WILLOW RUN RESEARCH CENTER
UNIVERSITY of MICHIGAN
Ypsilanti, Michigan

August 18, 1952

Errata Sheet No. 1
Project MIKO
Report No. UMM-91

Please make the following changes:

Page 6 -- Fourth paragraph, last sentence, delete "Although there is more than one platter for each area", and substitute "There is more than one platter for each area, and"

Page 11 - Third paragraph, last sentence, should be at end of second paragraph.

Page 21 - First paragraph, second line, change "section of" to "section on". Fourth paragraph, first line, change "were" to "was".

Page 25 - Last paragraph, fifth line, delete word "chart".

Page 30 - Second paragraph, delete last sentence.

Page 39 - Line 21, 481.1 seconds should be 48.1 seconds.

Page 41 - First line, paragraph b., change 35 to 30.

Analysis of Ground Observer Corps-

Participation in Air Defense Exercises-December 1951

by B. A. Harrison, R. Hobert and L. R. Bruner

Project MIRO
Contract No. AF 30 602 9

Expenditure Order Numbers:
RDO 166-17 R161-43
RDO 166-17 AD-4
RDO 166-17 AD-7

Willow Run Research Center
Engineering Research Institute
University of Michigan
UMM-91

October 18, 1949

TO: AN-GM Mailing List No. 8

FROM: University of Michigan Aeronautical Research Center
Willow Run Airport, Ypsilanti, Michigan

SUBJECT: Errata No. 1, Report UMM-31
"Analogue Computers for Servo Problems"
by Donald McDonald, July 20, 1949

Please make the following corrections and insertions in the copies of the above-referenced report:

Page 6 Third paragraph of the lower half of the page should read:

"For the case of addition, if the several inputs are summed but not amplified, ..."

Page 8 Top of the page should read:

"$w_h \leq 50{,}000$ rad/sec

or

$f_h \leq 8{,}000$ cps."

Then four lines below:

"$w_1 \geq \frac{1}{35}$ rad/sec

or

$f_1 \geq \frac{1}{200}$ cps.

Thus from 1/200 cps. to 8000 cps., ..."

and the third line below Equation (26) should read:

"$\frac{1}{200}$ cps. to 8000 cps."

Under "Summation:"

"$1 - A B_a \leq \frac{1}{700}$ (1 + number of inputs) . . . . ."

Page 9 Top of the page should read:

"$1 - A \left|B_d\right| \leq \frac{1}{400}$ $\qquad 0 < f < 50$ cps.

$\angle B_d \leq 3^\circ$

Integration:

$1 - A \left|B_1\right| \leq \frac{1}{400}$ $\qquad \frac{1}{200} < f < 8000$ cps.

$\angle B_1 \leq 3^\circ$ . . . . ."

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF TABLES

I

INTRODUCTION

The Ground Observer Corps constitutes a potentially effective method of gathering data on low-flying aircraft within the continental limits of the United States. As one of the data gathering methods utilized by the Ground Reporting System (which also uses radar, direction finding stations, etc.), the GOC is capable of supplying raid size, position, and identity. In addition, the GOC is invulnerable to electronic jamming (Ref. 1).

The experience of the Royal Observer Corps, the British counterpart of the GOC, is discussed in References 2 and 3.

In the United States, the GOC was moderately successful as a data gathering system during World War II. Although the World War II GOC did not participate in enemy interceptions, it was effective in providing data that were used in challenge-interceptions and in rescue operations. An overseas military version of the GOC also proved effective in detecting, tracking, identifying, and supplying raid-size information on both friendly and enemy aircraft.

After World War II, the GOC was disbanded. When it was reactivated in 1949, cognizance was not taken of the World War II GOC experience, and the resulting system did not reach the efficiency of the World War II system. The Grand Rapids GOC which is typical of the 1951 postwar system was studied by WRRC during the air defense exercises of June, 1951. A description of the Grand Rapids system and the results of the WRRC study were presented (Ref. 4). The study showed that the time between observation of a target and receipt of the plot at the Ground-Controlled Intercept (GCI) was longer than could be tolerated for successful exploitation of GOC potential; that the Filter Center filtering system became saturated at low levels of activity; and that the preponderance of tracks at the Filter Center were based on only one plot. Drastic redesign of this GOC system was recommended as a result of the study. Table I gives a comparison of operational times of the Grand Rapids and White Plains GOC stations; Table 2 shows the sources of time delay at White Plains.

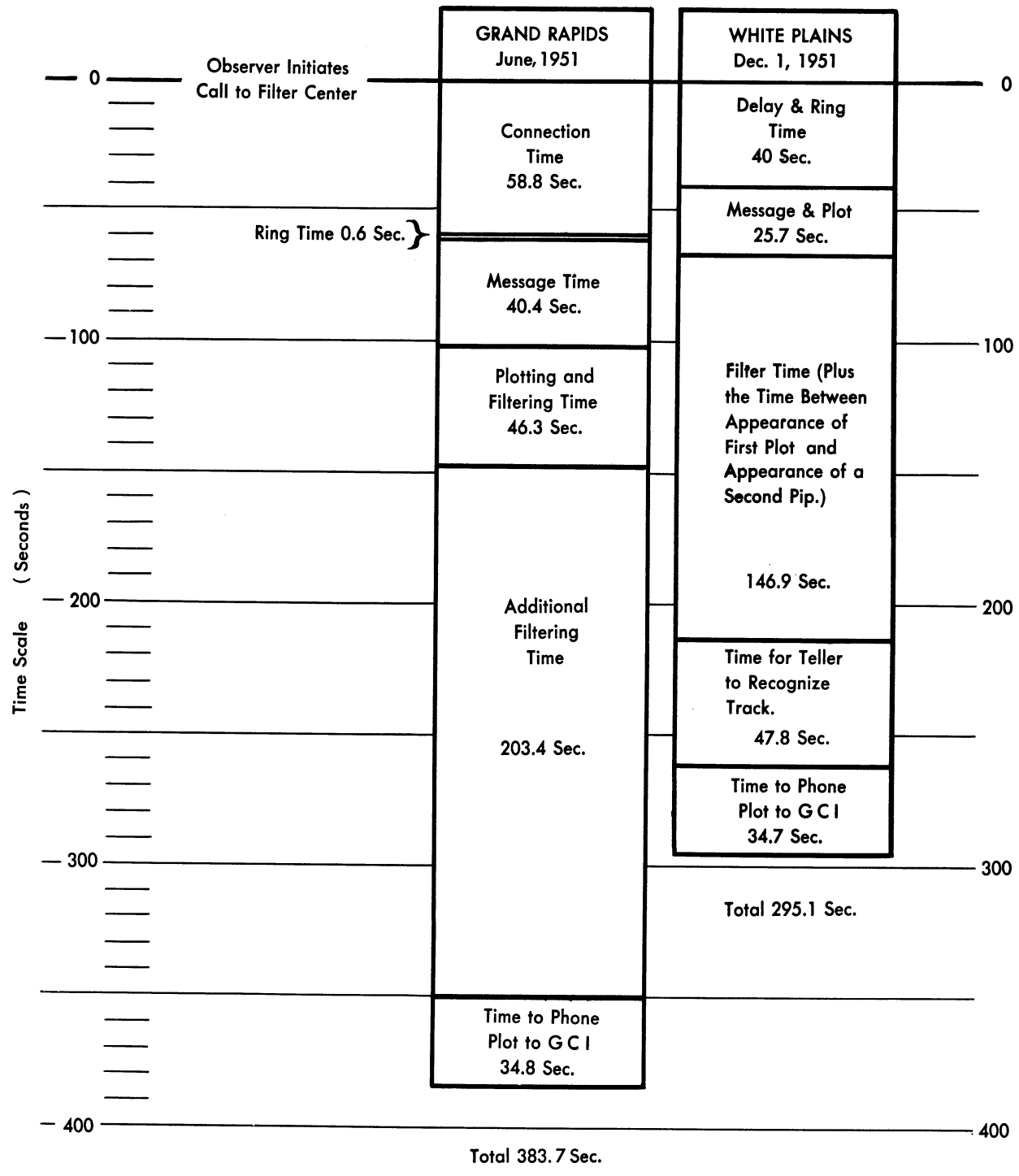


TABLE I TIME TO ESTABLISH TRACKS

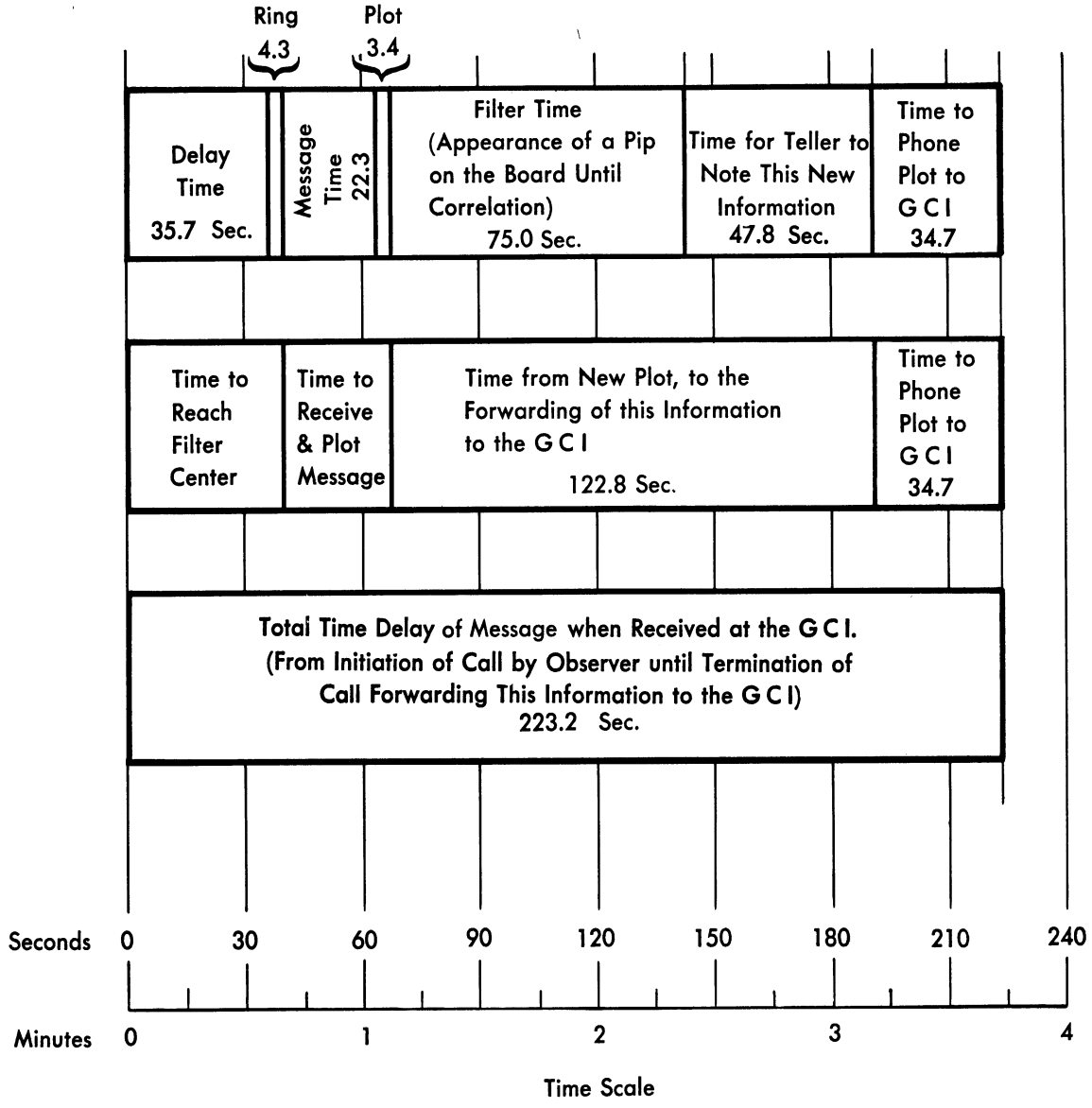


TABLE II SOURCES OF DELAY AT WHITE PLAINS

The potential value of the GOC and the ineffectiveness of the 1951 postwar system has been recognized by the Air Force, and the Continental Air Defense Study (CADS) has been requested to recommend improvements which will bring the GOC to at least the level of effectiveness of World War II. The CADS study recommended improvements that were incorporated in the design and operation of the Filter Center at White Plains, N. Y. It is believed that the intention of the Air Force is to have the White Plains system replace the 1951 postwar system as soon as equipment becomes available.

Willow Run Research Center personnel made an operational study of the White Plains system during its nine hour participation in an Air Defense exercise from 0800 hours to 1700 hours on 1 December 1951. This study is the subject of this report.

The White Plains GOC system appears on the basis of this study to be a decided improvement on the 1951 postwar system, especially in plotting techniques. This improvement is reflected in a reduction of over-all operation time of approximately 23 per cent (Table 1). The pip method of plotting used at White Plains is superior, in many respects, to the method using handprinted cards and stands used in the postwar system. The tracks obtained at White Plains are somewhat longer than those observed in the postwar system.

However, the analysis indicates that the improvements which have been made are not sufficient to exploit the full potential of the GOC. Although the pip system of plotting is an improvement over the other system now being used, the filtering and telling techniques used at White Plains do not result in much more useful data reaching the GCI. In general, two pips were required to constitute a track. The last position of this track is forwarded to the GCI. Hence, most two-plot tracks at the filter center are single-plot tracks at the GCI. It should be noted that a track (once established) might be expected to be more up-to-date at the GCI than the first plot of the track. However, few tracks were longer than one plot. One of the most urgent problems in the GOC is to produce longer tracks.

The average over-all operation time for a first report to go from the observer to the GCI is approximately 270 seconds. The 295.1 seconds (Table 1) represents a track established on two plots, while the

223.2 seconds (Table II) represents a track established on one plot (or an additional plot on an established track). The average track length was found to be 5.9 miles (single-plot tracks were considered to be zero length) and 70 per cent of the tracks were single-plot tracks as told to the GCI.

II

DESCRIPTION OF THE WHITE PLAINS SYSTEM

2.1 The Observer Post

On 1 December, there were 157 Observer Posts organized in the White Plains area. Of the 79 posts supposed to report to the East Board area, 50 were active by 0900 hours and 64 by the end of the exercise (Fig. 1 and 2). No check was possible on continued observation activity at each post. Activity is here defined in terms of phone calls from the observer to the Filter Center. An individual observer post may be located in a residence, a public building or in an open field, if telephone communication is, or can be made available. Post locations are random in nature; locations are chosen on the basis of convenience for personnel and availability of telephone communication.

The observer is given written instructions (Fig. 6), and some graphic material (e.g., azimuth charts).

2.2 Observer-Filter Center Link

Communication between the observers and the Filter Center is by means of voice message told over conventional telephone lines. The observer is instructed to contact the local operator, who checks the phone number with a list of authorized phone numbers. If the observer's number is on the list, the call is then channeled to the White Plains Filter Center (through normal long distance procedure, if necessary).

The observer call is received at the Filter Center by a plotter at the appropriate plotting board area (Fig. 3) corresponding to the telephone reporting area from which the call originated (Fig. 4). Although there is more than one plotter for each area, the call may be received at any plotter position in the given area.

2.3 The Plotting Board

The White Plains Filter Center plots, displays, and filters on two horizontal plotting boards (East and West). The data for this study were taken from the East board only.

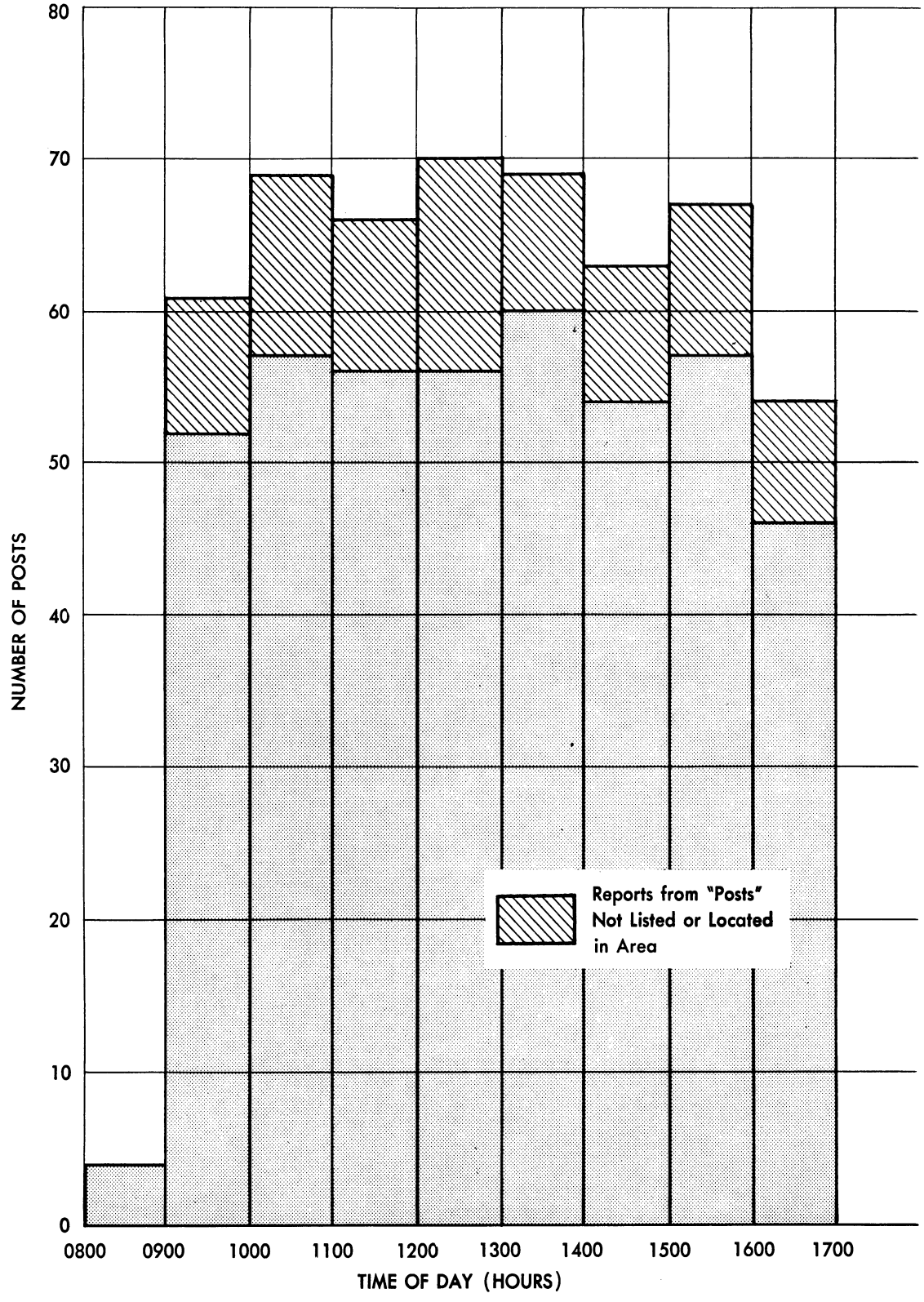


FIG. 1 NUMBER OF POSTS ACTIVE EACH HOUR (East Board)

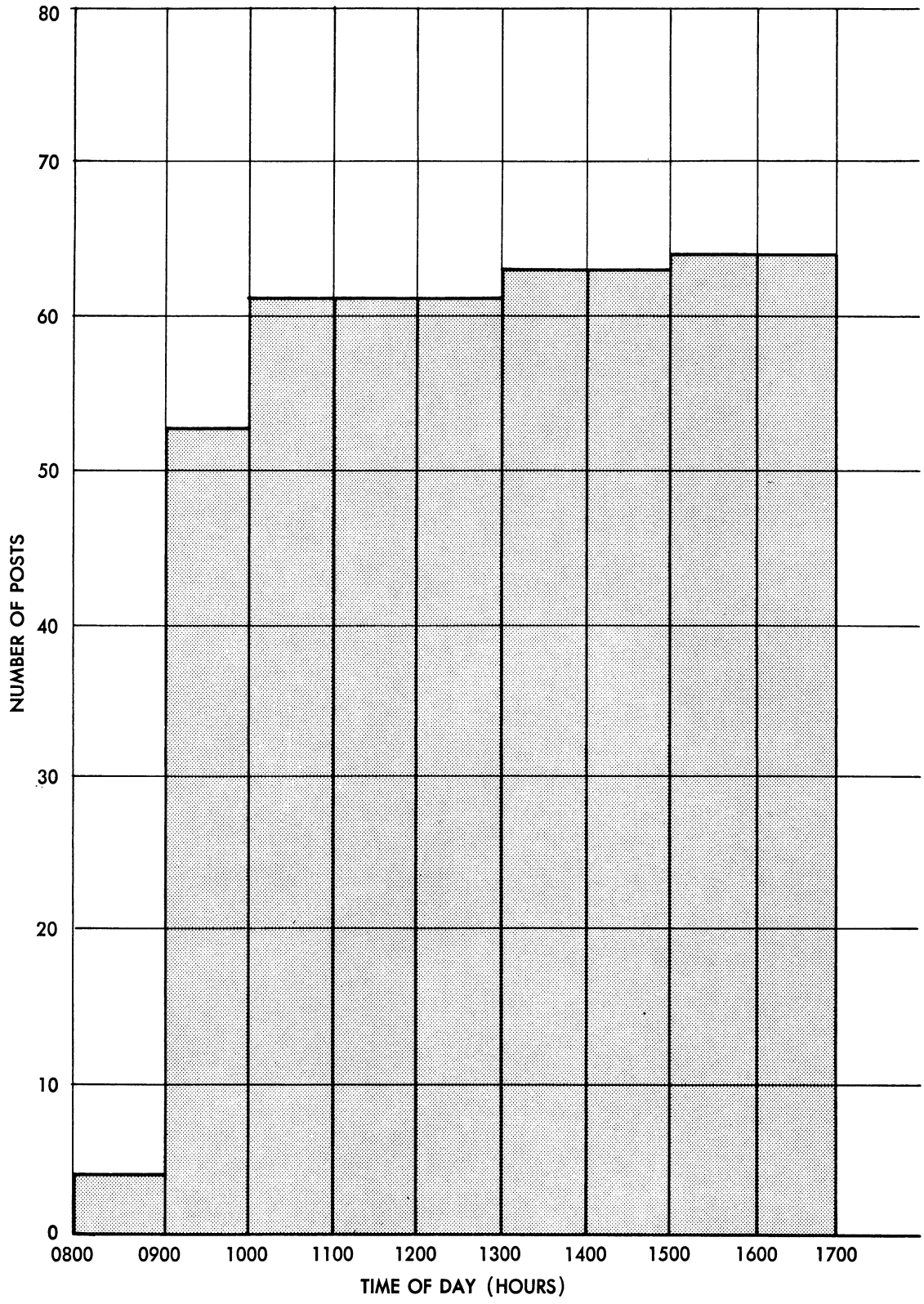
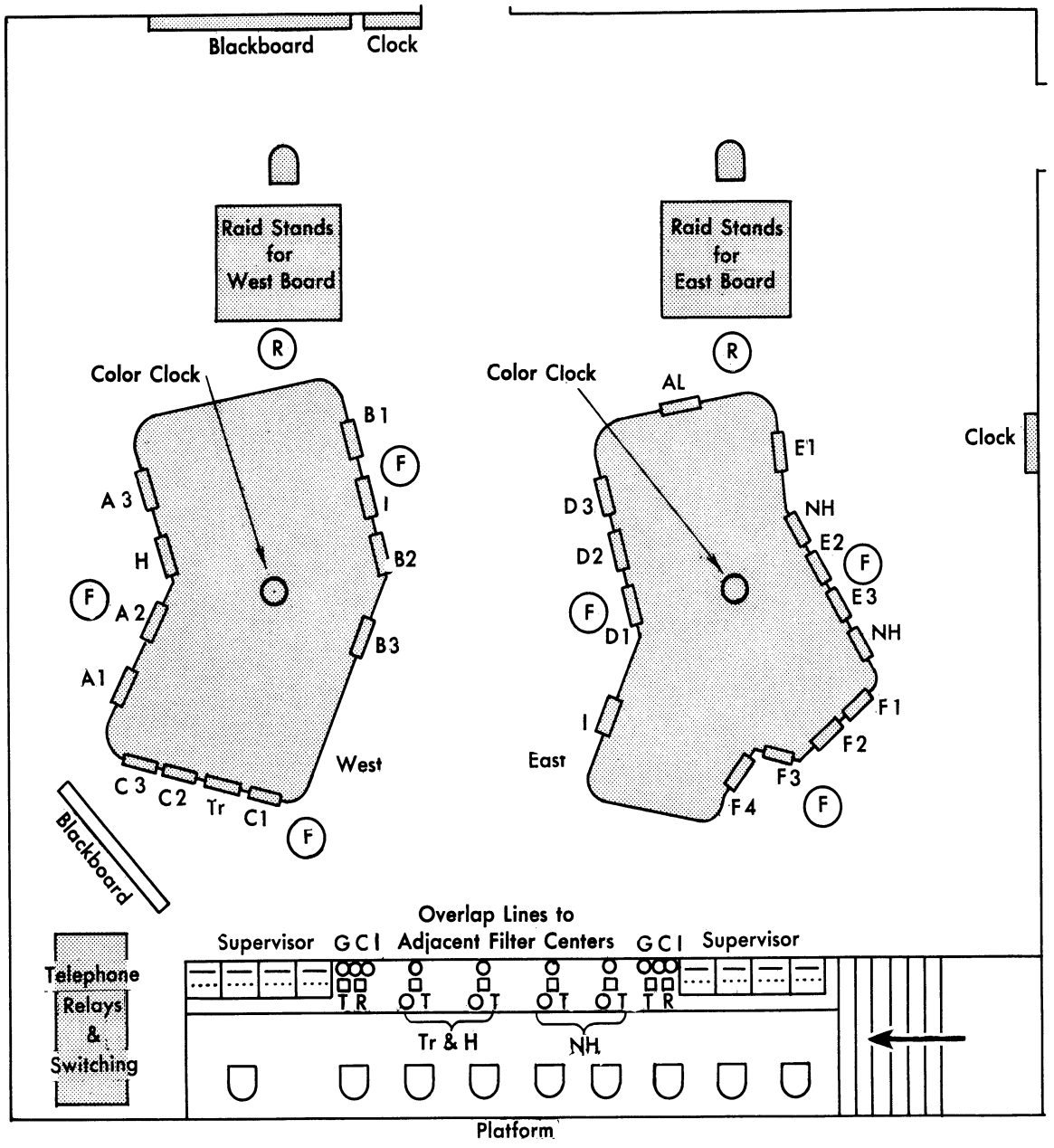


FIG. 2 NUMBER OF POSTS REPORTING (East Board)



Scale in Feet

0 2 4 6 8 10

Toll Areas		Overlap Areas			
A	Adam				
B	Bertram	AL	Albany	(R)	Runner
C	Chestnut	NH	New Haven	(F)	Filterer
D	Dudley	I	Internal	T	Teller
E	Eagle	H	Harrisburg	R	Recorder
F	Fenton	Tr	Trenton	O T	Overlap Teller

FIG. 3 FILTER CENTER LAYOUT

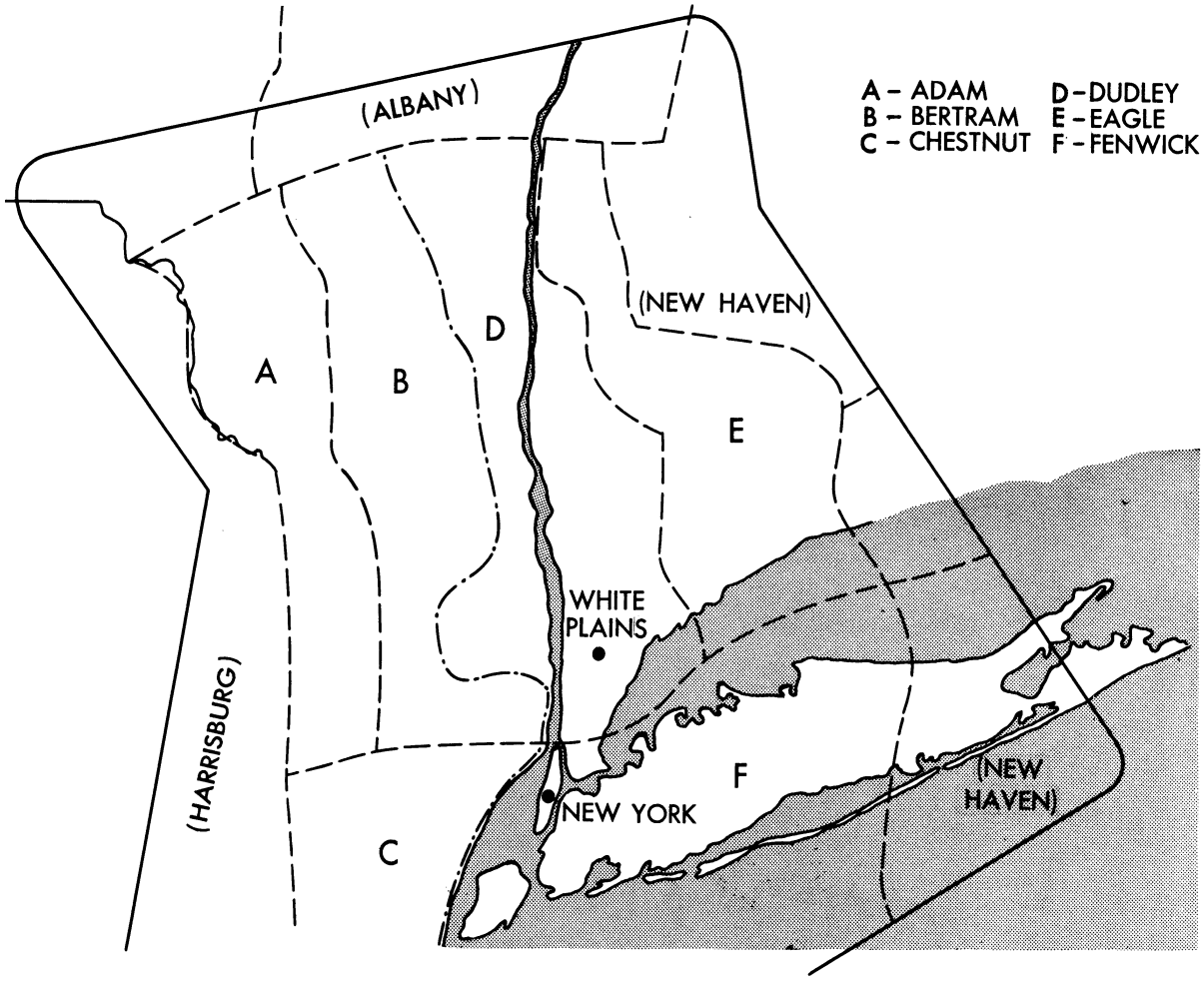


FIG. 4 WHITE PLAINS COVERAGE, SHOWING TOLL AREAS
(BOTH EAST AND WEST BOARDS)

The locations of the Observer Posts are shown on the plotting tables as dots (Fig. 5). A white ring with adhesive backing is placed over each dot and a larger adhesive ring is placed over the smaller one. When the first call comes from a given post, the larger ring is removed, indicating that the post is active. With this method of marking, active posts are clearly seen and rapidly located.

In the center of each plotting table is a flush-mounted glass panel under which is a light system indicating time by red, green, and orange color coding. During the exercise, this clock changed color every two minutes. The color cycle was therefore repeated every six minutes.

Due to the fact that many of the flights over the area during the exercise were slow flying planes operated by the Civil Air Patrol, many tracks were lost due to the short (four to six minutes) time stay on the board. If a longer time interval, such as 6-8 minutes had been used, the board would have had much more information on it at any time, and hence, it would have been more difficult to make the necessary correlations. Neither alternative is effective for tracking slow-flying aircraft. This method of displaying time is used to aid the plotter and filterer in establishing time-of-track.

2.4 Plotting

There are ten plotter positions about the East board and nine positions about the West board. Each plotter position has a double phone jack and a call indicator box.

When an observer call reaches a plotter position, the call box light goes on. The call is answered by one of the plotters at the appropriate area and the observer message is given in the following sequence:

1. Number of aircraft (one, few, many, unknown)
2. Type of aircraft (single motor, bi-motor, multi-motor, single jet, multi-jet, unknown)
3. Altitude of aircraft (very low, low, high, very high, unknown)
4. Time delay in reporting (delay to the nearest minute)
5. Code name of Observer Post
6. Direction of aircraft from Observer Post (one of eight compass directions)

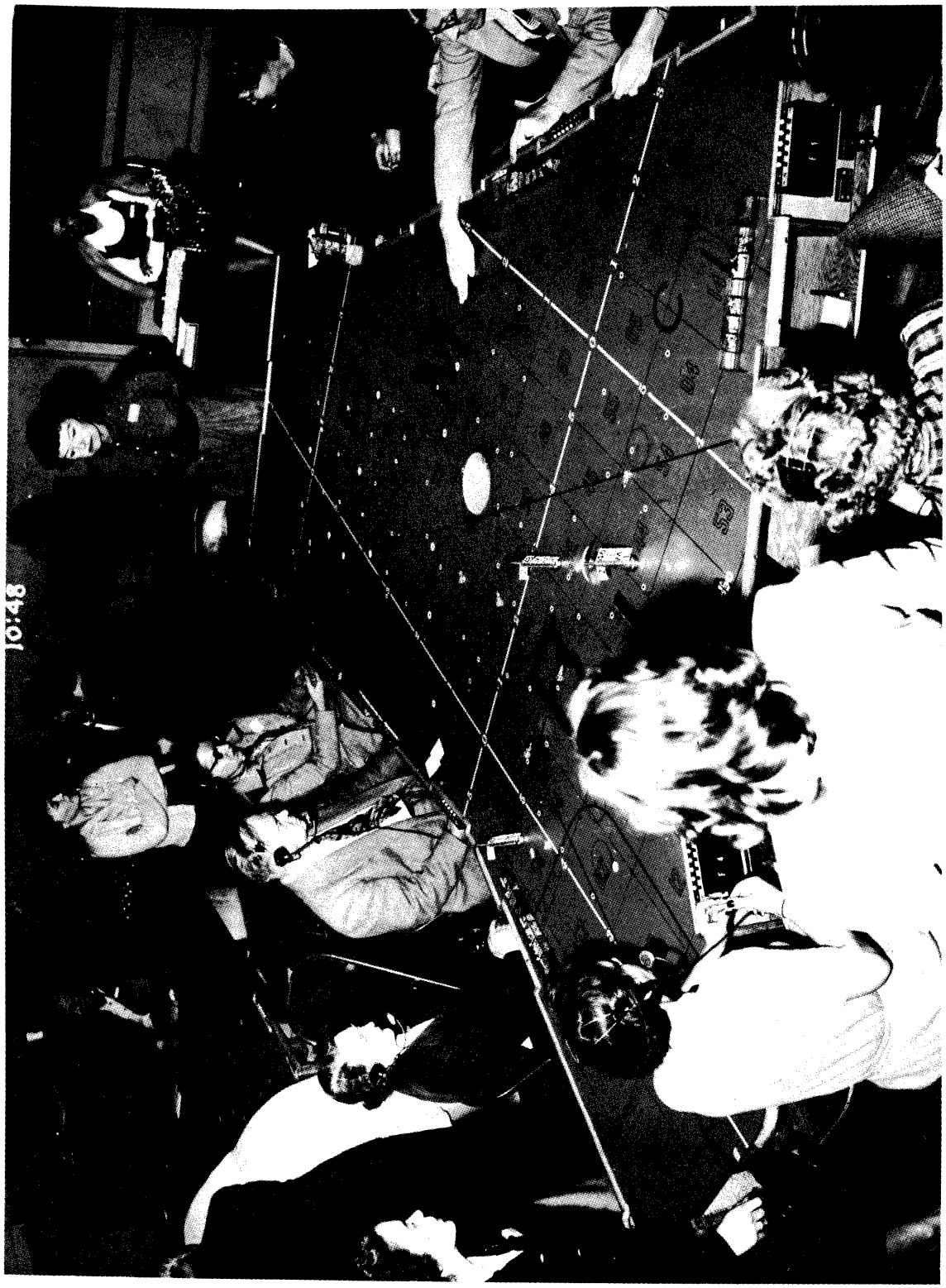


FIG. 5 EAST PLOTTING TABLE

UMM-91

Page number 1 Observation post code name BAKER MIKE 35 BLACK Date 1 12 51
(name)(name)(no.)(col.) (day/mo./yr.)

Call your telephone operator and say "AIRCRAFT FLASH" Tu. 1451
(give opr. your tel. ex. and no.)

Operator will connect you with your air defense filter center.

When the air defense operator answers and says, "AIR DEFENSE, GO AHEAD PLEASE," you say, "AIRCRAFT FLASH," and continue message you have checked on form below, in order indicated.

	Number of Aircraft	Type of Aircraft	Altitude of Aircraft	Time Delay in Reporting	Code Name of O.P.	Direction of Aircraft From O.P.	Distance of Aircraft From O.P.	Direction Aircraft are Flying	Special Remarks
	One Few Many Unknown	Single Motor Bi-Motor Multi-Motor Single-jet Multi-jet Unknown	Very Low Low High Very High Unknown	Report Delay to nearest minute. Say "Delay __ minutes," or if less than thirty seconds, say "no delay".	See top center of page.	N NW NE W E SW SE S OR "Overhead" (All aircraft within 1/2 mile of the O.P.)	Record to nearest mile.	N NW NE W E SW SE S SAY "Flying", Then give direction	Examples Hostile Aircraft, Blimp, Helicopter Aircraft in combat or distress, etc.
1	Many	MJ	L	2 Minutes	BM 35	Overhead		North	
2									
3									

FIG. 6 OBSERVER POST LOG

7. Distance of aircraft from Observer Post (nearest mile)
8. Direction aircraft are flying (one of eight compass directions)
9. Special remarks (hostile aircraft, blimp, distress, etc.)

The plotter racks up the information contained in Items 1 through 4 (above) on a plotting device called a pip (Fig. 7). The pip consists of four segments mounted on an axis so that each segment may be turned independently. Fig. 7 shows the markings on the faces of the pip segments. These segments show the raid size, plane type, height of target, and the time of observation (to the nearest two minutes).

Time of observation is indicated by turning the triangular tip segment of the pip so that the appropriate time code color is shown. If the observer reports no delay, the tip color is the same as that indicated on the color clock. If a delay is reported, the appropriate color is used.

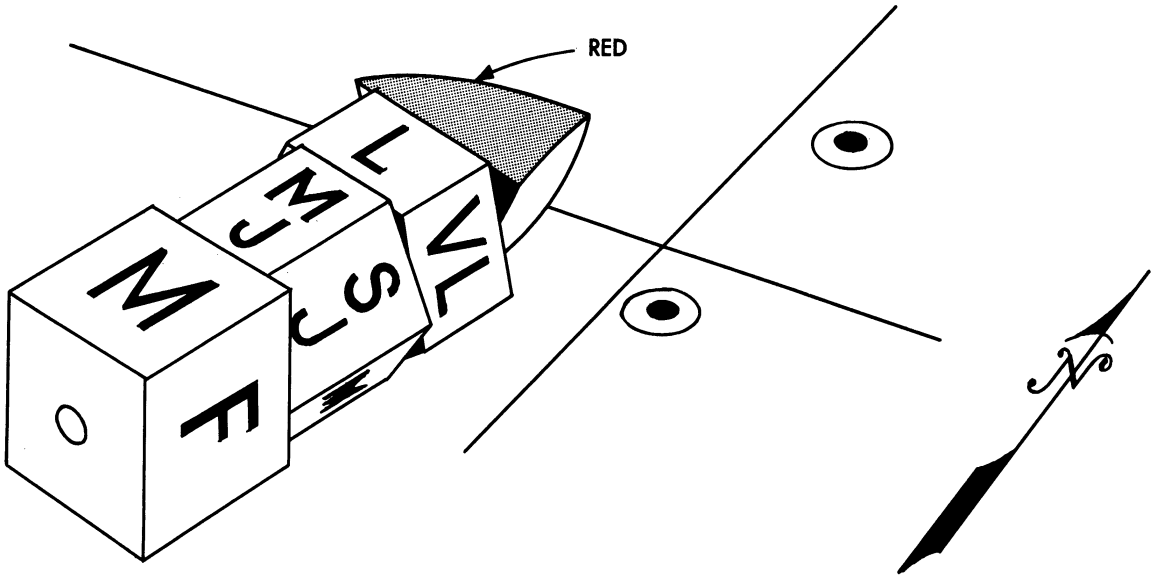


FIG. 7 DETAIL OF PIP

The pip is laid on the plotting table so that it displays the segment faces (Fig. 7) which correspond to the first four items in the observer message. Items 5 through 8 (above) of the observer message are indicated by the position of the pip on the plotting table. The direction of the pip shows the direction of flight. The information on the pip and its position on the table illustrate the entire observer message (Items 1 through 8, above).

Special remarks (Item 9) are written on small cards; these cards are placed on a small stand next to the pip.

2.5 Filtering

There are three civilian filterers for each of the plotting tables. In addition, Air Force personnel are present for supervision and assistance. The filterer correlates individual pips and thus forms tracks. Unless the operating procedure at any given time specifies otherwise, at least two pips are required to form a track. In some instances, one pip will constitute a track (e.g., jets are immediately reported to the GCI). If a pip never forms a track, it is removed when the color clock shows the same color as the pip (4 to 6 minutes after it first appeared).

When a filterer decides that one or more pips constitute a track, he will replace the pip or pips with a raid stand display and color coded plastic arrows (see Fig. 8). A raid stand operator and raid stand runners are provided for each plotting table. The filterer tells the information on the pip to a raid stand runner. The raid stand runner writes down or remembers this information and tells it to a raid stand operator at a desk at one side of the filter room (See Fig. 3). When a runner applies for a raid stand, the raid stand operator rings a bell on his desk. In response to the bell, track number is displayed at the platform on the opposite side of the room. The raid stand operator then makes up a stand using pre-formed display tabs from his tray. The raid stand display (Fig. 8) shows track number, raid size, plane type, and altitude; the last three items being obtained from the information on the pips which it replaces. The raid stand in Figure 8 displays the following information:

a. track number - 221

b. raid size - many

c. plane type - multi-jet

d. altitude - low

e. filter center first establishing track - F
(F is the code letter for the New Haven Filter Center. If no tab is displayed, the track was first established in the White Plains Area.)

The direction of the arrows at the base of the stand shows the target heading. The arrow at the head of the track will correspond in color to the color coded segment of the pip. Other arrows (representing two-minute time intervals) are arranged in the proper time-coded sequence. The color of the first arrow in the row is the color indicated on the pip. The color of the last arrow in this row is the color preceeding the current clock color. Thus on old plots, only one or two plastic arrows should be placed with the track. This is a confusing operation and was seldom adhered to in this exercise.

The raid stand and the arrows replace the pips which are removed by the filterer. As new pips are plotted and correlated with a particular track, the filterer moves the stand forward and puts down new arrows, the head arrow having the same color as appears on the pip it

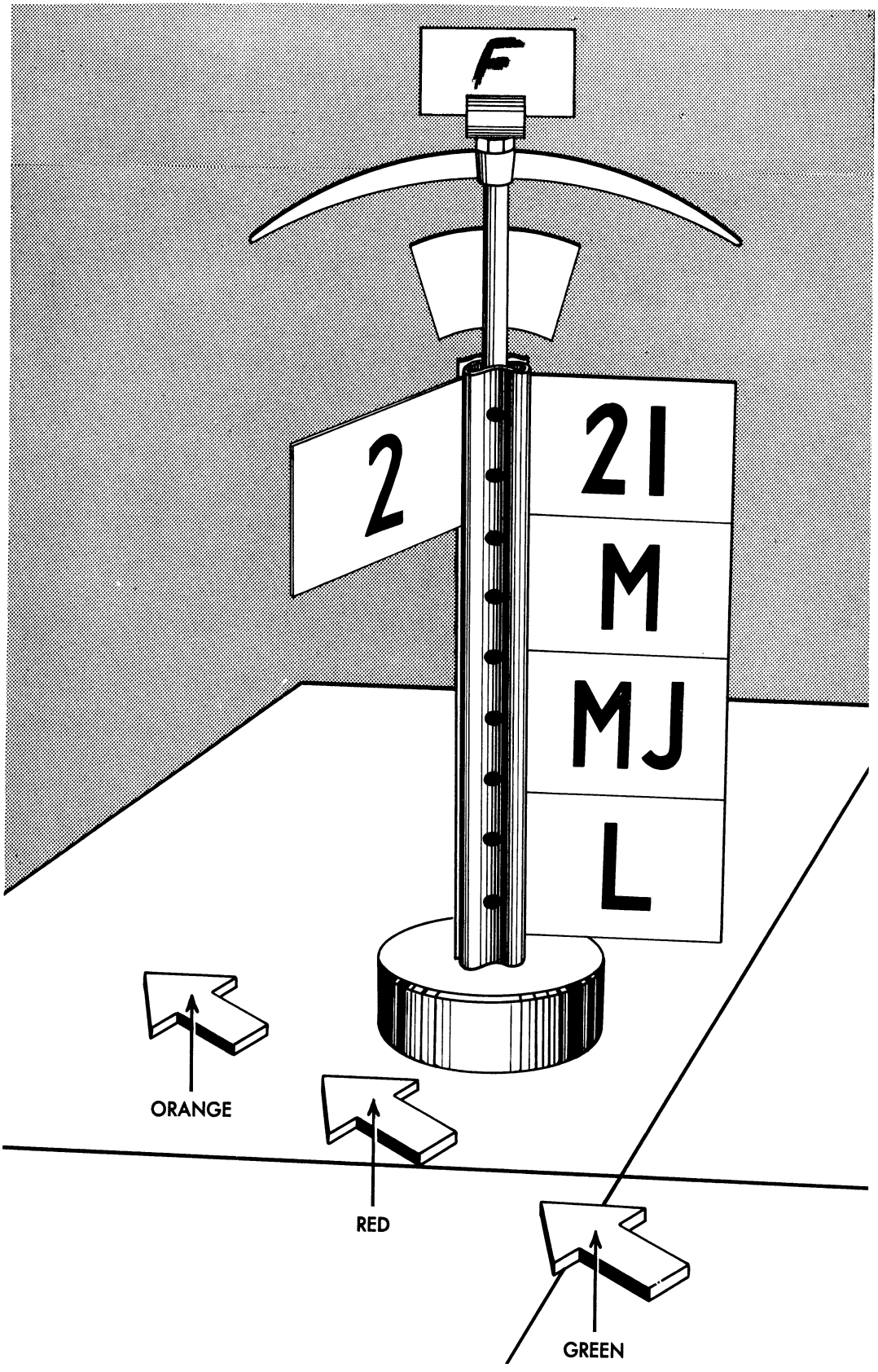


FIG. 8 RAID STAND

replaces. After a track is on the table the filterer removes an arrow every two minutes. The arrow to be removed is of the same color as that currently being indicated on the color clock. Therefore, if a new pip has not appeared on a track four to six minutes after the last pip appeared, all arrows are removed and the track is removed or "scrubbed".

2.6 GCI and Overlap Tellers

The track information which is displayed on the raid stands is read from an elevated platform at one end of the filter room by two GCI tellers and two recorders (one for each board). Both tellers are connected to the GCI by a single hot line. At the GCI, White Plains GOC plots are posted on the vertical display.

The overlap tellers are connected to adjacent Filter Centers and report tracks and plots entering these areas from the White Plains area. Incoming overlap plots are plotted on the board by overlap plotters, in the same way as plots originating in the White Plains area (However, a tab giving the code letter of the originating Filter Center is displayed at the top of the raid stand as indicated in Fig. 8).

The GCI and Overlap tellers are expected to keep abreast of the activity on the plotting boards. They are aided in this by the filterers, who call their attention to new tracks, to new plots on established tracks, and to "scrubbed" tracks.

2.7 Coverage

The area of coverage of the White Plains Filter Center is shown in Fig. 9. Observer post locations are shown as circles of two-mile radius. This is considered to be an average reporting range. For all targets that are detected, Fig. 10 shows that the probability (based on ranges reported by observers) of observation within a two mile circle is 0.5.

2.8 Filter Center Personnel

The filter center operation at White Plains required the use of 45 volunteers on each shift. .The assignments were as follows:

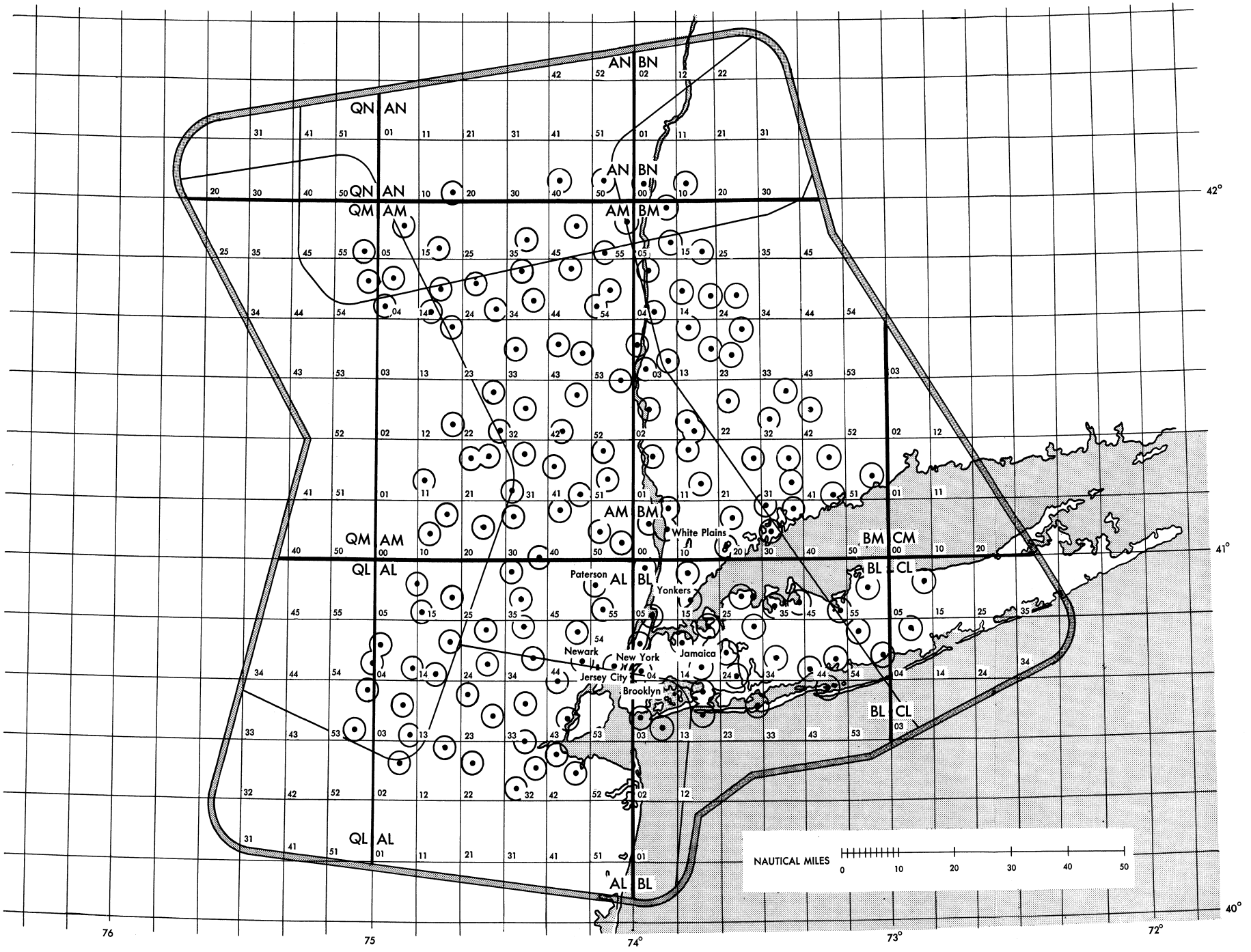


FIG. 9 AREA OF WHITE PLAINS COVERAGE

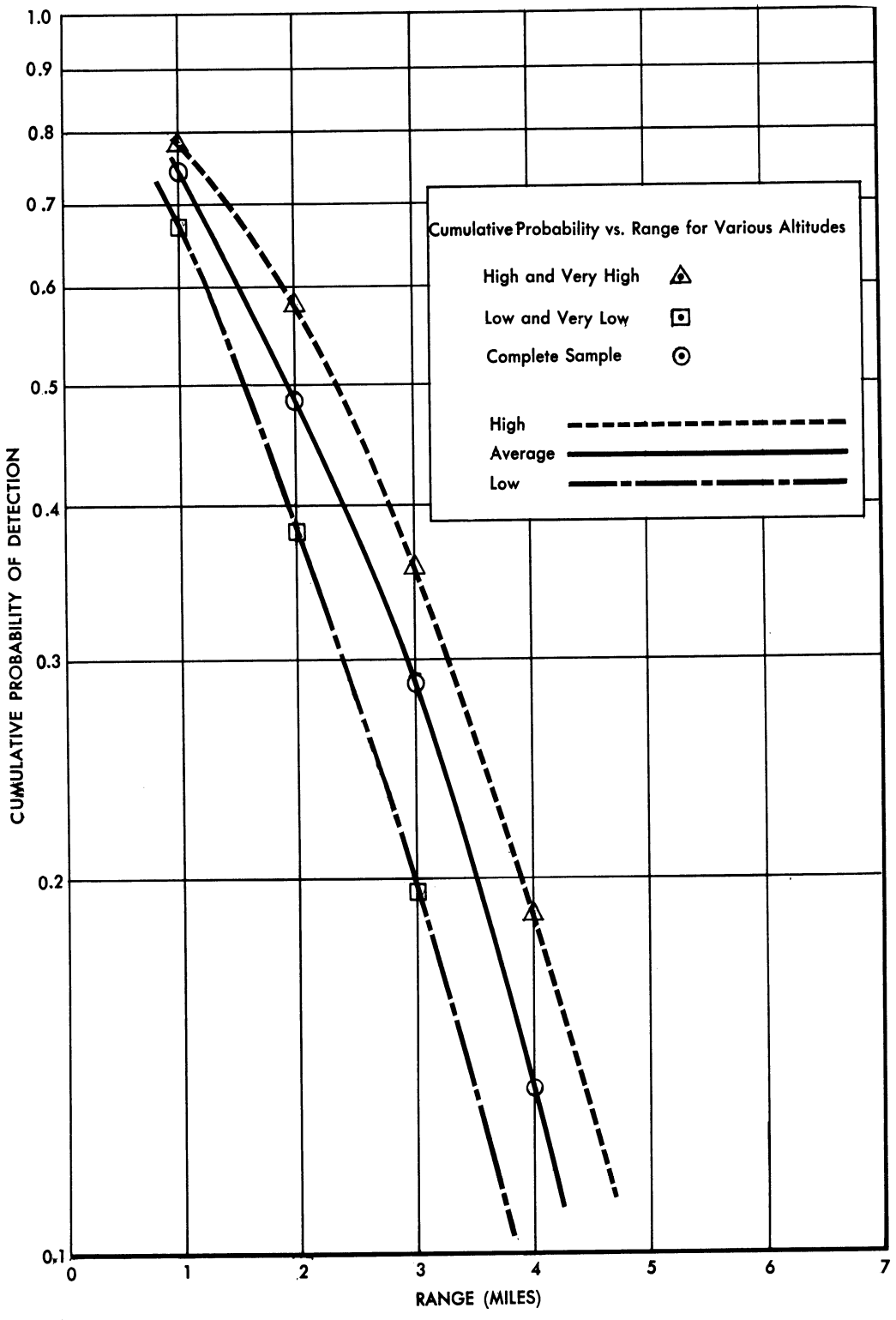


FIG. 10 PROBABILITY OF REPORTED RANGES

19 plotters

5 overlap plotters

6 filterers

2 runners

2 raid stand operators

1 track number assigner

2 GCI tellers

2 GCI recorders

2 overlap tellers (plotting table to plotting table)

4 overlap tellers (filter center to filter center)

Since two-hour shifts are used, a minimum of 540 volunteers would be required for operation on a 24-hour basis.

III

TIME STUDY AND STATISTICAL ANALYSIS

For the purposes of convenience and logical presentation, the section of statistics is divided into discussions of the various operations and is presented in the sequence of operations in the filtering process itself. Section 3.1 demonstrates correlations between the degree of activity at the various posts and the reporting ranges. The reported time delays encountered in reaching the center are presented in Section 3.2. In Section 3.3, the message characteristics and durations are defined and discussed and plotting times are shown. The filtering time, the continuity of the tracks, and the effect of greater input on tracking efficiency are shown in Section 3.4. Section 3.5 demonstrates correlations between input and output, and describes length of track.

Since the information used in the study is from several sources (see Appendix A), the data source from which each figure is constructed is indicated in the text. The sizes of the samples from these sources and the nature of the measurements differ considerably. However, there was good agreement when measurements on the same operation were made by a number of methods.

3.1 Observation

Some observer posts were manned by 0800 and were in a high degree of activity by 1000 hours. In the time interval between 1000 and 1500 hours, the number of active posts remained about the same.

Despite the fact that the number of active posts were approximately constant, it is evident that most of the posts did not report during the full time. Figure 1 shows the number of posts from which some information had been received during any given hour. Eighteen posts, or 28 per cent of the posts reporting during previous hours did not report during the last hour. One post reported for the first time during the last two hours of operation.

The over-all percentage of posts which were active is high, when compared with the results of the Grand Rapids Study (Ref. 4).

A better idea of the coverage can be obtained by realizing the limited range at which the observers report the aircraft. The ranges reported and their probability of occurrence within any given radius, as given in Fig. 10, are based on this exercise only and hence are limited to reports during daylight hours on a clear day. Studies by the Operations Evaluation Group (Ref. 5) indicate that the actual ranges of detection of aircraft should have been greater than those reported.

3.2 Observer - - Filter Center Link

The observer, having made an observation, enters the appropriate information in the observer post log (Fig. 6), and immediately attempts to reach the filter center. The time difference between observation and reaching filter center is defined as delay time. The probability of a delay of 40 seconds or longer was found to be about 0.5 (Fig. 11). The various mean delay times at different times of the day are shown in Fig. 12. There is a definite and systematic fluctuation of the mean delay, showing a marked increase during the filter center's most active hours (See Fig. 16). The delay time may be a function of telephone switchboard activity during those hours. It should be recognized that these delays are reported delays to the nearest minute.

The ringing time at the filter center is defined as the interval from the appearance of the light at the plotter's box to the pushing of the receive button by the plotter. The ringing time at the filter center was short (almost always less than 10 seconds), indicating that the plotters are generally capable of receiving more reports than they receive at present.

The average connection time reported for this exercise by the telephone company was 35.7 seconds, and the measured ringing time for a small sample measured was 4.3 seconds, giving a total delay time of 40.0 seconds. This agrees well with the delays reported by the observers.

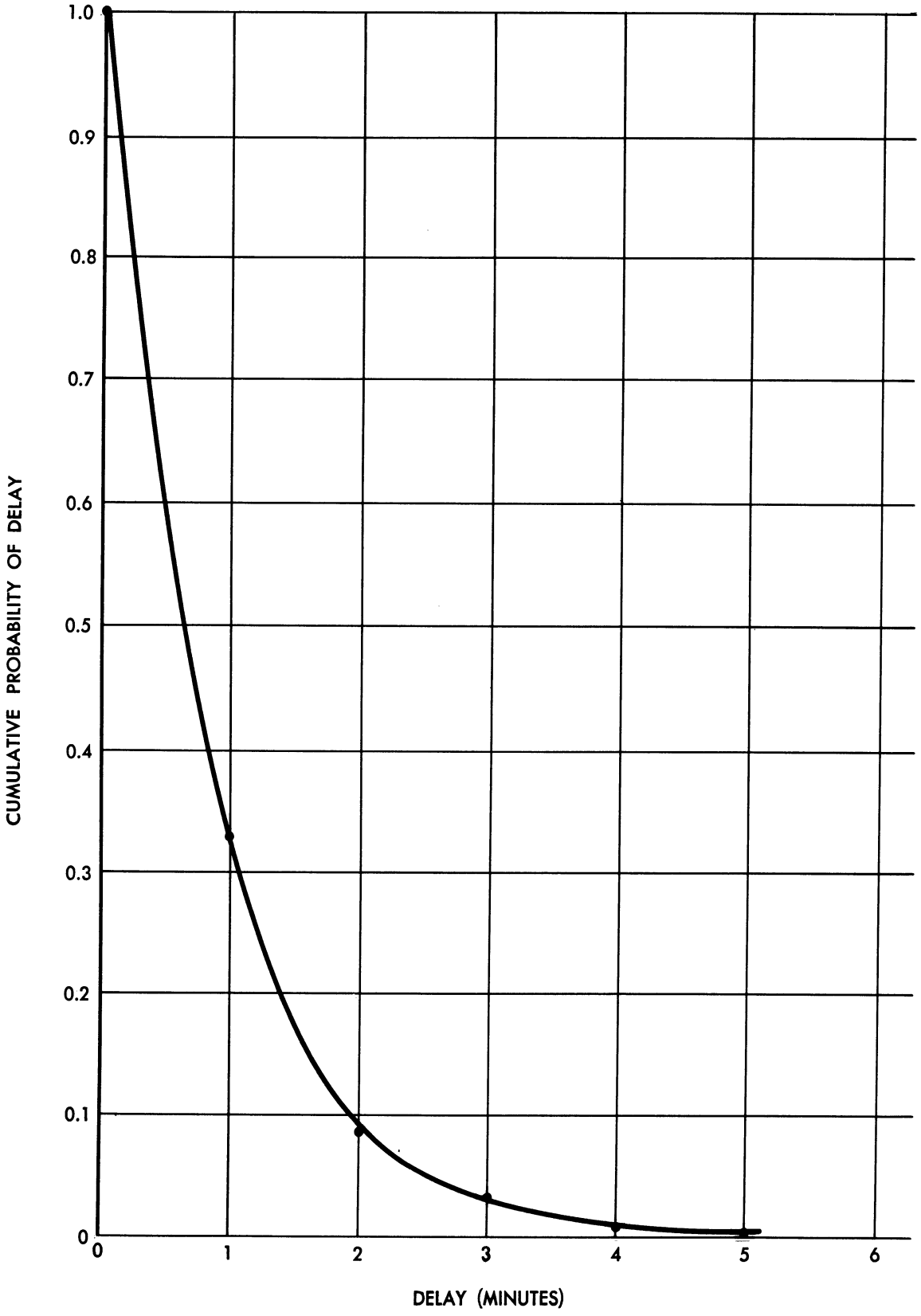


FIG. 11 PROBABILITY OF TIME DELAY IN REACHING FILTER CENTER

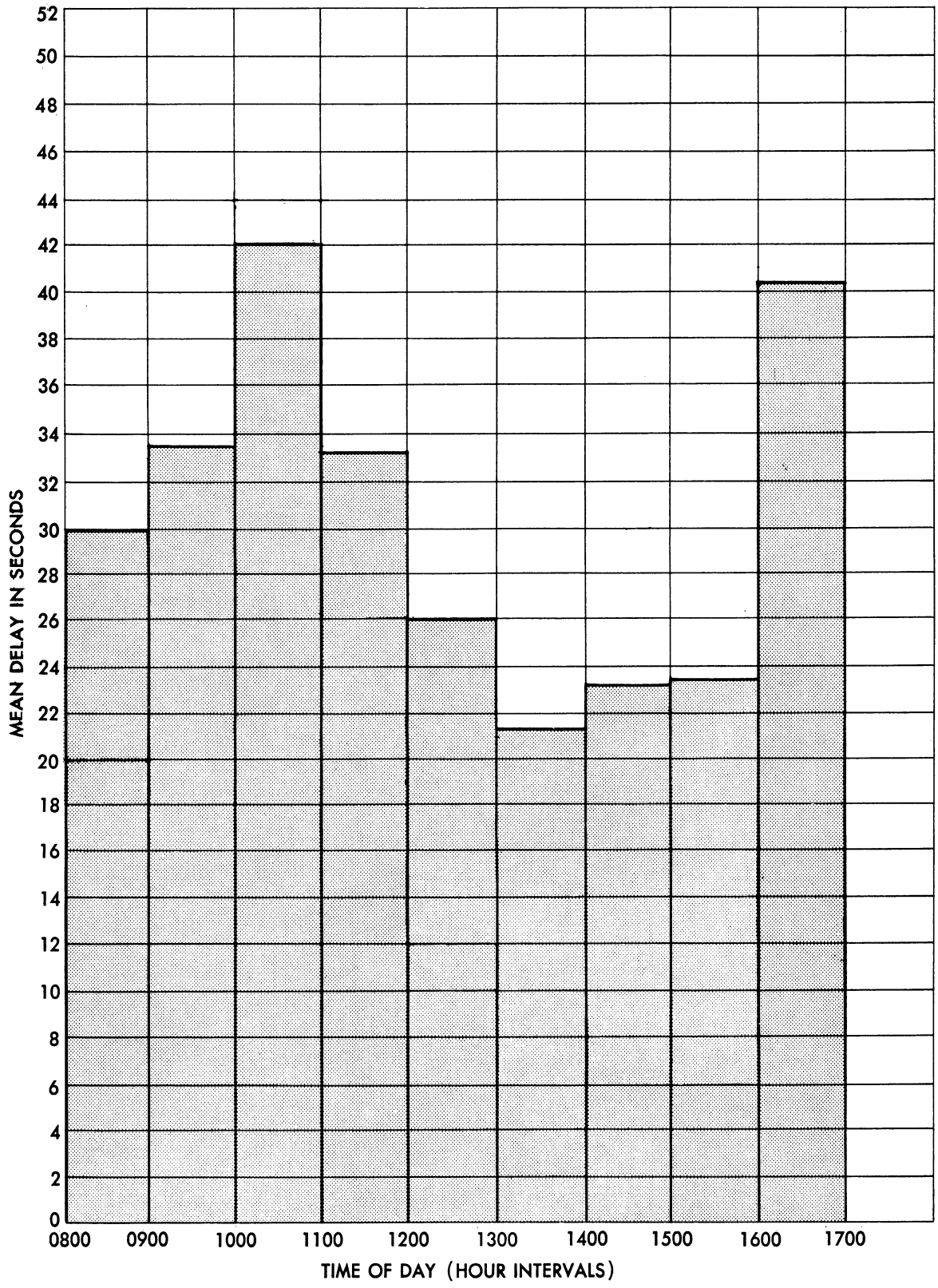


FIG. 12 TIME DELAY IN REACHING FILTER CENTER vs TIME OF DAY

3.3 Message and Plotting Operations

After the observer is connected with the filter center, he makes his report. During the call, the plotter arranges the pip, and during or at the end of the call, he places the pip on the plotting board in the correct position. For purposes of measurement, the time from answering the phone until the termination of the call was called message time. The time from message termination until the final plotting of the pip was measured and called additional plotting time. Since, in many cases, the plot was completed before the end of the phone message, some of the plotting times are negative. The probability of a given message duration is shown in Fig. 13. It can be seen from this figure that 50 per cent of the calls have a duration of 18 seconds or longer. In the over-all analysis of the system, the additional plotting time (average of 3.4 seconds) was considered as a correction applied to the message time. In the over-all analysis, message time plus additional plotting time averaged 25.7 seconds.

The message time is affected by the ability and care of the observer in making his report in a distinct and orderly manner, and by the ability of the plotter to receive this information and arrange the pip. At present, there is much repetition of the messages (Fig. 14). A repeat is defined as the repetition of a particular item of information. For example, if the altitude is repeated twice and the number of engines once, the total number of repeats for the message is three.

The variation in the number of repeats during the exercise is shown in Fig. 15. The high number of repetitions in the 1100 and 1400 hour periods was related to the great number of observations reported. The actual number of messages received during any hour is shown in Fig. 16. It is also evident from the superimposed line chart in Fig. 16 that the average number of repetitions per message increases as the rate of calls increases. This condition indicates that the cause of repetition is at least partly at the filter center. It is presumed, that the confusion associated with greater filter center activity causes much of the message difficulty.

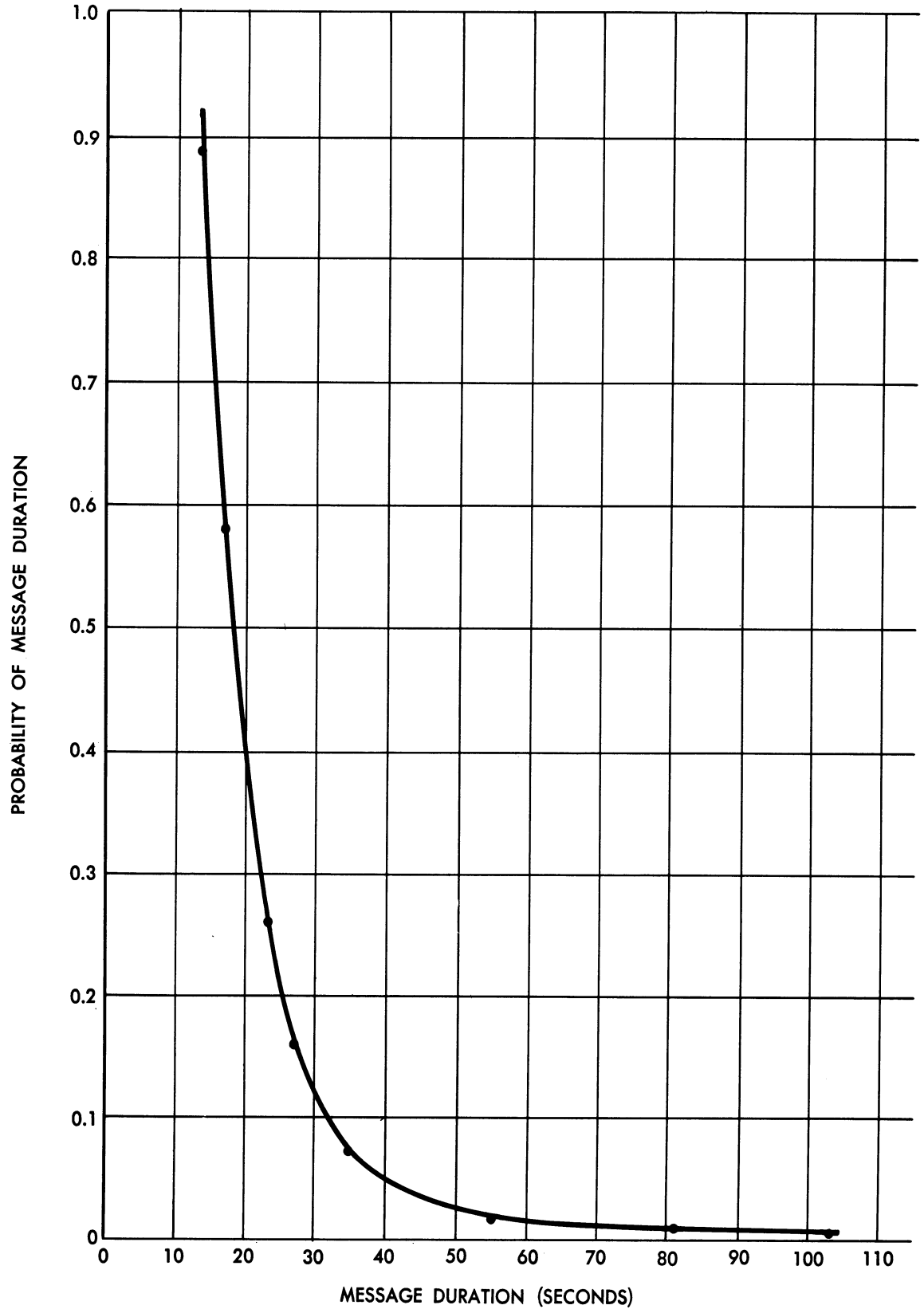


FIG. 13 PROBABILITY OF MESSAGE DURATION

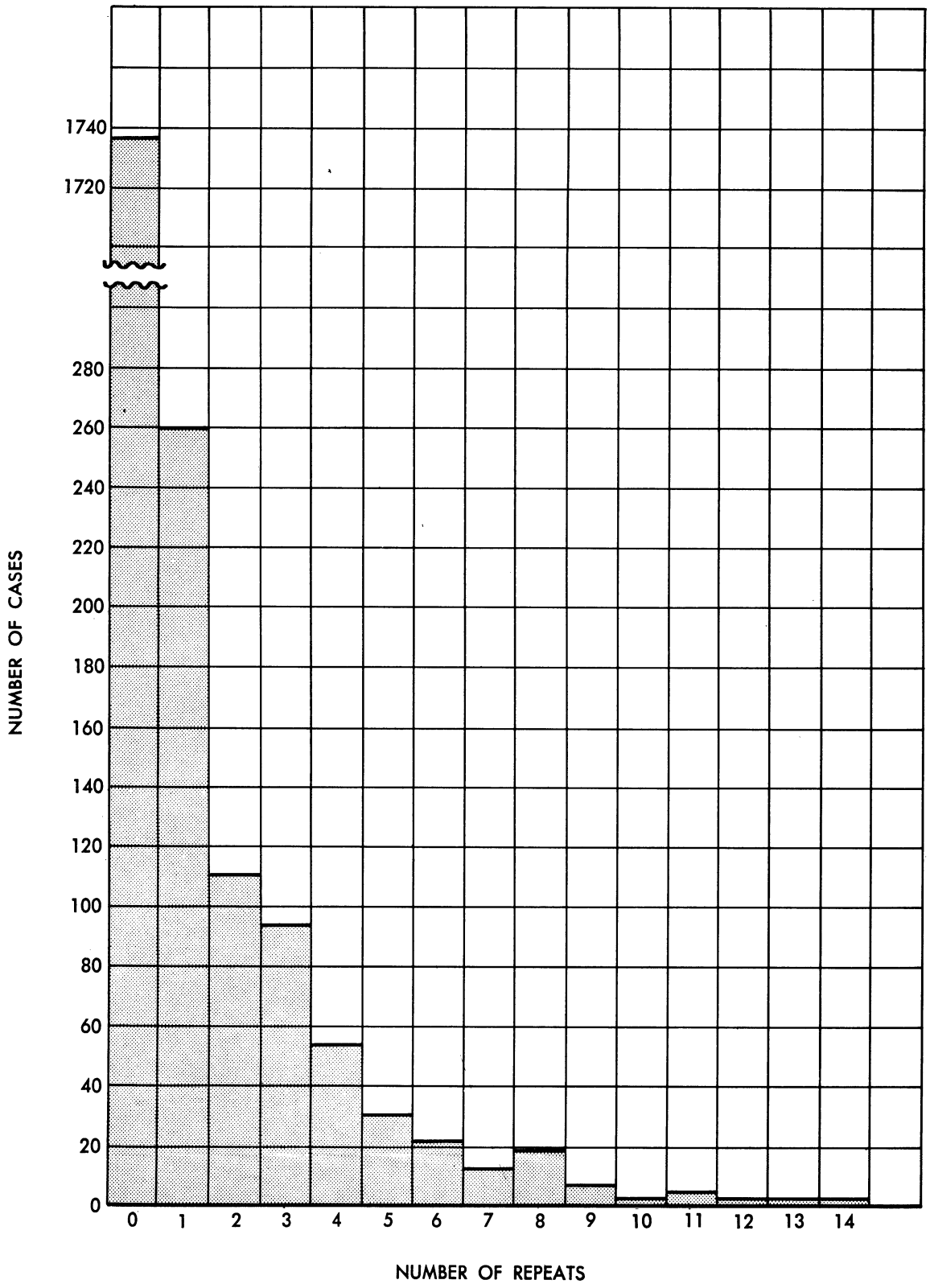


FIG. 14 OCCURRENCE OF REPEATS

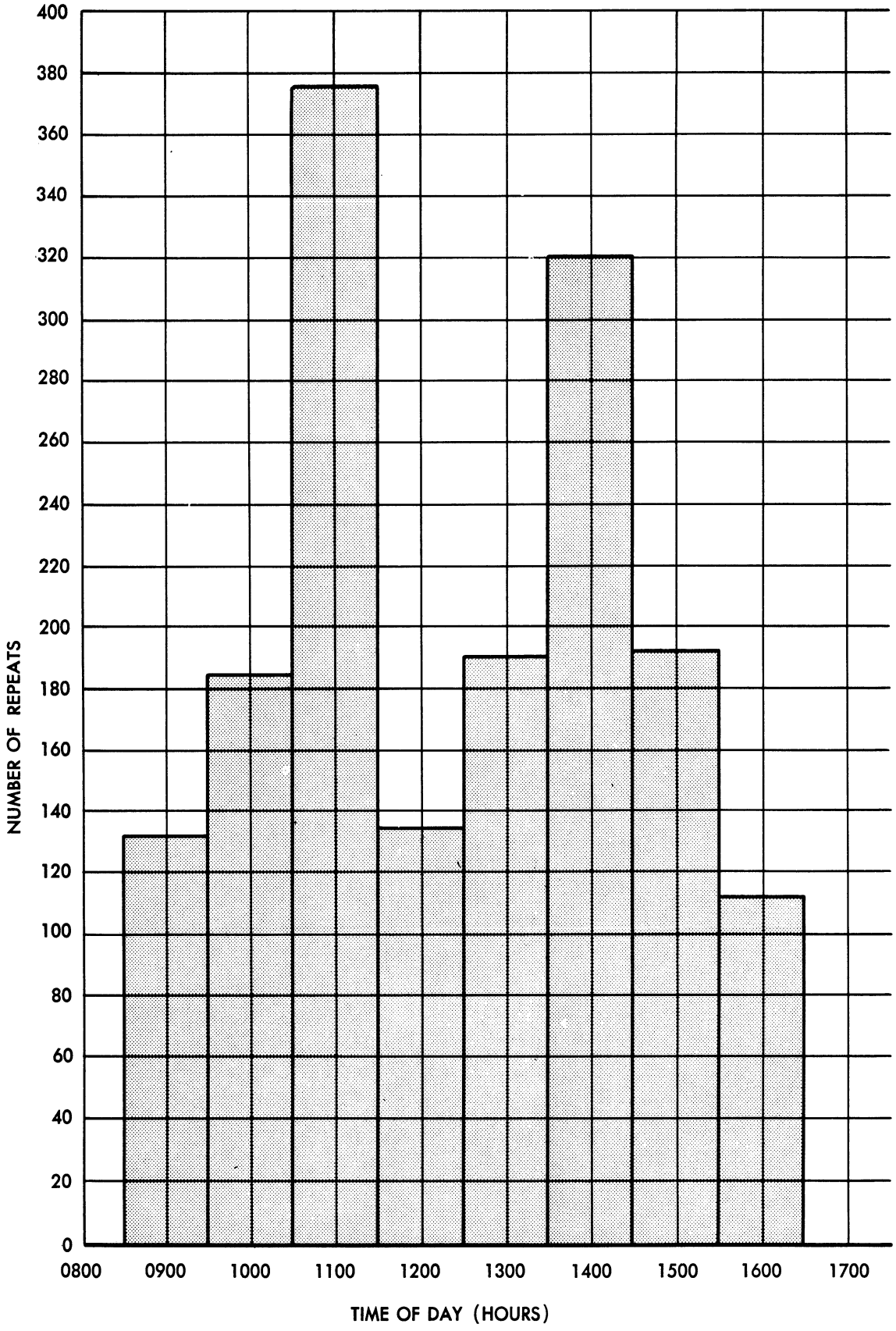


FIG. 15 REPETITIONS vs. TIME OF DAY

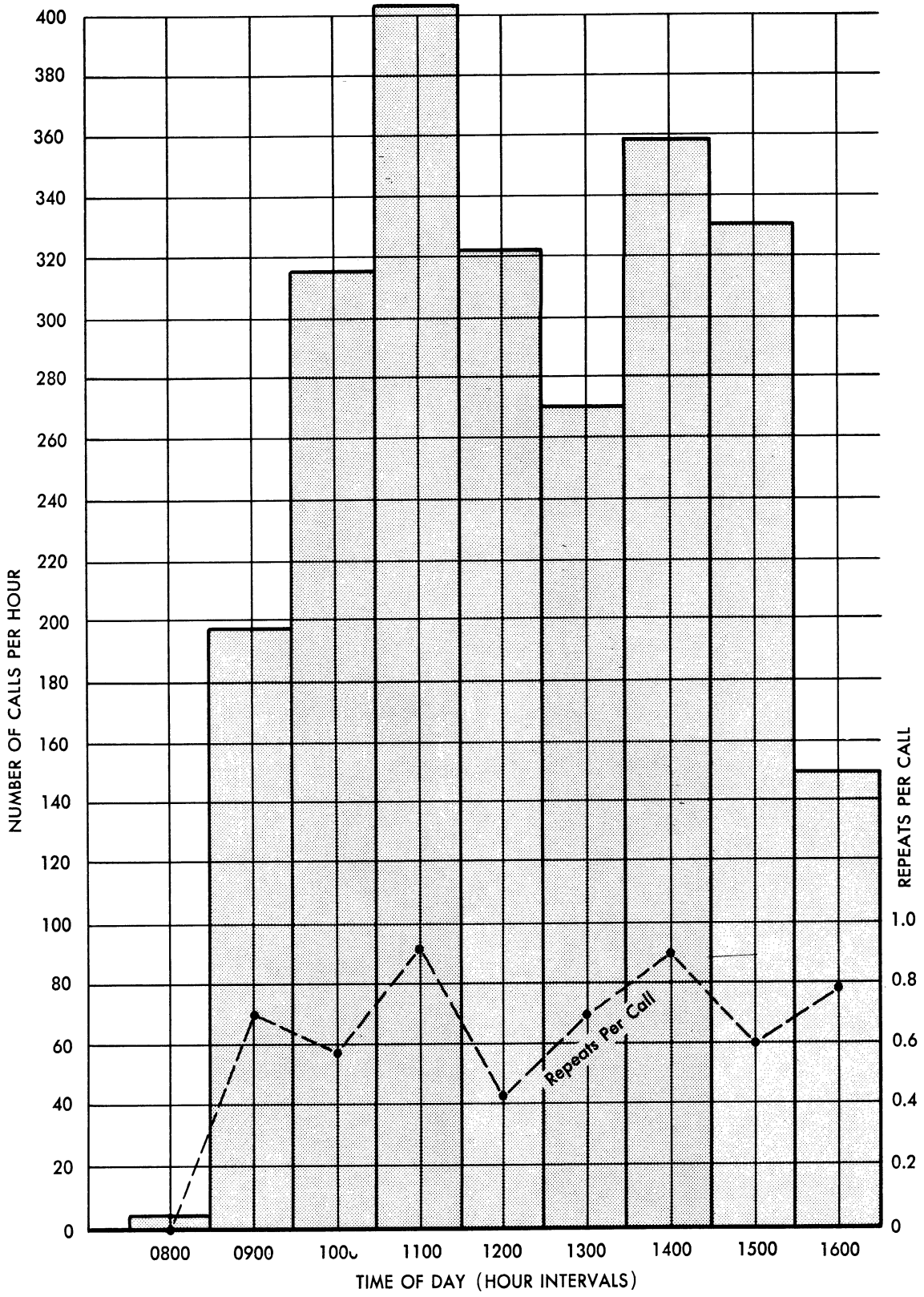


FIG. 16 MESSAGE LOAD SHOWING EFFECTS ON REPETITION

Although the beep signal required on all recorded phone conversations was used on the East table plotting positions, and was undoubtedly annoying to the observers and plotters, it is felt that the message time and repetition rate were not seriously affected. A time check study was made of the West table messages (which were not recorded), and these did not differ appreciably from the East table messages (which were recorded).

The message duration during different periods of the day are shown in Fig. 17. These seem to correlate highly with the number of repeats per call by hours (see Fig. 16).

The average number of pips appearing simultaneously on the East board is given in Fig. 18. These are the result of observations (Appendix A, Source C) and compare favorably with the averages from the photographs (Appendix A, Source B). The observations were used as the source for the figure, because the camera's view was sometimes partially blocked by persons taking part in the plotting and filtering operations. Since the field of vision of the camera is much the same as that of the tellers, the occasional long delays encountered in the telling operation are partially explained.

Making the assumption that the track information was on the East board for six minutes, it is possible to approximate the number of plots which were actually made. This approximation is reliable, since the track durations were of the order of five minutes and the scrubbing time for the pips was five minutes. By determining the number of plots which were made, it is possible to compare the number of input calls, the number of calls which were actually plotted, the number of tracks on the board resulting from this information, and the entries in the tellers' log which indicate the tracks actually forwarded to the GCI. This gives a measure of the information lost in each stage of the filtering process.

To determine the distortion of the information due to height classification used by the observers, an analysis was made of these classifications. Fig. 19 indicates that the observers tend to classify the flights as either "high" or "low", and almost never "very high" or "very low". Visual height estimates are crude at best, and at present little use of this information can be made by the GCI.

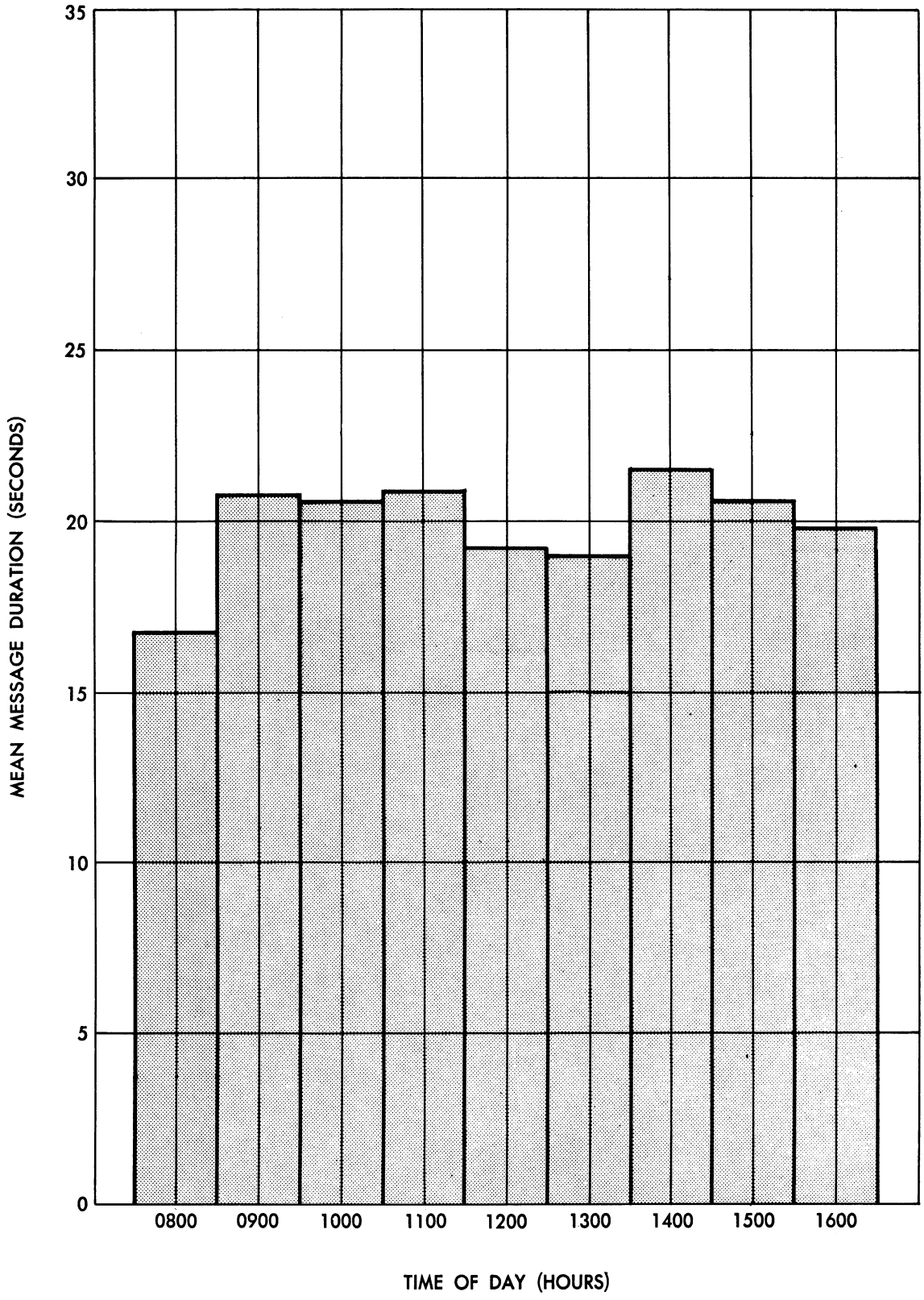


FIG. 17 MESSAGE DURATION vs. TIME OF DAY

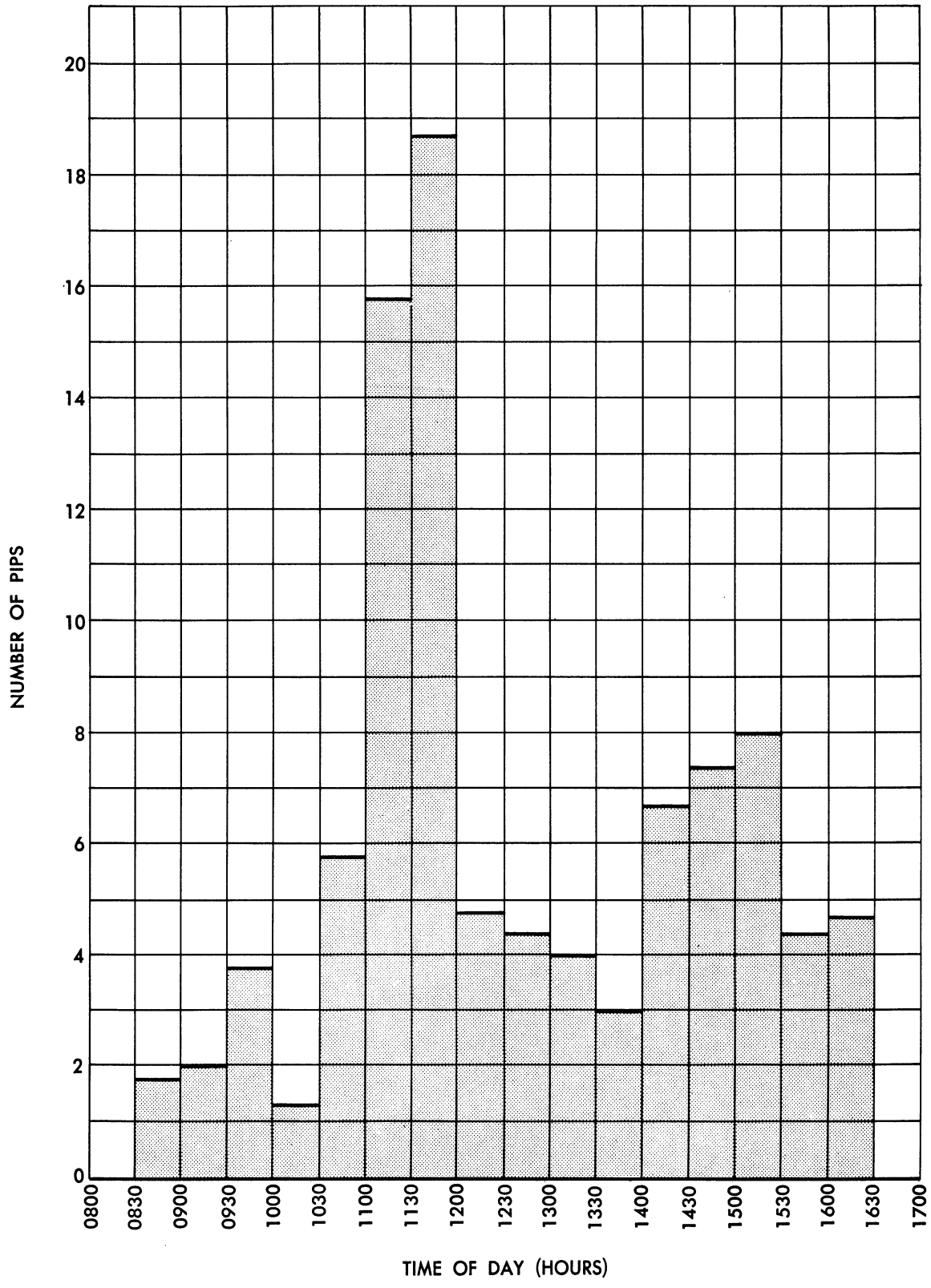


FIG. 18 FREQUENCY DISTRIBUTION OF PIPS (East Board)

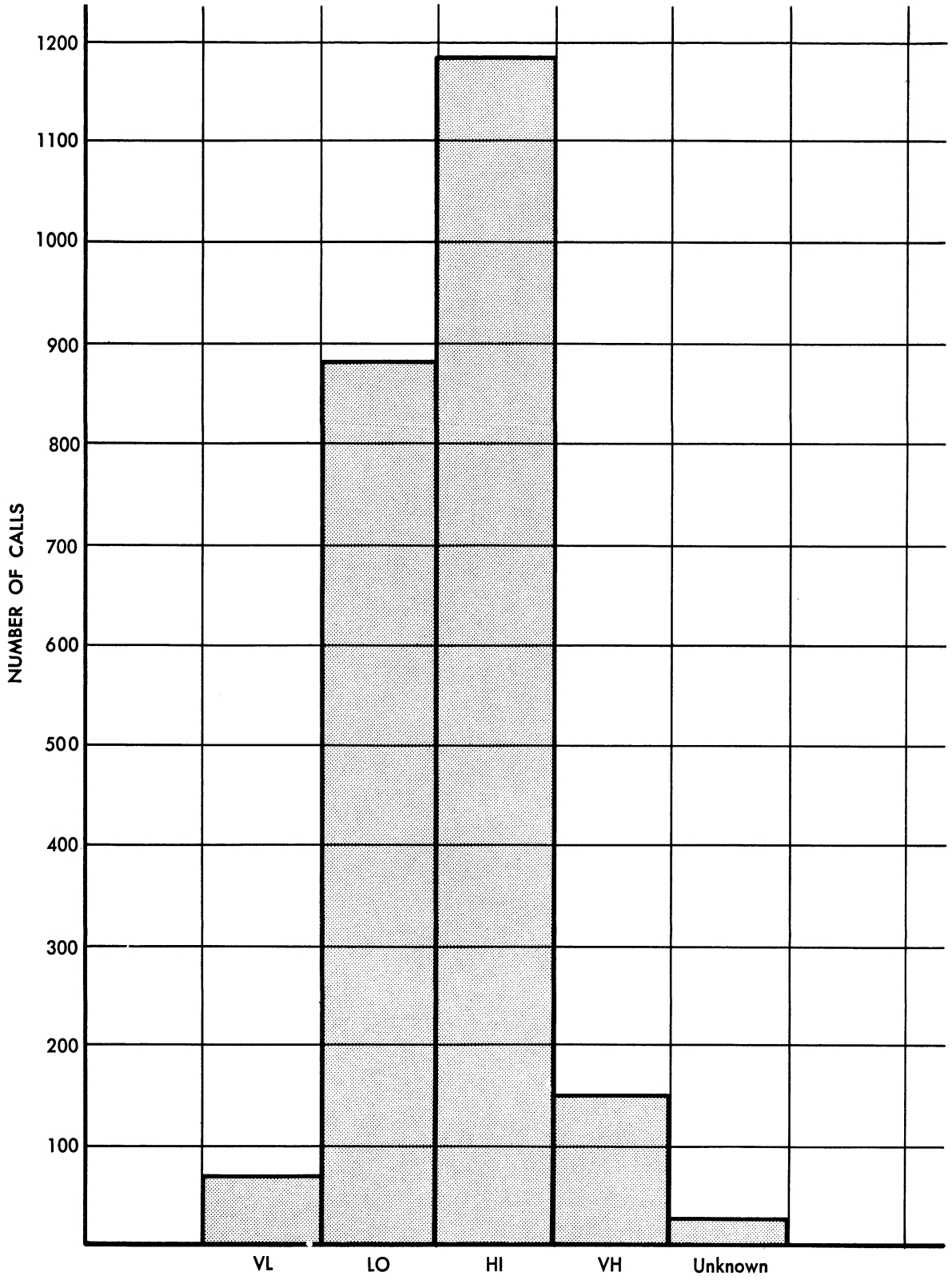


FIG. 19 REPORTED TARGET HEIGHT

The relative frequency of reported flight headings was also determined. In this case, it can be seen (Fig. 20) that the major points of the compass were favored. It is not possible to determine with any accuracy whether this was a tendency on the part of the observers, or a flight condition existing in the New York area at that time.

3.4 Filtering the Information

Once the GOC information is plotted on the Filter Center board, it is the function of the filterer to correlate the individual plots and form continuous tracks. The time from the final placing of the most recent pip to the placing of the raid stand in place of that pip was measured. This time is defined as the time to establish a track. The probability of having a time of a given duration is shown in Figure 21. The probability that the time will be 75 seconds or greater is 0.50. The delay is less when an additional plot is made on an established track, due to the fact that the raid stand is already made up for that track. This, then, is useful to indicate the amount the average plot at the GCI is out of date.

A measure of the effectiveness of the system is the continuity of track that the teller is able to achieve. The frequency distribution of number of plots per track reported to the GCI is shown in Figure 22. Only 5 per cent of the tracks were based on more than three plots. It has been pointed out in Ref. 7 that due to the short track length little or no use can be made of these data at the GCI. A count of the tracks on the board was made from the photographs of the operation and by observers of the exercise. The average number of tracks appearing simultaneously on the East Board (at given time intervals) during the exercise is shown in Figure 23.

3.5 Recognizing the Tracks and Forwarding the Information

After the tracks are established on the board by the filterers, the tellers must recognize the presence of these tracks, read the information displayed on the tracks, log the information (by a recorder), and forward it to the GCI.

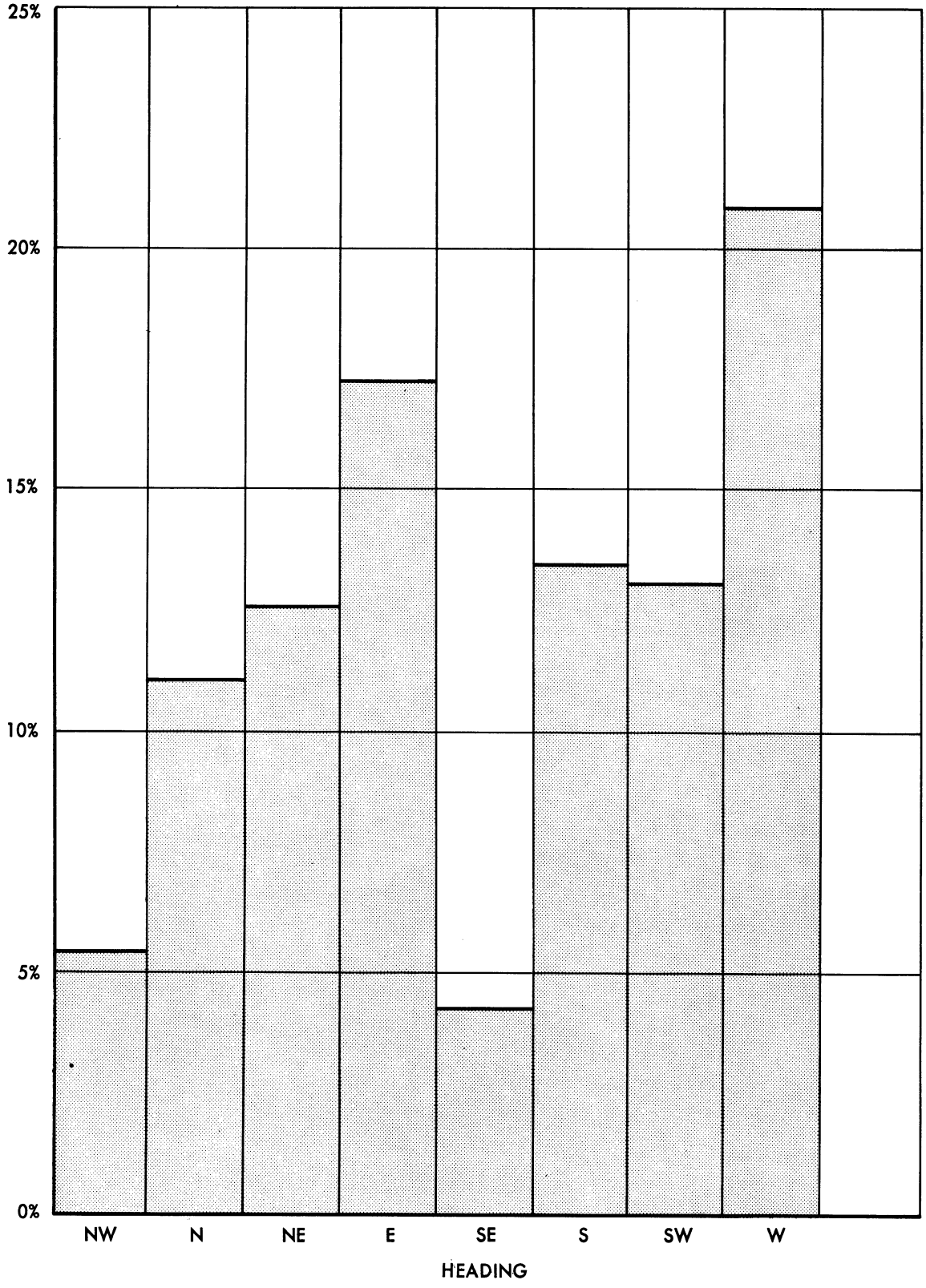


FIG. 20 FREQUENCY OF OBSERVATIONS BY FLIGHT HEADING
(2353 Cases)

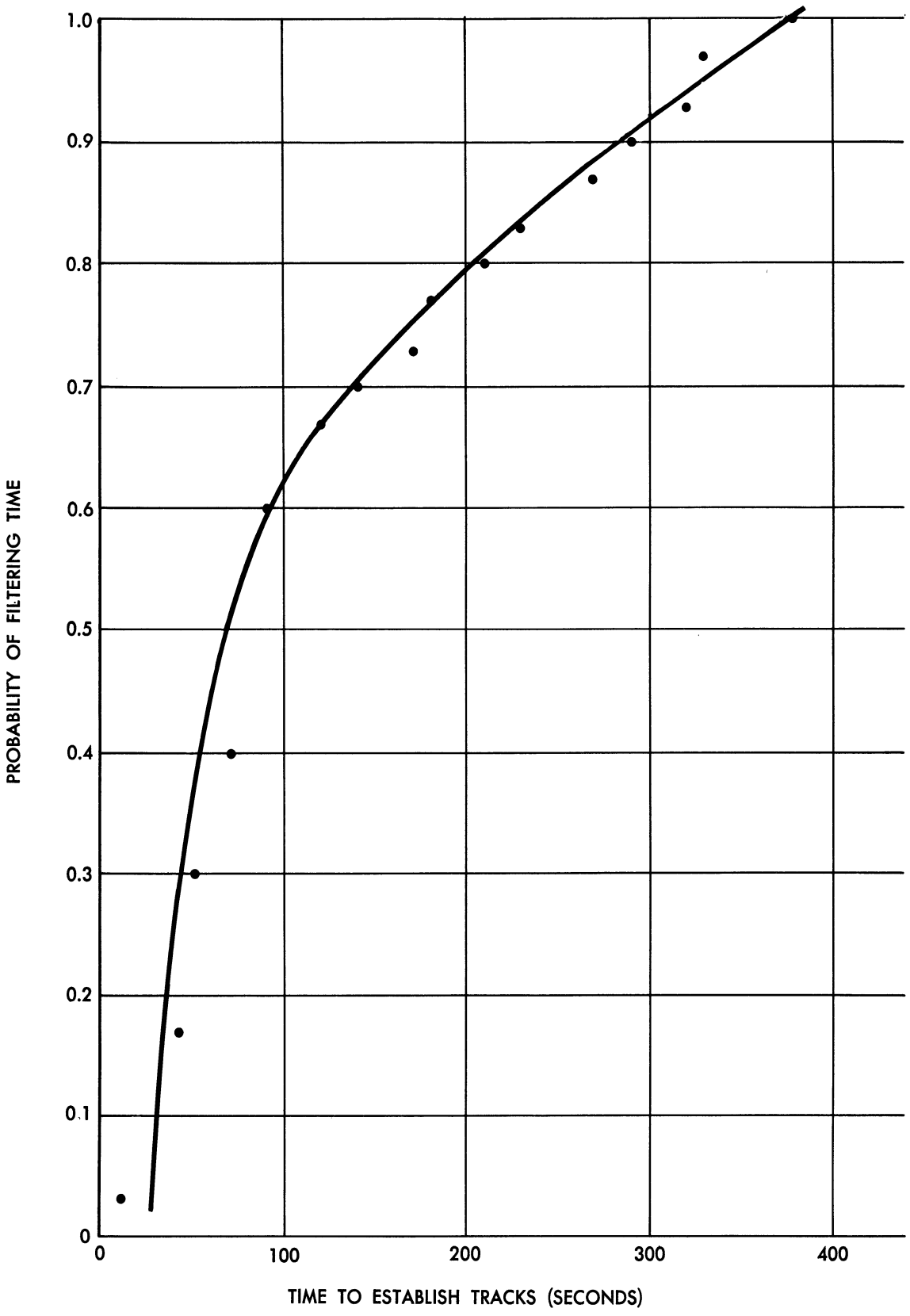


FIG. 21 TIME TO ESTABLISH TRACKS

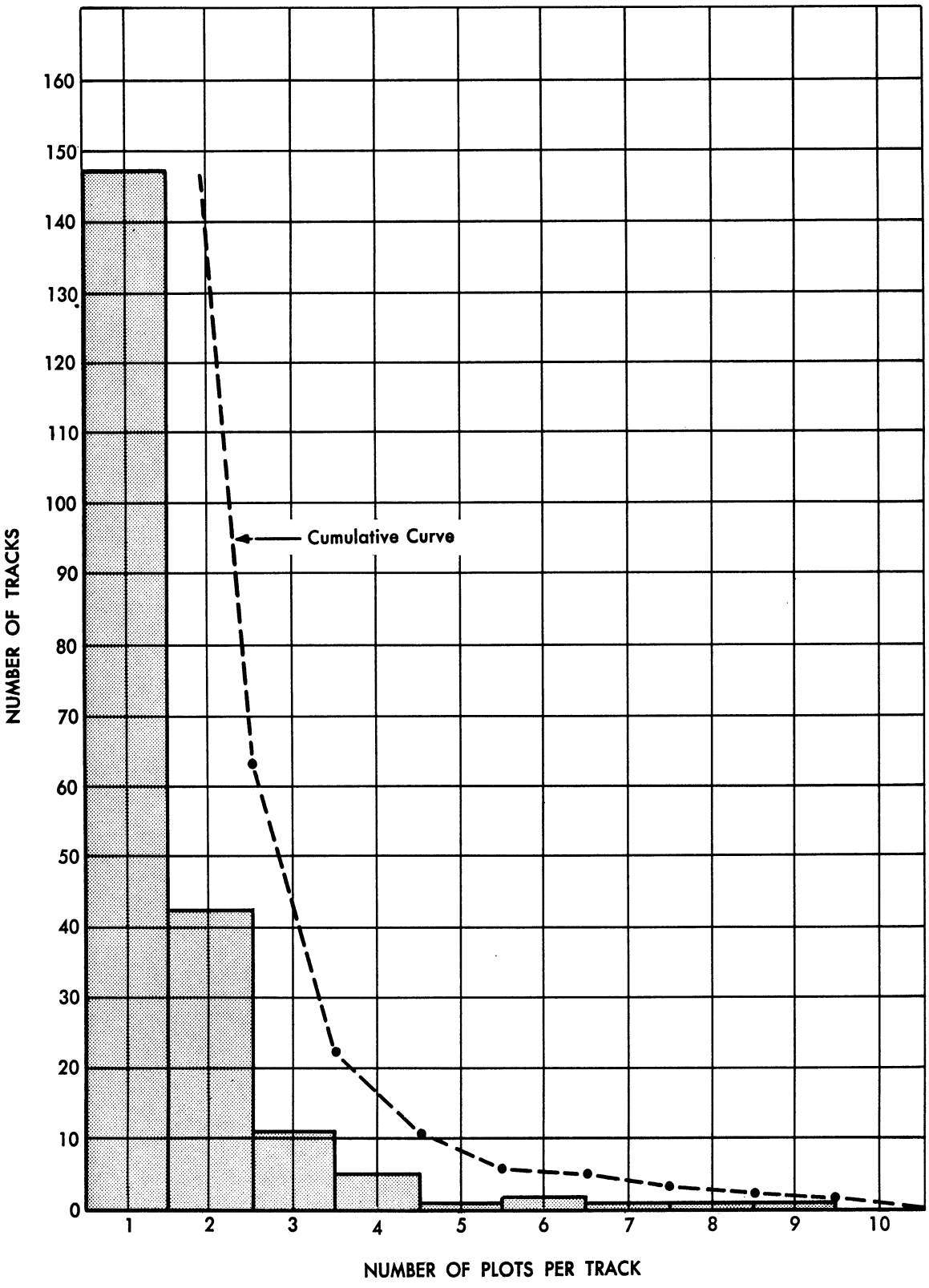


FIG. 22 NUMBER OF PLOTS PER TRACK

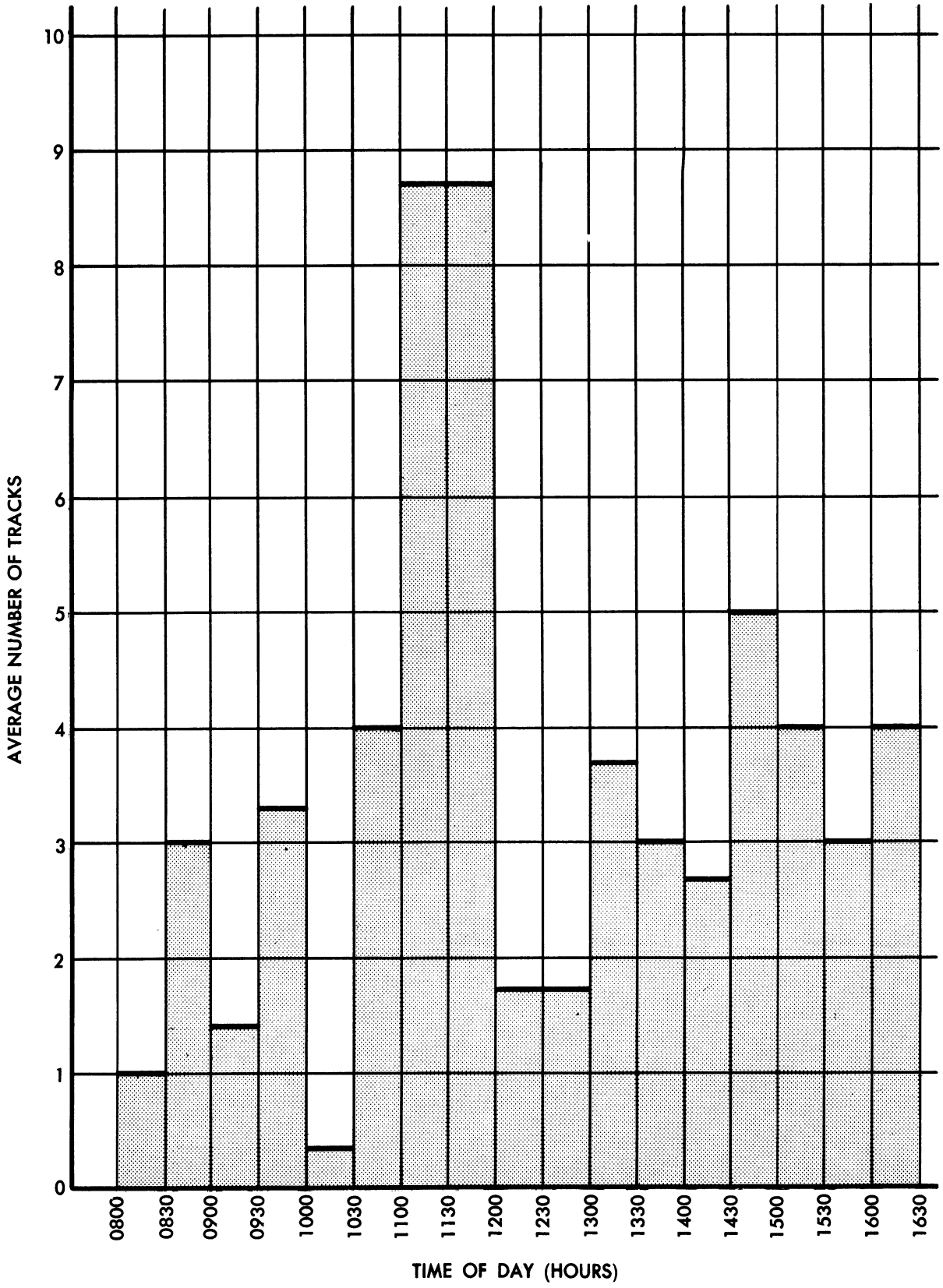
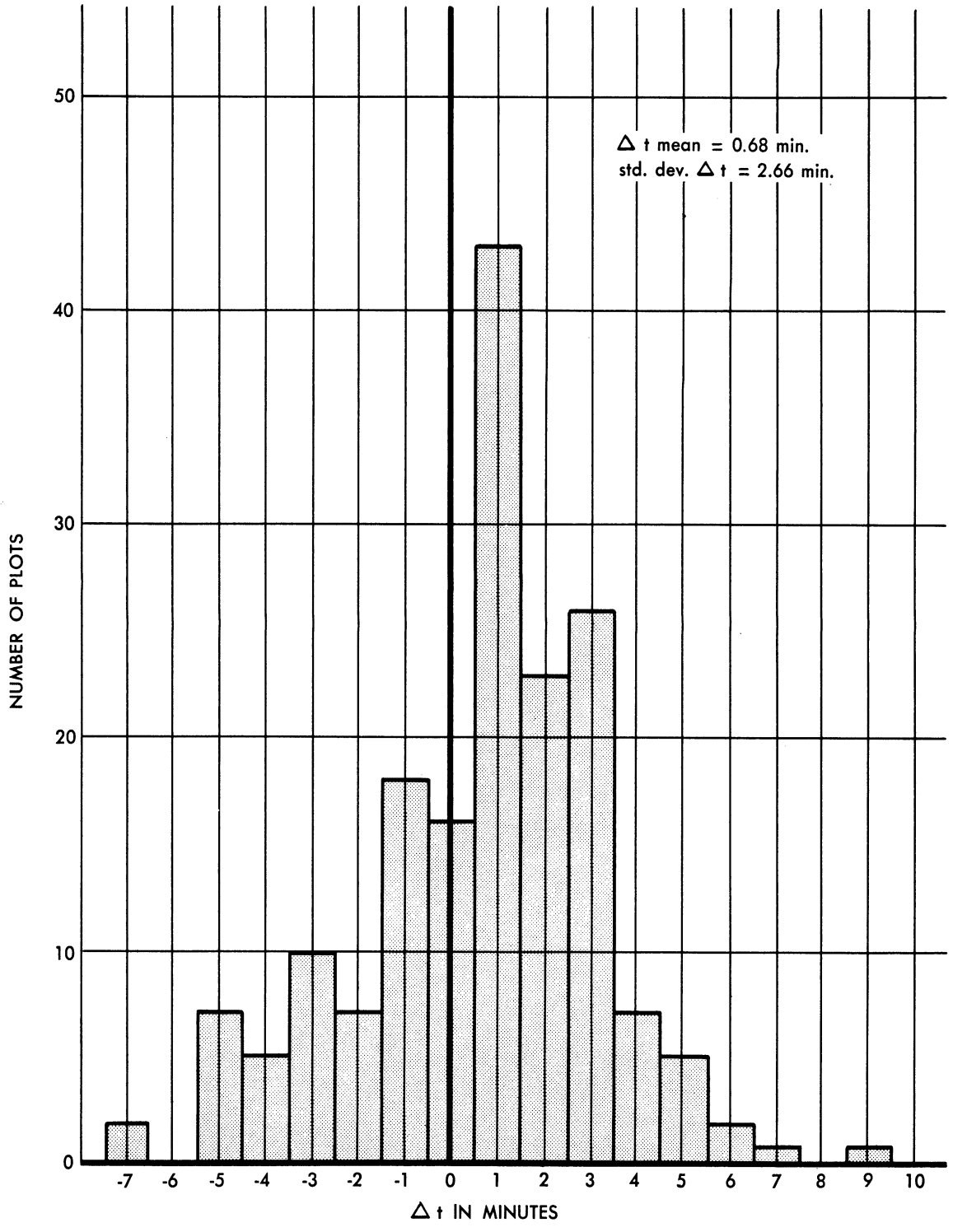


FIG. 23 AVERAGE NUMBER OF SIMULTANEOUS TRACKS

The measure of the operational efficiency of the teller and recorder was based on a comparison of the photographs of the board with the tellers log; the latter contains a record of information that was forwarded to the GCI. There were a number of errors in the teller's log data when compared to the photographs of the table. Such errors are indicative of teller and recorder inefficiency.

One measure of the efficiency of the teller and recorder was obtained by comparing the time of the first recorder plot on a track in the tellers' log with the time of the photograph containing this same plot. Since the photographs were taken at two minute intervals, the comparison of photograph time and telling time allows an estimate of error in recording and the delay in reporting information. A total of 173 tracks were analyzed by this method. The frequencies of the telling times are shown in Fig. 24. The large number of negative times indicates the inaccuracy in the recording information while the number of large positive times indicates poor reporting of the filtered display. If the delay caused by the filtering process is small, and has a small standard deviation, a standard time lag could be assumed. At present, the use of a standard time lag is of doubtful value. In this exercise the time delay had a mean of 47.8 seconds and a standard deviation of 481.1 seconds.



(First appearance of Track in Teller's log)—(First appearance of Track on Photograph)

FIG. 24 FREQUENCY OF TELLING TIME

IV

CONCLUSIONS AND RECOMMENDATIONS

1. a. The over-all time from observation of a target at the observer post to receipt of the first plot on a track at the GCI was found to average 270 seconds. Of this time, the greatest portion was spent at the Filter Center in the filtering process and was found to average 122 seconds.

   b. Of the tracks received at the GCI, only about 35 per cent were multiple plot tracks. The combined effect of this over-all average time and the small number of multiple plot tracks makes it unlikely that the track information would be useful at present for interception purposes (Ref. 6).

2. The study indicates that the observer message should be further standardized. Although an improved log form (Fig 6) is used, the message is often garbled, and 35 per cent of the messages are repeated in part. A simpler speech pattern should be used for reporting the message, this speech pattern should assure a definite order to the message, and the message should be repeated by the filter center operator to the observer for verification.

3. Parts of the filter center plotting tables are inaccessible to some plotters who should be able to reach them conveniently (Fig. 5). The plotting action should not leave any of the incoming phone lines unmanned if efficient use of personnel and of the lines is to be achieved. Since the plotters often rearranged the pips a number of times after the completion of the message which indicates that they are not confident of their ability to plot heading correctly, a method for aiding the plotters is recommended.

4. The filterers and tellers do not have an unobstructed view of the board. It is necessary to keep the plotters out of the line of vision if the filtering function is to be efficient.

5. It is recommended that height information be dispensed with until an aid to the observer can be designed.

6. The method of receiving and handling the track information at the GCI should be examined, since the use of the data at the GCI is an obviously important consideration. No more than four simultaneous tracks can be plotted at the Twin Lights GCI using White Plains GOC tracks.

7. Only minor redesign recommendations are made in this report. However, a major redesign study is being undertaken by WRRC and a report (Ref. 7) dealing with the conclusions and recommendations resulting from the study will be published in the near future.

APPENDIX A

The following are the four major sources of information, and the methods used to reduce data obtained from them:

Source A Recordings of the message input: Tape recordings were made of the message input of all of the observers reporting to the East plotting board. An automatic electronic time signal was superimposed on the observer report recordings as they were made.* It is estimated that approximately seven per cent of the data were lost in this stage due to low signal-to-noise ratio and loss of information due to changing tape. (This noise originated partly in the recording apparatus and partly in the telephone lines; the latter part of the noise also caused some difficulty in the transmission of the messages themselves).

The full audible sample was coded and the information punched on IBM cards. A separate card was used for each message. All of the information received at the filter center was included.

The duration of each of the messages was computed. The time of day and the message duration are included on the IBM cards with the messages. The number of repetitions during the message and coded comments describing the sources of error and difficulty were also punched on the cards. The analysis of these data and the tabulation of the results were all done with IBM equipment. The information from this analysis and tabulation was used wherever possible, because it was an extremely large sample and all of the pertinent data were included with each observation.

* This was a signal for timing purposes only and was not heard by observers or plotters. In addition to this, a beep tone was used, as required by law. This tone was audible to the observers and plotters.

Source B — Photographs were made of the plotting board every two minutes. These photographs were taken immediately after the color clock changed color. Hence, the times of the photographs are actual signal times used at the filter center.

Source C — Observations and measurements were made by WRRC observers. These observations and measurements were mainly time studies of operations on the plotting boards. These data were reduced by standard statistical methods.

Source D — Photographic copies were made of the tellers' logs to get an accurate measurement of the output from the filter center. Comparison of the logs with the photographs of the plotting board show that the teller was inaccurate, but the information was nevertheless used in the studies because it was the same information that was forwarded to the GCI.

REFERENCES

1. "Problems of Air Defenses", Final Report, Project Charles, Vol. 1 (SECRET).

2. ATI-82942, "An Analysis of Certain Operational Aspects of Exercise 'Dagger'", also see TRE-211 and TRE-385 (SECRET).

3. RB/FC Report 701, "An Analysis of Certain Operational Aspects of Exercise Emperor: Part I - Raid Reporting", (SECRET). N. D. also see CFE 155/50.

4. UMM-84, "Analysis of Ground Observer Corps. Participation in Air Defense Exercise - June 1951 (CONFIDENTIAL).

5. OEG Study No. 368, "Visual Detection in Air Interception", Operations Evaluation Group, October 1948 (CONFIDENTIAL).

6. AF-6032, "A Survey and Analysis of the Ground Observer Net; A Human Engineering Study", Dunlap Associates, Inc., Stamford, Connecticut, June 1950.

7. UMM-96, to be published.

DISTRIBUTION

To be distributed in accordance with the terms of the contract.