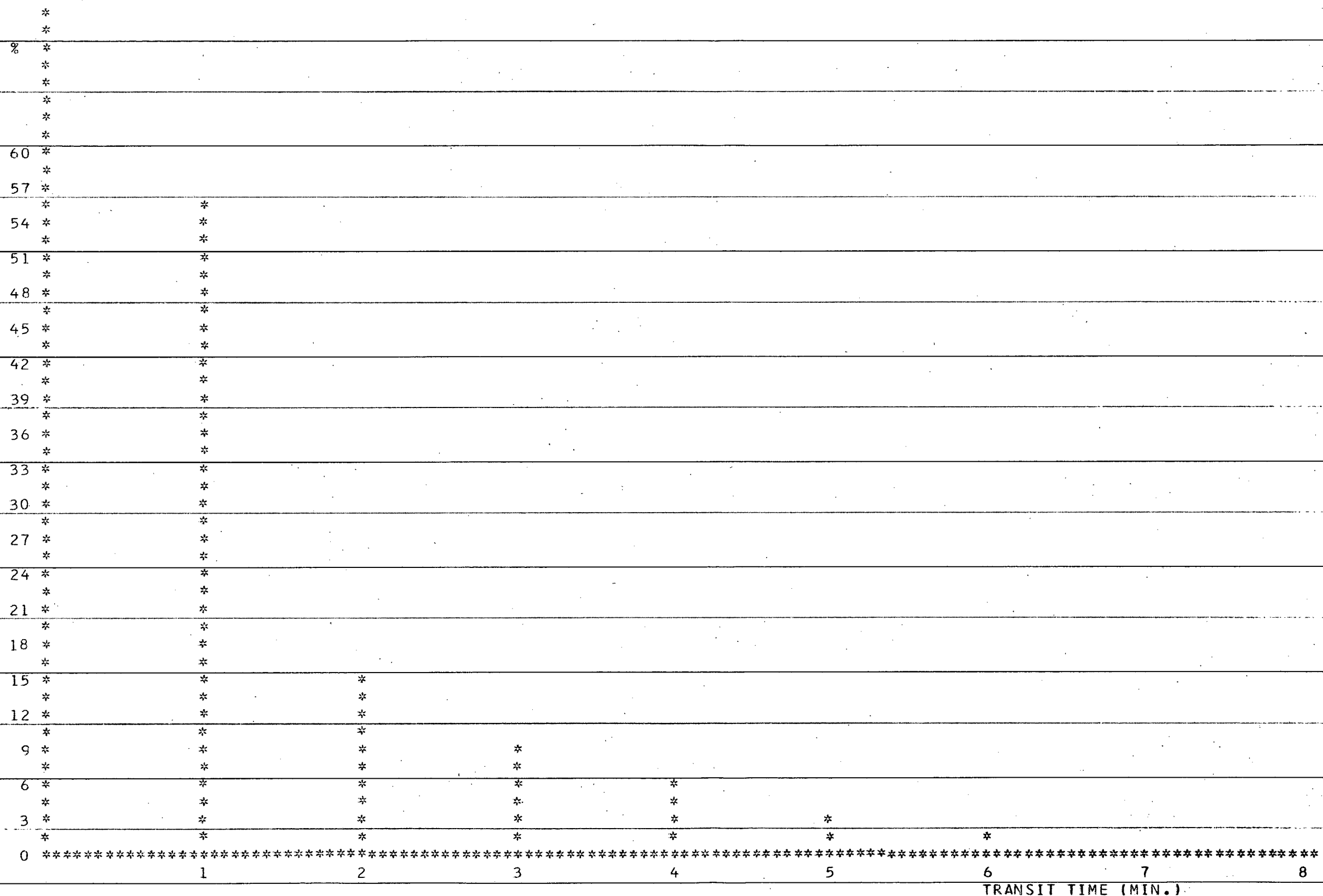


FIGURE 3: REL. FREQUENCY OF TRANST TIMES AT INFORMATION DESK

NUMBER OF JOBS WAITING FOR SERVICE AT DESK

TABLE TAB4
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

3055

1.219

1.824

3726.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	1637	53.58	53.5	46.4	-.000	-.668
1	498	16.30	69.8	30.1	.819	-.120
2	333	10.90	80.7	19.2	1.639	.427
3	238	7.79	88.5	11.4	2.459	.975
4	155	5.07	93.6	6.3	3.279	1.524
5	82	2.68	96.3	3.6	4.099	2.072
6	45	1.47	97.8	2.1	4.919	2.620
7	32	1.04	98.8	1.1	5.739	3.168
8	11	.36	99.2	.7	6.559	3.716
9	9	.29	99.5	.4	7.379	4.265
10	12	.39	99.9	.0	8.199	4.813
11	2	.06	99.9	.0	9.019	5.361
12	0	.00	99.9	.0	9.838	5.909
13	1	.03	100.0	.0	10.658	6.457

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

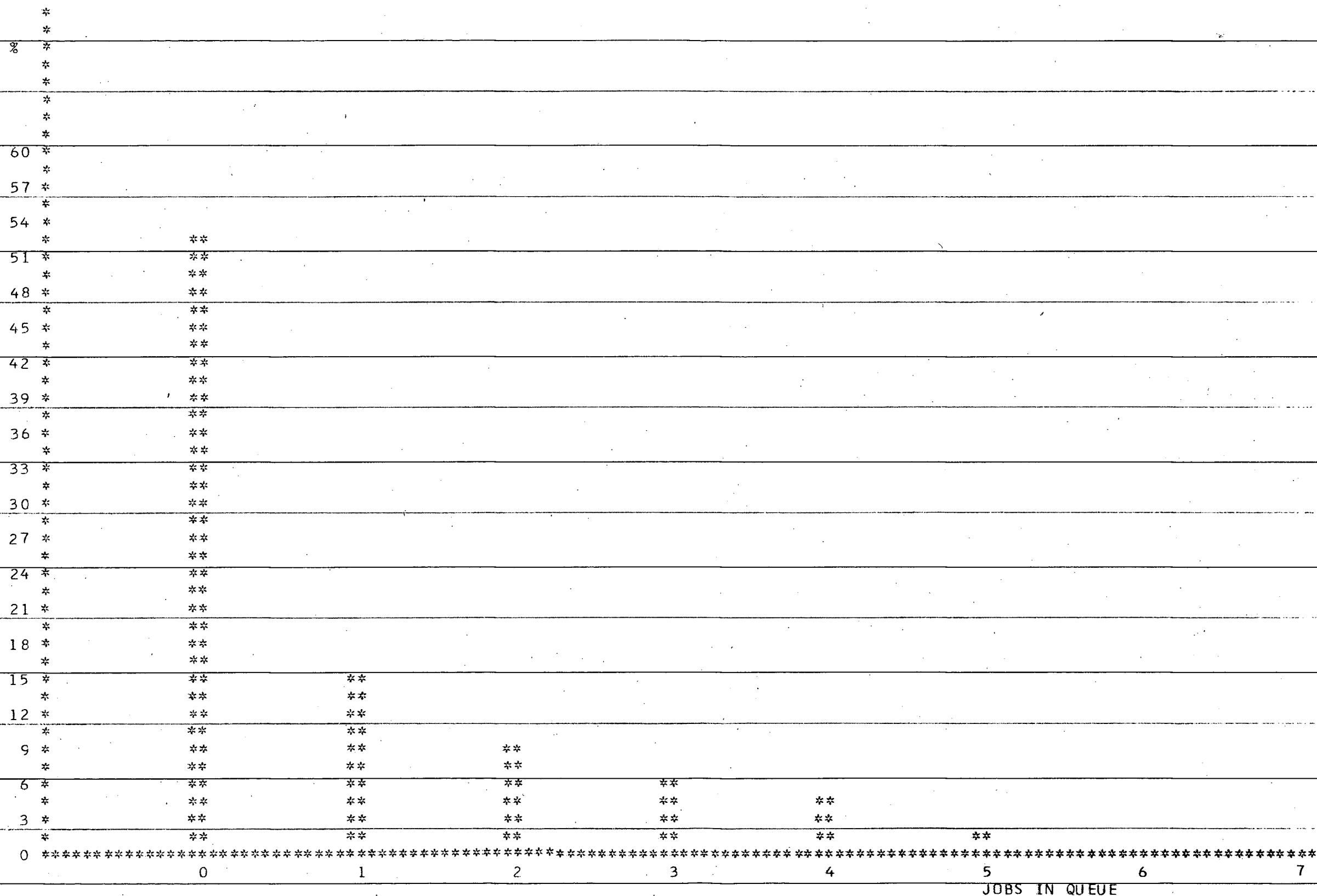


FIGURE 4: REL. FREQUENCY OF JOBS WAITING FOR SERVICE AT INFORMATION DESK

THE SHELVES AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
30	100	3.819	.038	2366	5.813	1	15

SHELF INTERARRIVAL TIMES (MIN.)

TABLE TAB5
ENTRIES IN TABLE
2364

MEAN ARGUMENT
1.521

STANDARD DEVIATION
1.722

SUM OF ARGUMENTS
3597.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	1524	64.46	64.4	35.5	.657	-.302
2	401	16.96	81.4	18.5	1.314	.277
3	190	8.03	89.4	10.5	1.971	.858
4	105	4.44	93.9	6.0	2.628	1.438
5	60	2.53	96.4	3.5	3.286	2.019
6	35	1.48	97.9	2.0	3.943	2.599
7	20	.84	98.7	1.2	4.600	3.180
8	9	.38	99.1	.8	5.257	3.760
9	9	.38	99.5	.4	5.914	4.341
10	5	.21	99.7	.2	6.572	4.921
11	1	.04	99.7	.2	7.229	5.502
12	1	.04	99.8	.1	7.886	6.082
13	1	.04	99.8	.1	8.543	6.663
14	1	.04	99.9	.0	9.201	7.243
15	2	.08	100.0	.0	9.858	7.824

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

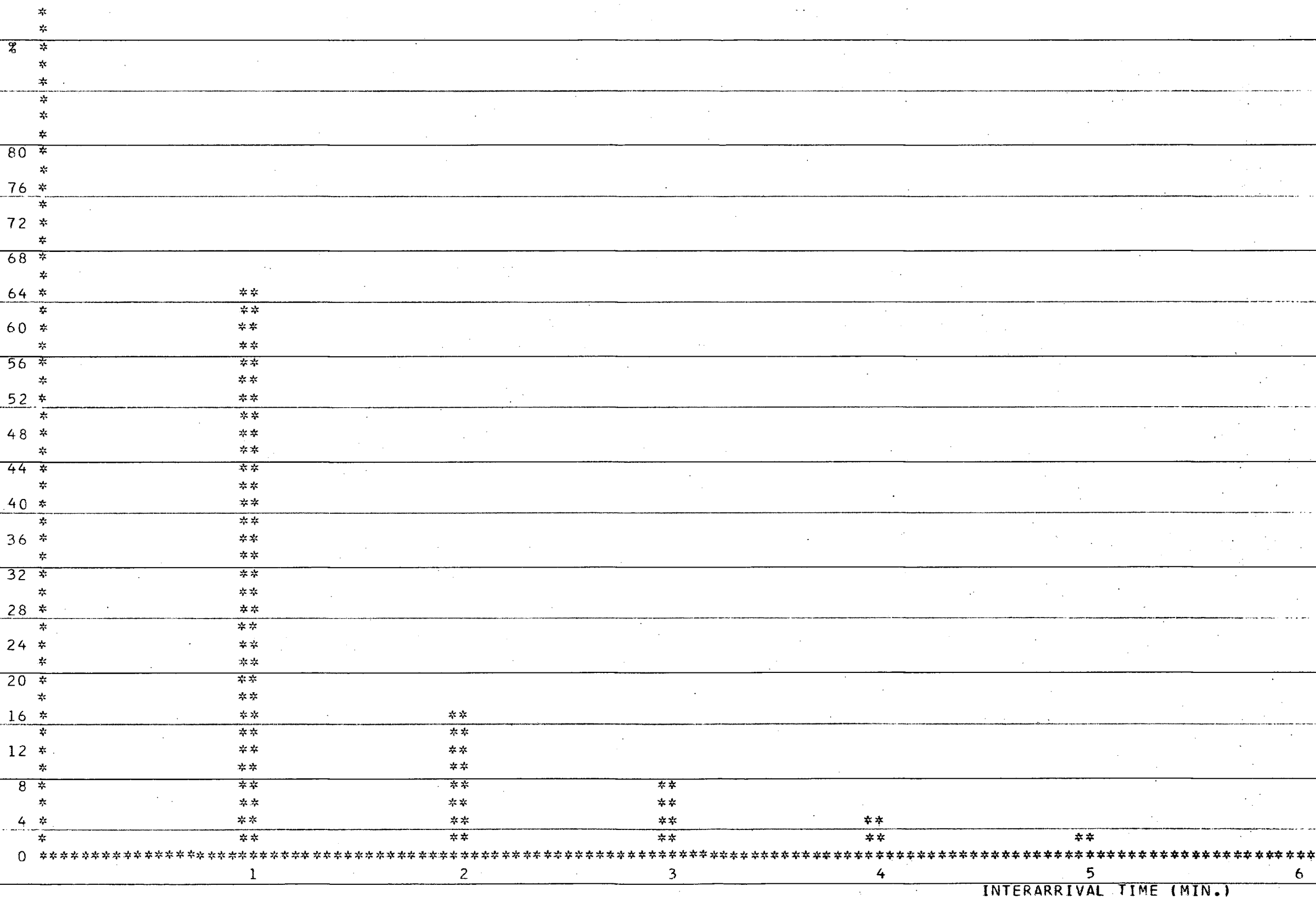


FIGURE 5: REL. FREQUENCY OF INTERARRIVAL TIMES

NUMBER OF ARRIVALS TO SHELVES/10 MIN.

TABLE TAB6
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

360

6.566

3.207

2364.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	3	.83	.8	99.1	-.000	-2.047
1	5	1.38	2.2	97.7	.152	-1.735
2	22	6.11	8.3	91.6	.304	-1.423
3	30	8.33	16.6	83.3	.456	-1.112
4	37	10.27	26.9	73.0	.609	-.800
5	57	15.83	42.7	57.2	.761	-.488
6	41	11.38	54.1	45.8	.913	-.176
7	38	10.55	64.7	35.2	1.065	.135
8	38	10.55	75.2	24.7	1.218	.446
9	24	6.66	81.9	18.0	1.370	.758
10	20	5.55	87.4	12.5	1.522	1.070
11	21	5.83	93.3	6.6	1.675	1.382
12	8	2.22	95.5	4.4	1.827	1.694
13	6	1.66	97.2	2.7	1.979	2.006
14	2	.55	97.7	2.2	2.131	2.317
15	5	1.38	99.1	.8	2.284	2.629
16	0	.00	99.1	.8	2.436	2.941
17	2	.55	99.7	.2	2.588	3.253
18	1	.27	100.0	.0	2.741	3.565

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

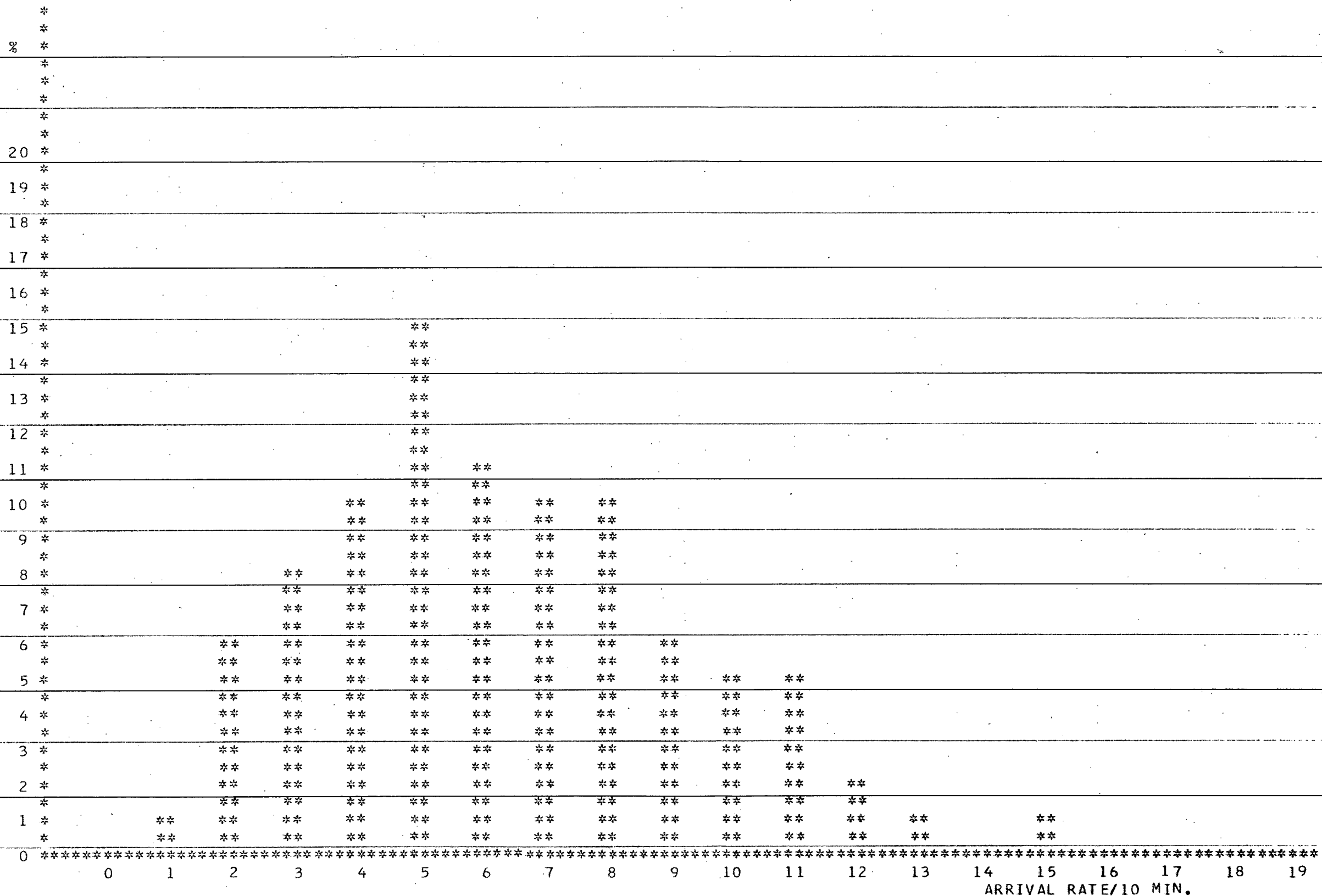


FIGURE 6: REL. FREQUENCY OF ARRIVALS TO SHELVES DURING 10 MIN.

SHELF TRANSIT TIMES (MIN)

TABLE TAB7
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

NON-WEIGHTED

2365

5.815

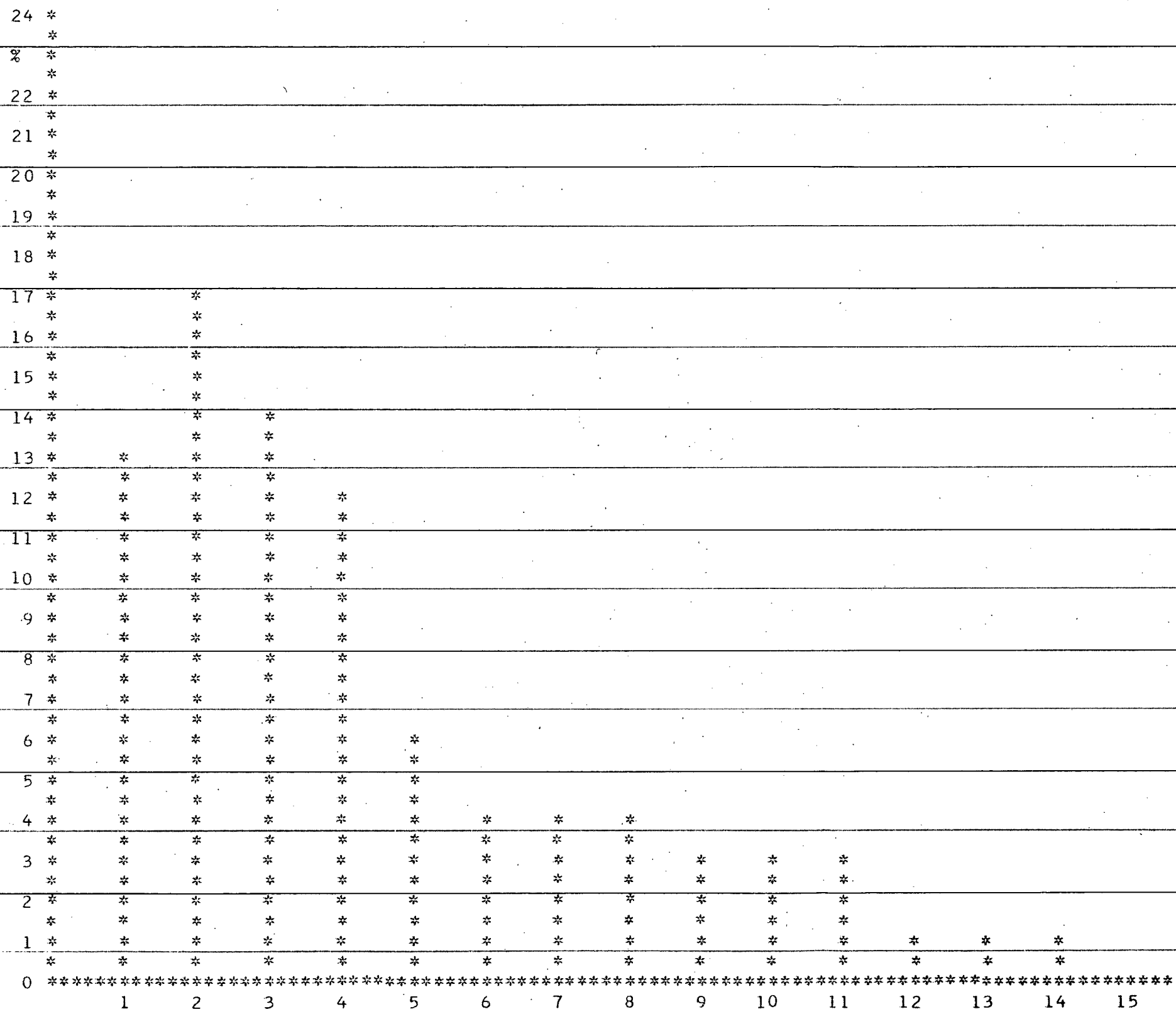
5.554

13753.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	324	13.69	13.6	86.3	.171	-.866
2	404	17.08	30.7	69.2	.343	-.686
3	343	14.50	45.2	54.7	.515	-.506
4	306	12.93	58.2	41.7	.687	-.326
5	142	6.00	64.2	35.7	.859	-.146
6	116	4.90	69.1	30.8	1.031	.033
7	104	4.39	73.5	26.4	1.203	.213
8	102	4.31	77.8	22.1	1.375	.393
9	71	3.00	80.8	19.1	1.547	.573
10	73	3.08	83.9	16.0	1.719	.753
11	87	3.67	87.6	12.3	1.891	.933
12	47	1.98	89.5	10.4	2.063	1.113
13	47	1.98	91.5	8.4	2.235	1.293
14	30	1.26	92.8	7.1	2.407	1.473
15	18	.76	93.6	6.3	2.579	1.653
16	17	.71	94.3	5.6	2.751	1.833
17	17	.71	95.0	4.9	2.923	2.013
18	13	.54	95.6	4.3	3.095	2.193
19	12	.50	96.1	3.8	3.267	2.373
20	9	.38	96.4	3.5	3.439	2.553
21	13	.54	97.0	2.9	3.611	2.733
22	14	.59	97.6	2.3	3.783	2.913
23	4	.16	97.8	2.1	3.955	3.093
24	9	.38	98.1	1.8	4.127	3.273
25	4	.16	98.3	1.6	4.299	3.453
26	6	.25	98.6	1.3	4.471	3.633
27	5	.21	98.8	1.1	4.642	3.813
28	8	.33	99.1	.8	4.814	3.993
29	7	.29	99.4	.5	4.986	4.173
30	8	.33	99.7	.2	5.158	4.353
31	5	.21	100.0	.0	5.330	4.533

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



TRANSIT TIME (MIN.)

FIGURE 7: REL. FREQUENCY OF TRANSIT TIMES AT SHELVES

OCCUPANCY OF SHELVES

TABLE TAB8
ENTRIES IN TABLE
2365

MEAN ARGUMENT
3.973

STANDARD DEVIATION
2.351

SUM OF ARGUMENTS
9397.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	78	3.29	3.2	96.7	-.000	-1.689
1	238	10.06	13.3	86.6	.251	-1.264
2	382	16.15	29.5	70.4	.503	-.839
3	415	17.54	47.0	52.9	.755	-.413
4	391	16.53	63.5	36.4	1.006	.011
5	303	12.81	76.4	23.5	1.258	.436
6	237	10.02	86.4	13.5	1.510	.861
7	132	5.58	92.0	7.9	1.761	1.287
8	84	3.55	95.5	4.4	2.013	1.712
9	52	2.19	97.7	2.2	2.265	2.137
10	20	.84	98.6	1.3	2.516	2.562
11	19	.80	99.4	.5	2.768	2.988
12	8	.33	99.7	.2	3.020	3.413
13	4	.16	99.9	.0	3.271	3.838
14	2	.08	100.0	.0	3.523	4.263

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

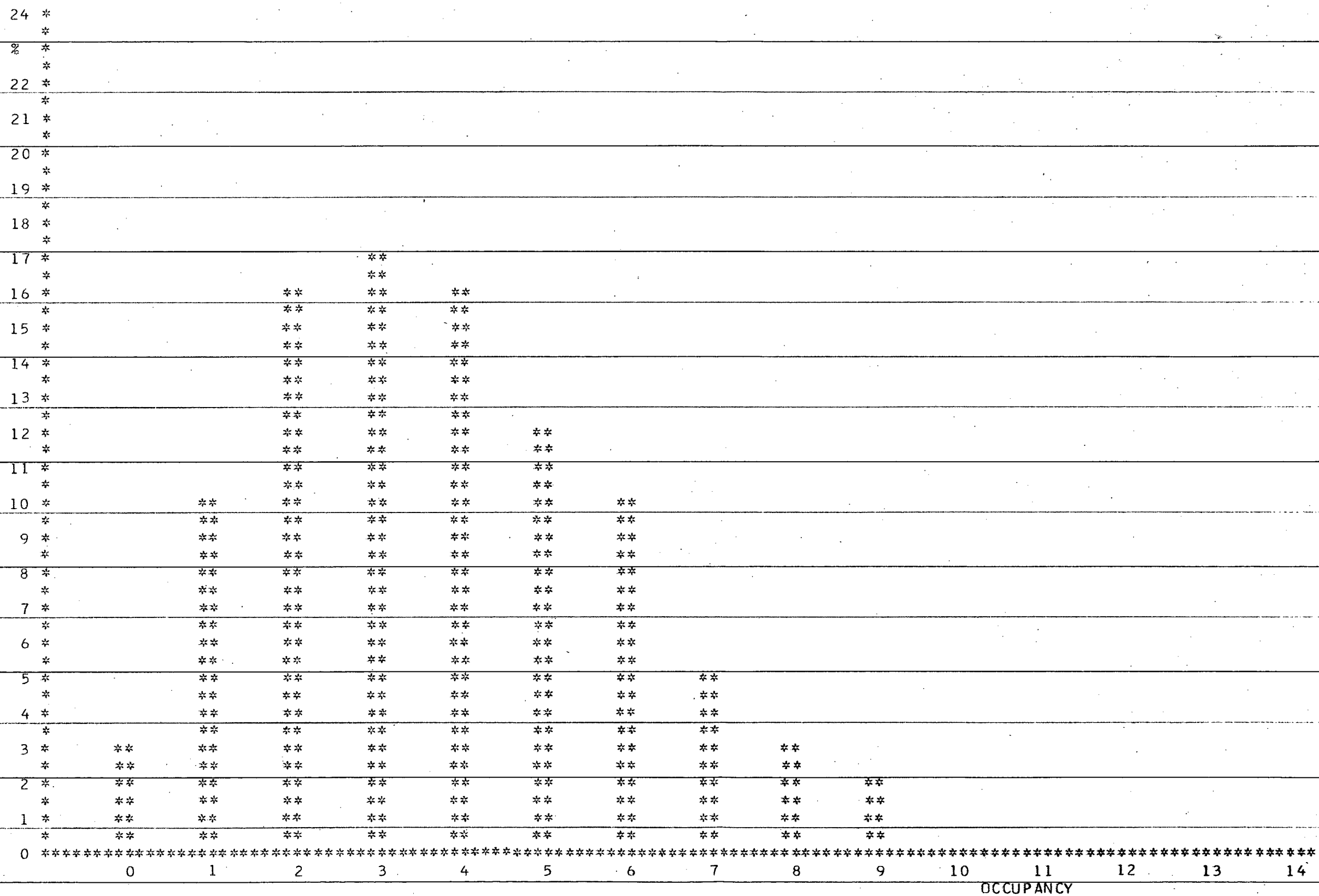


FIGURE 8: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE SHELVES

THE RECORDINGS COLLECTION (=DESK & SHELVES) AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
11	150	5.364	.035	5421	3.563	1	23

TRANSIT TIMES THROUGH REC. COLL. (MIN.) , (=DESK & SHELVES)

TABLE TAB9
ENTRIES IN TABLE
5420

MEAN ARGUMENT
3.563

STANDARD DEVIATION
4.441

SUM OF ARGUMENTS
19314.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	2039	37.61	37.6	62.3	.280	-.577
2	877	16.18	53.8	46.1	.561	-.352
3	670	12.36	66.1	33.8	.841	-.126
4	524	9.66	75.8	24.1	1.122	.098
5	277	5.11	80.9	19.0	1.403	.323
6	198	3.65	84.5	15.4	1.683	.548
7	153	2.82	87.4	12.5	1.964	.773
8	121	2.23	89.6	10.3	2.245	.998
9	84	1.54	91.1	8.8	2.525	1.224
10	87	1.60	92.8	7.1	2.806	1.449
11	93	1.71	94.5	5.4	3.086	1.674
12	49	.90	95.4	4.5	3.367	1.899
13	49	.90	96.3	3.6	3.648	2.124
14	30	.55	96.8	3.1	3.928	2.349
15	18	.33	97.2	2.7	4.209	2.574
16	17	.31	97.5	2.4	4.490	2.800
17	17	.31	97.8	2.1	4.770	3.025
18	13	.23	98.0	1.9	5.051	3.250
19	12	.22	98.3	1.6	5.331	3.475
20	9	.16	98.4	1.5	5.612	3.700
21	13	.23	98.7	1.2	5.893	3.925
22	14	.25	98.9	1.0	6.173	4.151
23	4	.07	99.0	.9	6.454	4.376
24	9	.16	99.2	.7	6.735	4.601
25	4	.07	99.2	.7	7.015	4.826
26	6	.11	99.3	.6	7.296	5.051
27	5	.09	99.4	.5	7.576	5.276
28	8	.14	99.6	.3	7.857	5.501
29	7	.12	99.7	.2	8.138	5.727
30	8	.14	99.9	.0	8.418	5.952
31	5	.09	100.0	.0	8.699	6.177

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

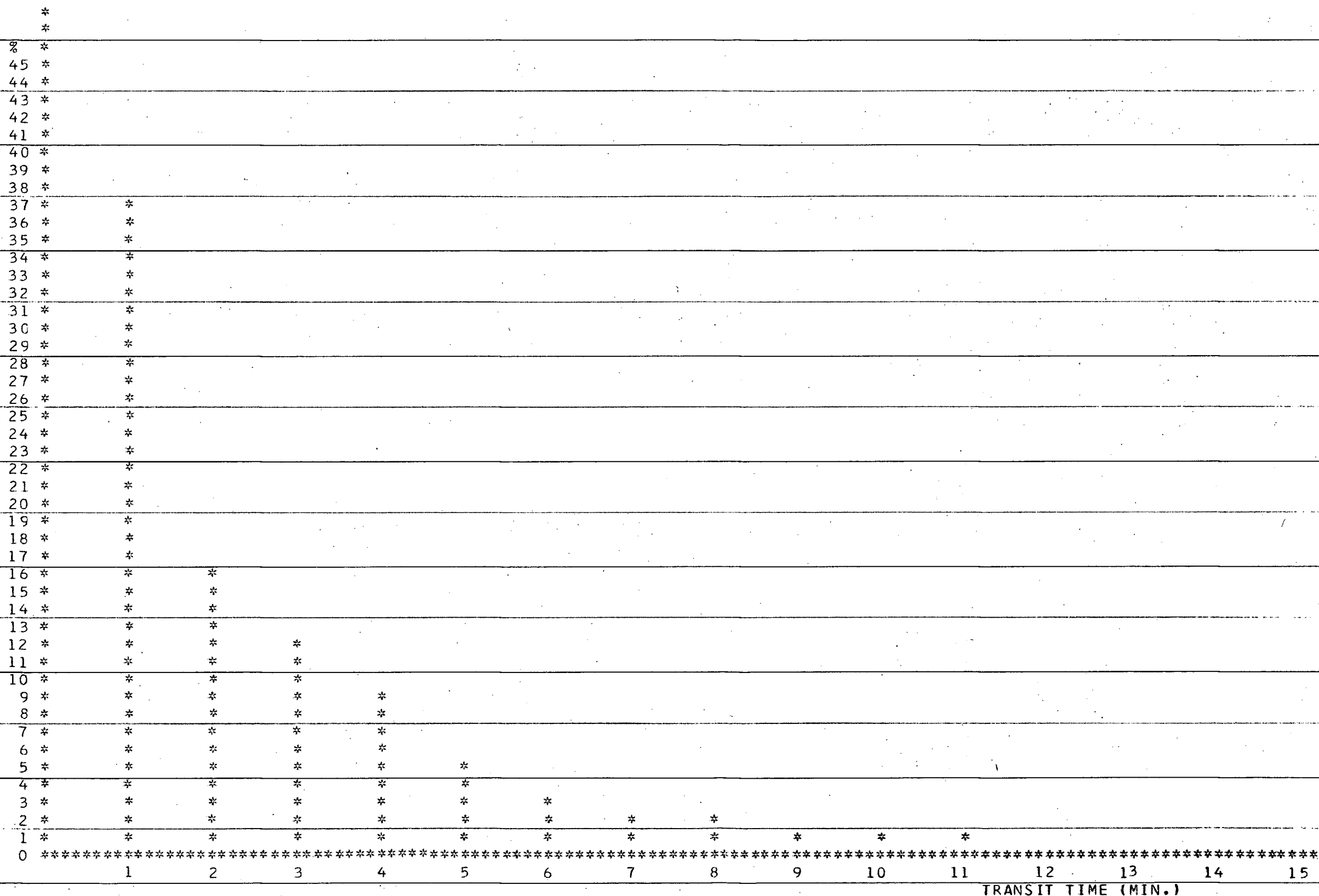


FIGURE 9: REL. FREQUENCY OF TRANSIT TIMES THROUGH THE RECORDINGS COLLECTION

OCCUPANCY OF RECORD. COLLECT. (=DESK & SHELVES)

TABLE TAB10
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

NON-WEIGHTED

5420

5.897

3.585

31964.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	88	1.62	1.6	98.3	-.000	-1.644
1	298	5.49	7.1	92.8	.169	-1.365
2	505	9.31	16.4	83.5	.339	-1.086
3	631	11.64	28.0	71.9	.508	-.807
4	713	13.15	41.2	58.7	.678	-.529
5	597	11.01	52.2	47.7	.847	-.250
6	587	10.83	63.0	36.9	1.017	.028
7	487	8.98	72.0	27.9	1.186	.307
8	373	6.88	78.9	21.0	1.356	.586
9	301	5.55	84.5	15.4	1.526	.865
10	214	3.94	88.4	11.5	1.695	1.144
11	183	3.37	91.8	8.1	1.865	1.422
12	136	2.50	94.3	5.6	2.034	1.701
13	101	1.86	96.1	3.8	2.204	1.980
14	75	1.38	97.5	2.4	2.373	2.259
15	49	.90	98.4	1.5	2.543	2.538
16	37	.68	99.1	.8	2.713	2.817
17	19	.35	99.5	.4	2.882	3.096
18	11	.20	99.7	.2	3.052	3.375
19	4	.07	99.7	.2	3.221	3.653
20	5	.09	99.8	.1	3.391	3.932
21	2	.03	99.9	.0	3.560	4.211
22	4	.07	100.0	.0	3.730	4.490

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

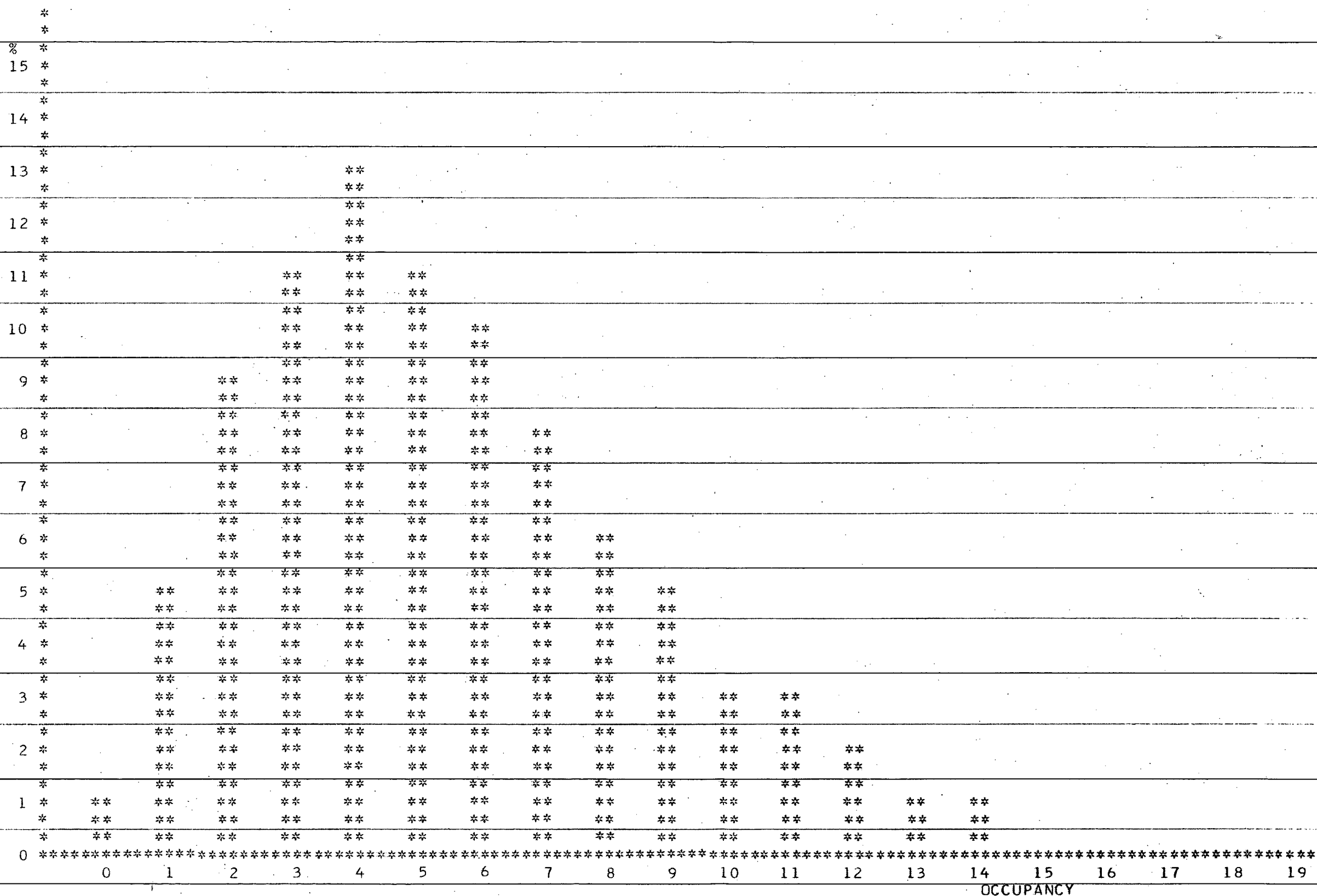


FIGURE 10: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY DESK AND SHELVES

THE LISTENING ROOM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
40	23	15.891	.690	1273	44.953	19	23

LISTENING ROOM INTERARRIVAL TIMES (MIN.)

TABLE TAB11
ENTRIES IN TABLE
1253

MEAN ARGUMENT
2.845

STANDARD DEVIATION
2.976

SUM OF ARGUMENTS
3565.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	512	40.86	40.8	59.1	.351	-.619
2	218	17.39	58.2	41.7	.702	-.283
3	163	13.00	71.2	28.7	1.054	.052
4	97	7.74	79.0	20.9	1.405	.387
5	85	6.78	85.7	14.2	1.757	.723
6	53	4.22	90.0	9.9	2.108	1.059
7	40	3.19	93.2	6.7	2.460	1.395
8	21	1.67	94.8	5.1	2.811	1.731
9	20	1.59	96.4	3.5	3.163	2.067
10	15	1.19	97.6	2.3	3.514	2.403
11	8	.63	98.3	1.6	3.866	2.739
12	6	.47	98.8	1.1	4.217	3.075
13	5	.39	99.2	.7	4.569	3.411
14	3	.23	99.4	.5	4.920	3.747
15	0	.00	99.4	.5	5.272	4.083
16	2	.15	99.6	.3	5.623	4.419
17	0	.00	99.6	.3	5.975	4.755
18	1	.07	99.6	.3	6.326	5.091
19	1	.07	99.7	.2	6.677	5.427
20	1	.07	99.8	.1	7.029	5.763
21	0	.00	99.8	.1	7.380	6.099
22	0	.00	99.8	.1	7.732	6.435
23	0	.00	99.8	.1	8.083	6.771
24	1	.07	99.9	.0	8.435	7.107
25	0	.00	99.9	.0	8.786	7.443
26	0	.00	99.9	.0	9.138	7.779
27	0	.00	99.9	.0	9.489	8.115
28	0	.00	99.9	.0	9.841	8.450
29	0	.00	99.9	.0	10.192	8.786
OVERFLOW	1	.07	100.0	.0		
AVERAGE VALUE OF OVERFLOW		34.00				

GRAPH

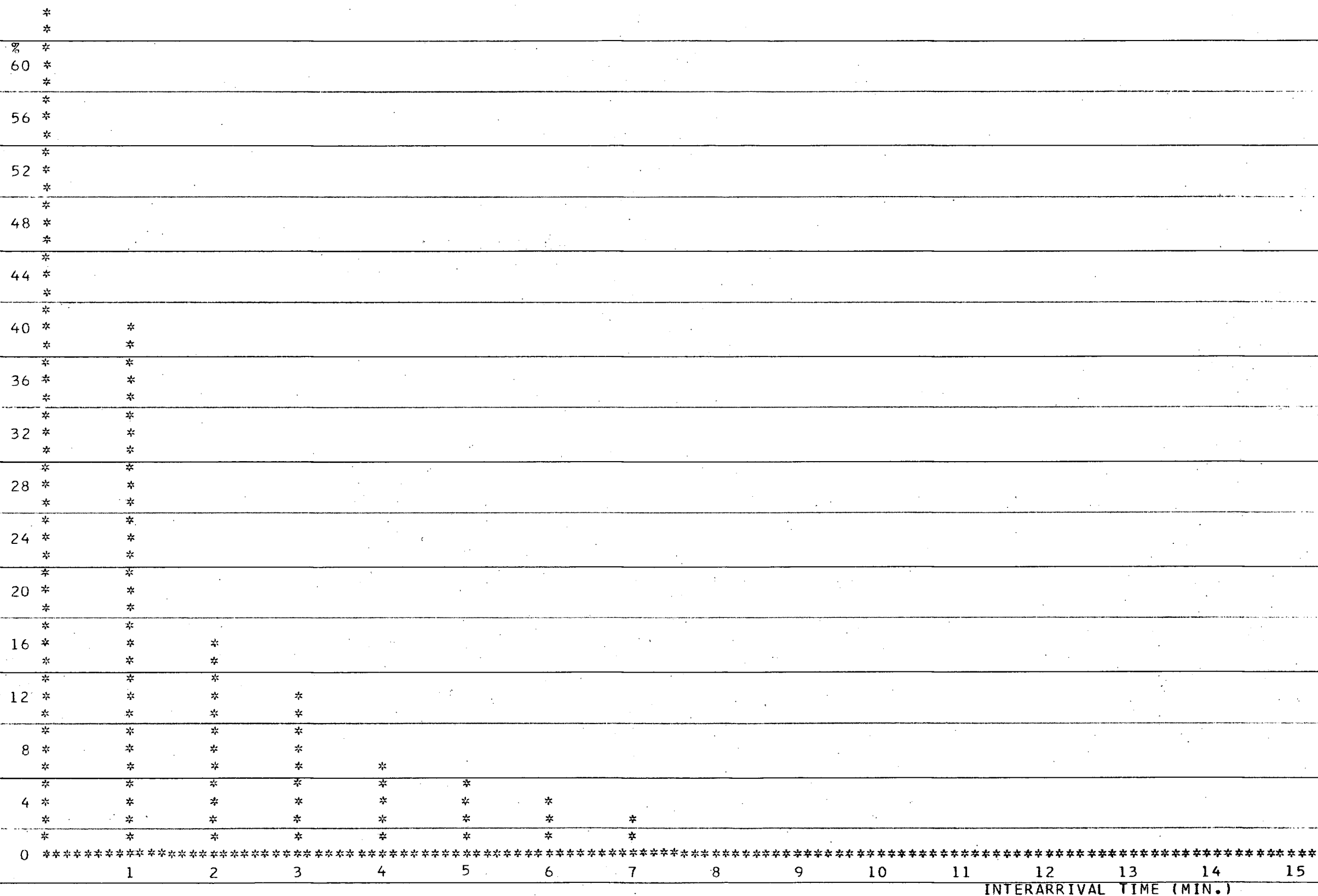


FIGURE 11: REL. FREQUENCY OF INTERARRIVAL TIMES TO LISTENING ROOM

NUMBER OF ARRIVALS TO LIST. ROOM/10 MIN

TABLE TAB12
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

360

3.477

1.914

1252.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	20	5.55	5.5	94.4	-.000	-1.816
1	33	9.16	14.7	85.2	.287	-1.294
2	66	18.33	33.0	66.9	.575	-.772
3	70	19.44	52.4	47.5	.862	-.249
4	67	18.61	71.1	28.8	1.150	.272
5	49	13.61	84.7	15.2	1.437	.795
6	33	9.16	93.8	6.1	1.725	1.317
7	12	3.33	97.2	2.7	2.012	1.840
8	8	2.22	99.4	.5	2.300	2.362
9	2	.55	100.0	.0	2.587	2.885

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

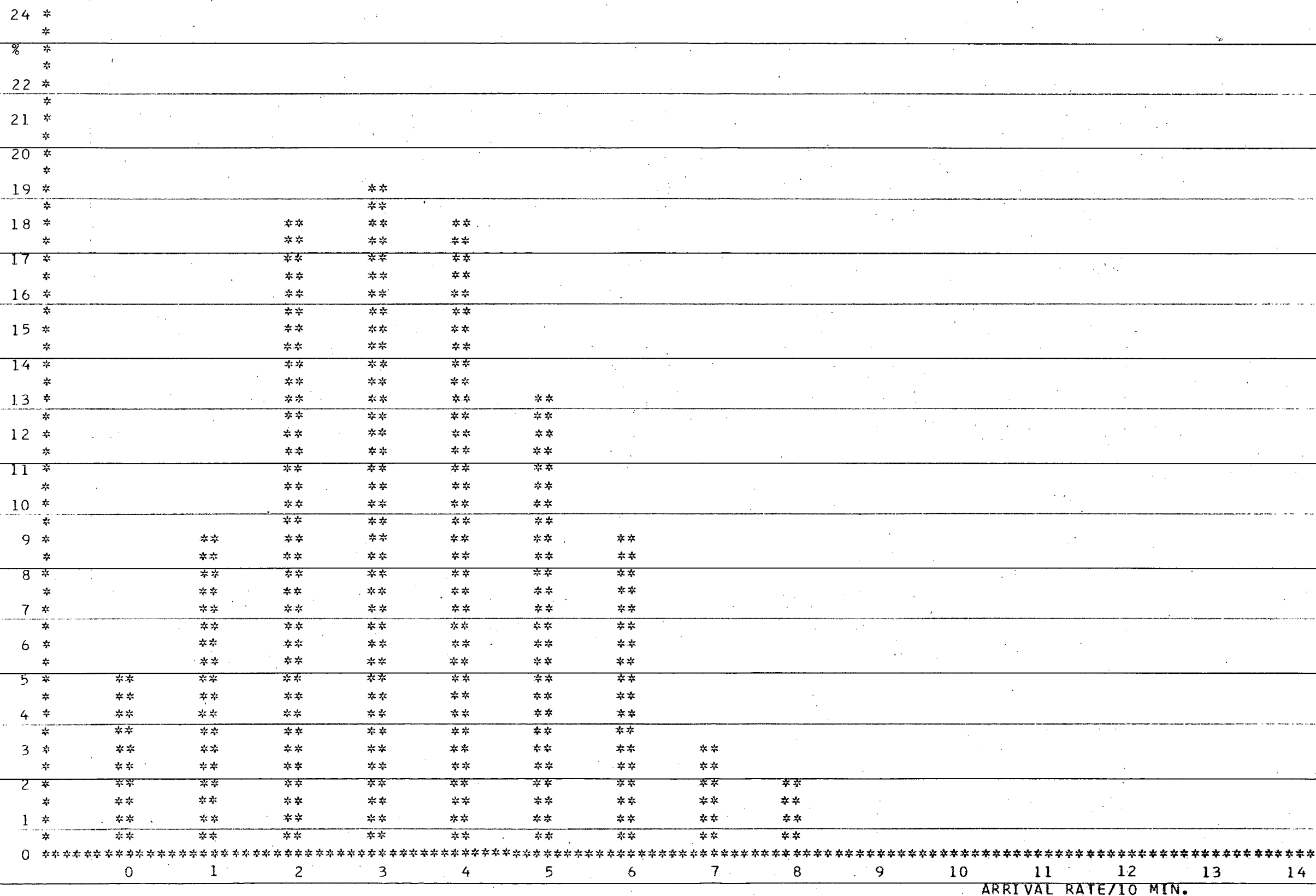


FIGURE 12: REL. FREQUENCY OF ARRIVALS TO LISTENING ROOM DURING 10 MIN.

LIST. ROOM SERVICE TIMES (MIN.)

TABLE TAB13
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

1254

45.206

35.625

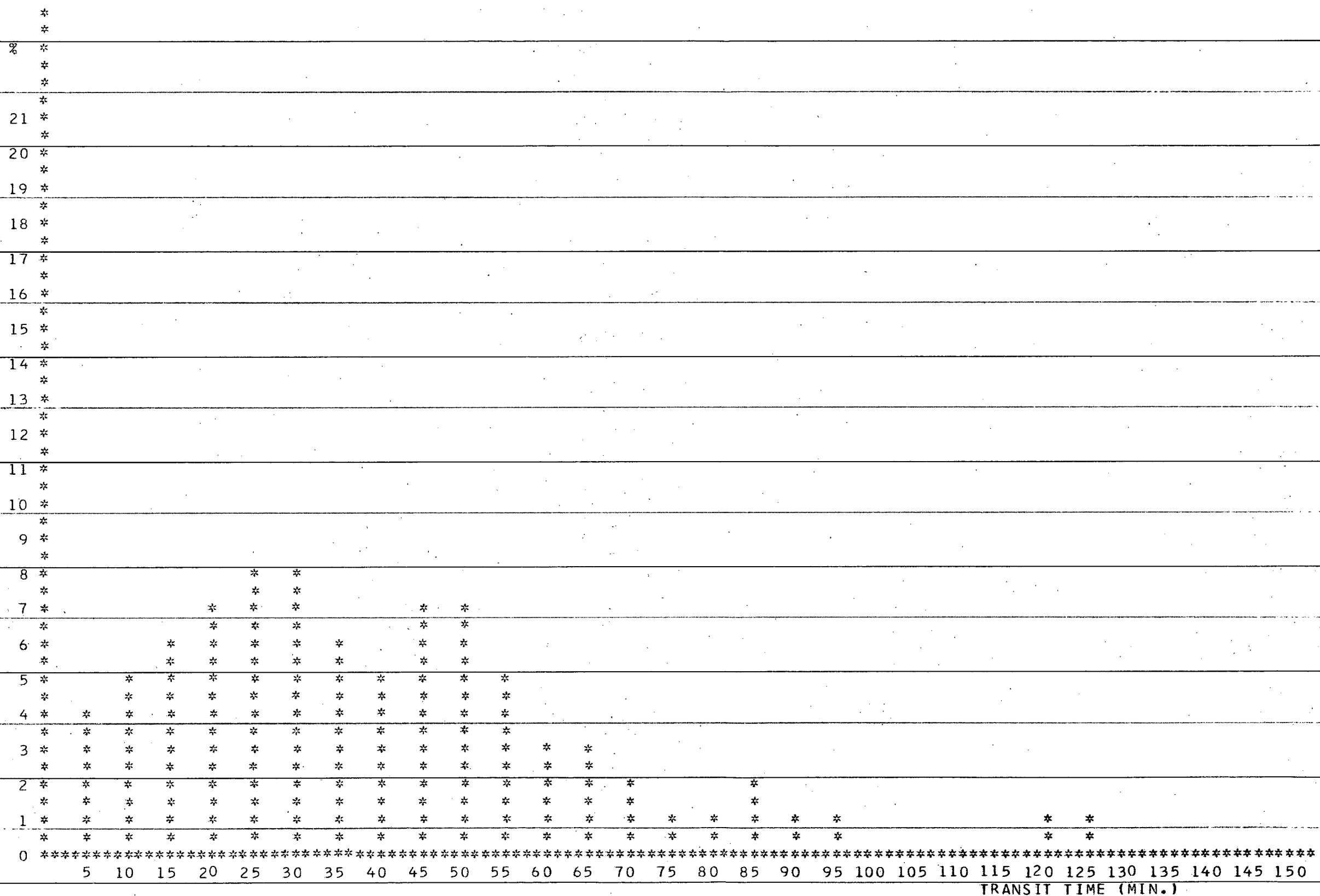
56689.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	7	.55	.5	99.4	-.000	-1.268
5	57	4.54	5.1	94.8	.110	-1.128
10	71	5.66	10.7	89.2	.221	-.988
15	84	6.69	17.4	82.5	.331	-.847
20	95	7.57	25.0	74.9	.442	-.707
25	104	8.29	33.3	66.6	.553	-.567
30	105	8.37	41.7	58.2	.663	-.426
35	80	6.37	48.0	51.9	.774	-.286
40	66	5.26	53.3	46.6	.884	-.146
45	94	7.49	60.8	39.1	.995	-.005
50	90	7.17	68.0	31.9	1.106	.134
55	67	5.34	73.3	26.6	1.216	.274
60	48	3.82	77.1	22.8	1.327	.415
65	43	3.42	80.6	19.3	1.437	.555
70	28	2.23	82.8	17.1	1.548	.695
75	24	1.91	84.7	15.2	1.659	.836
80	19	1.51	86.2	13.7	1.769	.976
85	26	2.07	88.3	11.6	1.880	1.117
90	15	1.19	89.5	10.4	1.990	1.257
95	17	1.35	90.9	9.0	2.101	1.397
100	12	.95	91.8	8.1	2.212	1.538
105	7	.55	92.4	7.5	2.322	1.678
110	7	.55	92.9	7.0	2.433	1.818
115	11	.87	93.8	6.1	2.543	1.959
120	13	1.03	94.8	5.1	2.654	2.099
125	13	1.03	95.9	4.0	2.765	2.239
130	6	.47	96.4	3.5	2.875	2.380
135	1	.07	96.4	3.5	2.986	2.520
140	3	.23	96.7	3.2	3.096	2.660
145	5	.39	97.1	2.8	3.207	2.801
150	4	.31	97.4	2.5	3.318	2.941
155	4	.31	97.7	2.2	3.428	3.081
160	6	.47	98.2	1.7	3.539	3.222
165	2	.15	98.4	1.5	3.649	3.362
170	6	.47	98.8	1.1	3.760	3.502
175	4	.31	99.2	.7	3.871	3.643
180	0	.00	99.2	.7	3.981	3.783
185	4	.31	99.5	.4	4.092	3.924
190	6	.47	100.0	.0	4.202	4.064

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



OCCUPANCY OF LIST. ROOM

TABLE TAB14
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

1254

15.705

3.382

19695.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-4.642
1	0	.00	.0	100.0	.063	-4.347
2	0	.00	.0	100.0	.127	-4.051
3	0	.00	.0	100.0	.191	-3.755
4	1	.07	.0	99.9	.254	-3.460
5	1	.07	.1	99.8	.318	-3.164
6	4	.31	.4	99.5	.382	-2.869
7	8	.63	1.1	98.8	.445	-2.573
8	13	1.03	2.1	97.8	.509	-2.277
9	23	1.83	3.9	96.0	.573	-1.982
10	35	2.79	6.7	93.2	.636	-1.686
11	50	3.98	10.7	89.2	.700	-1.391
12	77	6.14	16.9	83.0	.764	-1.095
13	113	9.01	25.9	74.0	.827	-.799
14	121	9.64	35.5	64.4	.891	-.504
15	145	11.56	47.1	52.8	.955	-.208
16	138	11.00	58.1	41.8	1.018	.086
17	128	10.20	68.3	31.6	1.082	.382
18	129	10.28	78.6	21.3	1.146	.678
19	86	6.85	85.4	14.5	1.209	.973
20	76	6.06	91.5	8.4	1.273	1.269
21	59	4.70	96.2	3.7	1.337	1.565
22	47	3.74	100.0	.0	1.400	1.860

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

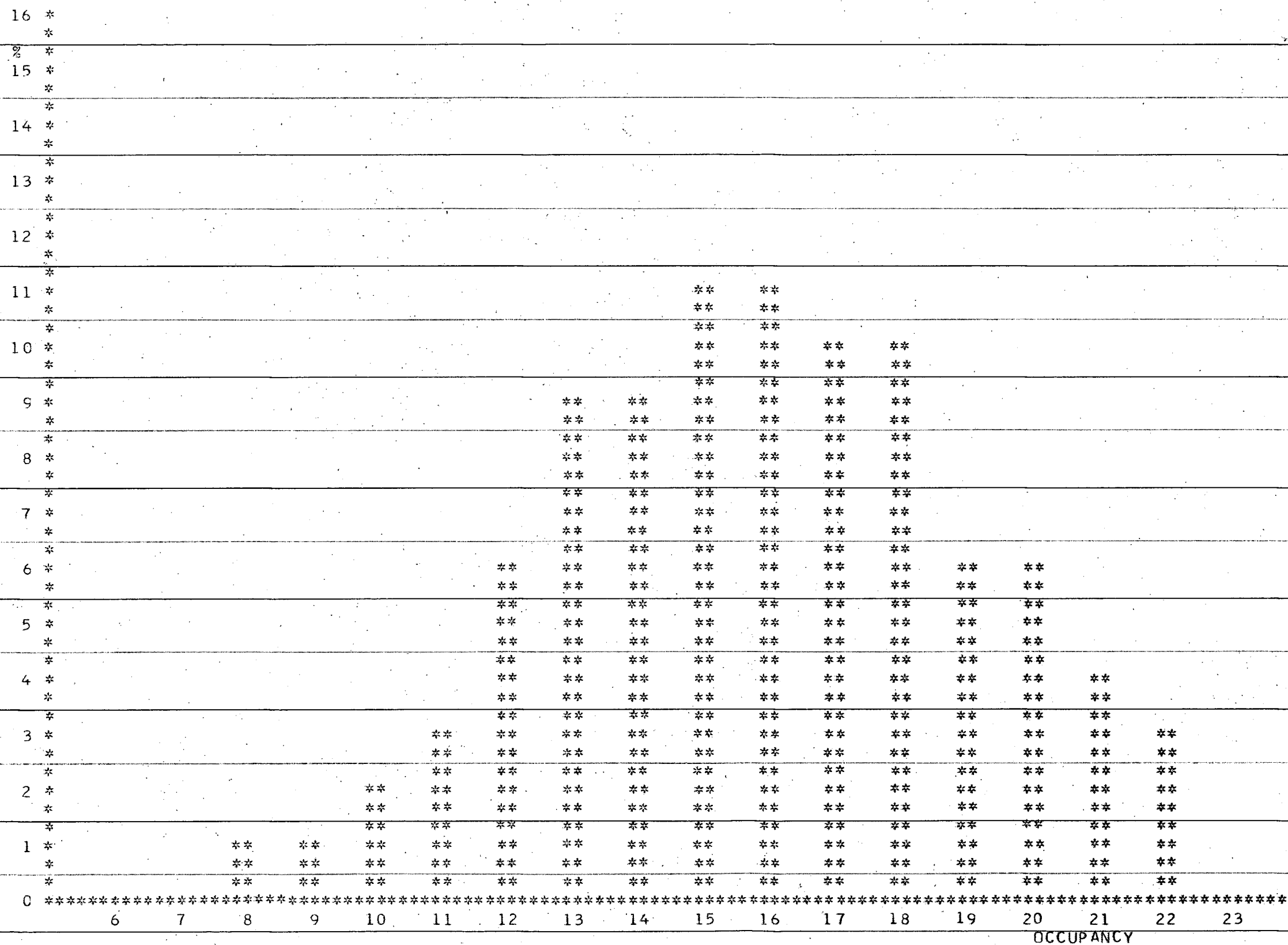


FIGURE 14: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE LISTENING ROOM

THE RESERV. LISTENING ROOM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
41	23	.690	.030	54	46.074		9

OCCUPANCY OF RESERVE LIST. ROOM

TABLE TAB17
ENTRIES IN TABLE
54

MEAN ARGUMENT
2.388

STANDARD DEVIATION
2.191

SUM OF ARGUMENTS
129.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	14	25.92	25.9	74.0	-.000	-1.090
1	11	20.37	46.2	53.7	.418	-.633
2	6	11.11	57.4	42.5	.837	-.177
3	5	9.25	66.6	33.3	1.255	.278
4	7	12.96	79.6	20.3	1.674	.735
5	6	11.11	90.7	9.2	2.093	1.191
6	3	5.55	96.2	3.7	2.511	1.647
7	1	1.85	98.1	1.8	2.930	2.104
8	1	1.85	100.0	.0	3.348	2.560

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

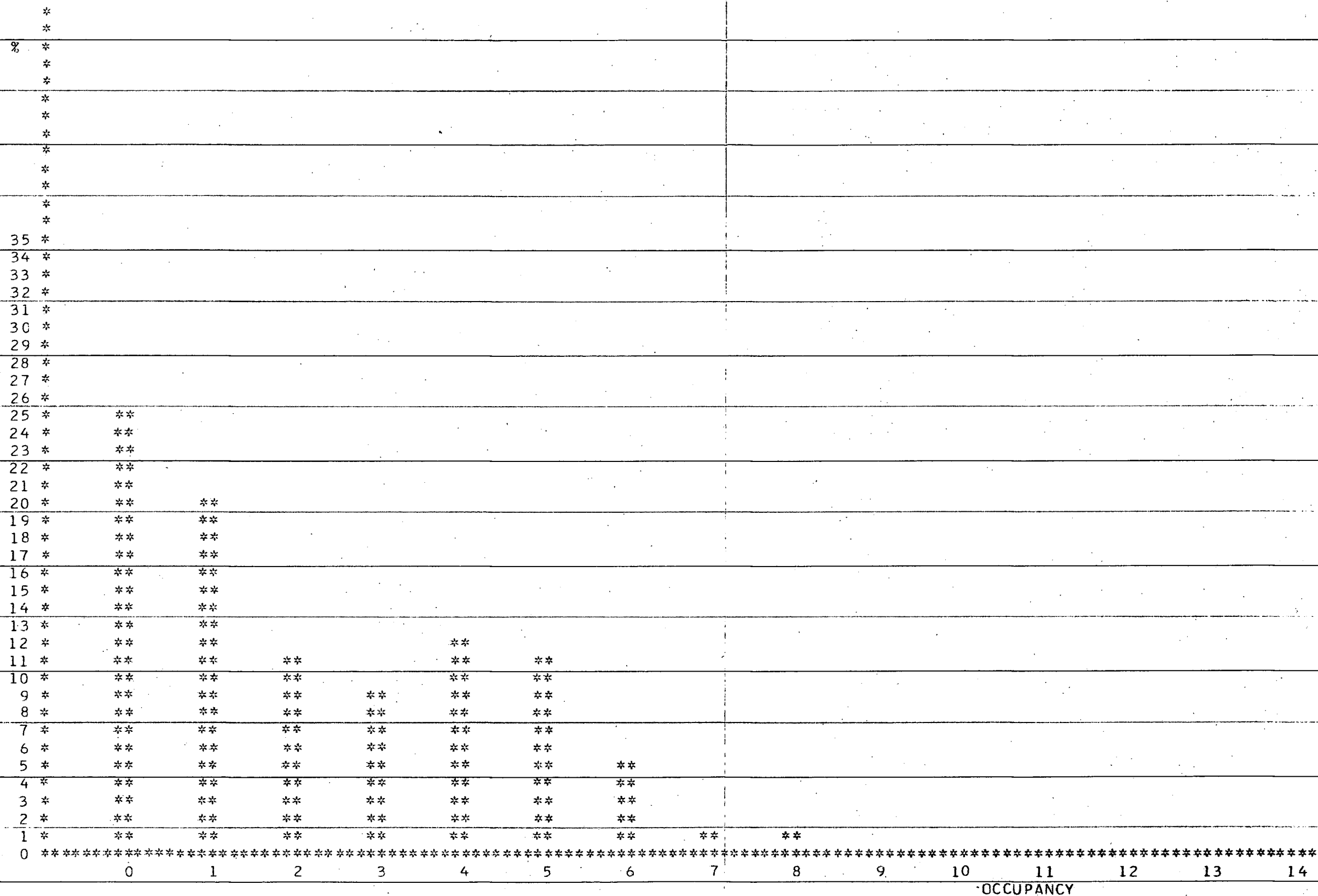


FIGURE 14A: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE LISTENING ROOM

THE SYSTEM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
10	200	21.946	.109	3212	24.604	20	45

SYSTEM TRANSIT TIMES (MIN.) (=SERVICE & WAIT. TIME)

TABLE TAB15
ENTRIES IN TABLE
3192MEAN ARGUMENT
4.273STANDARD DEVIATION
13.207SUM OF ARGUMENTS
13642.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	897	28.10	28.1	71.8	-.000	-.323
5	1882	58.95	87.0	12.9	1.169	.054
10	224	7.01	94.0	5.9	2.339	.433
15	51	1.59	95.6	4.3	3.509	.812
20	20	.62	96.3	3.6	4.679	1.190
25	15	.46	96.7	3.2	5.849	1.569
30	19	.59	97.3	2.6	7.019	1.947
35	10	.31	97.6	2.3	8.189	2.326
40	8	.25	97.9	2.0	9.359	2.705
45	11	.34	98.2	1.7	10.529	3.083
50	4	.12	98.4	1.5	11.699	3.462
55	11	.34	98.7	1.2	12.869	3.840
60	8	.25	98.9	1.0	14.038	4.219
65	3	.09	99.0	.9	15.208	4.598
70	2	.06	99.1	.8	16.378	4.976
75	2	.06	99.2	.7	17.548	5.355
80	3	.09	99.3	.6	18.718	5.733
85	4	.12	99.4	.5	19.888	6.112
90	0	.00	99.4	.5	21.058	6.490
95	2	.06	99.4	.5	22.228	6.869
100	1	.03	99.5	.4	23.398	7.248
105	2	.06	99.5	.4	24.568	7.626
110	0	.00	99.5	.4	25.738	8.005
115	1	.03	99.6	.3	26.908	8.383
120	2	.06	99.6	.3	28.077	8.762
125	1	.03	99.7	.2	29.247	9.141
130	0	.00	99.7	.2	30.417	9.519
135	0	.00	99.7	.2	31.587	9.898
140	1	.03	99.7	.2	32.757	10.276
145	0	.00	99.7	.2	33.927	10.655
150	1	.03	99.7	.2	35.097	11.033
155	1	.03	99.8	.1	36.267	11.412
160	1	.03	99.8	.1	37.437	11.791
165	0	.00	99.8	.1	38.607	12.169
170	0	.00	99.8	.1	39.777	12.548
175	0	.00	99.8	.1	40.947	12.926
180	0	.00	99.8	.1	42.116	13.305
185	2	.06	99.9	.0	43.286	13.684
190	3	.09	100.0	.0	44.456	14.062

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

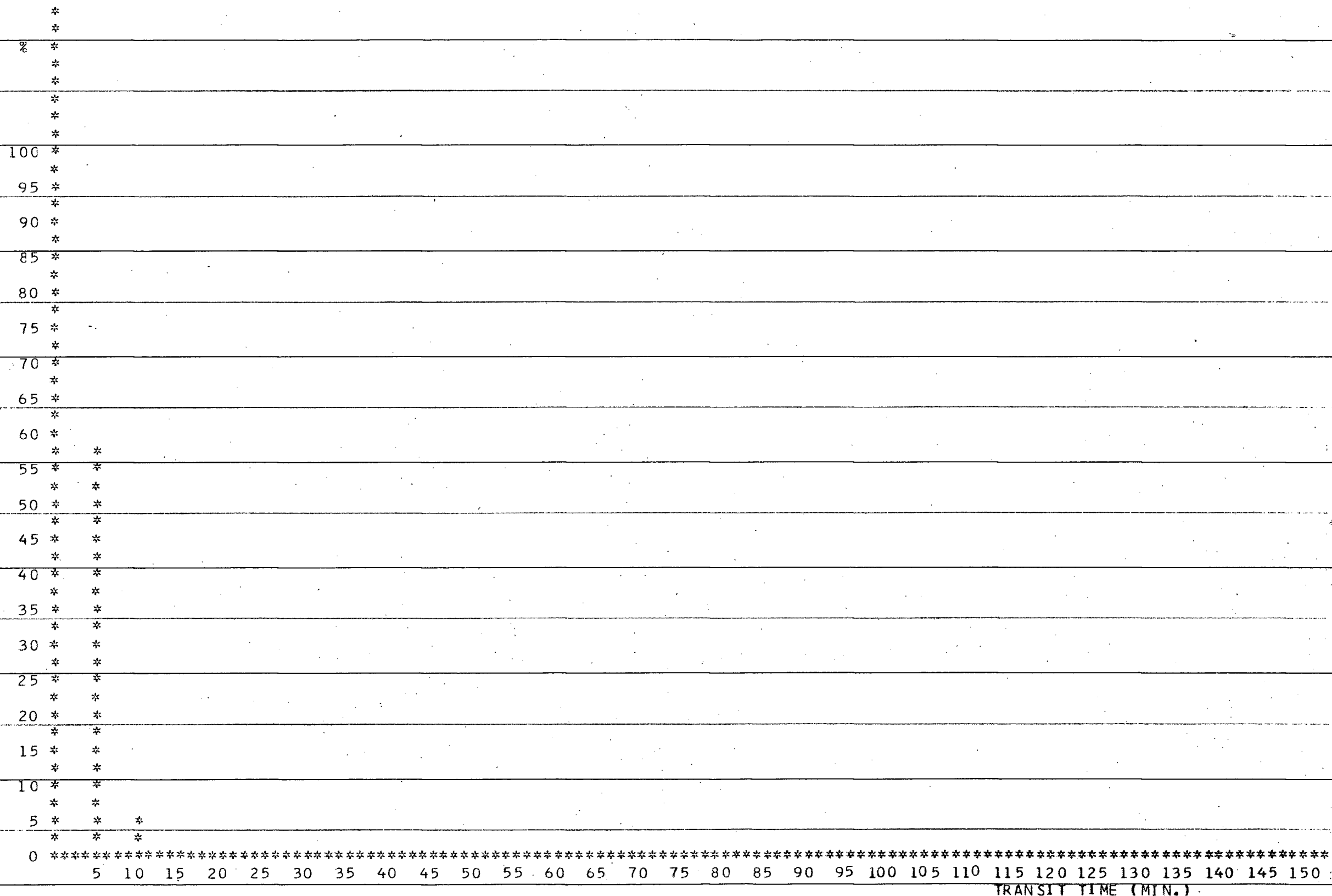


FIGURE 15: REL. FREQUENCY OF SYSTEM TRANSIT TIMES

OCCUPANCY OF SYSTEM (=DESK,SHELVES,LIST. ROOM)

TABLE TAB16
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

3192

22.597

5.921

72132.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-3.815
2	0	.00	.0	100.0	.088	-3.478
4	3	.09	.0	99.9	.177	-3.140
6	6	.18	.2	99.7	.265	-2.802
8	6	.18	.4	99.5	.354	-2.465
10	16	.50	.9	99.0	.442	-2.127
12	62	1.94	2.9	97.0	.531	-1.789
14	106	3.32	6.2	93.7	.619	-1.451
16	230	7.20	13.4	86.5	.708	-1.114
18	345	10.80	24.2	75.7	.796	-.776
20	461	14.44	38.6	61.3	.885	-.438
22	458	14.34	53.0	46.9	.973	-.100
24	441	13.81	66.8	33.1	1.062	.236
26	358	11.21	78.0	21.9	1.150	.574
28	213	6.67	84.7	15.2	1.239	.912
30	153	4.79	89.5	10.4	1.327	1.249
32	112	3.50	93.0	6.9	1.416	1.587
34	89	2.78	95.8	4.1	1.504	1.925
36	61	1.91	97.7	2.2	1.593	2.263
38	51	1.59	99.3	.6	1.681	2.600
40	15	.46	99.8	.1	1.770	2.938
42	4	.12	99.9	.0	1.858	3.276
44	2	.06	100.0	.0	1.947	3.614

REMAINING FREQUENCIES ARE ALL ZERO

~ GRAPH

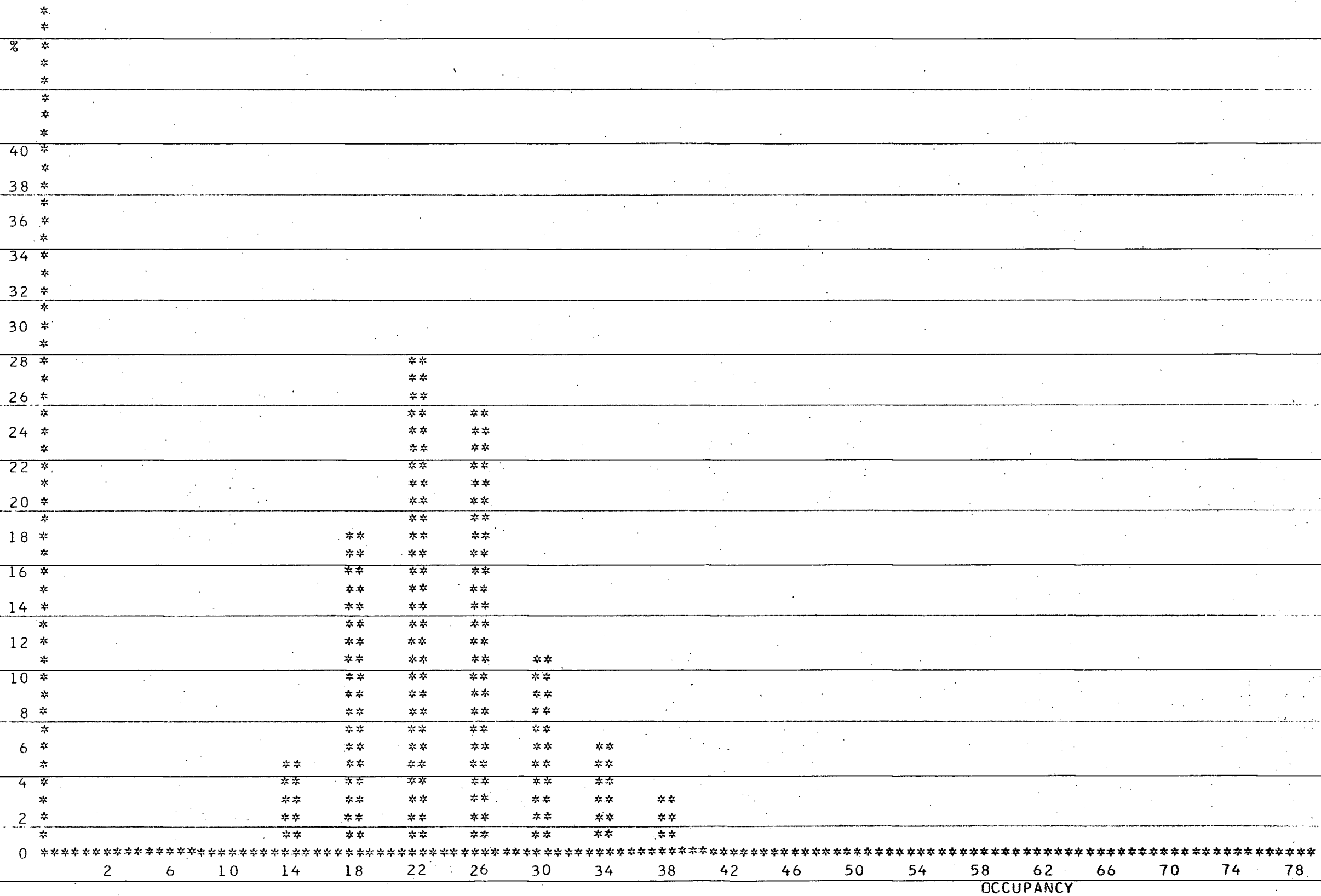


FIGURE 16: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE SYSTEM

*

END

CPU TIME USED:

ASSEMBLY: 3.173 SECONDS

EXECUTION: 64.841 SECONDS

EXECUTION TERMINATED

\$SIGNOFF

USER: WULI
DEPARTMENT: COMM

```

***** UN AT 00:12:49
***** OFF AT 00:14:23
***** ELAPSED TIME          94.136   SEC.
***** CPU TIME USED         71.257   SEC.
***** STORAGE USED          4437.03   PAGE-SEC.
***** CARDS READ            406
***** LINES PRINTED         9412
***** PAGES PRINTED         280
***** CARDS PUNCHED         0
***** DRUM READS            5
***** RATE FACTOR           0.6
***** APPROX. COST OF THIS RUN C$12.22

```

**** FILE STORAGE 0 PG-HR. .00

**LAST SIGNON WAS: 10:54:13 12-29-70

MMMM	MMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSS
MMMMMM	MMMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSSSSSS
MMMMMMM	MMMMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSSSSSSSSSS
MMMMMMMM	MMMMMMMM	TTTTT	SSSSSS
MMMMMMMMM	MMMMMMMMM	TTTTT	SSSSS
MMMMMMMMMM	MMMMMMMMMM	TTTTT	SSSSS
MMMMM	MMMMM	TTTTT	SSSSSS
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSS
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSS
MMMMM	MMMMMMMMMMMM	TTTTT	SSSSSSSSSSSSSS
MMMMM	MMMMMMMMMM	TTTTT	SSSSSSSS
MMMMM	MMMMMM	TTTTT	SSSSS
MMMMM	MMM	TTTTT	SSSSS
MMMMM	MMMMM	TTTTT	SSSSSSS
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSSSSSS
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSS
MMMMM	MMMMM	TTTTT	SSSSSSSSSS

***** THIS JOB SUBMITTED THROUGH FRONT DESK READER *****

\$SIGNON WULI T=150 P=400 PRIQ=V COPIES=4

**LAST SIGNON WAS: 00:28:20 12-30-70

USER "WULI" SIGNED ON AT 00:41:44 ON 12-31-70

\$RUN *STATUS PAR=FULL

EXECUTION BEGINS

STATUS OF WULI AT LAST SIGNOFF	USED	MAXIMUM	REMAINING
CUMULATIVE CHARGE (\$)	106.87	150.00	43.13
CURRENT DISK SPACE (PAGES)	0	50	50
CURRENT CELL SPACE (PAGES)	0	100	100
CUMULATIVE MEMORY--CPU (PG-HR)	5.91		
CUMULATIVE MEMORY--WAIT (PG-HR)	3.60		
CUMULATIVE CPU TIME (HR)	0.11		
CUMULATIVE LINES PRINTED	49611		
CUMULATIVE PAGES PRINTED	1643		
CUMULATIVE CARDS READ	8811		
BATCH SESSIONS	28		
EXPIRATION DATE AND TIME:	05-31-71 24:00.00		

EXECUTION TERMINATED

\$RUN *GPSS PAR=SIZE=B

EXECUTION BEGINS

BLOCK NUMBER	*LOC	OPERATION A,B,C,D,E,F,G	COMMENTS	CARD NUMBER
		SIMULATE		1
	*	SIMULATION OF UBC RECORDINGS COLLECTION BY JOHANNES KRAMAR		2
	*			3
	*	FUNCTION DEFINITIONS		4
	*			5
	*	SYSTEM ARRIVAL TIME EXPONENTIALLY DISTRIBUTED		6
		ARRIV FUNCTION RN1,C24	NEG. EXP. DISTR., MEAN=1MIN.	7
		0.0,0.0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69/.6,.915/.7,1.2/		8
		.75,1.38/.8,1.6/.84,1.83/.88,2.12/.9,2.3/.92,2.52/.94,2.81/.95,2.99		9
		.96,3.2/.97,3.5/.98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7.0/.9997,8.0		10
	*			11
	*	DESK SERVICE TIME EXPONENTIALLY DISTRIBUTED		12
		DESK FUNCTION RN1,C24	NEG. EXP. DISTR.	13
		0.0,0.0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69/.6,.915/.7,1.2/		14
		.75,1.38/.8,1.6/.84,1.83/.88,2.12/.9,2.3/.92,2.52/.94,2.81/.95,2.99		15
		.96,3.2/.97,3.5/.98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7.0/.9997,8.0		16
	*			17
	*	SHELF SERVICE TIME EXPONENTIALLY DISTRIBUTED		18
		SHELF FUNCTION RN1,C23	NEG. EXP. DISTR.	19
		0.0,0.0/.154,.840/.281,.250/.390,.420/.483,.580/.562,.750/.629,.92/		20
		.685,1.08/.733,1.25/.774,1.42/.808,1.59/.837,1.75/.862,1.92		21
		.883,2.08/.9,2.25/		22
		.916,2.42/.927,2.58/.937,2.75/.946,2.92/.953,3.08/.959,3.25		23
		.964,3.42/1.0,5.27		24
	*			25
	*	LISTENING ROOM SERVICE TIME GENERALLY DISTRIBUTED		26
		LIST FUNCTION RNI,C25	GEN. DISTRIBUTION	27
		0.0,0.0/.024,.063/.071,.187/.131,.312/.205,.437/.289,.563/.366,.690/		28
		.436,.820/.498,.940/.556,1.06/.623,1.18/.699,1.31/.754,1.44/.786,1.56/		29
		.814,1.69/.836,1.81/.855,1.94/.872,2.06/.888,2.18/.903,2.31/.917,2.44/		30
		.927,2.55/.962,3.19/.989,4.20/1.00,4.820		31
	*			32
	*	STORAGE DEFINITIONS		33
	10	STORAGE 200	DEFINE SIZE OF SYSTEM,S STORAGE	34
	11	STORAGE 150	DEFINE SIZE OF REC. COLL.	35
	30	STORAGE 100	DEFINE SIZE OF STOR. 30	36
	40	STORAGE 23	DEFINE SIZE OF STOR. 40	37
	41	STORAGE 23	DEFINE SIZE OF STOR. 41	38
	*	TABLE DEFINITIONS		39
	TAB1	TABLE IA,1,1,20	INTERARRIVAL TIME	40
	TAB2	TABLE RT,0,1,30,10	ARRIVAL RATE	41
	TAB3	TABLE M1,1,1,30	TRANSIT TIME TABLE	42
	TAB4	QTABLE 2,0,1,30	UNITS IN QUE.	43
	TAB5	TABLE IA,1,1,30	INTERARRIVAL TIME SHELVES	44
	TAB6	TABLE RT,0,1,20,10	ARRIVAL RATE	45
	TAB7	TABLE M1,1,1,60	TRANSIT TIME	46
	TAB8	TABLE S30,0,1,40	STOR. 30 OCCUPANCY	47
	TAB9	TABLE M1,1,1,60	TRANS. TIME SERVI	48
	TAB10	TABLE S11,0,1,60	STORAGE 11 OCCUPANCY	49
	TAB11	TABLE IA,1,1,30	INTERARR. TIME FAC. 40	50
	TAB12	TABLE RT,0,1,15,10	IARRIVALS FAC. 40	51
	TAB13	TABLE M1,0,5,60	TRANS. TIME FAC. 40	52
	TAB14	TABLE S40,0,1,26	STORE 40 OCCUPANCY	53
	TAB15	TABLE M1,0,2,80	TRANS. TIME IN SYSTEM	54
	TAB16	TABLE S10,0,2,60	SYST. OCCUPANCY	55
	TAB17	TABLE S41,0,1,26	STOR. 41 OCCUPANCY	56

	*				57
	*	GPSS PROGRAM			58
	*				59
1		GENERATE	1, FN\$ARRIV	ARRIVALS TO SYSTEM	60
2		ENTER	10	CUM. STOR. SYSTEM	61
3		TRANSFER	.36, STG3, STG2	GO TO 3 OR 2	62
4	STG2	MARK		SET TRANS. TIME = 0	63
5		ENTER	11	CUM. STORE RC.	64
6		QUEUE	2	JOIN QUE. 2	65
7		GATE NU	1, SER2		66
8	SER1	SEIZE	1	OCC. DESK SERV. 1	67

9		DEPART	2	LEAVE QUE. 2	68
10		ADVANCE	1, FN\$DESK	DESK SERVICE	69
11		RELEASE	1	RELEASE DESK SERV. 1	70
12		TRANSFER	, TWO		71
13	SER2	LINK	2, FIFO, RES2	LINK USER CHAIN 2	72
14	RES2	SEIZE	2	OCC. DESK SERV. 2	73
15		DEPART	2	LEAVE QUE. 2	74
16		ADVANCE	1, FN\$DESK	DESK SERVICE	75
17		RELEASE	2	RELEASE DESK	76
18	TWO	UNLINK	2, SER12, 1	UNLINK USER CHAIN 2	77
19		TRANSFER	, ONE		78
20	SER12	GATE NU	1, RES2		79
21		TRANSFER	, SER1		80
22	ONE	TABULATE	TAB1		81
23		TABULATE	TAB2	TAB. ARRIVALS	82
24		TABULATE	TAB3	TAB. TRANS. TIME	83
25		LEAVE	11		84
26		TABULATE	TAB9		85
27		TABULATE	TAB10		86
28		ASSIGN	2, K1	SET PI TO 1	87
29		TEST LE	C1, K3600, FINE	TEST TIME	88
30		TEST E	P3, K1, GEH2		89
31		TEST E	P4, K1, GEH3		90
32		TRANSFER	, EXIT		91
33	GEH2	TEST E	P4, K1, GEH4		92
34		TRANSFER	.75, STG3, EXIT		93
35	GEH3	TRANSFER	.96, STG4, EXIT		94
36	GEH4	TRANSFER	.73, GEH5, EXIT		95
37	GEH5	TRANSFER	.11, STG3, STG4		96
38	STG3	MARK			97
39		ENTER	11	CUM. STORE RC.	98
40		ENTER	30	ENTER STOR. 30	99
41		ADVANCE	6, FN\$SHELF	SHELF SERVICE TIME	100
42		LEAVE	30	LEAVE STOR. 30	101
43		TABULATE	TAB5	INTERARRIVAL TIME	102
44		TABULATE	TAB6	ARRIVAL RATE	103
45		TABULATE	TAB7	TRANSIT TIME	104
46		TABULATE	TAB8	STORE. SHELVES OCCUPANCY	105
47		LEAVE	11	LEAVE STORE 11	106
48		TABULATE	TAB9		107
49		TABULATE	TAB10	STORE RECORD. COLLECT.	108
50		ASSIGN	3, K1	SET P2 TO 1	109
51		TEST LE	C1, K3600, FINE	TEST TIME	110
52		TEST E	P2, K1, GEH7		111
53		TEST E	P4, K1, GEH8		112
54		TRANSFER	, EXIT		113
55	GEH7	TEST E	P4, K1, GEH9		114
56		TRANSFER	.28, STG2, EXIT		115
57	GEH8	TRANSFER	.22, STG4, EXIT		116
58	GEH9	TRANSFER	.14, GEH10, EXIT		117
59	GEH10	TRANSFER	.58, STG2, STG4		118
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61		GATE SNF	40, OFLOW		120
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64		LEAVE	40	LEAVE STORAGE 40	123
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72		LEAVE	41		131
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76		TEST E	P3, K1, GEH11		135
77		TRANSFER	.09, STG2, EXIT		136
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81	GEH13	TRANSFER	.08, GEH14, EXIT		140
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*			178
* GRAPH			179
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	X	,2,2,0,1,30	182
	Y	0,1,21,2	183
7	STATEMENT	4,1,%	184
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.	185
10	STATEMENT	55,64,FIGURE 2: REL. FREQUENCY OF ARRIVALS TO INF. DE1	186
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*			192
* GRAPH			193
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	X	,,14,1,1,8	196
	Y	0,3,20,2	197
7	STATEMENT	4,1,%	198
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	199
10	STATEMENT	55,60,FIGURE 3: REL. FREQUENCY OF TRANST TIMES AT INF1	200
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*			206
* GRAPH			207
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	Y	0,3,20,2	211
7	STATEMENT	4,1,%	212
100	STATEMENT	52,13,JOBS IN QUEUE	213
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	Y	0,4,20,2	227
7	STATEMENT	4,1,%	228
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10	STATEMENT	55,46,FIGURE 5: REL. FREQUENCY OF INTERARRIVAL TIMES	230
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	X	,2,4,0,1,20	238
	Y	0,1,20,2	239
7	STATEMENT	4,1,%	240
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.	241
10	STATEMENT	55,62,FIGURE 6: REL. FREQUENCY OF ARRIVALS TO SHELVES1	242
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*			248
* GRAPH			249
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	ORIGIN	50,10	251
	X	,,5,1,1,15	252
	Y	0,1,24,2	253
7	STATEMENT	4,1,%	254
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	255
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* GRAPH			263
	GRAPH	TP,TAB8	264
	ORIGIN	50,10	265
	X	,2,6,0,1,15	266
	Y	0,1,24,2	267
7	STATEMENT	4,1,%	268
100	STATEMENT	52,9,OCCUPANCY	269
10	STATEMENT	55,79,FIGURE 8: REL. FREQUENCY OF NUMBER OF JOBS OCCU1	270
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	SHELVES)		278
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* GRAPH			281
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	X	,,7,1,1,15	284
	Y	0,1,45,1	285
7	STATEMENT	4,1,%	286
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	287
10	STATEMENT	55,75,FIGURE 9: REL. FREQUENCY OF TRANSIT TIMES THROU	288
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*			294
* GRAPH			295
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	Y	0,1,15,3	299
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100	STATEMENT	52,9,OCCUPANCY	301
10	STATEMENT	55,85,FIGURE 10: REL. FREQUENCY OF NUMBER OF JOBS OCC1	302
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	SPACE	3	307
TAB	TITLE	11,LISTENING ROOM INTERARRIVAL TIMES (MIN.)	308
	EJECT		309
*			310
* GRAPH			311
	GRAPH	TP,TAB11	312
	ORIGIN	50,10	313
	X	,,7,1,1,15	314
	Y	0,4,15,3	315
7	STATEMENT	4,1,%	316
100	STATEMENT	52,25,INTERARRIVAL TIME (MIN.)	317
10	STATEMENT	55,64,FIGURE 11: REL. FREQUENCY OF INTERARRIVAL TIMES1	318
TO LISTENING ROOM			319
	ENDGRAPH		320
*			321
TAB	TITLE	12,NUMBER OF ARRIVALS TO LIST. ROOM/10 MIN	322
	EJECT		323
*			324
* GRAPH			325
	GRAPH	TP,TAB12	326
	ORIGIN	50,10	327
	X	,2,6,0,1,15	328
	Y	0,1,24,2	329
7	STATEMENT	4,1,%	330
100	STATEMENT	52,20,ARRIVAL RATE/10 MIN.	331
10	STATEMENT	55,70,FIGURE 12: REL. FREQUENCY OF ARRIVALS TO LISTEN1	332
ING ROOM DURING 10 MIN.			333
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*			335
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	EJECT		337

*			338
* GRAPH			339
	GRAPH	TP,TAB13	340
	ORIGIN	50,10	341
	X	,,3,5,1,30	342
	Y	0,1,15,3	343
7	STATEMENT	4,1,%	344
100	STATEMENT	52,19,TRANSIT TIME (MIN.)	345
10	STATEMENT	55,58,FIGURE 13: REL. FREQUENCY OF TRANSIT TIME OF LI1	346
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	EJECT		351
*			352
* GRAPH			353
	GRAPH	TP,TAB14	354
	ORIGIN	50,10	355
	X	,2,4,6,1,18	356
	Y	0,1,16,3	357
7	STATEMENT	4,1,%	358
100	STATEMENT	52,9,OCCUPANCY	359
10	STATEMENT	55,87,FIGURE 14: REL. FREQUENCY OF NUMBER OF JOBS OCCU	360
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	ENDGRAPH		362
*			363
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	SPACE	3	365
TAB	TITLE	17,OCCUPANCY OF RESERVE LIST. ROOM	366
	EJECT		367
*			368
* GRAPH			369
	GRAPH	TP,TAB17	370
	ORIGIN	50,10	371
	X	,2,6,0,1,15	372
	Y	0,1,24,2	373
7	STATEMENT	4,1,%	374
100	STATEMENT	52,9,OCCUPANCY	375
10	STATEMENT	55,96,FIGURE 14A: REL. FREQUENCY OF NUMBER OF JOBS OC1	376
	CUPYING SIMULTANEOUSLY THE LISTENING ROOM		377
	ENDGRAPH		378
*			379
STO	TITLE	10,THE SYSTEM AS STORAGE	380
	SPACE	3	381
TAB	TITLE	15,SYSTEM TRANSIT TIMES (MIN.) (=SERVICE & WAIT. TIME1	382
)			383
	EJECT		384
*			385
* GRAPH			386
	GRAPH	TP,TAB15	387
	ORIGIN	50,10	388
	X	,,11,0,1,9	389
	Y	0,2,15,3	390
7	STATEMENT	4,1,%	391

100	STATEMENT	52,19,TRANSIT TIME (MIN.)	392
10	STATEMENT	55,49,FIGURE 15: REL. FREQUENCY OF SYSTEM TRANSIT TIM1	393
ES			394
	ENDGRAPH		395
*			396
TAB	TITLE	16, OCCUPANCY OF SYSTEM (=DESK, SHELVES, LIST. ROOM)	397
	EJECT		398
*			399
* GRAPH			400
	GRAPH	TP, TAB16	401
	ORIGIN	50,10	402
	X	,2,4,2,2,20	403
	Y	0,2,20,2	404
7	STATEMENT	4,1,%	405
100	STATEMENT	52,9,OCCUPANCY	406
10	STATEMENT	55,79,FIGURE 16: REL. FREQUENCY OF NUMBER OF JOBS OCC1	407
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	ENDGRAPH		409
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BLOCK NUMBER SYMBOL REFERENCES BY CARD NUMBER

75	BEIDE	128	133					
83	EXIT	91	93	94	95	113	115	116
		117	136	139	140			
87	FINE	88	110	137				
59	GEH10	117						
78	GEH11	135						
81	GEH13	138						
82	GEH14	140						
33	GEH2	89						
35	GEH3	90						
36	GEH4	92						
37	GEH5	95						
55	GEH7	111						
57	GEH8	112						
58	GEH9	114						
70	OFLOW	120						
22	ONE	78						
14	RES2	72	79					
8	SER1	80						
20	SER12	77						
13	SER2	66						
4	STG2	62	115	118	136	141		
38	STG3	62	93	96	139	141		
60	STG4	94	96	116	118			
18	TWO	71						

TABLE SYMBOLS AND CORRESPONDING NUMBERS

1	TAB1
10	TAB10
11	TAB11
12	TAB12
13	TAB13
14	TAB14
15	TAB15
16	TAB16
17	TAB17
2	TAB2
3	TAB3
4	TAB4
5	TAB5
6	TAB6
7	TAB7
8	TAB8
9	TAB9

FUNCTION SYMBOLS AND CORRESPONDING NUMBERS

1	ARRIV
2	DESK
4	LIST
3	SHELF

*

* FUNCTION DEFINITIONS.

*

* SYSTEM ARRIVAL TIME EXPONENTIALLY DISTRIBUTED

1	FUNCTION	RN1	C24		
0.0	0.0	.1	.104	.2	.222
.3	.355	.4	.509	.5	.69
.6	.915	.7	1.2	.75	1.38
.8	1.6	.84	1.83	.88	2.12
.9	2.3	.92	2.52	.94	2.81
.95	2.99	.96	3.2	.97	3.5
.98	3.9	.99	4.6	.995	5.3
.998	6.2	.999	7.0	.9997	8.0

*

* DESK SERVICE TIME EXPONENTIALLY DISTRIBUTED

2	FUNCTION	RN1	C24		
0.0	0.0	.1	.104	.2	.222
.3	.355	.4	.509	.5	.69
.6	.915	.7	1.2	.75	1.38
.8	1.6	.84	1.83	.88	2.12
.9	2.3	.92	2.52	.94	2.81
.95	2.99	.96	3.2	.97	3.5
.98	3.9	.99	4.6	.995	5.3
.998	6.2	.999	7.0	.9997	8.0

*

* SHELF SERVICE TIME EXPONENTIALLY DISTRIBUTED

3	FUNCTION	RN1	C23		
0.0	0.0	.154	.840	.281	.250
.390	.420	.483	.580	.562	.750
.629	.92	.685	1.08	.733	1.25
.774	1.42	.808	1.59	.837	1.75
.862	1.92	.883	2.08	.9	2.25
.916	2.42	.927	2.58	.937	2.75
.946	2.92	.953	3.08	.959	3.25
.964	3.42	1.0	5.27		

*

* LISTENING ROOM SERVICE TIME GENERALLY DISTRIBUTED

4	FUNCTION	RN1	C25		
0.0	0.0	.024	.063	.071	.187
.131	.312	.205	.437	.289	.563
.366	.690	.436	.820	.498	.940
.556	1.06	.623	1.18	.699	1.31
.754	1.44	.786	1.56	.814	1.69
.836	1.81	.855	1.94	.872	2.06
.888	2.18	.903	2.31	.917	2.44
.927	2.55	.962	3.19	.989	4.20
1.00	4.820				

*

* STORAGE DEFINITIONS

10	STORAGE	200
11	STORAGE	150
30	STORAGE	100
40	STORAGE	23
41	STORAGE	23

* TABLE DEFINITIONS

1	TABLE	IA	1	1	20	
2	TABLE	RT	0	1	30	10
3	TABLE	M1	1	1	30	

4	QTABLE	2	0	1	30	
5	TABLE	IA	1	1	30	
6	TABLE	RT	0	1	20	10
7	TABLE	M1	1	1	60	
8	TABLE	S30	0	1	40	
9	TABLE	M1	1	1	60	
10	TABLE	S11	0	1	60	
11	TABLE	IA	1	1	30	
12	TABLE	RT	0	1	15	10
13	TABLE	M1	0	5	60	
14	TABLE	S40	0	1	26	
15	TABLE	M1	0	2	80	
16	TABLE	S10	0	2	60	
17	TABLE	S41	0	1	26	
*						
* GPSS PROGRAM						
*						
1	GENERATE	1		FN1		
2	ENTER	10				
3	TRANSFER	.360	38	4		
4	MARK					
5	ENTER	11				
6	QUEUE	2				
7	GATE NU	1	13			
8	SEIZE	1				
9	DEPART	2				
10	ADVANCE	1	FN2			
11	RELEASE	1				
12	TRANSFER		18			
13	LINK	2	FIFO	14		
14	SEIZE	2				
15	DEPART	2				
16	ADVANCE	1	FN2			
17	RELEASE	2				
18	UNLINK	2	20	1		
19	TRANSFER		22			
20	GATE NU	1	14			
21	TRANSFER		8			
22	TABULATE	1				
23	TABULATE	2				
24	TABULATE	3				
25	LEAVE	11				
26	TABULATE	9				
27	TABULATE	10				
28	ASSIGN	2	K1			
29	TEST LE	C1	K3600	87		
30	TEST E	P3	K1	33		
31	TEST E	P4	K1	35		
32	TRANSFER		83			
33	TEST E	P4	K1	36		
34	TRANSFER	.750	38	83		
35	TRANSFER	.960	60	83		
36	TRANSFER	.730	37	83		
37	TRANSFER	.110	38	60		
38	MARK					
39	ENTER	11				
40	ENTER	30				
41	ADVANCE	6	FN3			
42	LEAVE	30				
43	TABULATE	5				

44	TABULATE	6		
45	TABULATE	7		
46	TABULATE	8		
47	LEAVE	11		
48	TABULATE	9		
49	TABULATE	10		
50	ASSIGN	3	K1	
51	TEST LE	C1	K3600	87
52	TEST E	P2	K1	55
53	TEST E	P4	K1	57
54	TRANSFER		83	
55	TEST E	P4	K1	58
56	TRANSFER	.280	4	83
57	TRANSFER	.220	60	83
58	TRANSFER	.140	59	83
59	TRANSFER	.580	4	60
60	MARK			
61	GATE SNF	40	70	
62	ENTER	40		
63	ADVANCE	40	FN4	
64	LEAVE	40		
65	TABULATE	11		
66	TABULATE	12		
67	TABULATE	13		
68	TABULATE	14		
69	TRANSFER		75	
70	ENTER	41		
71	ADVANCE	40	FN4	
72	LEAVE	41		
73	TABULATE	17		
74	TRANSFER		75	
75	ASSIGN	4	K1	
76	TEST E	P3	K1	78
77	TRANSFER	.090	4	83
78	TEST LE	C1	K3600	87
79	TEST E	P2	K1	81
80	TRANSFER	.380	38	83
81	TRANSFER	.080	82	83
82	TRANSFER	.140	4	38
83	LEAVE	10		
84	TABULATE	15		
85	TABULATE	16		
86	TERMINATE			
87	LEAVE	10		
88	TABULATE	15		
89	TABULATE	16		
90	TERMINATE	1		

* CONTROL CARD

START 1

STATISTICS CONCERNING THE INFORMATION DESK, SERV.1

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
1	.557	3379	.593	69	

STATISTICS CONCERNING THE INFORMATION DESK, SERV.2

FACILITY	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRAN	SEIZING TRANS. NO.	PREEMPTING TRANS. NO.
2	.385	2439	.569		

STATISTICS CONCERNING THE DESK QUEUE

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
2	20	.777	5818	4537	77.9	.481	2.186	4	

\$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

STATISTICS CONCERNING THE DESK USER CHAIN

USER CHAIN	TOTAL ENTRIES	AVERAGE TIME/TRANS	CURRENT CONTENTS	AVERAGE CONTENTS	MAXIMUM CONTENTS
2	1768	1.176		.577	16

DESK INTERARRIVAL TIMES (MIN.)

TABLE TAB1
ENTRIES IN TABLE
5816MEAN ARGUMENT
.618STANDARD DEVIATION
.808SUM OF ARGUMENTS
3598.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	5129	88.18	88.1	11.8	1.616	.471
2	528	9.07	97.2	2.7	3.232	1.708
3	111	1.90	99.1	.8	4.849	2.945
4	37	.63	99.8	.1	6.465	4.183
5	8	.13	99.9	.0	8.082	5.420
6	2	.03	99.9	.0	9.698	6.657
7	1	.01	100.0	.0	11.315	7.894

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

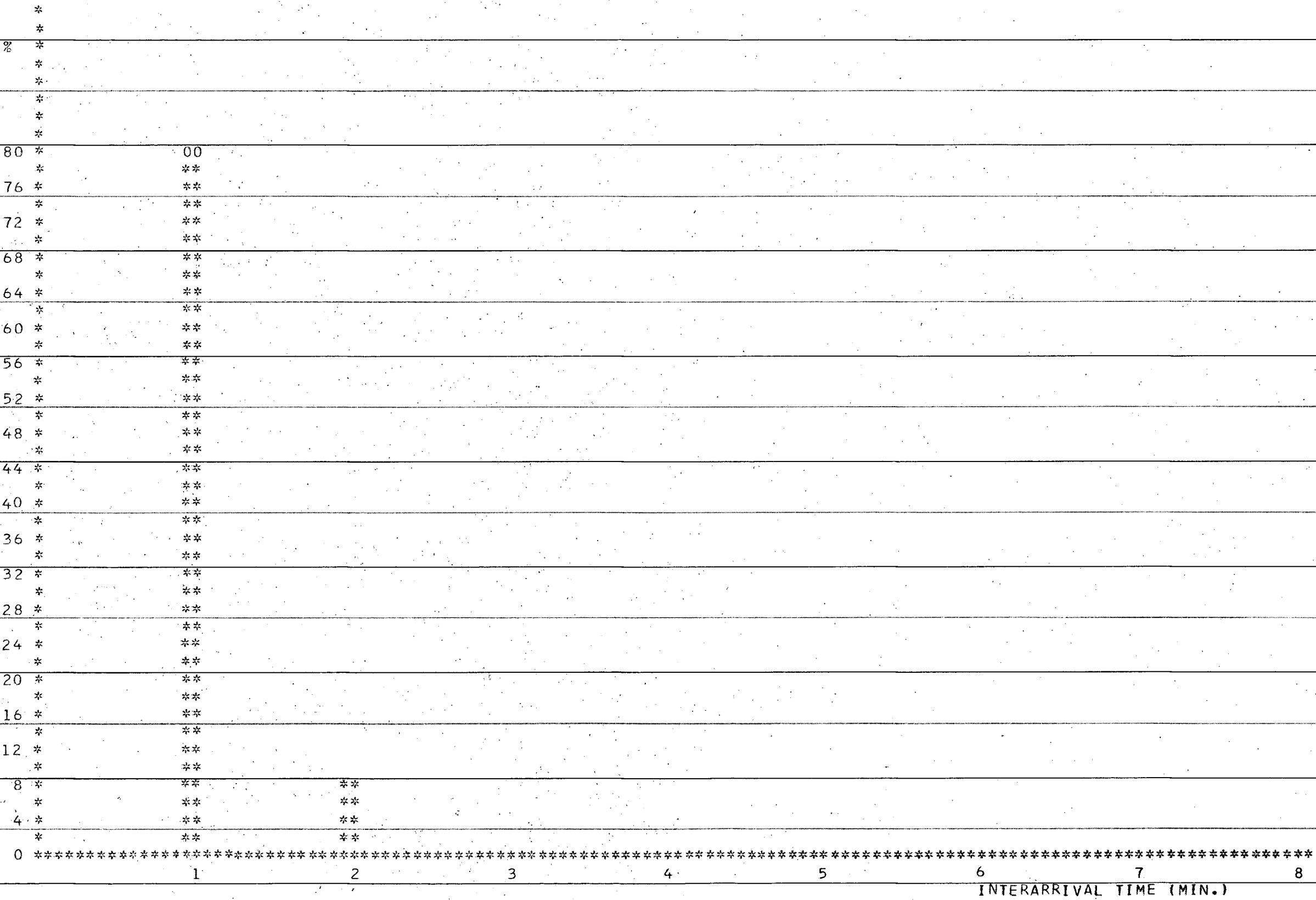


FIGURE 1: REL. FREQUENCY OF INTERARRIVAL TIMES

NUMBER OF ARRIVALS TO DESK/10 MIN.

TABLE TAB2
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

NON-WEIGHTED

360

16.155

5.089

5816.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-3.174
1	0	.00	.0	100.0	.061	-2.977
2	0	.00	.0	100.0	.123	-2.781
3	0	.00	.0	100.0	.185	-2.584
4	0	.00	.0	100.0	.247	-2.388
5	1	.27	.2	99.7	.309	-2.191
6	4	1.11	1.3	98.6	.371	-1.995
7	5	1.38	2.7	97.2	.433	-1.798
8	12	3.33	6.1	93.8	.495	-1.602
9	10	2.77	8.8	91.1	.557	-1.405
10	11	3.05	11.9	88.0	.618	-1.209
11	20	5.55	17.4	82.5	.680	-1.012
12	23	6.38	23.8	76.1	.742	-.816
13	34	9.44	33.3	66.6	.804	-.619
14	27	7.49	40.8	59.1	.866	-.423
15	25	6.94	47.7	52.2	.928	-.227
16	25	6.94	54.7	45.2	.990	-.030
17	33	9.16	63.8	36.1	1.052	.165
18	20	5.55	69.4	30.5	1.114	.362
19	18	4.99	74.4	25.5	1.176	.558
20	21	5.83	80.2	19.7	1.237	.755
21	15	4.16	84.4	15.5	1.299	.951
22	15	4.16	88.6	11.3	1.361	1.148
23	10	2.77	91.3	8.6	1.423	1.344
24	13	3.61	94.9	5.0	1.485	1.541
25	5	1.38	96.3	3.6	1.547	1.737
26	5	1.38	97.7	2.2	1.609	1.934
27	3	.83	98.6	1.3	1.671	2.130
28	1	.27	98.8	1.1	1.733	2.327
OVERFLOW	4	1.11	100.0	.0		
AVERAGE VALUE OF OVERFLOW		32.75				

GRAPH

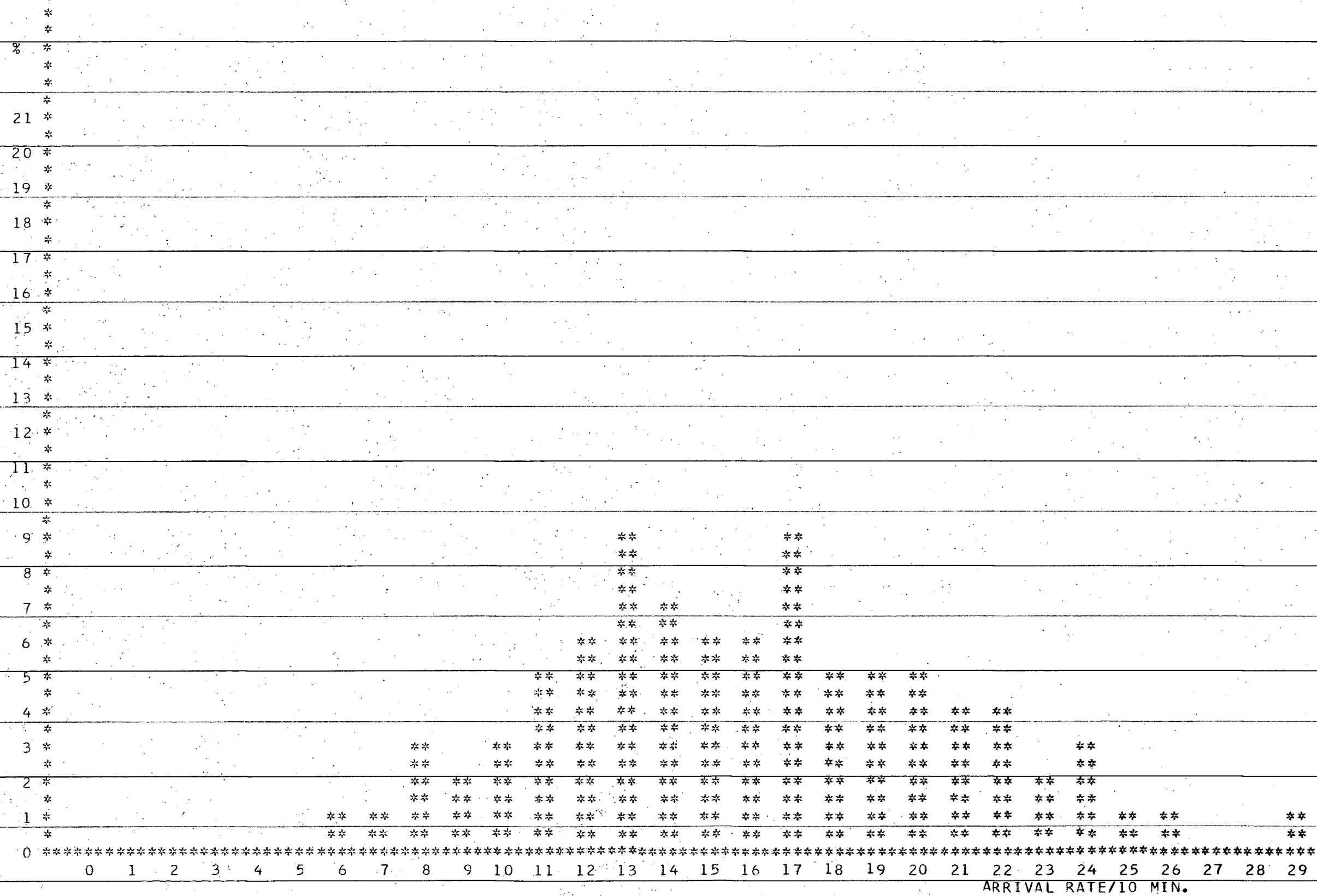


FIGURE 2: REL. FREQUENCY OF ARRIVALS TO INF. DESK DURING 10 MIN.

DESK TRANSIT TIMES (MIN.) (=WAIT. & SERVICE TIME)

TABLE TAB3
ENTRIES IN TABLE

MEAN ARGUMENT 1.065
STANDARD DEVIATION 1.570
SUM OF ARGUMENTS 6196.000
NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	4338	74.57	74.5	25.4	.938	-.041
2	708	12.17	86.7	13.2	1.877	.595
3	333	5.72	92.4	7.5	2.816	1.232
4	193	3.31	95.7	4.2	3.755	1.868
5	117	2.01	97.7	2.2	4.694	2.505
6	49	.84	98.6	1.3	5.632	3.142
7	26	.44	99.0	.9	6.571	3.779
8	18	.30	99.3	.6	7.510	4.416
9	16	.27	99.6	.3	8.449	5.053
10	6	.10	99.7	.2	9.388	5.689
11	11	.18	99.9	.0	10.327	6.326
12	2	.03	100.0	.0	11.265	6.963

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

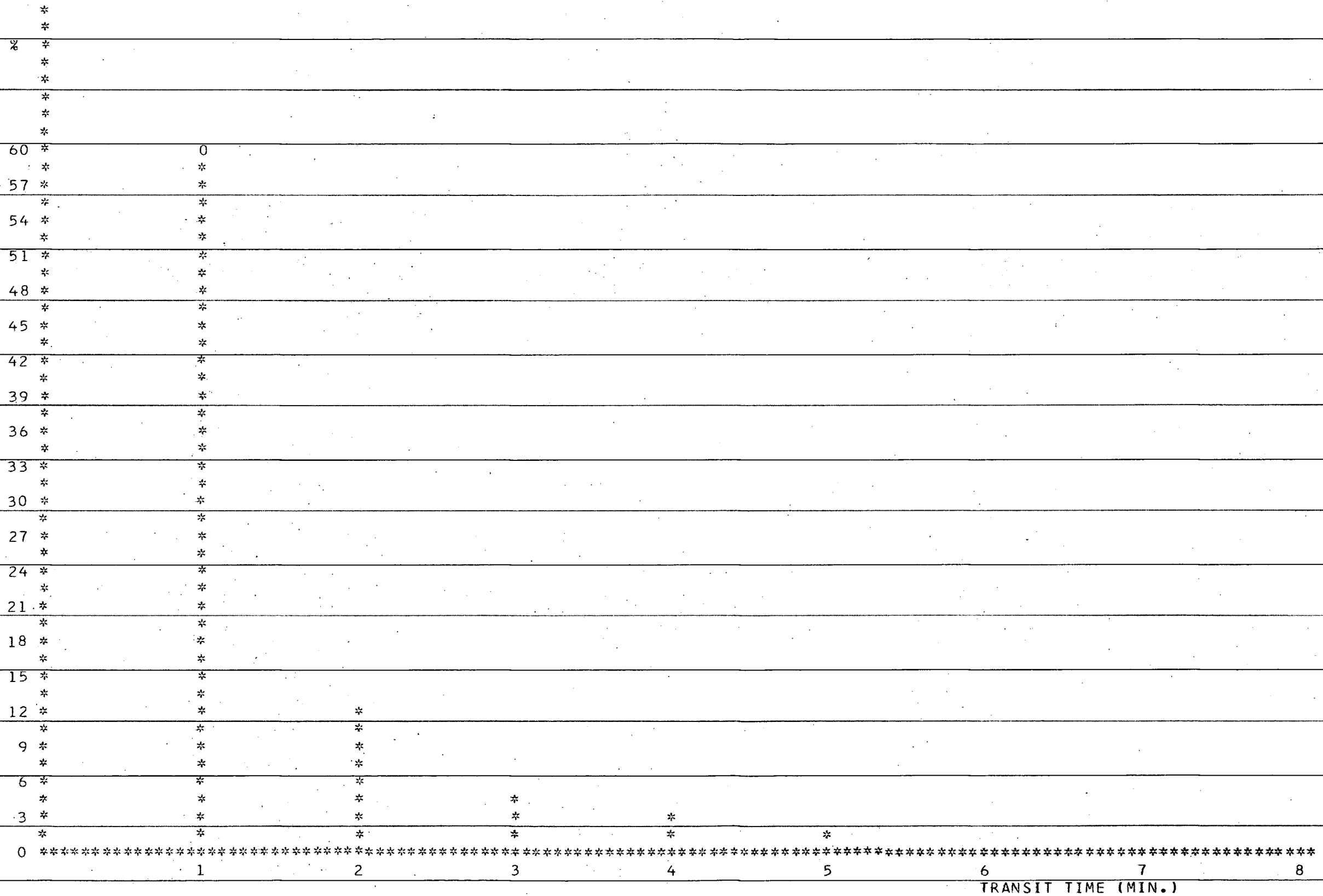


FIGURE 3: REL. FREQUENCY OF TRANST. TIMES AT INFORMATION DESK

NUMBER OF JOBS WAITING FOR SERVICE AT DESK

TABLE TAB4
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

5818

.481

1.226

2801.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	4537	77.98	77.9	22.0	-.000	-.392
1	655	11.25	89.2	10.7	2.077	.422
2	266	4.57	93.8	6.1	4.154	1.238
3	134	2.30	96.1	3.8	6.231	2.053
4	100	1.71	97.8	2.1	8.308	2.868
5	56	.96	98.7	1.2	10.385	3.683
6	22	.37	99.1	.8	12.462	4.499
7	16	.27	99.4	.5	14.539	5.314
8	12	.20	99.6	.3	16.616	6.129
9	12	.20	99.8	.1	18.694	6.945
10	4	.06	99.9	.0	20.771	7.760
11	4	.06	100.0	.0	22.848	8.575

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

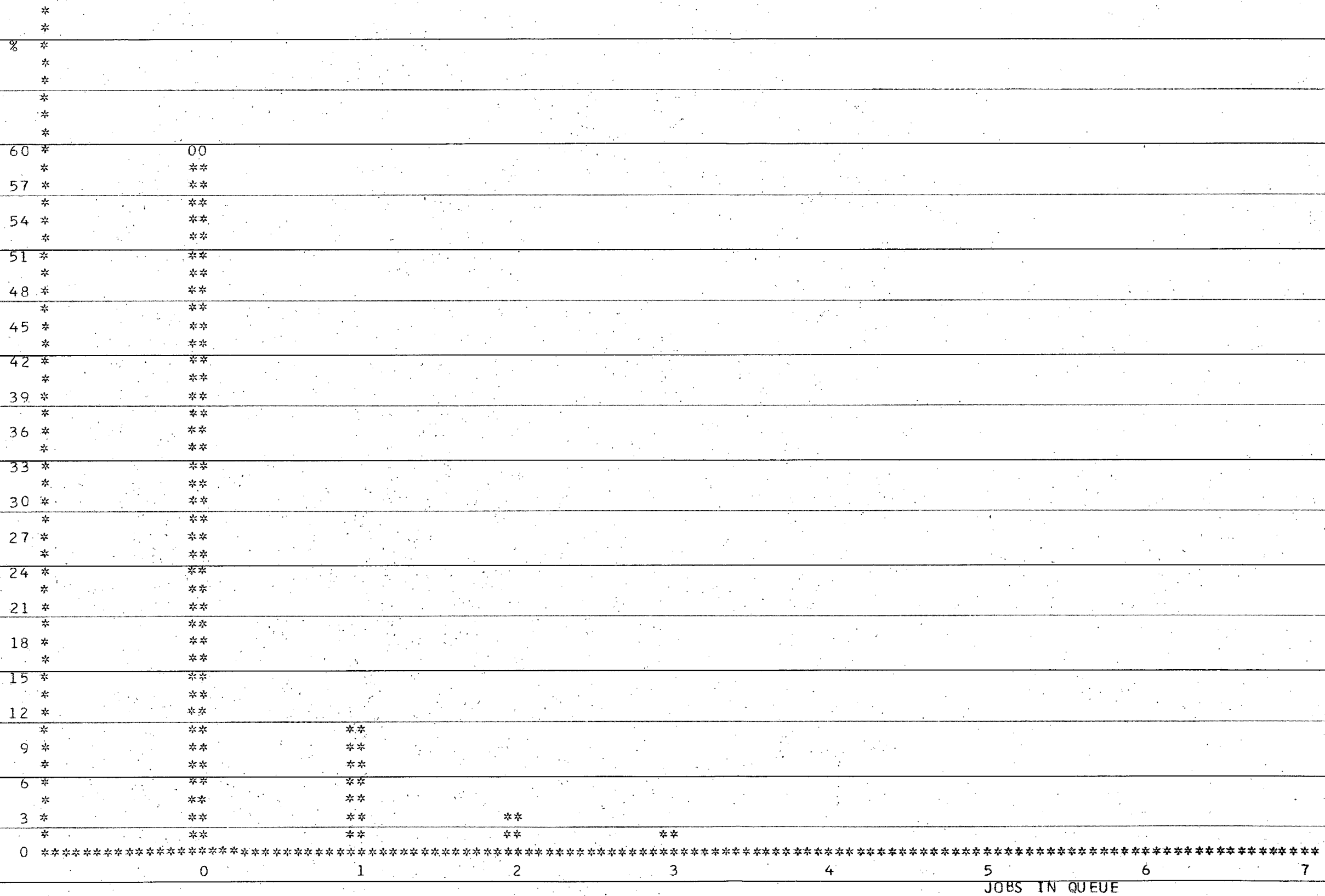


FIGURE 4: REL. FREQUENCY OF JOBS WAITING FOR SERVICE AT INFORMATION DESK

GRAPH

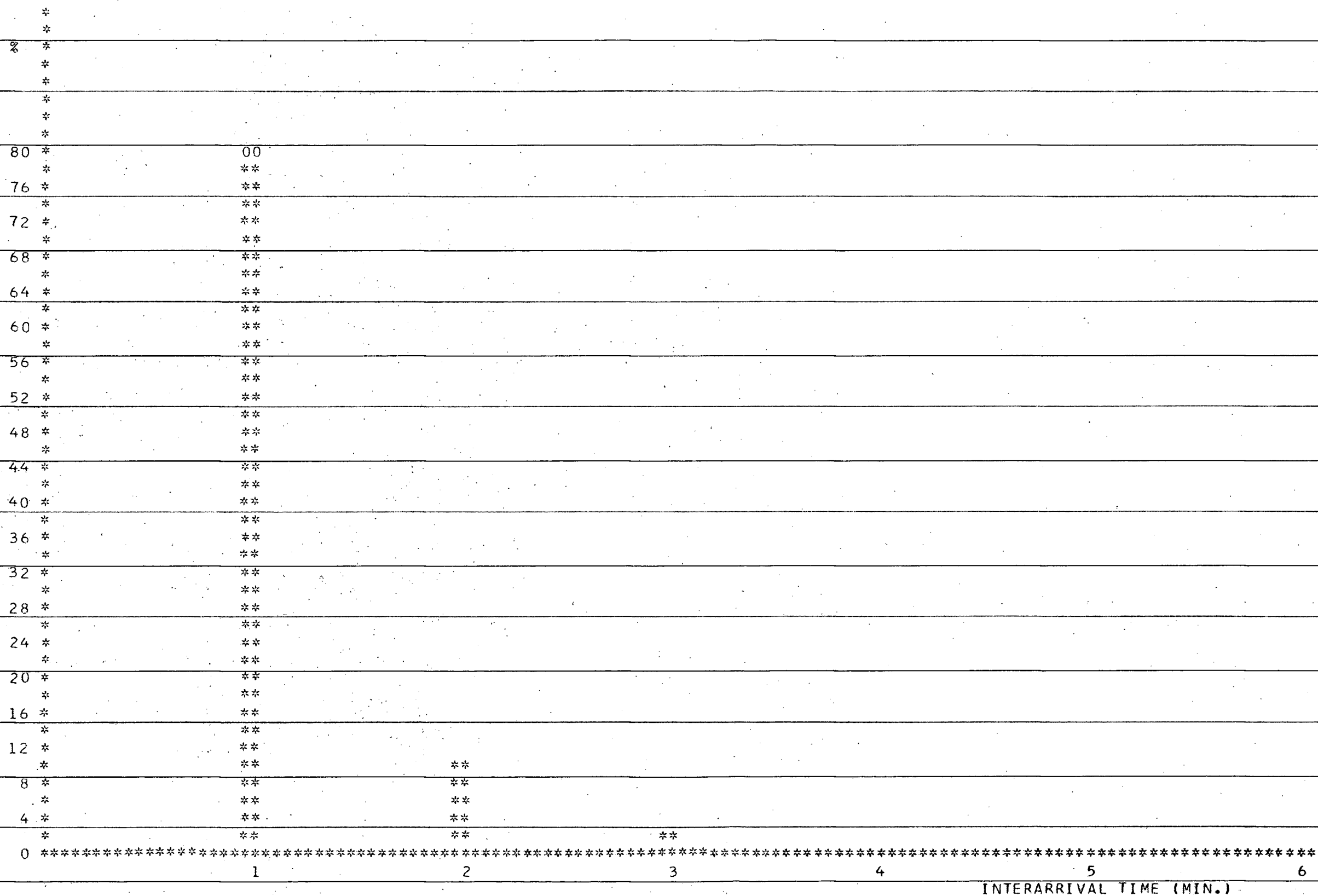


FIGURE 5: REL. FREQUENCY OF INTERARRIVAL TIMES

THE SHELVES AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
30	100	7.343	.073	4534	5.832	6	24

SHELF INTERARRIVAL TIMES (MIN.)

TABLE TAB 5
ENTRIES IN TABLE
4527

MEAN ARGUMENT
.794

STANDARD DEVIATION
.974

SUM OF ARGUMENTS
3598.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	3815	84.27	84.2	15.7	1.258	.210
2	473	10.44	94.7	5.2	2.516	1.237
3	154	3.40	98.1	1.8	3.774	2.263
4	52	1.14	99.2	.7	5.032	3.290
5	16	.35	99.6	.3	6.290	4.316
6	8	.17	99.8	.1	7.549	5.343
7	5	.11	99.9	.0	8.807	6.370
8	2	.04	99.9	.0	10.065	7.396
9	1	.02	99.9	.0	11.323	8.423
10	0	.00	99.9	.0	12.581	9.449
11	1	.02	100.0	.0	13.840	10.476

REMAINING FREQUENCIES ARE ALL ZERO

NUMBER OF ARRIVALS TO SHELVES/10 MIN.

TABLE TAB6
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

360

12.572

4.785

4526.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-2.627
1	0	.00	.0	100.0	.079	-2.418
2	0	.00	.0	100.0	.159	-2.209
3	8	2.22	2.2	97.7	.238	-2.000
4	2	.55	2.7	97.2	.318	-1.791
5	9	2.49	5.2	94.7	.397	-1.582
6	13	3.61	8.8	91.1	.477	-1.373
7	14	3.88	12.7	87.2	.556	-1.164
8	20	5.55	18.3	81.6	.636	-.955
9	37	10.27	28.6	71.3	.715	-.746
10	24	6.66	35.2	64.7	.795	-.537
11	27	7.49	42.7	57.2	.874	-.328
12	35	9.72	52.4	47.5	.954	-.119
13	22	6.11	58.6	41.3	1.034	.089
14	38	10.55	69.1	30.8	1.113	.298
15	31	8.61	77.7	22.2	1.193	.507
16	18	4.99	82.7	17.2	1.272	.716
17	15	4.16	86.9	13.0	1.352	.925
18	8	2.22	89.1	10.8	1.431	1.134
OVERFLOW	39	10.83	100.0	.0		

AVERAGE VALUE OF OVERFLOW 21.87

GRAPH

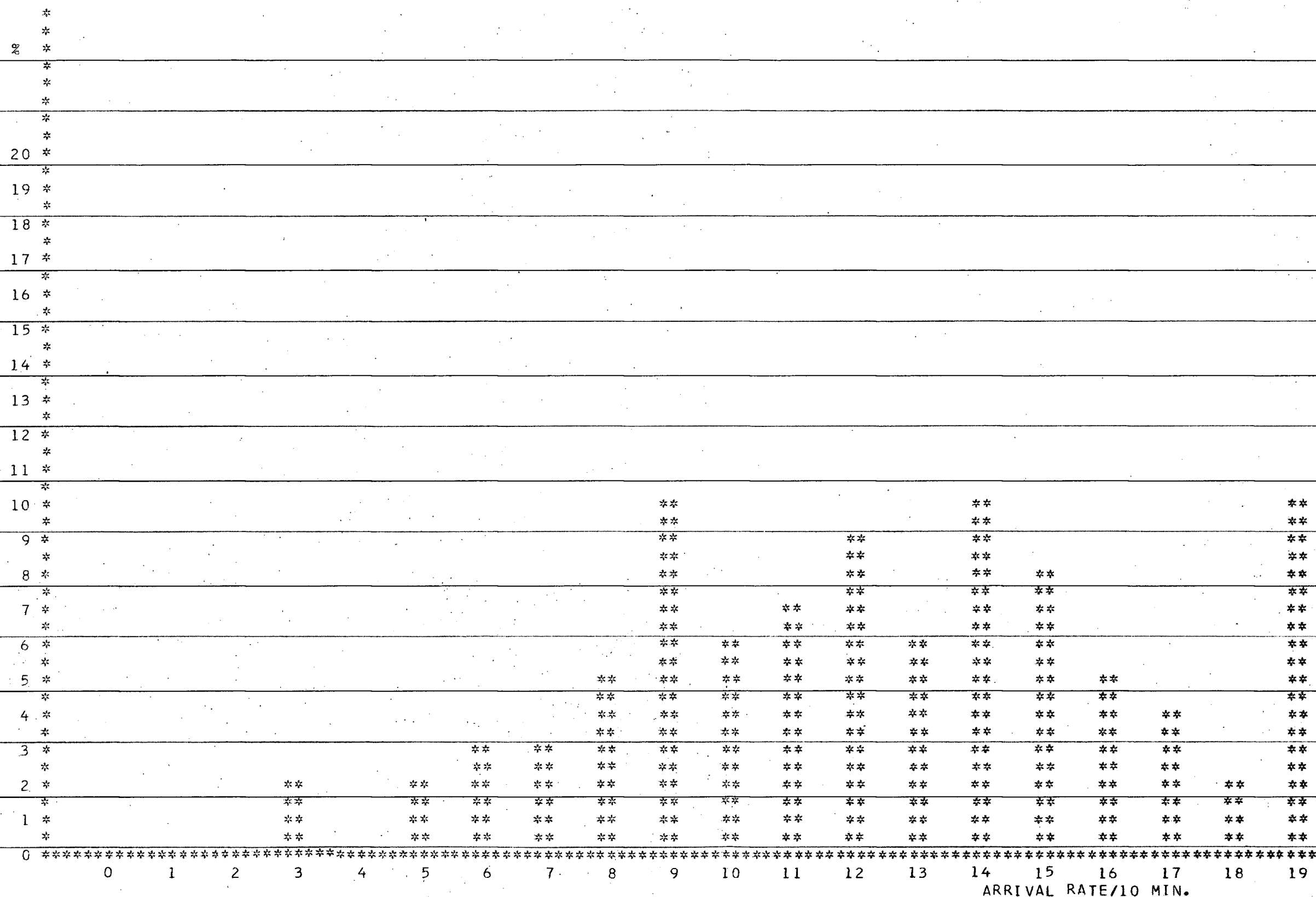


FIGURE 6: REL. FREQUENCY OF ARRIVALS TO SHELVES DURING 10 MIN.

SHELF TRANSIT TIMES (MIN)

TABLE TAB7
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

NON-WEIGHTED

4528

5.833

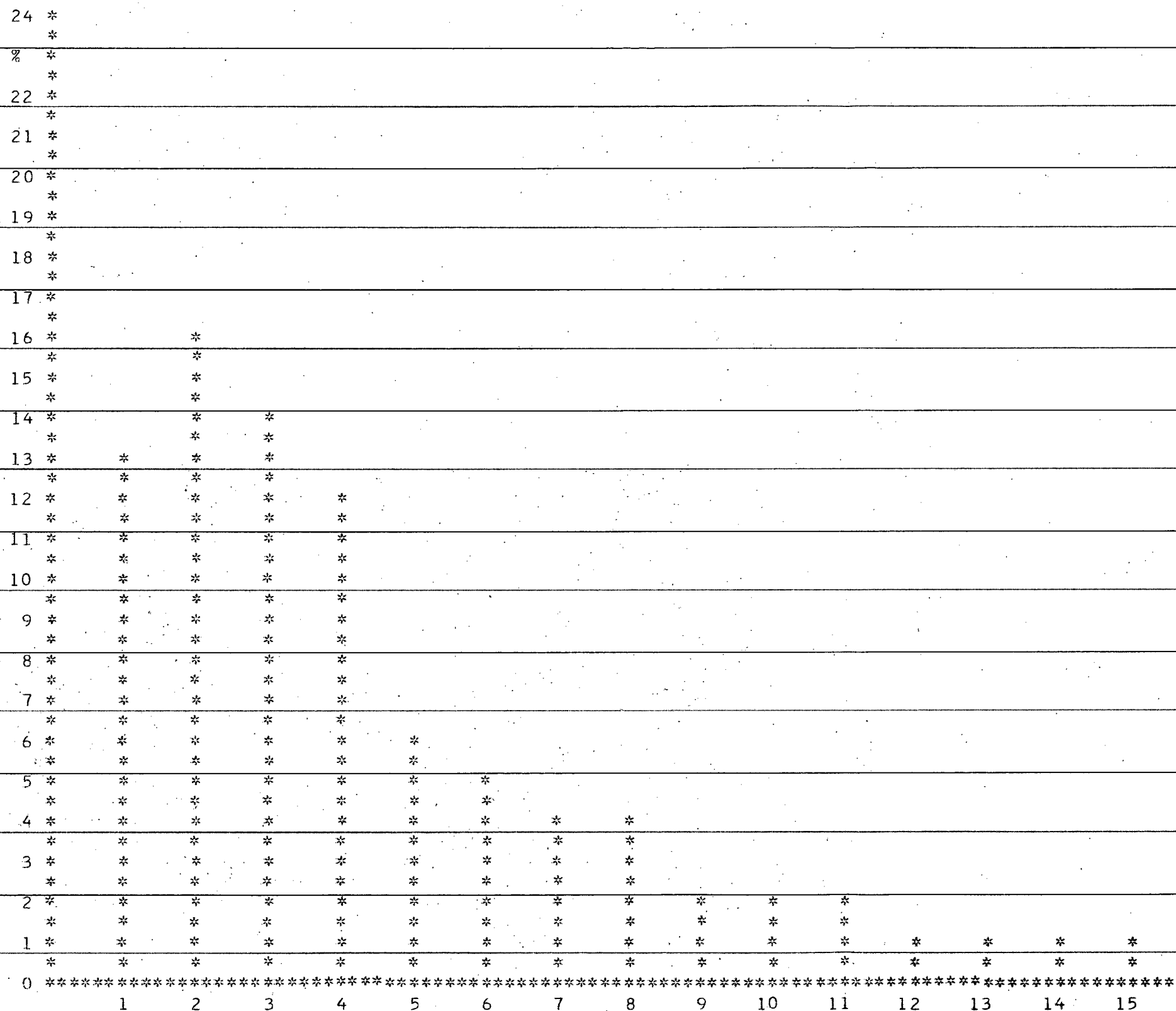
5.601

26415.000

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	602	13.29	13.2	86.7	.171	-.862
2	765	16.89	30.1	69.8	.342	-.684
3	674	14.88	45.0	54.9	.514	-.505
4	571	12.61	57.6	42.3	.685	-.327
5	304	6.71	64.3	35.6	.857	-.148
6	264	5.83	70.2	29.7	1.028	.029
7	196	4.32	74.5	25.4	1.199	.208
8	192	4.24	78.7	21.2	1.371	.386
9	128	2.82	81.6	18.3	1.542	.565
10	126	2.78	84.4	15.5	1.714	.743
11	122	2.69	87.1	12.8	1.885	.922
12	85	1.87	88.9	11.0	2.057	1.100
13	64	1.41	90.3	9.6	2.228	1.279
14	62	1.36	91.7	8.2	2.399	1.457
15	56	1.23	92.9	7.0	2.571	1.636
16	50	1.10	94.1	5.8	2.742	1.814
17	43	.94	95.0	4.9	2.914	1.993
18	37	.81	95.8	4.1	3.085	2.171
19	17	.37	96.2	3.7	3.256	2.350
20	13	.28	96.5	3.4	3.428	2.528
21	15	.33	96.8	3.1	3.599	2.707
22	22	.48	97.3	2.6	3.771	2.886
23	12	.26	97.6	2.3	3.942	3.064
24	18	.39	98.0	1.9	4.114	3.243
25	11	.24	98.2	1.7	4.285	3.421
26	16	.35	98.6	1.3	4.456	3.600
27	12	.26	98.8	1.1	4.628	3.778
28	17	.37	99.2	.7	4.799	3.957
29	8	.17	99.4	.5	4.971	4.135
30	18	.39	99.8	.1	5.142	4.314
31	8	.17	100.0	.0	5.313	4.492

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



TRANSIT TIME (MIN.)

FIGURE 7: REL. FREQUENCY OF TRANSIT TIMES AT SHELVES.

OCCUPANCY OF SHELVES

TABLE TAB8
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

4528

7.407

3.363

33543.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	9	.19	.1	99.8	-.000	-2.202
1	70	1.54	1.7	98.2	.134	-1.905
2	158	3.48	5.2	94.7	.269	-1.607
3	278	6.13	11.3	88.6	.404	-1.310
4	387	8.54	19.9	80.0	.539	-1.013
5	473	10.44	30.3	69.6	.674	-.715
6	552	12.19	42.5	57.4	.809	-.418
7	536	11.83	54.3	45.6	.944	-.121
8	526	11.61	66.0	33.9	1.079	.176
9	431	9.51	75.5	24.4	1.214	.473
10	342	7.55	83.0	16.9	1.349	.770
11	247	5.45	88.5	11.4	1.484	1.068
12	176	3.88	92.4	7.5	1.619	1.365
13	118	2.60	95.0	4.9	1.754	1.662
14	88	1.94	96.9	3.0	1.889	1.960
15	58	1.28	98.2	1.7	2.024	2.257
16	33	.72	98.9	1.0	2.159	2.554
17	17	.37	99.3	.6	2.294	2.852
18	11	.24	99.6	.3	2.429	3.149
19	8	.17	99.7	.2	2.564	3.446
20	6	.13	99.9	.0	2.699	3.743
21	2	.04	99.9	.0	2.834	4.041
22	1	.02	99.9	.0	2.969	4.338
23	1	.02	100.0	.0	3.104	4.635

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

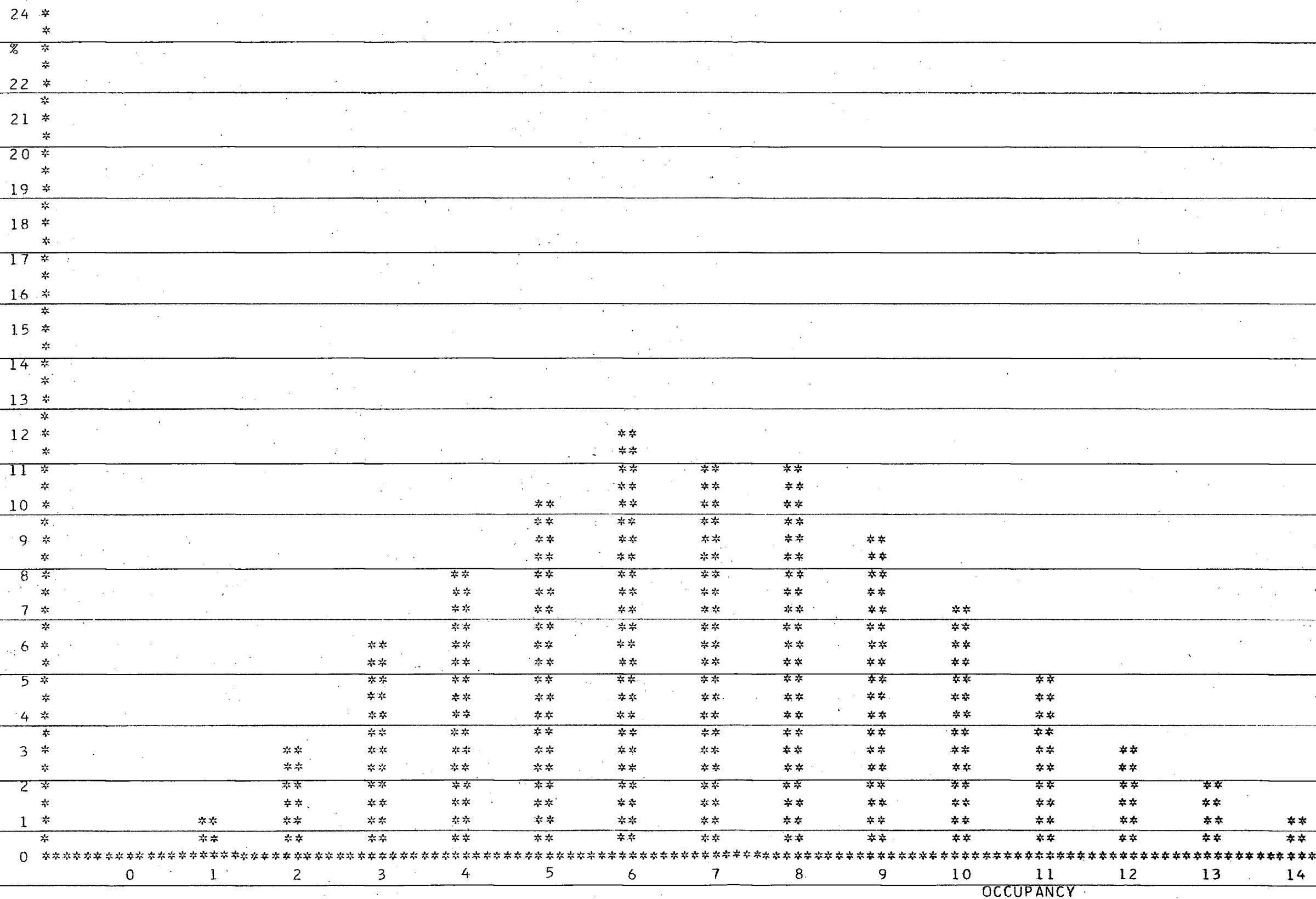


FIGURE 8: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE SHELVES

THE RECORDINGS COLLECTION (=DESK & SHELVES) AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
11	150	9.064	.060	10352	3.153	7	34

TRANSIT TIMES THROUGH REC. COLL. (MIN.) , (=DESK & SHELVES)

TABLE TAB9
ENTRIES IN TABLE
10345

MEAN ARGUMENT
3.152

STANDARD DEVIATION
4.550

SUM OF ARGUMENTS
32611.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	4940	47.75	47.7	52.2	.317	-.472
2	1473	14.23	61.9	38.0	.634	-.253
3	1007	9.73	71.7	28.2	.951	-.033
4	764	7.38	79.1	20.8	1.268	.186
5	421	4.06	83.1	16.8	1.586	.406
6	313	3.02	86.2	13.7	1.903	.625
7	222	2.14	88.3	11.6	2.220	.845
8	210	2.02	90.3	9.6	2.537	1.065
9	144	1.39	91.7	8.2	2.855	1.284
10	132	1.27	93.0	6.9	3.172	1.504
11	133	1.28	94.3	5.6	3.489	1.724
12	87	.84	95.1	4.8	3.806	1.944
13	64	.61	95.7	4.2	4.123	2.163
14	62	.59	96.3	3.6	4.441	2.383
15	56	.54	96.9	3.0	4.758	2.603
16	50	.48	97.4	2.5	5.075	2.823
17	43	.41	97.8	2.1	5.392	3.042
18	37	.35	98.1	1.8	5.710	3.262
19	17	.16	98.3	1.6	6.027	3.482
20	13	.12	98.4	1.5	6.344	3.702
21	15	.14	98.6	1.3	6.661	3.921
22	22	.21	98.8	1.1	6.978	4.141
23	12	.11	98.9	1.0	7.296	4.361
24	18	.17	99.1	.8	7.613	4.581
25	11	.10	99.2	.7	7.930	4.800
26	16	.15	99.3	.6	8.247	5.020
27	12	.11	99.5	.4	8.565	5.240
28	17	.16	99.6	.3	8.882	5.460
29	8	.07	99.7	.2	9.199	5.679
30	18	.17	99.9	.0	9.516	5.899
31	8	.07	100.0	.0	9.833	6.119

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

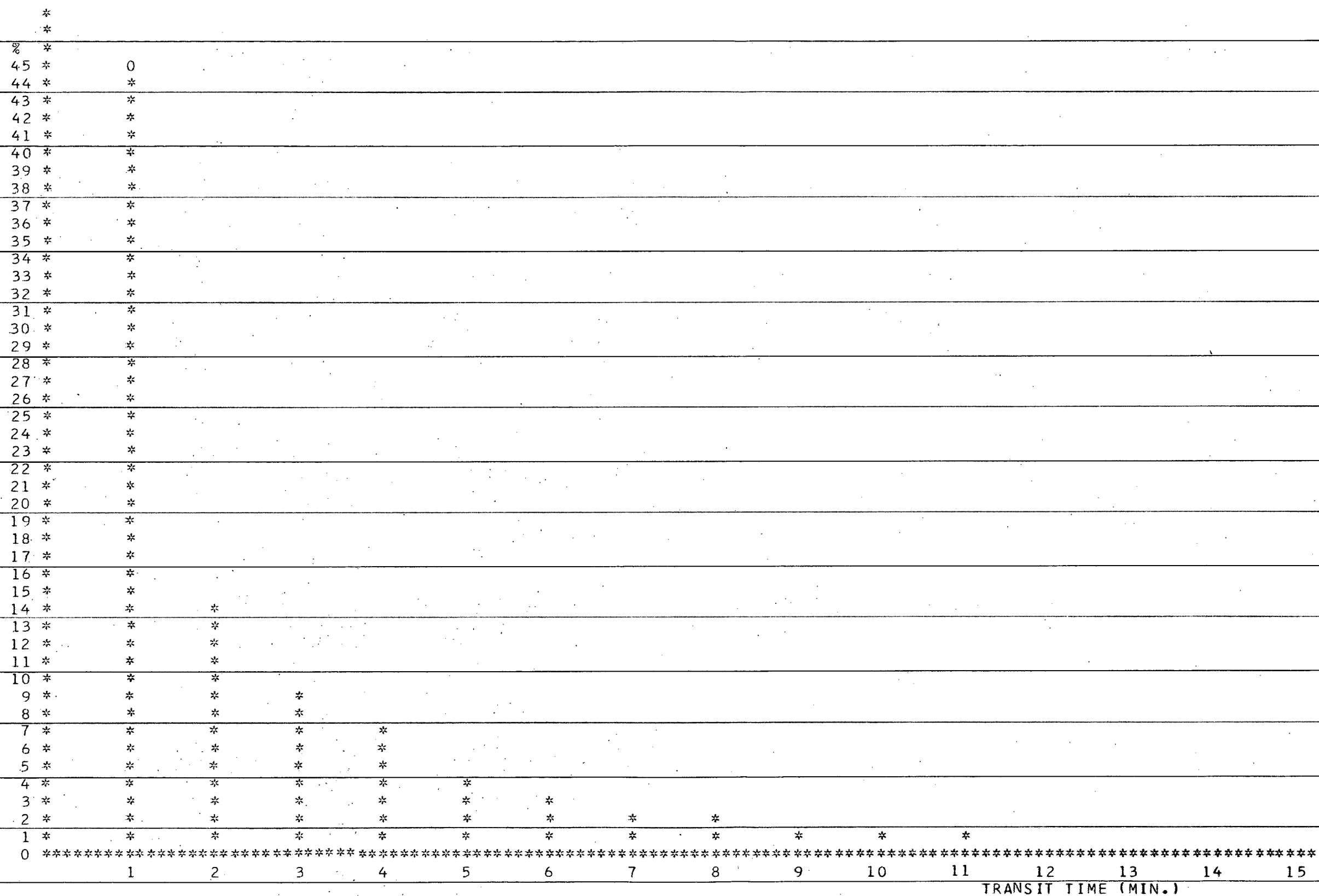


FIGURE 9: REL. FREQUENCY OF TRANSIT TIMES THROUGH THE RECORDINGS COLLECTION

OCCUPANCY OF RECORD. COLLECT. (=DESK & SHELVES)

TABLE TAB10
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

10345

9.402

4.707

97267.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	12	.11	.1	99.8	-.000	-1.997
1	74	.71	.8	99.1	.106	-1.785
2	219	2.11	2.9	97.0	.212	-1.572
3	411	3.97	6.9	93.0	.319	-1.360
4	550	5.31	12.2	87.7	.425	-1.147
5	788	7.61	19.8	80.1	.531	-.935
6	876	8.46	28.3	71.6	.638	-.722
7	1021	9.86	38.1	61.8	.744	-.510
8	1023	9.88	48.0	51.9	.850	-.297
9	958	9.26	57.3	42.6	.957	-.085
10	883	8.53	65.8	34.1	1.063	.126
11	706	6.82	72.7	27.2	1.169	.339
12	645	6.23	78.9	21.0	1.276	.551
13	471	4.55	83.4	16.5	1.382	.764
14	357	3.45	86.9	13.0	1.488	.976
15	304	2.93	89.8	10.1	1.595	1.189
16	248	2.39	92.2	7.7	1.701	1.401
17	214	2.06	94.3	5.6	1.808	1.614
18	135	1.30	95.6	4.3	1.914	1.826
19	85	.82	96.4	3.5	2.020	2.039
20	73	.70	97.1	2.8	2.127	2.251
21	60	.57	97.7	2.2	2.233	2.463
22	61	.58	98.3	1.6	2.339	2.676
23	36	.34	98.6	1.3	2.446	2.888
24	26	.25	98.9	1.0	2.552	3.101
25	27	.26	99.2	.7	2.658	3.313
26	20	.19	99.4	.5	2.765	3.526
27	17	.16	99.5	.4	2.871	3.738
28	12	.11	99.6	.3	2.977	3.951
29	13	.12	99.8	.1	3.084	4.163
30	8	.07	99.8	.1	3.190	4.375
31	4	.03	99.9	.0	3.297	4.588
32	4	.03	99.9	.0	3.403	4.800
33	4	.03	100.0	.0	3.509	5.013

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

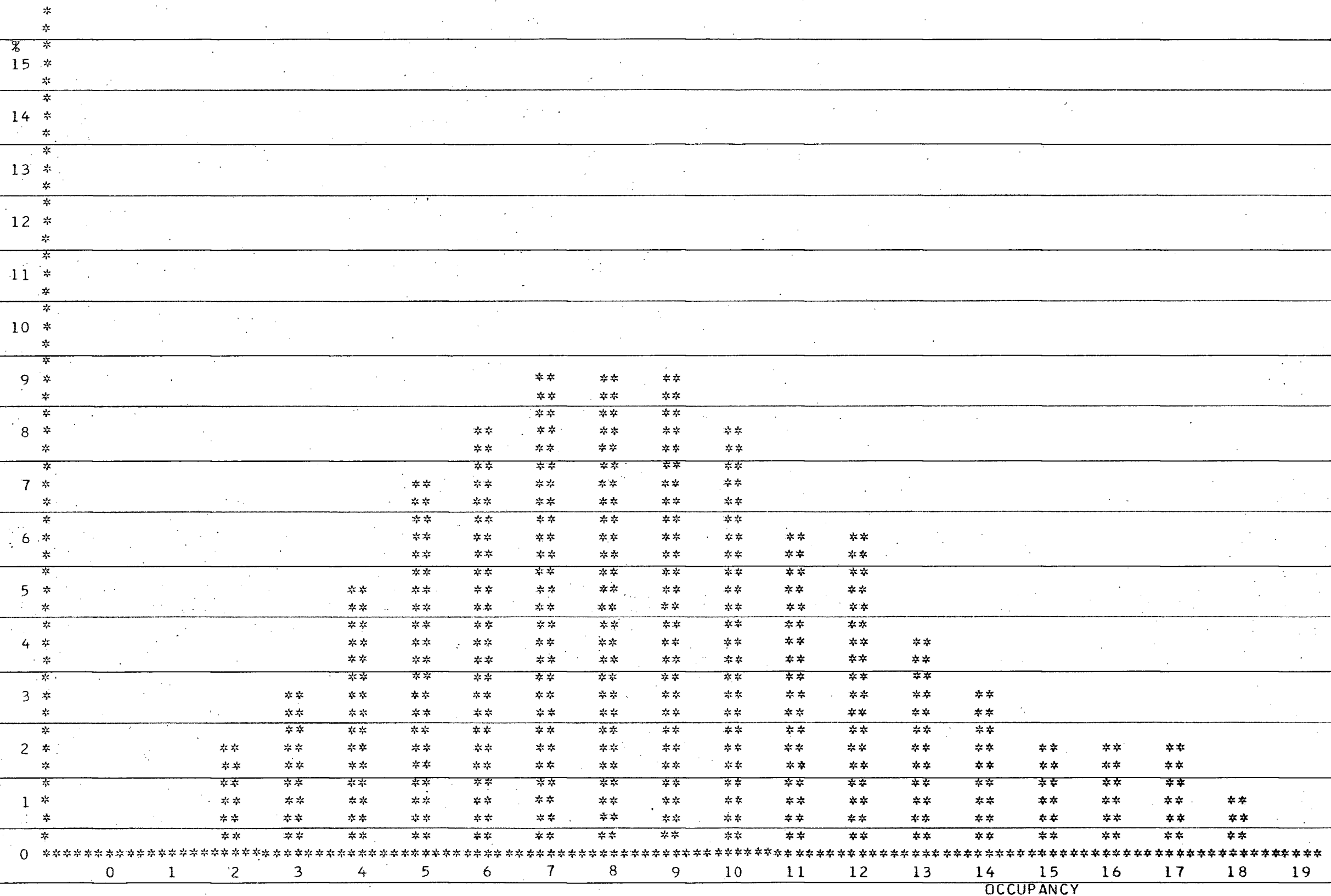


FIGURE 10: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY DESK AND SHELVES

THE LISTENING ROOM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
40	23	20.925	.909	1634	46.116	21	23

LISTENING ROOM INTERARRIVAL TIMES (MIN.)

TABLE TAB11
ENTRIES IN TABLE
1612MEAN ARGUMENT
2.216STANDARD DEVIATION
2.191SUM OF ARGUMENTS
3573.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
1	776	48.13	48.1	51.8	.451	-.555
2	299	18.54	66.6	33.3	.902	-.098
3	211	13.08	79.7	20.2	1.353	.357
4	144	8.93	88.7	11.2	1.804	.813
5	54	3.34	92.0	7.9	2.255	1.270
6	36	2.23	94.2	5.7	2.706	1.726
7	35	2.17	96.4	3.5	3.158	2.182
8	17	1.05	97.5	2.4	3.609	2.639
9	16	.99	98.5	1.4	4.060	3.095
10	12	.74	99.2	.7	4.511	3.551
11	6	.37	99.6	.3	4.962	4.008
12	1	.06	99.6	.3	5.413	4.464
13	2	.12	99.8	.1	5.865	4.920
14	2	.12	99.9	.0	6.316	5.377
15	1	.06	100.0	.0	6.767	5.833

REMAINING FREQUENCIES ARE ALL ZERO

NUMBER OF ARRIVALS TO LIST. ROOM/10 MIN

TABLE TAB12
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

360

4.474

2.039

1611.000

NON-WEIGHTED

UPPER
LIMIT

OBSERVED
FREQUENCY

PER CENT
OF TOTAL

CUMULATIVE
PERCENTAGE

CUMULATIVE
REMAINDER

MULTIPLE
OF MEAN

DEVIATION
FROM MEAN

0

5

1.38

1.3

98.6

-.000

-2.194

1

19

5.27

6.6

93.3

.223

-1.704

2

36

9.99

16.6

83.3

.446

-1.213

3

57

15.83

32.4

67.5

.670

-.723

4

74

20.55

53.0

46.9

.893

-.232

5

67

18.61

71.6

28.3

1.117

.257

6

37

10.27

81.9

18.0

1.340

.747

7

39

10.83

92.7

7.2

1.564

1.238

8

15

4.16

96.9

3.0

1.787

1.728

9

7

1.94

98.8

1.1

2.011

2.219

10

4

1.11

100.0

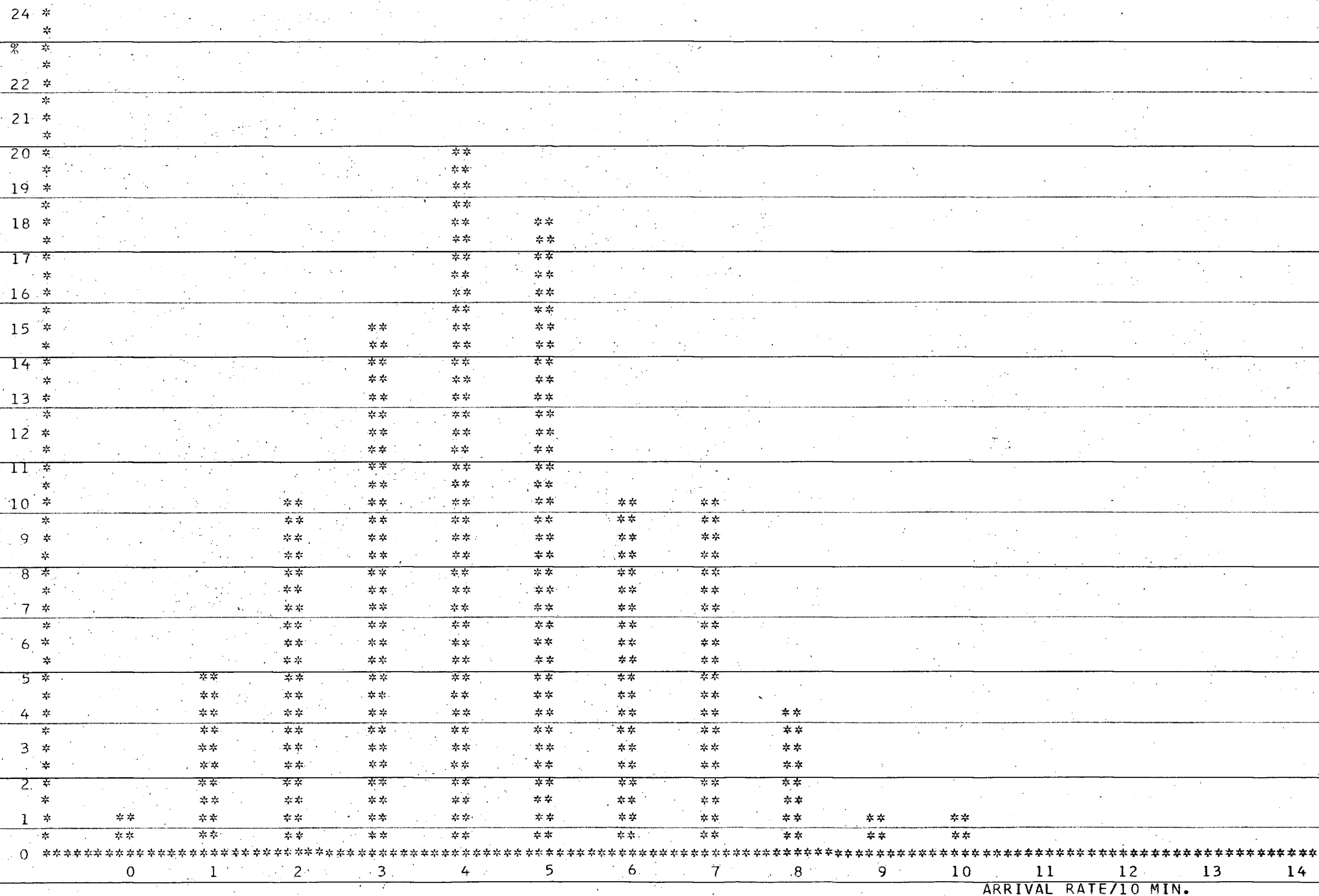
.0

2.234

2.709

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH



ARRIVAL RATE/10 MIN.

FIGURE 12: REL. FREQUENCY OF ARRIVALS TO LISTENING ROOM DURING 10 MIN.

LIST: ROOM SERVICE TIMES (MIN.)

TABLE TAB13
ENTRIES IN TABLE
1613MEAN ARGUMENT
46.275STANDARD DEVIATION
36.750SUM OF ARGUMENTS
74642.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	9	.55	.5	99.4	-.000	-1.259
5	89	5.51	6.0	93.9	.108	-1.123
10	79	4.89	10.9	89.0	.216	-.987
15	92	5.70	16.6	83.3	.324	-.851
20	132	8.18	24.8	75.1	.432	-.714
25	122	7.56	32.4	67.5	.540	-.578
30	119	7.37	39.8	60.1	.648	-.442
35	114	7.06	46.8	53.1	.756	-.306
40	93	5.76	52.6	47.3	.864	-.170
45	105	6.50	59.1	40.8	.972	-.034
50	125	7.74	66.8	33.1	1.080	.101
55	99	6.13	73.0	26.9	1.188	.237
60	56	3.47	76.5	23.4	1.296	.373
65	46	2.85	79.3	20.6	1.404	.509
70	44	2.72	82.0	17.9	1.512	.645
75	18	1.11	83.1	16.8	1.620	.781
80	25	1.54	84.7	15.2	1.728	.917
85	34	2.10	86.8	13.1	1.836	1.053
90	34	2.10	88.9	11.0	1.944	1.189
95	25	1.54	90.5	9.4	2.052	1.325
100	26	1.61	92.1	7.8	2.160	1.461
105	15	.92	93.0	6.9	2.269	1.597
110	7	.43	93.4	6.5	2.377	1.734
115	6	.37	93.8	6.1	2.485	1.870
120	3	.18	94.0	5.9	2.593	2.006
125	12	.74	94.7	5.2	2.701	2.142
130	10	.61	95.4	4.5	2.809	2.278
135	4	.24	95.6	4.3	2.917	2.414
140	5	.30	95.9	4.0	3.025	2.550
145	8	.49	96.4	3.5	3.133	2.686
150	7	.43	96.8	3.1	3.241	2.822
155	5	.30	97.2	2.7	3.349	2.958
160	9	.55	97.7	2.2	3.457	3.094
165	8	.49	98.2	1.7	3.565	3.230
170	10	.61	98.8	1.1	3.673	3.366
175	4	.24	99.1	.8	3.781	3.502
180	5	.30	99.4	.5	3.889	3.638
185	3	.18	99.6	.3	3.997	3.774
190	6	.37	100.0	.0	4.105	3.910

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

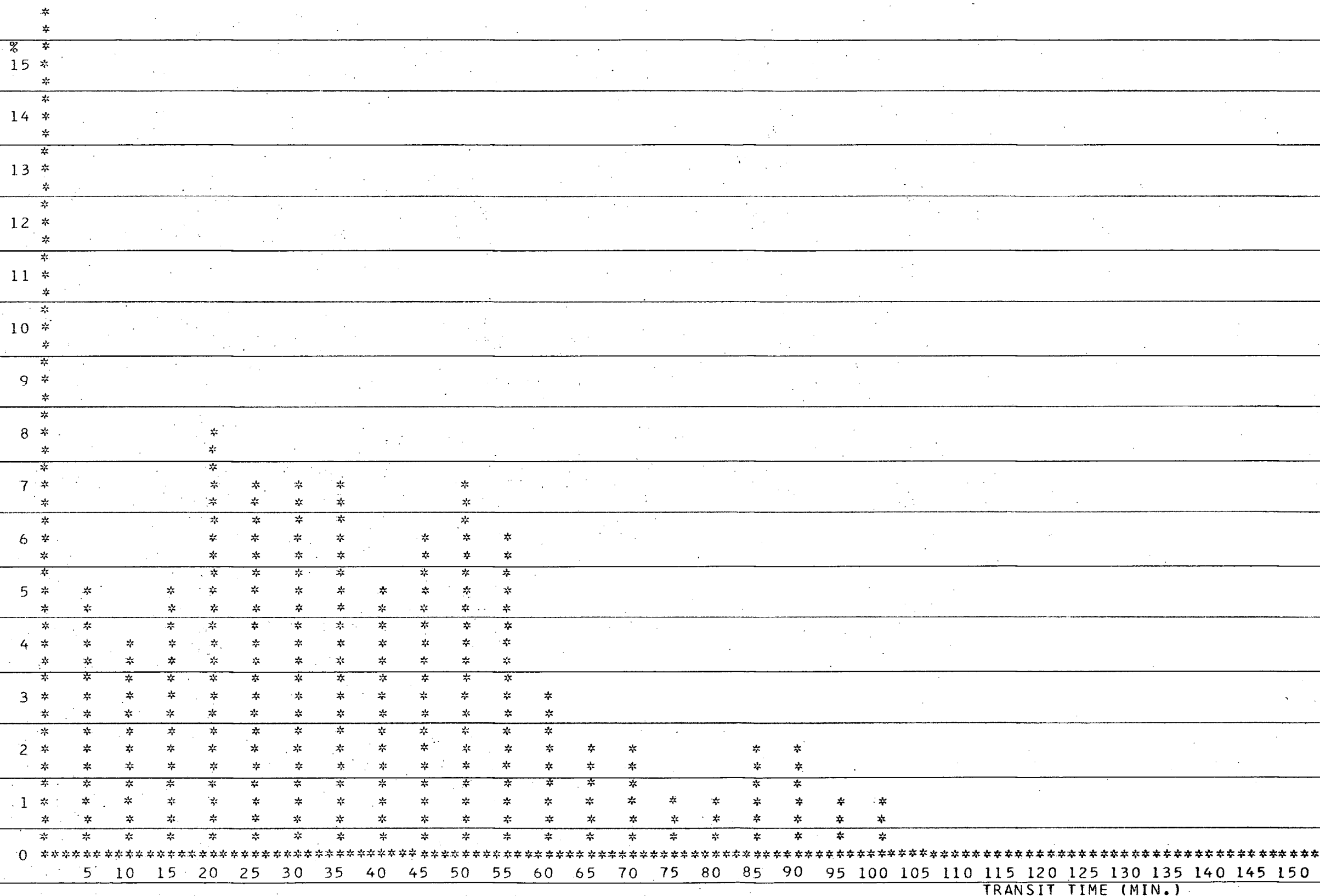


FIGURE 13: REL. FREQUENCY OF TRANSIT TIME OF LISTENING ROOM

OCCUPANCY OF LIST. ROOM

TABLE TAB14
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

1613

20.050

2.238

32341.000

NON-WEIGHTED

UPPER
LIMITOBSERVED
FREQUENCYPER CENT
OF TOTALCUMULATIVE
PERCENTAGECUMULATIVE
REMAINDERMULTIPLE
OF MEANDEVIATION
FROM MEAN

0

0

.00

.0

100.0

-.000

-8.957

1

0

.00

.0

100.0

.049

-8.511

2

0

.00

.0

100.0

.099

-8.064

3

0

.00

.0

100.0

.149

-7.617

4

0

.00

.0

100.0

.199

-7.170

5

0

.00

.0

100.0

.249

-6.724

6

0

.00

.0

100.0

.299

-6.277

7

0

.00

.0

100.0

.349

-5.830

8

0

.00

.0

100.0

.398

-5.383

9

1

.06

.0

99.9

.448

-4.936

10

1

.06

.1

99.8

.498

-4.490

11

3

.18

.3

99.6

.548

-4.043

12

5

.30

.6

99.3

.598

-3.596

13

19

1.17

1.7

98.2

.648

-3.149

14

24

1.48

3.2

96.7

.698

-2.703

15

44

2.72

6.0

93.9

.748

-2.256

16

47

2.91

8.9

91.0

.797

-1.809

17

71

4.40

13.3

86.6

.847

-1.362

18

101

6.26

19.5

80.4

.897

-.915

19

150

9.29

28.8

71.1

.947

-.469

20

255

15.80

44.6

55.3

.997

-.022

21

365

22.62

67.3

32.6

1.047

.424

22

527

32.67

100.0

.0

1.097

.871

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

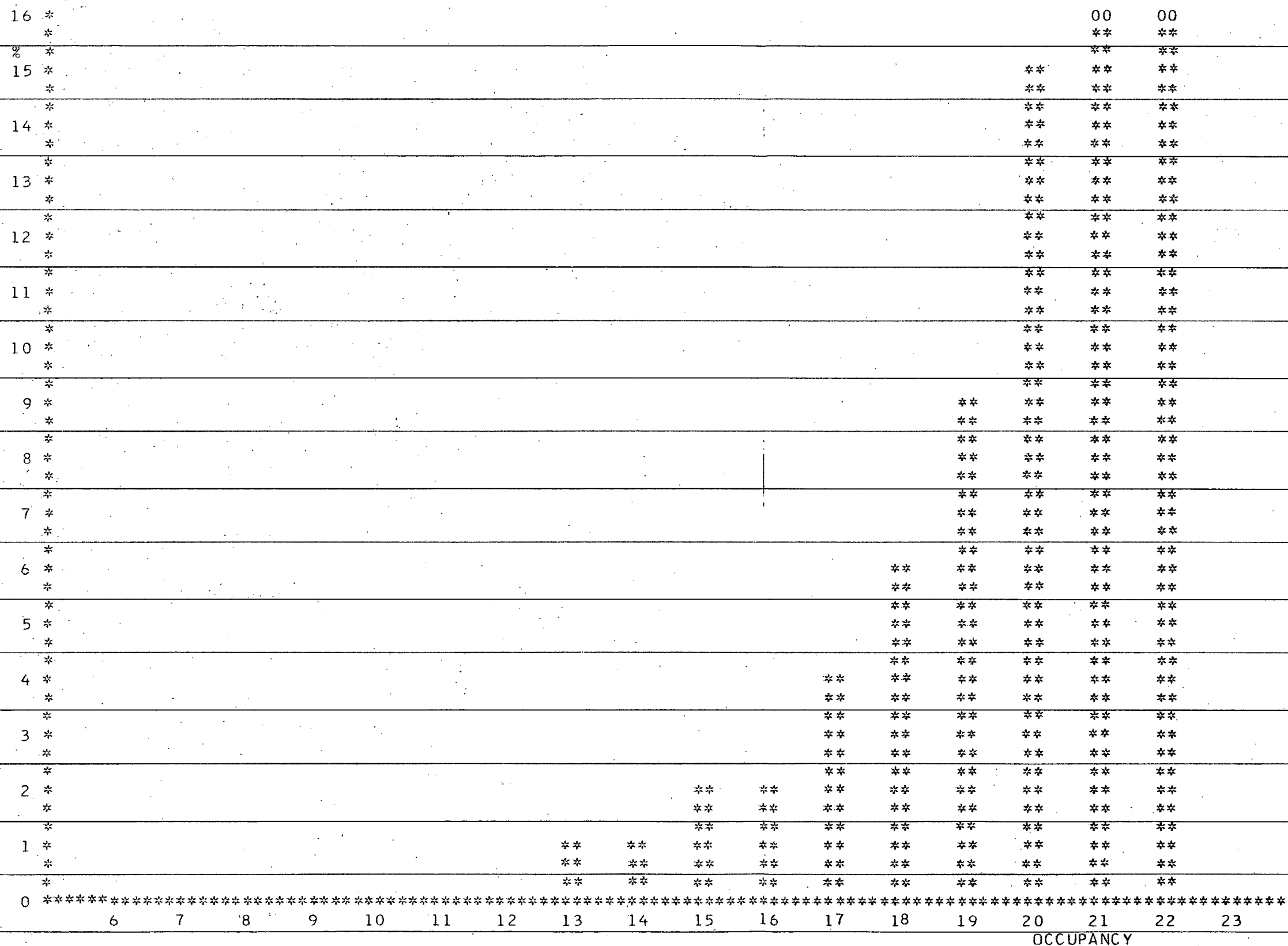


FIGURE 14: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE LISTENING ROOM

THE RESERV. LISTENING ROOM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
41	23	10.281	.447	846	43.763	9	23

OCCUPANCY OF RESERVE LIST. ROOM

TABLE TAB17
ENTRIES IN TABLE
837

MEAN ARGUMENT
12.549

STANDARD DEVIATION
5.507

SUM OF ARGUMENTS
10504.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	2	.23	.2	99.7	-.000	-2.278
1	4	.47	.7	99.2	.079	-2.096
2	9	1.07	1.7	98.2	.159	-1.915
3	12	1.43	3.2	96.7	.239	-1.733
4	16	1.91	5.1	94.8	.318	-1.552
5	32	3.82	8.9	91.0	.398	-1.370
6	47	5.61	14.5	85.4	.478	-1.189
7	57	6.81	21.3	78.6	.557	-1.007
8	54	6.45	27.8	72.1	.637	-.826
9	53	6.33	34.1	65.8	.717	-.644
10	47	5.61	39.7	60.2	.796	-.462
11	56	6.69	46.4	53.5	.876	-.281
12	52	6.21	52.6	47.3	.956	-.099
13	51	6.09	58.7	41.2	1.035	.081
14	39	4.65	63.4	36.5	1.115	.263
15	40	4.77	68.2	31.7	1.195	.444
16	41	4.89	73.1	26.8	1.274	.626
17	35	4.18	77.2	22.7	1.354	.808
18	32	3.82	81.1	18.8	1.434	.989
19	29	3.46	84.5	15.4	1.513	1.171
20	34	4.06	88.6	11.3	1.593	1.352
21	35	4.18	92.8	7.1	1.673	1.534
22	60	7.16	100.0	.0	1.753	1.715

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

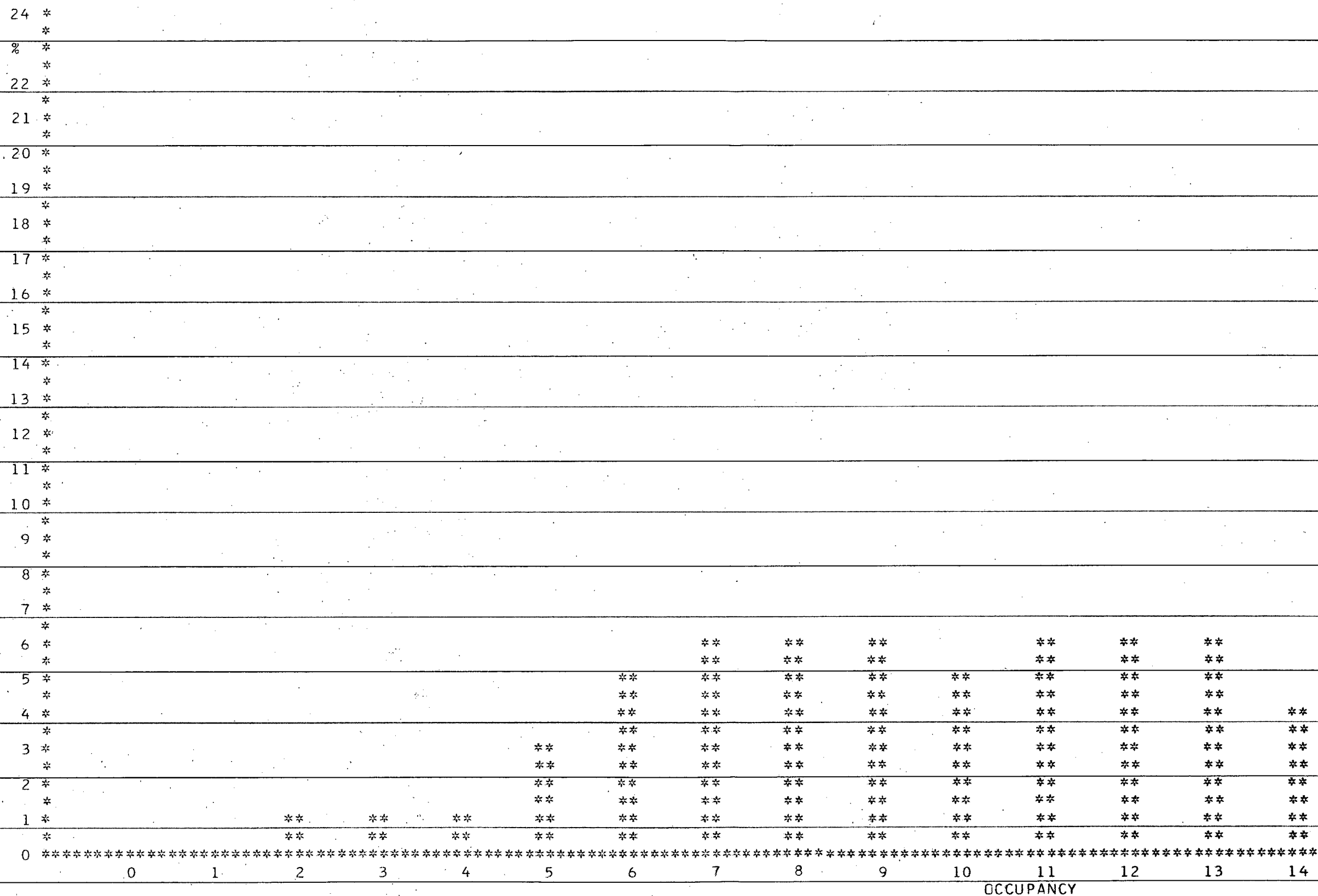


FIGURE 14A: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE LISTENING ROOM

THE SYSTEM AS STORAGE

STORAGE	CAPACITY	AVERAGE CONTENTS	AVERAGE UTILIZATION	ENTRIES	AVERAGE TIME/TRAN	CURRENT CONTENTS	MAXIMUM CONTENTS
10	200	40.318	.201	6123	23.711	37	78

SYSTEM TRANSIT TIMES (MIN.) (=SERVICE & WAIT. TIME)

TABLE TAB15
ENTRIES IN TABLE
6086MEAN ARGUMENT
3.367STANDARD DEVIATION
11.707SUM OF ARGUMENTS
20493.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	2585	42.47	42.4	57.5	-.000	-.287
2	2112	34.70	77.1	22.8	.593	-.116
4	655	10.76	87.9	12.0	1.187	.054
6	229	3.76	91.7	8.2	1.781	.224
8	112	1.84	93.5	6.4	2.375	.395
10	64	1.05	94.5	5.4	2.969	.566
12	44	.72	95.3	4.6	3.563	.737
14	30	.49	95.8	4.1	4.157	.908
16	25	.41	96.2	3.7	4.751	1.079
18	18	.29	96.5	3.4	5.345	1.249
20	11	.18	96.6	3.3	5.939	1.420
22	9	.14	96.8	3.1	6.533	1.591
24	7	.11	96.9	3.0	7.127	1.762
26	11	.18	97.1	2.8	7.721	1.933
28	9	.14	97.2	2.7	8.315	2.104
30	17	.27	97.5	2.4	8.909	2.274
32	11	.18	97.7	2.2	9.503	2.445
34	8	.13	97.8	2.1	10.097	2.616
36	4	.06	97.9	2.0	10.691	2.787
38	15	.24	98.1	1.8	11.285	2.958
40	3	.04	98.2	1.7	11.879	3.129
42	6	.09	98.3	1.6	12.473	3.299
44	6	.09	98.4	1.5	13.067	3.470
46	9	.14	98.5	1.4	13.661	3.641
48	11	.18	98.7	1.2	14.255	3.812
50	7	.11	98.8	1.1	14.848	3.983
52	3	.04	98.9	1.0	15.442	4.154
54	2	.03	98.9	1.0	16.036	4.324
56	6	.09	99.0	.9	16.630	4.495
58	2	.03	99.0	.9	17.224	4.666
60	2	.03	99.1	.8	17.818	4.837
62	3	.04	99.1	.8	18.412	5.008
64	2	.03	99.2	.7	19.006	5.179
66	3	.04	99.2	.7	19.600	5.350
68	0	.00	99.2	.7	20.194	5.520
70	2	.03	99.2	.7	20.788	5.691
72	0	.00	99.2	.7	21.382	5.862
74	1	.01	99.3	.6	21.976	6.033
76	2	.03	99.3	.6	22.570	6.204
78	2	.03	99.3	.6	23.164	6.375
80	1	.01	99.3	.6	23.758	6.545
82	2	.03	99.4	.5	24.352	6.716

84	2	.03	99.4	.5	24.946	6.887
86	5	.08	99.5	.4	25.540	7.058
88	0	.00	99.5	.4	26.134	7.229
90	1	.01	99.5	.4	26.728	7.400
92	0	.00	99.5	.4	27.322	7.570
94	1	.01	99.5	.4	27.916	7.741
96	1	.01	99.5	.4	28.510	7.912
98	1	.01	99.6	.3	29.103	8.083
100	1	.01	99.6	.3	29.697	8.254
102	4	.06	99.6	.3	30.291	8.425
104	1	.01	99.7	.2	30.885	8.595
106	0	.00	99.7	.2	31.479	8.766
108	0	.00	99.7	.2	32.073	8.937
110	1	.01	99.7	.2	32.667	9.108
112	1	.01	99.7	.2	33.261	9.279
114	0	.00	99.7	.2	33.855	9.450
116	0	.00	99.7	.2	34.449	9.620
118	0	.00	99.7	.2	35.043	9.791
120	0	.00	99.7	.2	35.637	9.962
122	0	.00	99.7	.2	36.231	10.133
124	0	.00	99.7	.2	36.825	10.304
126	0	.00	99.7	.2	37.419	10.475
128	0	.00	99.7	.2	38.013	10.645
130	2	.03	99.7	.2	38.607	10.816
132	0	.00	99.7	.2	39.201	10.987
134	1	.01	99.7	.2	39.795	11.158
136	2	.03	99.8	.1	40.389	11.329
138	0	.00	99.8	.1	40.983	11.500
140	1	.01	99.8	.1	41.577	11.670
142	1	.01	99.8	.1	42.171	11.841
144	0	.00	99.8	.1	42.765	12.012
146	0	.00	99.8	.1	43.358	12.183
148	1	.01	99.8	.1	43.952	12.354
150	0	.00	99.8	.1	44.546	12.525
152	0	.00	99.8	.1	45.140	12.696
154	1	.01	99.8	.1	45.734	12.866
156	0	.00	99.8	.1	46.328	13.037
OVERFLOW	7	.11	100.0	.0		
AVERAGE VALUE OF OVERFLOW		167.00				

GRAPH

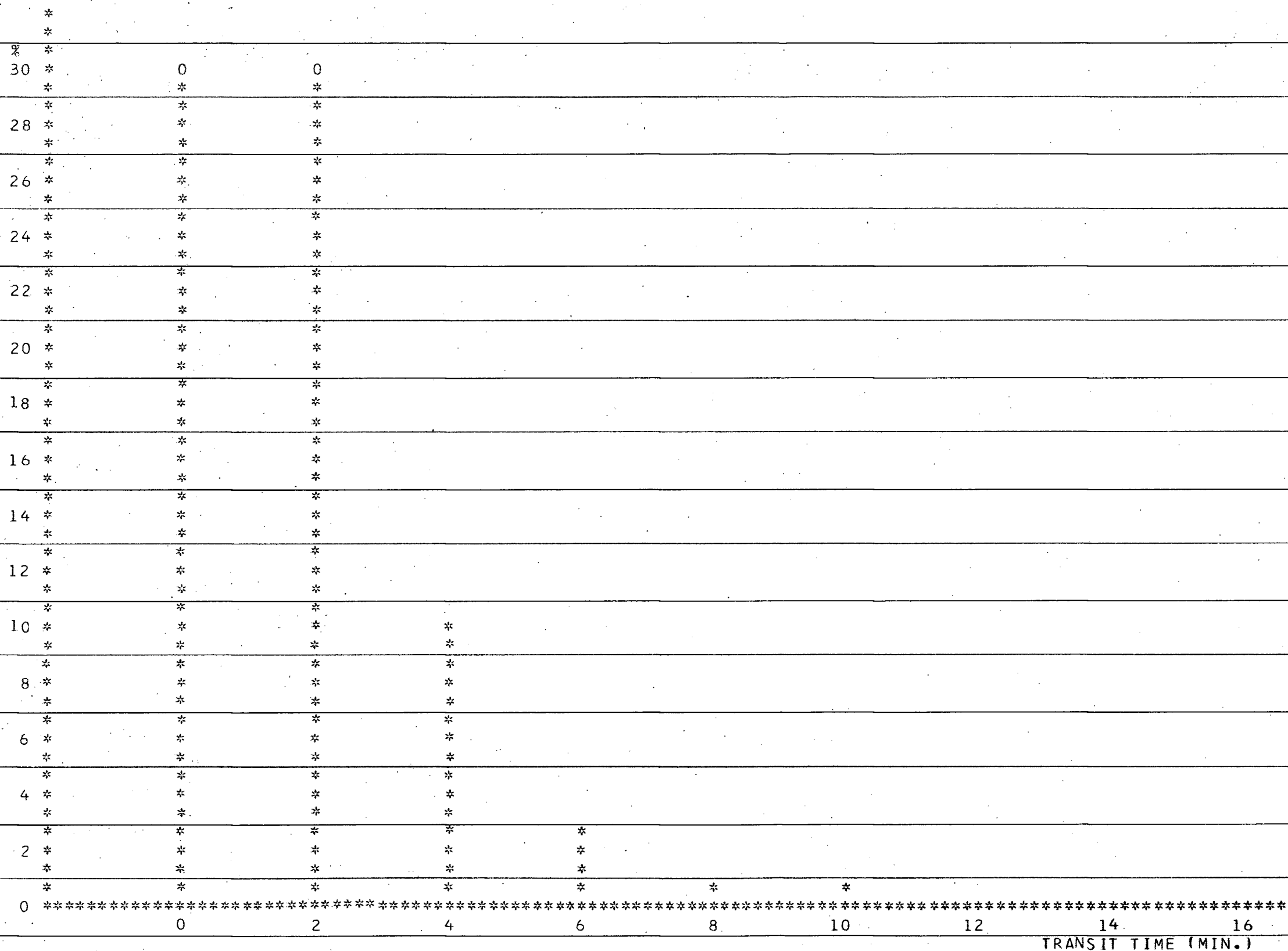


FIGURE 15: REL. FREQUENCY OF SYSTEM TRANSIT TIMES

OCCUPANCY OF SYSTEM (=DESK,SHELVES,LIST. ROOM)

TABLE TAB16
ENTRIES IN TABLE

MEAN ARGUMENT

STANDARD DEVIATION

SUM OF ARGUMENTS

6086

40.922

9.230

249055.000

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	-.000	-4.433
2	2	.03	.0	99.9	.048	-4.216
4	3	.04	.0	99.9	.097	-4.000
6	1	.01	.0	99.9	.146	-3.783
8	4	.06	.1	99.8	.195	-3.566
10	2	.03	.1	99.8	.244	-3.350
12	1	.01	.2	99.7	.293	-3.133
14	4	.06	.2	99.7	.342	-2.916
16	5	.08	.3	99.6	.390	-2.700
18	11	.18	.5	99.4	.439	-2.483
20	40	.65	1.1	98.8	.488	-2.266
22	86	1.41	2.6	97.3	.537	-2.050
24	90	1.47	4.0	95.9	.586	-1.833
26	98	1.61	5.7	94.2	.635	-1.616
28	133	2.18	7.8	92.1	.684	-1.399
30	220	3.61	11.5	88.4	.733	-1.183
32	270	4.43	15.9	84.0	.781	-.966
34	365	5.99	21.9	78.0	.830	-.749
36	488	8.01	29.9	70.0	.879	-.533
38	594	9.76	39.7	60.2	.928	-.316
40	641	10.53	50.2	49.7	.977	-.099
42	554	9.10	59.3	40.6	1.026	.116
44	484	7.95	67.3	32.6	1.075	.333
46	440	7.22	74.5	25.4	1.124	.550
48	364	5.98	80.5	19.4	1.172	.766
50	336	5.52	86.0	13.9	1.221	.983
52	249	4.09	90.1	9.8	1.270	1.200
54	185	3.03	93.1	6.8	1.319	1.416
56	146	2.39	95.5	4.4	1.368	1.633
58	95	1.56	97.1	2.8	1.417	1.850
60	42	.69	97.8	2.1	1.466	2.066
62	34	.55	98.3	1.6	1.515	2.283
64	25	.41	98.7	1.2	1.563	2.500
66	16	.26	99.0	.9	1.612	2.716
68	10	.16	99.2	.7	1.661	2.933
70	17	.27	99.4	.5	1.710	3.150
72	14	.23	99.7	.2	1.759	3.366
74	11	.18	99.9	.0	1.808	3.583
76	5	.08	99.9	.0	1.857	3.800
78	1	.01	100.0	.0	1.906	4.016

REMAINING FREQUENCIES ARE ALL ZERO

GRAPH

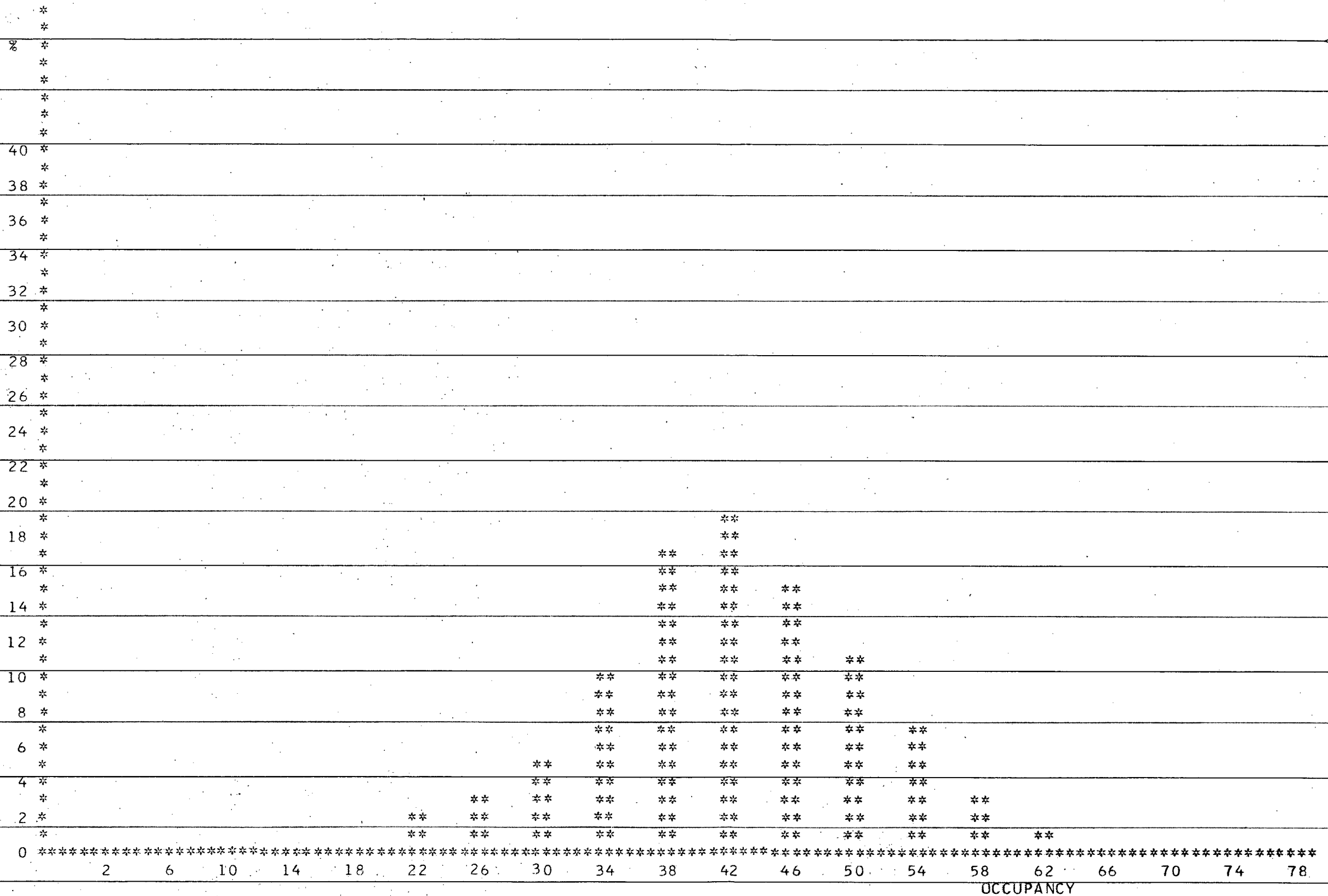


FIGURE 16: REL. FREQUENCY OF NUMBER OF JOBS OCCUPYING SIMULTANEOUSLY THE SYSTEM

USER: WULI
DEPARTMENT: COMM

**** ON AT 00:41:44
**** OFF AT 00:51:04
**** ELAPSED TIME 560.043 SEC.
**** CPU TIME USED 130.934 SEC.
**** STORAGE USED 8349.18 PAGE-SEC.
**** CARDS READ 418
**** LINES PRINTED 9904
**** PAGES PRINTED 284
**** CARDS PUNCHED 0
**** DRUM READS 95
**** RATE FACTOR 0.6
**** APPROX. COST OF THIS RUN C\$15.17

**** FILE STORAGE 0 PG-HR. .00

**LAST SIGNON WAS: 00:28:20 12-30-70

*

END

CPU TIME USED:

ASSEMBLY: 3.262 SECONDS

EXECUTION: 123.857 SECONDS

EXECUTION TERMINATED

\$SIGNOFF

MMMMM	MMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSS	
MMMMMM	MMMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSSSSSSSS	
MMMMMMM	MMMMMMM	TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT	SSSSSSSSSSSSSSSSSSSS	
MMMMMMMM	MMMMMMMM	TTTTT	SSSSSS	SSSSSS
MMMMMMMMM	MMMMMMMMM	TTTTT	SSSSS	SSSSS
MMMMMMMMMM	MMMMMMMMMM	TTTTT	SSSSS	
MMMMM	MMMMM	TTTTT	SSSSSS	
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSSSS	
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSSSS	
MMMMM	MMMMMMMMMMMM	TTTTT	SSSSSSSSSSSSSSSS	
MMMMM	MMMMMMMMMM	TTTTT		SSSSSSSS
MMMMM	MMMMMM	TTTTT		SSSSS
MMMMM	MMMMM	TTTTT		SSSSS
MMMMM	MMM	TTTTT	SSSSS	SSSSS
MMMMM	MMMMM	TTTTT	SSSSSSS	SSSSSSS
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSSSSSSSS	
MMMMM	MMMMM	TTTTT	SSSSSSSSSSSSSSSS	
MMMMM	MMMMM	TTTTT	SSSSSSSSSS	