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AIR FORCE MANPOWER REQUIREMENTS DETERMINATION: AN ANALYSIS OF WORKER NONAVAILABILITY

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The purpose of this thesis was to assess the use of constant nonavailable time estimates in the determination of Air Force manpower standards. Analysis of data from several sources revealed significant differences in the amount of time personnel in the various pay grades (military and civilian) were available for primary duty. The effect upon manpower standards caused by the use of erroneous availability estimates is simulated through the application of various estimates to a work center. The authors conclude that current methods of estimating worker availability are inadequate and recommend incorporation of availability estimates in work sampling studies.

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AIR FORCE MANPOWER REQUIREMENTS DETERMINATION: AN ANALYSIS OF WORKER NONAVAILABILITY

A Thesis

Presented to the Faculty of the School of Systems and Logistics

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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CHAPTER I

INTRODUCTION AND BACKGROUND

PROBLEM STATEMENT

Recent years have seen a sharp increase in the proportion of the total Air Force budget expended for salaries, retirement benefits, and other manpower costs with the buying power of the Defense budget decreasing. Because of the rising cost of manpower, it is becoming increasingly important that requirements for this valuable resource be correctly determined. Manpower resource requirements determination, one of the primary functions of management, is accomplished throughout the Air Force by the Management Engineering Program (MEP). Within the MEP, an estimate of worker availability is applied throughout requirements determination computations. This available time figure is used as if it were constant for all work centers in the Air Force. The only indication of official awareness that the availability of assigned personnel may vary is the use of separate availability estimates for civilian and military personnel. The authors thought that the assumption of a constant availability factor for

various grades and types of work centers could be invalid. If the assumption were invalid, the result could be a loss of accuracy in the requirements determination and subsequent allocation of manpower authorizations throughout the Air Force.

Additional research indicated that the authors were not alone in being concerned about the use of a constant estimate for available time. Operations research personnel at Air Staff are currently conducting analysis with the objective of constructing a model which will predict worker availability in future time frames.(1) The dramatic rise in cost has made manpower a resource which demands increased management attention to insure that requirements are determined accurately. Factors such as availability estimates must be more precisely determined to preclude degradation of mission capability due to inadequate authorizations and/or over-investment in the manpower resource caused by excessive authorizations.

The following background outlines the impact of rising manpower costs and provides an explanation of factors underlying the need for accuracy in manpower requirements determination.

BACKGROUND

During the period 1964 through 1972, the total expenditures for the Department of Defense rose from $54.5 billion to $75.1 billion.(44853) During this same period,

however, the purchasing power of the defense budget declined.(9:i) The defense budget, when expressed as a percentage of the gross national product, declined from 7.9% in 1964 to 6.8% in 1971 (9:141) and is expected to reach 6.4% in 1973.(35:144) When expressed as a percentage of total federal spending, the decrease is from 44.1% to 30.7%.(9:96) The impact of these percentages on defense planning can be summed up by the opening sentence to the 1972 Department of Defense publication, The Economics of Defense Spending: "National Defense spending for fiscal year (FY) 1973 in dollars of constant buying power will be at the lowest level since FY 1951."(9:i)

Although the total defense budget is decreasing, manpower costs have shown a significant increase, both in terms of constant dollars and as a percentage of the budget. Between 1968 and 1973, pay and related costs increased from 32.6% of the budget to 52.1%.(54:30) During this same period the military force was decreased by 1.2 million men. (9&48) The major cause of the increase in the defense payroll was an attempt to raise military pay to a level commensurate with civilian pay in the private sector.(8:3)

The real significance in the rising cost of manpower is that less money is left for force maintenance and modernization. Senator Dominick (R-Colo.) voiced his concern in Ordnance when he said, "Since more than half of the budget is for manpower, a relatively small amount is left for new equipment and research and development."(27:283)

Senator Byrd (D-Va.) indicated that current procedures must be examined when he said, "Defense manpower is a very expensive resource, and it is incumbent on the DOD to manage it as such."(13) The December, 1972, issue of Fortune pointed out why we must be concerned with the rising cost of military manpower: "...while the forces are being paid better,...they have less capital for investment in the military technologies that alone can make their diminished numbers count for more."(35:142)

There is considerable effort in Congress and in defense procurement agencies to obtain the required weapons to meet the expected threat for the least possible cost. (35:150) This study will; however, investigate the other portion of the security dollar--that of manpower costs.

The data presented to this point merely highlight the effect of past manpower cost increases. There is every indication, however, that the rising trend in manpower costs will continue.(8:4) Competitive levels have now been reached for most military pay grades and it is a matter of law that future pay increases will occur automatically as civilian pay rises.(10:3)

A point often overlooked is the fact that in addition to increases in basic pay, there has been an upward adjustment in basic allowance for quarters, as well as a significant increase in the amount of the reenlistment bonus payment. Another point which is being given current attention is that the significant increases in basic pay

have caused corresponding and proportional increases in the cost of maintaining the retirement system.(10:3) Also, there are continuing attempts to increase the level of reenlistment bonuses, continuation pay for officers, and bonuses and special pay for medical officers, lawyers, and nuclear qualified personnel.(5:4)

The three services have all felt the effects of rising manpower costs; however, a comprehensive study of manpower costs through DOD would be an undertaking quite beyond the scope of this paper. This study will, therefore, be limited to the Air Force where the trend of rising military manpower costs cited earlier holds equally true.

Budgetary pressures are being felt at all levels of the Air Force organization. Maj Gen Bray (Deputy Chief of Staff, Plans and Operations, HQ USAF) emphasizes this when he says, operational managers "...will be constrained in budgets, in personnel, and in hardware..."(2:287) Over the past five years, manpower's share of the Air Force budget has increased at an annual compound rate of approximately five and one-half percent.(3:18) Between 1964 and 1975, the pay and allowances of uniformed Air Force personnel increased from 21.6% to 36.2% of the Air Force budget. During the same period, expenditures for the procurement of aircraft and missiles, prime weapon systems, decreased from 29.3% to 12.3%.(44&53) The significance of the percentages is perhaps more readily seen when a comparison over a longer time period is made. Figure 1-1 shows the

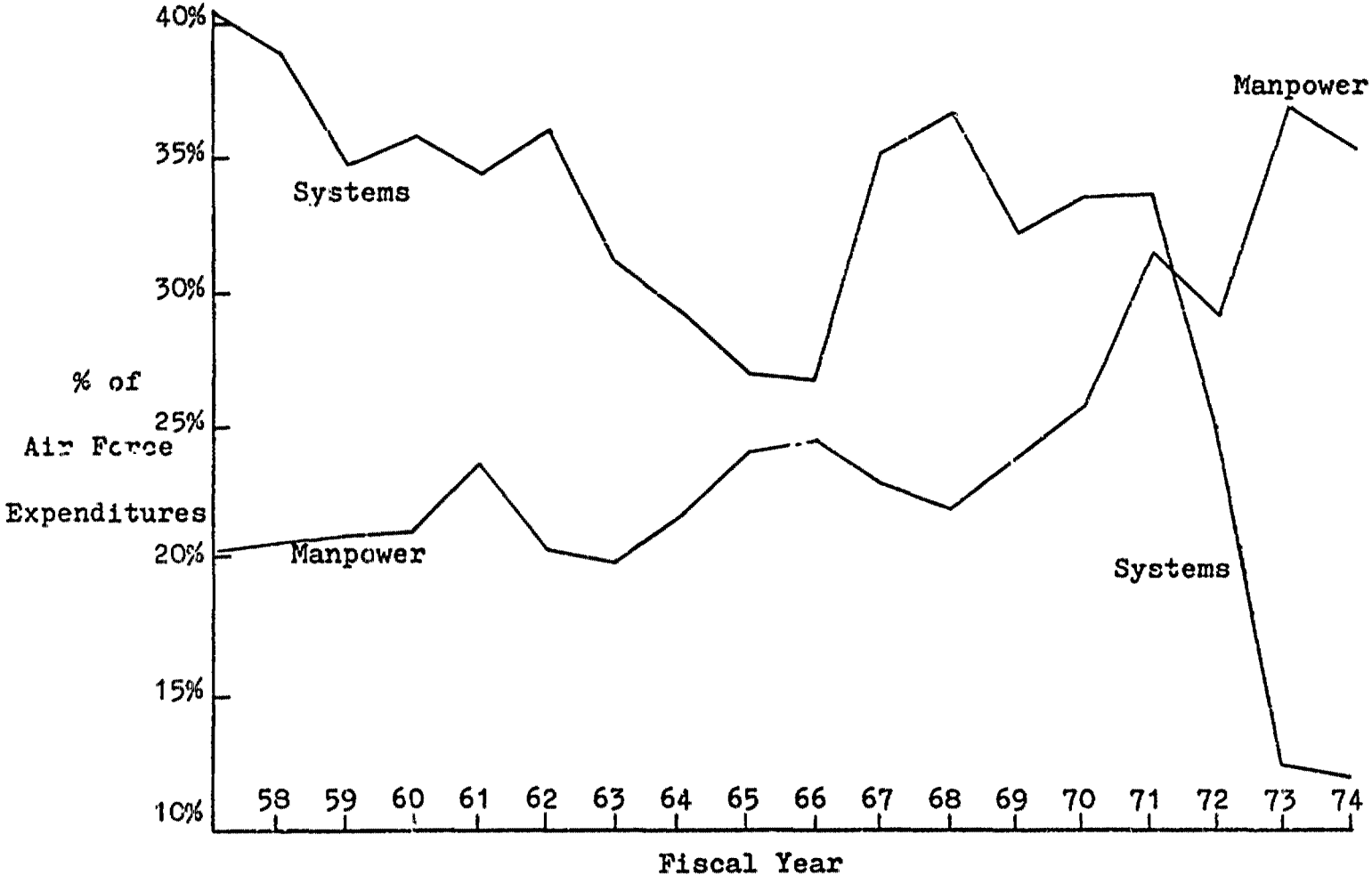

Figure 1-1 AIR FORCE EXPENDITURES FOR MANPOWER AND WEAPONS SYSTEMS

trends in amounts expended for prime Air Force weapon systems and for manpower during the 1957-1974 time frame.* Another way of viewing the increase in Air Force manpower costs is on the basis of average cost per man. This figure has risen from $4031.52 per man per year in 1957 to $10,471.47 in 1974--an increase of 258%.(40-53)

Classical economic theory points out the implications of the rise of manpower costs in the Air Force.

To some extent, the different factors of production engage in mutual and continuous competition. If one factor becomes too costly in terms of its productivity relative to another, a corrective substitution takes place. For example, a sharp rise in wage rates may stimulate the introduction of machines to displace labor. This implies an attempt to combine the factors of production in the most economical way. This discussion, of course, describes occurrences in the private sector, where the motivating force is maximization of profit. The same arguments, however, can be applied to the public sector including the military, since

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*The data depicted in Figure 1-1 were extracted from annual issues of Budget of the United States Government. The graph labeled manpower costs includes uniformed, active duty military personnel pay and allowances; systems costs includes expenditures for aircraft and missiles. All data through fiscal year 1972 reflect actual funds expended. Fiscal years 1973 and 1974 are Office of Management and Budget projections extracted from the same source. It should also be noted that short run trends in manpower cost as a percent of total Air Force expenditures are greatly affected by fluctuations in manning strength. For example, the expected decrease in manpower costs between 1973 and 1974 reflects an expected reduction in force from 692,000 to 666,000.

the long-run objective is the economical combination of the factors of production for any required output. Provision of required output at least cost could be likened to maximizing profit in civilian firms.

The ideal situation, of course, is an economically efficient balance among the factors of production. In the short run, changes to bring the factors into balance are restricted. Cost of the factor may, however, be reduced by increasing efficiency of the factor, thereby requiring less of the input factor to achieve the same level of production. If the factor is manpower being paid at a given rate, the cost of production can be reduced by either reducing the total manpower, increasing efficiency of remaining manpower, or both.

The marginal return of a worker as an additional unit of manpower can be expressed as the ratio of the quantity of output over the cost of the worker.

$$\text{Marginal return} = \frac{\text{Output}}{\text{Cost}}$$

The denominator is the average cost to employ a worker over time and is established by Congress. Thus, Air Force managers can improve marginal return only by increasing the numerator. The quantity of output is a function of both the productivity of available man-hours and the amount of time a worker is available to production. While attention has long been focused on finding better ways of doing work, little consideration has been given to the amount of time

available for productive work versus the amount of time a worker is engaged in activities outside the work center to which he is assigned.(15:6-26) The fact that a worker is not producing in his primary capacity as a member of a functioning work center represents a significant cost which many managers in the Air Force have a tendency to overlook.

The tendency to overlook the cost of nonproductive manpower can be directly related to the financial management system used by the Air Force. Under the system as it operates today, the mission and the approved spending plan for each organization are centrally controlled by functional managers at Major Air Command (MAJCOM) or higher.(6:20-6) Therefore, operational level managers have their resources, including military personnel, actually controlled by others. The operating manager lacks knowledge of what his productive outputs actually cost, and is encouraged to think of his prime resource input--people--as being "free" from an economic standpoint.(6:20-7) The end result is that there is no imposed motivation for managers to focus on effective utilization of this valuable resource.

Operational managers are not involved in the manpower requirements determination process. Management Engineering Teams (MET), assigned to major air command manpower and organization directorates, are responsible for computing manpower requirements throughout the command.(16:1-1)

Within this unusual environment it is imperative that the Air Force manager understand the manpower determination process, and have confidence in the accuracy of the computations. The Management Engineering function has an obligation to the Air Force as a whole to ensure that overall manpower requirements are accurate; additionally, they have an obligation to every work center manager in the Air Force to accurately determine the requirements for each work center.

OBJECTIVES

As previously indicated, the accuracy of manpower authorizations depends upon the accuracy of the factors used in requirements computations. The accuracy of the measurement of nonavailable time has considerable impact on the accuracy of computed manpower requirements. Additionally, if the assumption of constant availability for all grades is incorrect, the accuracy of the manpower requirements will be adversely affected. Consequently, the objectives of this thesis are the assessment of:
1) errors in manpower standards caused by the constant estimates currently used for man-hour availability, and
2) the effect upon authorizations caused by errors in availability estimates. The authors feel that the thesis objectives can be adequately achieved by answering the following research questions:

(1) Are all Air Force personnel homogeneous

(i.e. are not significantly different) with respect to the time available for primary duty?

(2) Are all Air Force civilian employees homogeneous with respect to the time available for primary duty?

(3) Is the available time measured during Management Engineering Studies significantly different from the available time determined by other methods?

(4) To what degree will an error in the determination of available time affect manpower standards?

(5) Are manpower authorizations affected by errors in the manpower standards?

CHAPTER II

METHODOLOGY

This chapter consists of three parts. The first will cover the quantitative data collection and will include the detailed collection procedures, as well as the preliminary computations required to reduce the data to a useful form. Part two will include the qualitative data collection methodology and the qualitative analysis procedures required to accomplish the objectives. Part three will consist of the quantitative analysis procedures required to accomplish research questions one through four.

PART ONE: QUANTITATIVE DATA COLLECTION PROCEDURES

Four separate data sets were collected. Each data set will be covered separately.

Civilian Availability Study

Headquarters Air Force is currently conducting a study to determine if the on-the-job availability of civilian employees of the Air Force is significantly different from the current estimate of 149 hours per month. The Wright-Patterson AFB MET team granted the authors access to the available data collected for this study. This data

included two documents. The first was a command summary of data collected at six installations: Hill Air Force Base, Kelly Air Force Base, McClellan Air Force Base, Robins Air Force Base, Tinker Air Force Base and Newark Air Force Station. This summary was compiled from inputs collected by Management Engineering personnel located at each of the six locations. The collection method was directed by Headquarters AFLC Management Engineering Division and was the same for all installations.(25)

The second document was the complete data set from the Wright-Patterson Air Force Base portion of the study. This document contained data from 1723 civilian timecards randomly selected from a cross section of 27 pay periods. Each timecard covered a two week, 80 hour period. The categories of time collected were: regular hours, overtime hours, annual leave, sick leave, leave without pay, absent without pay, and special absences. The data was aggregated by Management Engineering Team personnel in an attempt to determine the average availability for all civilians at Wright-Patterson Air Force Base.

Two additional characteristics of both documents are of special significance. First, an additive was included in the computations for all installations in the form of an estimate for the number of hours the average civilian devotes monthly to training. This figure was provided by civilian personnel. Secondly, the analysts conducting the study did not compute the variance of the

estimate of monthly available time; consequently, a statistical confidence interval for the available time estimate could not be constructed. The AFIC Command summary is included as Appendix A.

Civilian Timecard Data

The authors collected data similar to the civilian availability study with some notable exceptions. Civilians at Wright-Patterson Air Force Base were randomly selected and six months data was extracted from their timecards. Categories of data for each individual were: regular hours, leave, sick leave, leave without pay, absent without leave, holidays, and special absences. Each entry for each individual was checked to insure that the timecard totaled 80 hours. If the entry did not total 80 hours, records maintenance personnel explained the discrepancy. After the data was collected, each category was totaled for each individual. The holiday hours were subtracted from the total to give the assigned hours. The categories of annual leave, sick leave, leave without pay, absent without leave, and special absences were added for each individual and divided by the assigned hours to give the proportion of nonavailable time. This figure was then multiplied by 168 assigned hours to give the nonavailable hours per month:

$$\frac{\text{nonavailable hours}}{\text{assigned hours}} \times 168 \text{ assigned hours/month} = \text{nonavailable hours/month}$$

Additional data for the selected individuals were

extracted from their personnel records. Date of birth, total active federal service date, sex, and pay grade were recorded. (Of the 232 in the original sample, personal data on 26 could not be collected due to the duplication of last name and initial.) The date of birth was converted to "age" by subtracting the year of birth from 73. The total active federal service date was translated into years of service in a like manner.

In order to rank all individuals on a single pay grade scale it was necessary to convert hourly wage grades into GS equivalents. The civilian personnel office has a standard procedure for this conversion. Their procedure was employed as follows: using a pay scale of all steps of civilian grades, the hourly wage scale for the first shift was converted into an annual salary by multiplying by 2080:

$$\frac{\$}{\text{hour}} \times \frac{2080 \text{ hours}}{\text{year}} = \$/\text{year}$$

This amount was compared with the fourth step of the General Schedule pay scale. The conversion was to the GS pay grade with the closest annual salary, maintaining integer pay grades. The completed data set was in the following format:

Nonavailable Time Sex Age Years Service Pay Grade

Data From Air Force Survey

The Air Force has recently revised the availability estimate for military personnel from 142 to 144 hours. The

major source of data for this change was part three of the annual Air Force Survey dated July, 1973. Headquarters Air Force provided the responses to this section of the survey. The data was in the form of an unweighted frequency distribution of each response for each rank from E-1 through O-6. The applicable questions from the Air Force Survey and an example of the data received are contained in Appendix B.

Reduction of the data to usable form required the translation of question responses into times. Each response was either a range of hours or a range of days. The value of each response was taken as the midpoint of the range. For the questions which were expressed in hours, the translation into hours lost to production was direct. Responses of whole days, e.g. leave and R&R, included weekends and holidays. Therefore, the following procedure was used to convert these responses into hours lost to production.

$$\frac{365 \text{ days}}{\text{year}} - \frac{102 \text{ weekend days}}{\text{year}} - \frac{9 \text{ holidays}}{\text{year}} = 254 \text{ workdays/year}$$

$$\frac{254 \text{ workdays/year} \times 8 \text{ hours/workday}}{365 \text{ days/year}} = 5.567 \text{ hours/day}$$

This indicates that one day of leave or R&R is equivalent to an average of 5.567 hours lost to production. Therefore, all responses in days were multiplied by this factor. The hourly values were then divided by 12 to convert to monthly hours.

The authors determined the mean and variance for each rank and question as follows. The mean was computed by summing the products of the hourly response values and

the unweighted frequencies, then dividing the sum by the number of respondents of that grade. Variance was computed using the unbiased estimator of the sum of deviations squared divided by the number in the sample minus one. The mean and variance for each question and rank are included in Appendix B.

Work Sampling Data

One of three methods used in the data measurement phase of Management Engineering standards is work sampling. In this procedure the proportion of assigned time a worker spends in various categories is actually measured by observation. One category measured during all work sampling studies is nonavailable time. The definition of nonavailable time used by work sampling technicians is the same definition used by the analysts who determine the estimate of availability.(16:A2-4)

The authors were granted access to the work sampling studies on file at Headquarters AFLC. The data included studies of 128 work centers from seven different Air Force installations. Nonavailable time was expressed as a proportion of the total hours measured. The proportion of nonavailable time was multiplied by 168 hours to obtain the average nonavailable time per man for each work center. For ease of analysis the data was manually grouped by base of origin. The grouped data is included in Appendix C.

Due to the nature of the confidentiality of indi-

vidual identities in work sampling studies, the names, ranks and any other data that might conceivably be used to identify individuals are not retained in Management Engineering backup data and, therefore, were not available to the authors.

PART TWO: QUALITATIVE DATA COLLECTION

The gathering of qualitative data concerning manpower determination/authorization was conducted with the aim of providing an understandable explanation of the flow from manpower standards development, through programming, to allocation of authorizations. Particular emphasis was applied to the interface between MEP units, Major Air Command (MAJCOM), and HQ USAF in the manpower determination and programming processes, and to the interface between HQ USAF, MAJCOM, and units in the authorization allocation process.

The first step in the data gathering process was a review and consolidation of existing information in Air Force directives concerning manpower determination, programming and the authorization allocation processes. The authors found that many directives contained information pertinent to one or more aspects of the combined process due to the extensive number of interfaces between various levels of command and functional areas. The explanation of the processes in Chapter IV is an attempt to identify interfaces and clarify relationships.

Upon completion of the directive review, the authors conducted interviews with base level MEP, MAJCOM MEP and Manpower and Organization personnel to clarify the base/ MAJCOM relationships in the determination/allocation process. Personnel possessing recent experience with the Air Staff were interviewed to determine the relationships between MAJCOM and Air Staff level and pertinent actions at HQ USAF level. Appendix D provides a listing of personnel interviewed. Information was also obtained from HQ USAF concerning current manpower procedures.

PART THREE: QUANTITATIVE ANALYSIS PROCEDURES

In analysis based on statistical sampling procedures there is a possibility that the conclusions are in error. The probability of faulty conclusions; however, can be computed and an acceptable level established. The maximum acceptable probability of incorrectly rejecting a true statistical hypothesis is what is referred to as the level of significance.(38:8) The significance level is 5% for all statistical tests in this thesis.

Research Question 1--The data collected through the Air Force Survey was used to answer this research question. To avoid possible confusion the following explanation will be for one pay grade. Identical analyses were conducted on each of 15 pay grades, on the total sample of officers, and on the entire sample of airmen.

The survey included 21 questions concerning activities which contribute to nonavailable time. Taking

each pay grade separately, the average response for each question was computed. The average for each question can be considered as a statistical variable. The sum of the averages of any number of variables gives the expected value of the sum.(29:217) Therefore, the total nonavailable time measured by the survey is the summation of the average response for all questions.

To construct a statistical confidence interval around the nonavailable time estimate, the variance must be computed. The sum of variances for a number of variables, however, is not the variance of the sum unless the covariance is zero. The variance of the sum of any two variables X and Y can be expressed as:

$$V(X+Y) = V(X) + V(Y) - Cov(X,Y)$$

The equation for determination of the correlation coefficient is:

$$Cov(X,Y)/(V(X))^{\frac{1}{2}} \cdot (V(Y))^{\frac{1}{2}} \qquad (30:7)$$

The variances of X and Y are squared terms and are always positive. This indicates that the sign of the covariance is the sign of the correlation coefficient. An analysis of all questions was conducted by the authors, and no logical argument could be presented to support a negative correlation between any two questions. Therefore, the assumption was made that the covariance is nonnegative. If the responses to each question are independent, the covariance is zero and the variance of the sum is the sum of the variances. If the responses are correlated in a positive

manner the sum of the variances will be higher than the true variance of the sum. A confidence interval computed using this estimate for the variance will be conservatively wide.

The mean and variance determined by summing means and variances for each question were used to construct a 95% confidence interval as follows:

$$CI = \bar{X} \pm 1.96\left(\frac{V(X)}{N}\right)^{\frac{1}{2}} \qquad (29:379)$$

For this computation to be valid, either the original data must be normally distributed or the size of each sample must be large enough for the central limit theorem to apply. There is no reason to assume nonavailable time follows a normal distribution, but the sample size for each pay grade, except warrant officers, is well beyond 25, which is the minimum value generally accepted for application of the central limit theorem.(29:288)

There were only 12 warrant officers in an officer sample of over 7000. Warrant officers make up less than two tenths of one percent of the officer population of the Air Force. Their impact was considered to be negligible and they were not considered in answering research question one.

The final step was to compare the 95% confidence intervals for the estimates of nonavailability due to the activities covered by the survey. If the confidence intervals for two ranks were mutually exclusive, then the

two ranks were considered to be heterogeneous with regard to nonavailable time.

A test was also conducted to determine if there is a significant dependent relationship between rank and nonavailable time. Linear regression analysis was conducted first on the sample of officers then on the sample of airmen to determine the possible relationship between rank and nonavailable time. A statistical hypothesis test was employed to test the hypothesis that the correlation coefficient was zero. The expression $r(\frac{n-2}{1-r^2})^{\frac{1}{2}}$, where r is the coefficient of determination, follows Student's t distribution with n-2 degrees of freedom. If the probability that t_{n-2} is greater than $r(\frac{n-2}{1-r^2})^{\frac{1}{2}}$ is less than the level of significance the hypothesis can be rejected. If the hypothesis is rejected, the conclusion is that nonavailable time and rank are statistically dependent. A conclusion of dependence is sufficient to reject homogeneity.

Research Question 2--Data from the civilian manpower availability study and the data collected by the authors from civilian timecards were used to answer this research question.

The nonavailable time measurement from the civilian timecards, as mentioned earlier, was collated by sex, pay grade, age, and length of service. The first analysis was on a possible difference between men and women employees with regard to nonavailability. A 95% confidence interval

was constructed for the sample of males and another for the sample of females. Both samples were large enough for application of the central limit theorem. The two confidence intervals were then compared for mutual exclusiveness.

The analysis to determine a significant difference between pay grades was accomplished almost identically to the procedure outlined for research question one. Each data point was the total monthly nonavailable time average for an individual. There was no requirement to sum categories and; hence, no requirement for the assumption of nonnegativity of covariance.

The analysis of a significant difference due to age or length of service centered around the hypothesis test of a zero correlation. If the hypothesis could be rejected, a significant dependent relationship existed which indicated an absence of homogeneity.

Research Question 3--The data from the MET work sampling studies were used to answer this research question. The mean available time and variance was computed. It should be noted that the data points were for work centers, not for individuals. The authors had no way to determine the proportion of civilians and military personnel assigned to each of the work centers. Additionally, analysis by individual traits such as rank, age, et cetera, could not be conducted. This data is also unique in that it is the only measurement of availability that is conducted through

actual observation.

The current estimate of military availability is 144 hours per month. The current study of civilian availability has estimated that the average availability for AFLC is 140.35 hours per month. Application of the central limit theorem allows the sampling distribution to be considered as a normal distribution. Using the sampling distribution, the authors computed the probability of a deviation from the sample mean ($\bar{X}$) as severe or more severe than the difference between $\bar{X}$ and 144 or the difference between $\bar{X}$ and 140.35. The level of significance was set at 5%.

Research Question 4--The data from the civilian timecards was used to answer this research question.

The authors constructed a simple computer simulation model which simulates the conversion of measured man-hours into the number of required people. The inputs to the program are the size of the work center and the availability. The monthly allowed hours are divided by the monthly availability per person to determine the required number of hours. The number of allowed hours is determined by actual measurement of productive hours extrapolated to a monthly basis.(16:6-3.b.(5)) The assumption of the simulation model is that the allowed man-hours are equal to the available man-hours. Another way to state the assumption is that during the work measurement study, practical utilization of available

workers was 100%. That is to say, the work center required the exact number of personnel assigned. The simulation makes random draws from a distribution of available time to build a random work center. The distribution used by the authors was constructed using the data from the civilian timecards. While it is realized that this distribution may not be appropriate for the entire Air Force, it is the best estimate of the shape of the distribution of monthly availability.

For a given size work center and availability estimate, the model simulates the resultant manning for 1000 work centers. A frequency distribution of the average number of required workers is computed for each work center size.

Two variations of the model were used. The first used the fractional man rule applicable to civilian work centers while the other used the 7.7% rule for military work centers. The simulation included work centers from size 1 to 25 and was repeated with 5 estimates of availability; the true mean of the distribution, 5% above and below the mean, and 10% above and below the mean.

CHAPTER III

ANALYSIS OF NONAVAILABLE TIME ESTIMATE

This chapter covers three major points. The first is the analysis of the hypothesis of a homogeneous work force with respect to nonavailable time. The second is an analysis of the current measurement of worker availability and the third, the effect of a biased estimate of nonavailable time on work center requirements determination.

HOMOGENEITY OF WORKER AVAILABILITY

The Air Force Management Engineering Program recognizes heterogeneity between civilian and military employees. However, all personnel within each of these broad classifications are treated as if they were homogeneous.(16) If each of these groups is truly homogeneous with respect to availability, then the measured available time is a statistical independent variable for the population of that group. If it can be shown that a significant difference exists between the availability of different samples from the same population, or if it can be shown that availability has a dependent relationship with some other variable, the hypothesis of homogeneity can be rejected.

The computational accuracy of Management Engineering work center manning standards is dependent upon the assumption of worker homogeneity with respect to nonavailable time. Therefore, rejection of the hypothesis of homogeneity would indicate that manpower standards are in error.

Homogeneity of Military Workers

A 95% confidence interval of the estimate of nonavailable time measured by the Air Force Survey was computed for the sample of 7502 officers and for the sample of 20,320 airmen. The central limit theorem indicates that a distribution of sample means approaches a normal distribution as the sample size becomes large.(29:288) Application of the central limit theorem allows the assumption of normality and the computation of the 95% confidence interval of the estimate of the mean becomes the sample mean $\pm$1.96 standard deviations. The results of the computations are as follows:

	Sample Mean	Sample Variance	Sample Size	Variance of Sampling Distribution	Std Dev of Sampling Distribution
Officers	17.5139	41.2770	7,502	.0055	.0742
Airmen	15.7975	44.3059	20,320	.0022	.0469

95% Confidence Interval

Officers	17.3685	to	17.6593
Airmen	15.7056	to	15.8894

The upper limit of the confidence interval for airmen is below the lower confidence limit for officers; therefore,

the data indicates that nonavailable time of Air Force officers and nonavailable time of airmen does not come from the same population.

The hypothesis was modified to determine if the population of officers is homogeneous with respect to non-available time. Ninety-five percent confidence intervals for each rank were computed as follows:

Rank	Sample Mean	Sample Variance	Sample Size	Variance of Sampling Distribution	Std Dev of Sampling Distribution
Col	18.7017	45.7380	457	.1001	.3164
LtCol	19.0422	37.1908	1000	.0372	.1929
Maj	18.4354	39.1866	1515	.0259	.1609
Capt	17.6263	38.9758	2840	.0137	.1170
1Lt	16.6781	40.2433	950	.0424	.2059
2Lt	13.4399	30.2353	740	.0409	.2022

95% Confidence Interval

Col	18.0816	to	19.3218
LtCol	18.6641	to	19.4203
Maj	18.1200	to	18.7508
Capt	17.3970	to	17.8556
1Lt	16.2745	to	17.0817
2Lt	13.0436	to	13.8362

The confidence intervals are graphically displayed in Figure 3-1 on the following page. The data indicates the nonavailable times for grades of major through colonel are not significantly different. However, the confidence intervals for 1st lieutenants, 2nd lieutenants, and captains do not overlap with those of any other officer grade. The hypothesis of homogeneity can therefore be rejected and

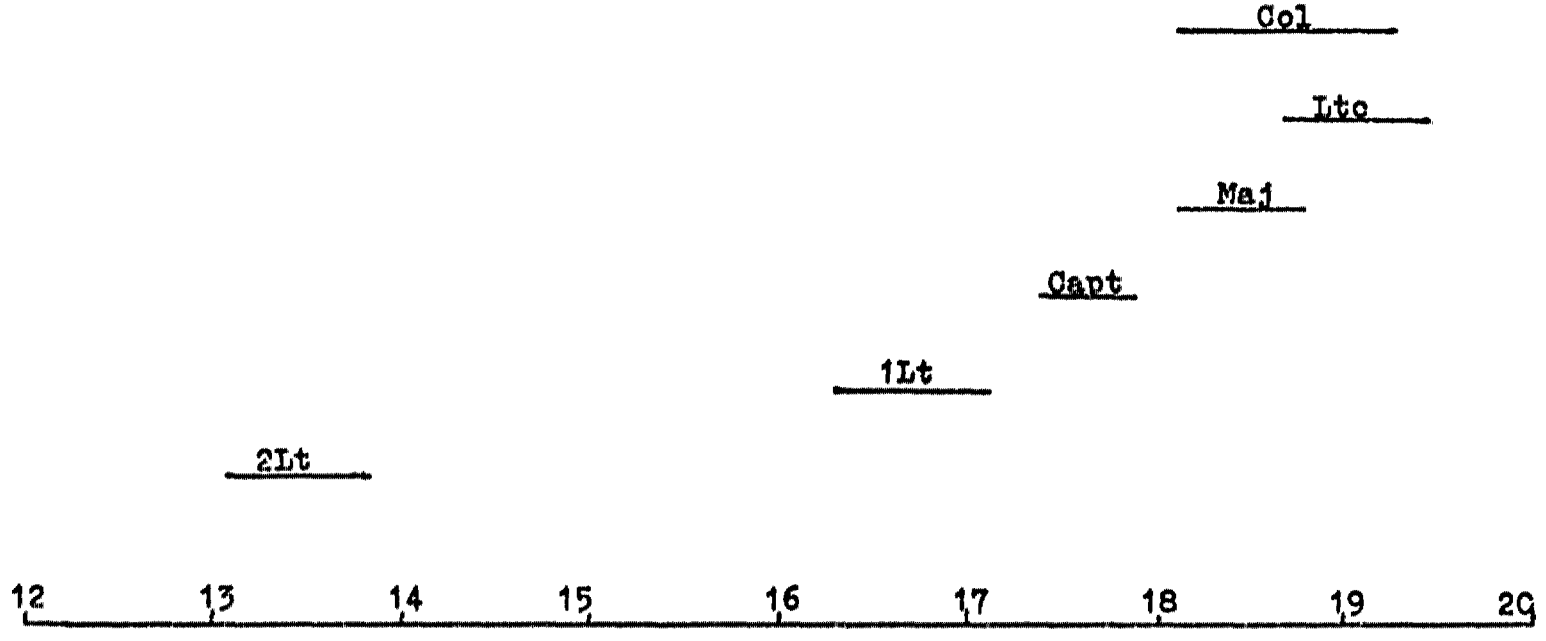

Figure 3-1 CONFIDENCE INTERVALS OF OFFICER NONAVAILABILITY

the conclusion reached that nonavailable time is not a homogeneous variable for all Air Force officers.

This conclusion is supported by the analysis to determine if a dependent relationship exists between rank and nonavailable time for Air Force officers. The statistical hypothesis is that the linear correlation coefficient of officer grade and nonavailable time is zero.

X = Officer grade;

2Lt, X = 1

1Lt, X = 2

Capt, X = 3

Maj, X = 4

LtCol, X = 5

Col, X = 6 N = 6

Y = average nonavailable hours measured by the Air Force Survey.

X	Y	X^2	Y^2	XY	
1	13.4399	1	180.6309	13.4399	
2	16.6781	4	278.1590	33.3562	
3	17.6263	9	310.6865	52.8789	
4	18.4354	16	339.8640	73.7416	
5	19.0422	25	362.6054	95.2110	
6	18.7017	36	349.7536	112.2102	
21	103.9236	91	1821.6993	380.8378	Sum

$$b = \frac{N*Sum(XY)-Sum(X)*Sum(Y)}{N*Sum(X^2)-Sum(X)^2}$$

$$= ((6)(380.8378)-(21)(103.9236))/((6)(91)-21^2)$$

$$= (2285.0268-2182.3956)/(546-441)$$

$$= 102.6312/105 = .977$$

$a = (\text{Sum}(Y)-b\cdot\text{Sum}(X))/N$

$= (103.9236-(.977)(21))/6$

$= 13.9011$

$\text{Total variation} = (N\cdot\text{Sum}(Y^2)-\text{Sum}(Y)^2)/N$

$= ((6)(1821.6993)-103.9236^2)/6$

$= (10{,}930.195-10{,}800.114)/6$

$= 130.081/6 = 21.680$

$\text{Explained variation} = a\cdot\text{Sum}(Y)+b\ \text{Sum}(XY)-\text{Sum}(Y)^2/N$

$= (13.9011)(103.9236)+(.977)(380.8378)-10{,}800.114/6$

$= 1444.6523 + 372.0785 - 1800.019$

$= 16.7118$

$\text{Coefficient of Determination} = \frac{\text{Explained Variation}}{\text{Total Variation}} = r^2$

$= 16.7118/21.680$

$= .7708$

Coefficient of Correlation = $r = .878$

H_o: Zero correlation

H_1: Correlation not zero, Significance level = .05

If H_o is true, $r((N-2)/(1-r^2))^{\frac{1}{2}}$ follows Student's t distribution with N-2 degrees of freedom.

$r((N-2)/(1-r^2))^{\frac{1}{2}} = .878(4/.2292)^{\frac{1}{2}}$

$= (.878)(17.452)^{\frac{1}{2}}$

$= 3.668$ (31)

The probability that t_4 is greater than 2.776 is less than the significance level of .05. Therefore, the hypothesis can be rejected.(31)

The data indicates a significant dependent relationship between grade and nonavailable time for Air Force

officers.

A similar hypothesis was applied to determine if the population of enlisted personnel were homogeneous with respect to nonavailable time. Ninety-five percent confidence intervals for each rank were computed as follows:

Rank	Sample Mean	Sample Variance	Sample Size	Variance of Sampling Distribution	Std Dev of Sampling Distribution
E9	17.1210	38.4229	254	.1513	.3890
E7	16.3440	36.6403	1603	.0229	.1513
E6	15.8104	39.4658	3057	.0129	.1136
E5	15.8421	44.4808	4809	.0092	.0959
E4	16.6356	51.0688	5110	.0100	.1000
E3	15.6337	42.4371	3354	.0127	.1127
E2	12.7734	33.2348	1408	.0236	.1536
E1	10.3317	22.4978	639	.0352	.1876

	95% Confidence Interval		
E9	16.3586	to	17.8834
E7	16.0475	to	16.6405
E6	15.5877	to	16.0331
E5	15.6541	to	16.0301
E4	16.4396	to	16.8316
E3	15.4128	to	15.8546
E2	12.4723	to	13.0745
E1	9.9640	to	10.6994

The confidence intervals were plotted as shown in Figure 3-2 on the following page. The data indicates that the nonavailable time for grades within the category containing E3s, E5s, and E6s and those within the category containing E4s, E7s, and E9s are not significantly different. The two categories; however, are exclusive. The

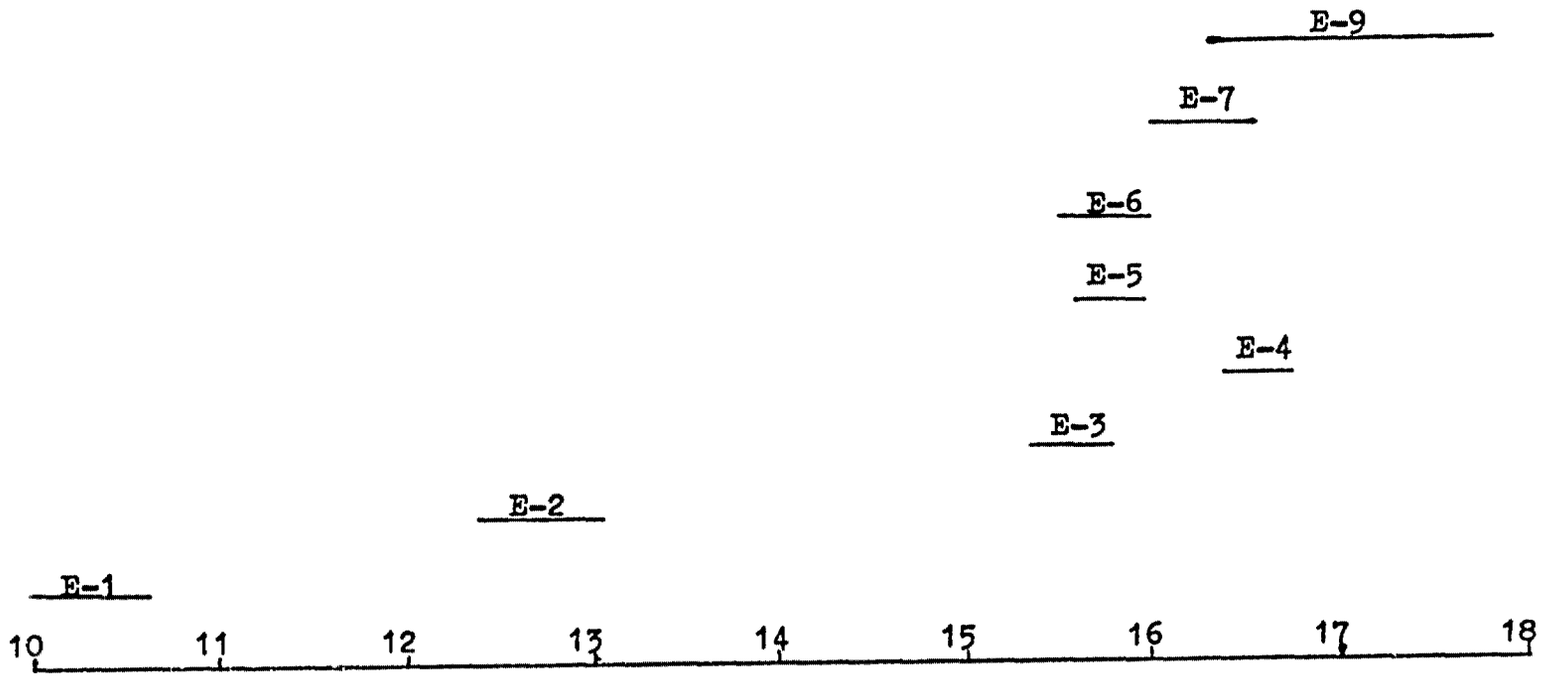

Figure 3-2 CONFIDENCE INTERVALS OF AIRMAN NONAVAILABILITY

confidence intervals for E1s and E2s do not overlap any other confidence intervals. The hypothesis of homogeneity can, therefore, be rejected, resulting in the conclusion that Air Force enlisted personnel are not homogeneous with respect to nonavailable time.

The conclusion is supported by the following regression analysis to determine if a dependent relationship exists between rank and nonavailable time for Air Force enlisted personnel. The statistical hypothesis tested is that the linear correlation coefficient of enlisted grades and nonavailable time is zero.

X = enlisted grade

E1, X = 1
E2, X = 2
E3, X = 3
E4, X = 4
E5, X = 5
E6, X = 6
E7, X = 7
E9, X = 9 N = 8

Y = average nonavailable hours measured by the Air Force Survey.

X	Y	X^2	Y^2	XY	
1	10.3317	1	106.7440	10.3317	
2	12.7734	4	163.1597	25.5468	
3	15.6337	9	244.4126	46.9011	
4	16.6356	16	276.7432	66.5424	
5	15.8421	25	250.9721	79.2105	
6	15.8104	36	249.9687	94.8624	
7	16.3440	49	267.1263	114.4080	
9	17.1210	81	293.1286	154.0890	
37	120.4919	221	1852.2552	591.8919	Sum

$$b = \frac{N \cdot Sum(XY) - Sum(X) \cdot Sum(Y)}{N \cdot Sum(X^2) - Sum(X)^2}$$

$= ((8)(591.8919) - (37)(120.4919))/((8)(221) - 37^2)$

$= (4735.1352 - 4458.2003)/(1768 - 1369)$

$= 276.9349/399$

$= .694$

$a = (Sum(Y) - b \cdot Sum(X))/N$

$= (120.4919 - (.694)(37)/8$

$= 11.8517$

Total Variation $= (N \cdot Sum(Y^2) - Sum(Y)^2)/N$

$= ((8)(1852.2552) - 120.4919^2)/8$

$= (14,818.041 - 14,518.297)/8$

$= 37.468$

Explained variation $= a \cdot Sum(Y) + b \cdot Sum(XY) - Sum(Y)^2/N$

$= (11.8517)(120.4919) + (.694)(591.8919) - 14,518.297/8$

$= 1428.0338 + 410.7730 - 1814.7871$

$= 24.0197$

Coefficient of Determination $= \frac{\text{Explained Variation}}{\text{Total Variation}} = r^2$

$= 24.0197/37.468$

$= .6411$

Coefficient of Correlation $= r = .801$

H_0: Zero correlation

H_1: Correlation no zero, Significance level = .05

If H_0 is true, $r((N-2)/(1-r^2))^{\frac{1}{2}}$ follows Student's t distribution with N-2 degrees of freedom.

$r((N-2)/(1-r^2))^{\frac{1}{2}} = .801(6/.3666)^{\frac{1}{2}}$

$= (.801)(16.3666)^{\frac{1}{2}}$

$$r((N-2)/(1-r^2))^{\frac{1}{2}} = 3.240 \qquad (31)$$

The probability that t_6 is greater than 2.447 is less than .05. (31) Therefore, the hypothesis can be rejected at a significance level of .05.

The data indicates a significant dependent relationship between grade and nonavailable time for Air Force enlisted personnel.

Summary

The data indicates a significant difference between the population of nonavailable time for Air Force officers and the population of nonavailable time for airmen. The data also indicates that populations of nonavailable time for military grades are significantly different. The data further indicates a significant dependent relationship between military rank and nonavailable time. The hypothesis of a homogeneous population of nonavailable time for Air Force military personnel can therefore be rejected which supports the contention that manpower standards for military work centers are in error.

Homogeneity of Air Force Civilian Employees

The mean and standard deviation of the population of nonavailable time for civilian employees at Wright-Patterson Air Force Base was estimated through a sample of civilian timecards. The sample mean was 19.1802 hours and the sample standard deviation was 22.9235 hours. The data was analyzed to investigate possible significant

differences due to sex and pay grade. Tests were then conducted to determine if a significant dependent relationship exists between nonavailable time and pay grade, longevity, or age. The data was arranged as follows to determine if a significant difference due to sex of worker exists.

	Sample Mean	Sample Size	Standard Deviation of Sampling Distribution
Females	21.1911	56	3.0632
Males	18.3389	147	1.8907

Application of the central limit theorem to the sampling distribution allows the computation of the probability of a deviation as extreme or more extreme than actually occurred. For males the deviation is:

$$\frac{X-\bar{X}}{\text{std dev}} = \frac{18.3389 - 19.1802}{1.8907} = -.4450$$

Prob($\bar{X}$ less than -.4450) = .33

There is no significant difference between the mean of all civilians measured and the mean of the sample of males. For females the deviation is:

$$\frac{21.1911 - 19.1802}{3.0632} = .656$$

Prob($\bar{X}$ greater .656) = .2546

A significant difference between the mean of all civilians measured and the mean of the sample of females cannot be established at the 5% level. A similar analysis to determine a significant difference due to pay grade also proved inconclusive at the 5% level.

The following is an analysis to determine if a significant dependent relationship exists between pay grade

and nonavailable time for Air Force civilian personnel. The statistical hypothesis tested is that the linear correlation coefficient of civilian personnel pay grade and nonavailable time is zero.

X = civilian pay grade

Y = nonavailable hours per individual

N = 203

Sum X	Sum X^2	Sum Y	Sum Y^2	Sum XY
1921	20,765	3882.5182	105,761.58	35,406.364

$$b = \frac{N \cdot \text{Sum}(XY) - \text{Sum}(X) \cdot \text{Sum}(Y)}{N \cdot \text{Sum}(X^2) - \text{Sum}(X)^2}$$

$$= \frac{(203)(35,406.364) - (1921)(3882.5182)}{(203)(20,765) - 1921^2}$$

$$= (7,187,491.8 - 7,458,317.4)/(4,215,295 - 3,690,241)$$

$$= -270,825.6/525,054$$

$$= -.5158$$

$$a = (\text{Sum}(Y) - b \cdot \text{Sum}(X))/N$$

$$= (3882.5182 - (-.5158)(1921))/203$$

$$= (3882.5182 + 990.8518)/203$$

$$= 24.0067$$

$$\text{Total variation} = (N \cdot \text{Sum}(Y^2) - \text{Sum}(Y)^2)/N$$

$$= ((203)(105,761.58) - 3882.5182)^2/203$$

$$= 21,469,600 - 15,073,947/203$$

$$= 31,505.679$$

$$\text{Explained variation} = a \cdot \text{Sum}(Y) + b \cdot \text{Sum}(XY) - \text{Sum } Y^2/N$$

$$= (24.0067)(3882.5182) +$$

$$(-.5158)(35,406.364) - 3882.5182^2/203$$

Explained variation = 93,206.449 - 18,262.602 - 74,255.896

= 687.951

Coefficient of Determination = $\frac{\text{Explained variation}}{\text{Total variation}} = r^2$

= 687.951/31,505.679

$r^2 = .0218$

Coefficient of correlation = r = -.1477

H_o: Zero correlation

H_1: Correlation not zero, Significance level = .05

If H_o is true, $r((N-2)/(1-r^2))^{\frac{1}{2}}$ follows Student's t distribution with N-2 degrees of freedom.

$r((N-2)/(1-r^2))^{\frac{1}{2}} = (-.1477)(201/.9782)^{\frac{1}{2}}$

$= (-.1477)(205.4794)^{\frac{1}{2}}$

$= -2.1172$

The probability that t_{201} is less than -1.97, is less than .05. Therefore, the hypothesis can be rejected at a significance level of .05.

The data indicates a significant dependent relationship between pay grade and nonavailable time for Air Force civilian personnel.

The following is an analysis to determine if a significant dependent relationship exists between worker age and nonavailable time for Air Force civilian personnel. The statistical hypothesis tested is that the linear correlation coefficient of civilian personnel age and nonavailable time is zero.

X = civilian worker age

Y = nonavailable hours per individual worker

N = 203

Sum X	Sum X^2	Sum Y	Sum Y^2	Sum XY
8736	400,024	3882.5182	105,761.58	170,422.95

$$b = \frac{N \cdot \text{Sum}(XY) - \text{Sum}(X) \cdot \text{Sum}(Y)}{N \cdot \text{Sum}(X^2) - \text{Sum}(X)^2}$$

$$= \frac{(203)(170,422.95) - (8736)(3882.5182)}{(203)(400,024) - 8736^2}$$

$$= (34,595,858 - 33,917,678)/(8,120,487.2 - 76,317,696)$$

$$= 678,180/4,887,176$$

$$b = .1388$$

$$a = (\text{Sum}(Y) - b \cdot \text{Sum}(X))/N$$

$$= (3882.5182 - (.1388)(8736))/203$$

$$a = 13.1539$$

$$\text{Total variation} = (N \cdot \text{Sum}(Y^2) - \text{Sum}(Y)^2)/N$$

$$= ((203)(105,761.58) - 3882.5182^2)/203$$

$$= (21,469,600 - 15,073,947)/203$$

$$= 31,505.679$$

$$\text{Explained variation} = a \cdot \text{Sum}(Y) + b \cdot \text{Sum}(XY) - (\text{Sum}(Y))^2/N$$

$$= (13.1539)(3882.5182) + (.1388)(170,422.95) - 3882.5182^2/203$$

$$= 51,070.256 + 23,654.705 - 74,255.896$$

$$= 469.065$$

$$\text{Coefficient of Determination} = \frac{\text{Explained variation}}{\text{Total variation}} = r^2$$

$$= 496.065/31,505.679$$

$$r^2 = .0149$$

$$\text{Coefficient of correlation} = r = .1221$$

H_0: Zero correlation

H_1: Correlation not zero, Significance level = .05

If H_0 is true, $r((N-2)/(1-r^2))^{\frac{1}{2}}$ follows Student's t distribution with N-2 degrees of freedom.

$$r((N-2)/(1-r^2))^{\frac{1}{2}} = (.1221)(201/.9851)^{\frac{1}{2}}$$
$$= (.1221)(14.2843)$$
$$= 1.7441$$

The probability that t_{201} is greater than 1.97, is not less than .05. Therefore, the hypothesis cannot be rejected at a significance level of .05.

The data indicates no significant dependent relationship between worker age and nonavailable time for Air Force civilian personnel.

The following is an analysis to determine if a significant dependent relationship exists between worker length of service and nonavailable time for Air Force civilian personnel. The statistical hypothesis tested is that the linear correlation coefficient of civilian employee length of service and nonavailable time is zero.

X = civilian worker length of service

Y = nonavailable hours per individual worker

N = 203

Sum X	Sum Y	Sum X^2	Sum Y^2	Sum XY
3618	3882.5182	81,960	105,761.58	73,975.391

$$b = \frac{N \cdot Sum(XY) - Sum(X) \cdot Sum(Y)}{N \cdot Sum(X^2) - Sum(X)^2}$$

$$b = \frac{(203)(73,975.391) - (3618)(3882.5182)}{(203)(81,960) - 3618^2}$$

$$= (15,017,004 - 14,046,950)/(16,637,880 - 13,089,924)$$

$$= 970,054/3,547,956$$

$$b = .2734$$

$$a = (\text{Sum}(Y) - b*\text{Sum}(X))/N$$

$$= (3882.5182 - (.2734)(3618))/203$$

$$= 14.253$$

$$\text{Total variation} = (N*\text{Sum}(Y^2) - \text{Sum}(Y)^2)/N$$

$$= ((203)(105,761.58) - 3882.5182^2)/203$$

$$= (21,469,600 - 15,073,947)/203$$

$$= 31,505.679$$

$$\text{Explained variation} = a*\text{Sum}(Y) + b*\text{Sum}(XY) - \text{Sum}(Y)^2/N$$

$$= (14.253)(3882.5182)+(.2734)(73,975.391)-3882.5182^2/203$$

$$= 55,337.531 + 20,224.871 - 74,255.896$$

$$= 1306.506$$

$$\text{Coefficient of Determination} = \frac{\text{Explained variation}}{\text{Total variation}} = r^2$$

$$= 1306.506/31,505.679$$

$$= .0415$$

$$\text{Coefficient of Correlation} = r = .204$$

H_o: Zero correlation

H_1: Correlation not zero, Significance level = .05

If H_o is true, $r((N-2)/(1-r^2))^{\frac{1}{2}}$ follows Student's t distribution with N-2 degrees of freedom.

$$r((N-2)/(1-r^2))^{\frac{1}{2}} = (.204)(201/.9585)^{\frac{1}{2}}$$

$$= (.204)(14.4811)$$

$$= 2.95$$

Probability (t_{20} is greater than 1.97) is less than the level of significance. Therefore, the hypothesis of zero correlation can be rejected which demonstrates a significant dependent relationship between length of service and nonavailable time for Air Force civilian personnel.

Summary

The data does not indicate a significant difference between the population of nonavailable time for civilian personnel males and females, or between civilian pay grades at a significance level of .05. The data does indicate, however, that a significant dependent relationship exists between pay grade and nonavailable time, and between longevity and nonavailable time which demonstrates that the assumption of homogeneity of nonavailable time for civilian work centers is in error.

ANALYSIS OF CURRENT ESTIMATE OF WORKER AVAILABILITY

Of the methods currently used to estimate nonavailable time, only the measurement recorded during MET work sampling studies uses actual observation as the source of data. Additionally, this measurement technique is the only technique in current use that measures nonavailable time as a single value. All other measurement devices are forced to include subjective estimate additives and/or collect data from several different sources.(26) An analysis was conducted to determine if the measurement conducted during

work sampling studies differs significantly from the estimates measured by the other techniques in current use. A population consisting of the nonavailable time of workers assigned to AFLC was used for this analysis.

Availability Measured by Work Sampling Studies

A study of military availability completed in March 1973 estimates the average nonavailable time for military personnel to be 24 hours per month.(32) A study to determine the available time for civilian employees of the Air Force is being conducted as of this writing. The analysis for AFLC has been completed with an estimate of nonavailability for civilian employees of 27.65 hours per month.(25) The current manning of AFLC is approximately 90% civilians and 10% military.(34) The weighted average of the estimated available time for workers in AFLC is (.9)(27.65)+(.1)(24)= 27.285 hours/month. A sample of 128 work sampling studies conducted at AFLC installations has a mean of 29.6726 hours and a standard deviation of 14.0271 hours/man month and a standard deviation of the sampling distribution of 1.2398 hours/month. Application of the central limit theorem allows the following computation of the probability of a deviation as extreme or more extreme than the deviation experienced:

$$Z = \frac{27.285-29.6726}{1.2398} = -1.925 \text{ standard deviations.}$$

Probability (Z less than -1.925) = .0274, which is less than the level of significance of .05. Therefore, the data

indicates a significant difference between the nonavailable time measured by work sampling studies and the measurement by the techniques in current use.

Credibility of Current Availability Estimate

Analysis of measurements of nonavailable time made by various techniques and at various times raises several unanswered questions concerning the accuracy of the estimate. Work sampling studies listed the available time for the same bases. Assuming that both methods were accurate and were properly utilized, it would be expected that the average available times derived by the two separate studies would display a high degree of positive correlation. The following analysis; however, indicates a negative correlation.

Base	Study Estimate	Rank	Work Smpl Estimate	Rank	d	d^2
Hill	142.50	3	133.45	6	-3	9
Kelly	138.60	6	145.38	1	5	25
McClellan	139.39	5	138.08	3	2	4
Robins	142.58	2	142.18	2	0	0
Tinker	139.48	4	134.76	5	-1	1
W-P	143.97	1	136.33	4	-3	9
						48

Spearman rank Correlation Coefficient $r_s = 1 = \frac{6\ \mathrm{Sum}(d^2)}{N^3-N}$

$$r_s = 1 - \frac{(6)(48)}{6^3-6} = 1 - 1.371 = -.371$$ (38:204)

This apparent contradiction raises questions about the accuracy of the data.

The credibility of the data is further degraded by

comparison of two Air Force studies to determine military availability conducted in 1971 and 1973. The overall results indicate a decrease in nonavailability from 26 to 24 hours per month. Comparison of individual activities which are included in nonavailable time, shown below, reveal substantial differences which are not indicated by the total change.

Nonavailable Category	1971	1973
Leave	11.28	6.89
Medical	2.62	3.80
Education and Training	6.83	3.81
Sqd duties and other misc special absences	5.32	9.44

(18:Vol I(CI)Table 2-1 & 32)

These two studies were conducted by the same people using the same analysis procedures.(32) It is possible that the change in the amount of time expended per month in the categories of Education and Training and Squadron Duties can be traced to policy change. However, the average amount of time expended for Leave and Medical reasons should be fairly stable over time. Research has uncovered no factors which cause the changes indicated by the measurement.

EFFECTS OF AVAILABILITY ESTIMATE ERROR

To determine the possible effect of a deviation of the estimate from the true mean of the distribution of available time, the authors constructed a simplified model of a portion of the requirements process. The model

simulates the translation of measured allowed time for a work center into the discrete number of people required. An accurate simulation of reality requires knowledge of the distribution of available time. The authors found no prior research to determine this distribution; therefore, the best estimate of the shape of the distribution was constructed using the data from civilian timecards. This distribution is very probably somewhat in error. Discrepancies in the distribution however, should not negate the general conclusions reached through the simulation.

AFM 25-5 prescribes two rounding rules in manpower calculations. The civilian fractional rounding rule is applied to all work centers having at least one civilian authorization.(34) Under this procedure all requirements calculations resulting in a number plus a fraction are increased to the next highest whole number. The military rounding rule is applied to work centers for which only military personnel are authorized. For military work centers which are authorized from one to twelve personnel, the whole number portion of required personnel is multiplied by .077. The resulting number is then compared to the fractional portion of required personnel to determine actual authorizations. For illustrative purposes, assume the requirements for a work center were 6.4 personnel. Then:

$$6(.077) = .462 = \text{allowed overtime}$$

Since the fractional portion of required personnel (.4) is

less than allowed overtime, actual authorizations for the work center would be established at six people. If the requirements determination results in 13 or more personnel, the fraction is dropped to reduce the number authorized to the next lowest whole number.(16:6-20) The model was modified to simulate both rounding procedures.

The results of the simulation are contained in tabular and graphical form in Appendix E. The results provide insight into the effects of three variables on the requirements determination process: the method of fractional rounding, the size of the work center, and the error in the estimate of available time.

Fractional Rounding

Computed civilian work center requirements are three to six percent above the computed requirements for military work centers when all other variables are held constant.

Work Center Size

For very small work centers, current procedures cause computed requirements to be above actual requirements. As the size of the work centers increases, the curve of computed requirements as a percent of actual requirements decreases sharply, approaching a constant for large work centers. The shape of the curve makes the computed requirements for small work centers very sensitive to both changes in the estimate of available time, and fractional rounding procedures.

Available Time Estimate

A change in the estimate of available time of a given percent "X", causes a change in the computed requirements of approximately the same "X" percent for large work centers. The same "X" percent change in the estimate of available time for small work centers is affected by the shape of the curve and results in an error somewhat greater than "X" percent. Thus, if the available time estimate is determined inaccurately, manpower standards will be in error.

CHAPTER SUMMARY

The analysis has shown that the assumption of worker homogeneity with respect to nonavailable time is invalid. The significance of this finding is that the computational accuracy of manning standards is based on this assumption. The result is loss of accuracy in manpower standards.

Comparison of the current estimate of nonavailable time with work sampling data and with prior estimates strongly suggests that the current estimate is in error. A simulation model indicates that an error in the nonavailable time estimate will cause a loss of accuracy in work center manpower standards.

CHAPTER IV

MANPOWER PROGRAMMING AND ALLOCATION CYCLE

It has been shown in the previous chapter that significant differences exist in the availability of Air Force workers, and that inaccurate availability estimates inject error into manpower standards. A review of the manpower requirements determination, programming and authorization process will demonstrate the impact of an error in manpower standards on authorizations.

Air Force manpower requirements are not the simple aggregation of grade determinations made through analysis of individual positions; consideration must also be given to statutory and budgetary constraints on personnel authorizations. Statutes currently limit the number of general officers, field grade officers, and the number of airmen in the top two enlisted grades. An additional ceiling is imposed yearly by OSD on the number serving in the top six enlisted grades.(17:3-1) Also affecting the manpower process is the fact that the Air Force budget is subject to approval by the Congress. The Air Force rarely enjoys a funding level sufficient to allow manning at total determined requirements. As a consequence, manning authori-

zations may be well below the required number determined through management engineering studies.

Within this constrained environment, the Air Force determines manpower requirements and allocates manpower authorizations. To facilitate an understanding of the process, the general flow of the DOD Planning, Programming and Budgeting System will be outlined from the Air Force viewpoint.

THE PLANNING, PROGRAMMING, AND BUDGETING SYSTEM

The DOD Planning, Programming, and Budgeting System (PPBS), established in 1962 and revised in 1970, controls the scope of the major categories of programs and associated DOD resources. It is an integrated system which provides for the establishment, maintenance, and revision of the Five Year Defense Program (FYDP) and the DOD budget. The FYDP summarizes the approved plans and programs for the DOD.(12:14)

To understand the process by which the PPBS functions, one must begin with the basic building block of the FYDP--the program element. The program element is a description of a mission through identification of the organizations and resources required for performance of an assigned mission. Resources consist of forces, manpower, material quantities, and costs, as applicable.(20:2) Included are time phased actions and the means necessary for accomplishment. Programs elements are aggregated to

form programs, which are subsequently aggregated to form the FYDP.

Within the Air Force, the Force and Financial Program (F&FP) reflects the program approved by the Secretary of Defense and is consistent with the FYDP. It contains considerably more detail than the FYDP for the Air Force program elements. Each element represents a combination of manpower, equipment, and facilities constituting a related mission or force capability and the associated resources. The program elements are grouped in major DOD Programs on the basis of similarity of mission or purpose. The F&FP includes the following ten major program volumes and a summary volume:(20:3)

(1) Strategic Forces
(2) General Purpose Forces
(3) Intelligence, Communications
(4) Airlift/Sealift
(5) Guard and Reserve Forces
(6) Research and Development
(7) Central Supply and Maintenance
(8) Training, Medical, and Other General Personnel Activities
(9) Administrative and Associated Activities
(10) Support of Other Nations

Each program volume shows the approved programs and resources, number of wings and squadrons, total Unit Equipage aircraft, buy/delivery quantities, flying hours,

and manpower strengths by officers, airmen, and civilians. (20:3)

The planning/programming/budgeting process begins when the Secretary of Defense issues a memorandum to the Military Departments providing a schedule of significant actions of the PPBS cycle for the next calendar year. The sequence of actions displayed, on the following page in Figure 4-1, is typical:*

1. February--The Air Force receives the Planning and Programming Guidance Memorandum (PPGM) from OSD.

2. February-May--The impact of the guidance contained in the PPGM is evaluated by HQ USAF. Primary emphasis is on program exercises used to test alternatives for inputs to the Joint Force Memorandum (JFM).

3. May--The Air Force provides their input to the JFM which is then submitted to OSD. The JFM provides the combined services' recommendations on the joint force program within the fiscal guidance provided in the PPGM. The Air Force Program Objective Memorandum (POM) is also submitted to OSD in May. The POM is the balanced, total force and support program and is within the constraints provided by OSD. The F&FP is updated to reflect the POM submission.

4. May-July--As circumstances require, the AF may submit changes to the POM. Reclamas to OSD decisions on

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*Information used in the construction of charts presented in this chapter was extracted from AFM 26-4 and material provided by Maj William Biliunas.

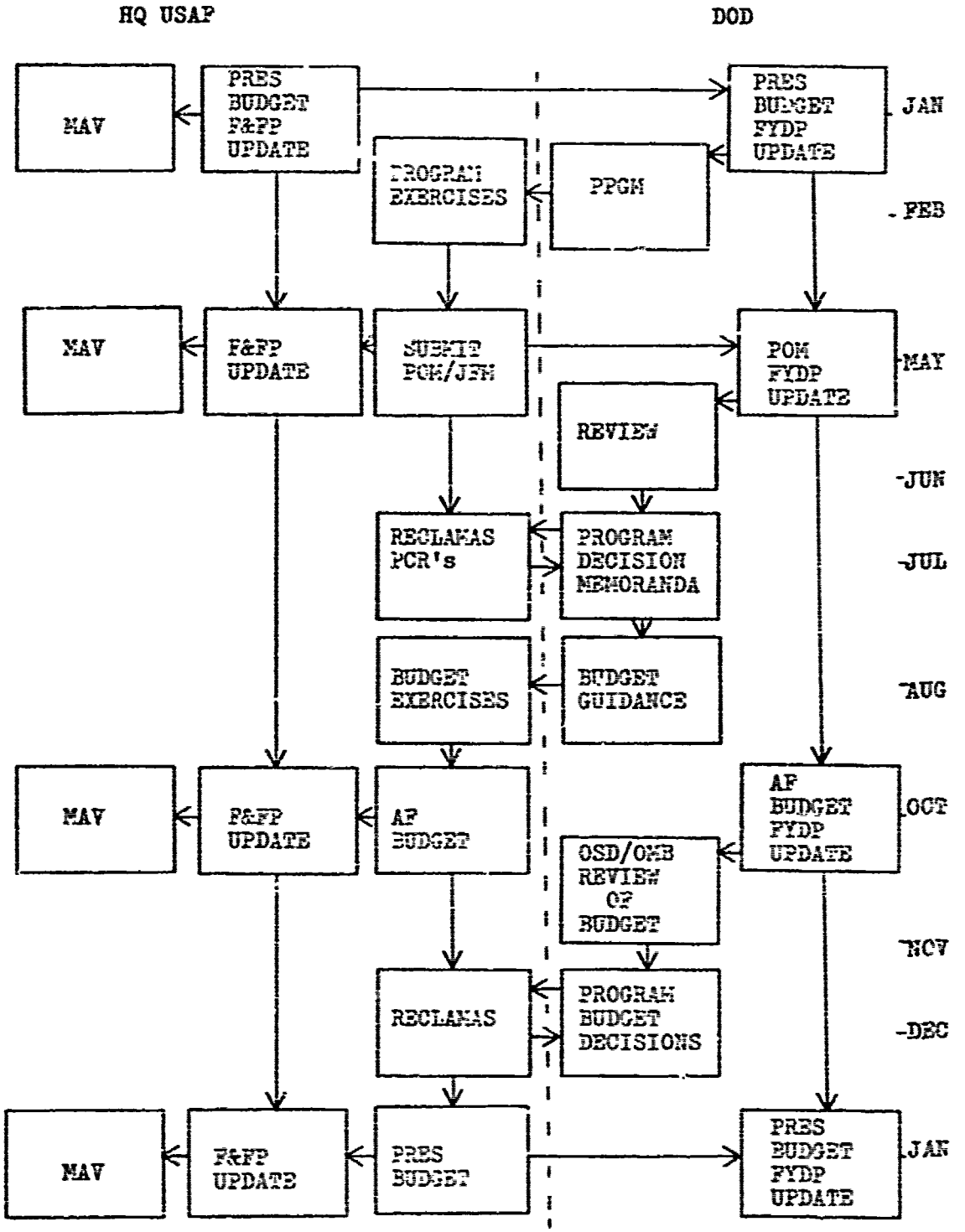

Figure 4-1 GENERAL AIR FORCE PROGRAMMING PROCESS

the changes may also be submitted.

5. July--OSD issues Program Decision Memorandums to the Air Force. Decisions on reclamas are also issued. Program Change Requests may be submitted to OSD as necessary. The Air Force publishes the Manpower Authorization Voucher(MAV).

6. October--The Air Force budget is submitted to OSD. The F&FP is updated to reflect the budget submission. The MAV is published.

7. October-December--The budget is reviewed by OSD and OMB. Program Budget Decisions are issued by OSD. Reclamas may be submitted as necessary.

8. January--The USAF F&FP is updated and published to reflect the President's budget. HQ USAF publishes the MAV.

THE MANPOWER PROGRAMMING PROCESS

Within the PPBS, manpower programming follows the general outline depicted in Figure 4-2 on the following page. Actual man-hour and workload requirement data is compiled through manpower studies conducted by management engineering teams at the work center level. The results of the studies are forwarded to the major command where manpower standards are established.

The term "work center Manpower Standard" normally refers to a product developed from a number of inputs, not just to the data developed at one location.(16:6-1) Each

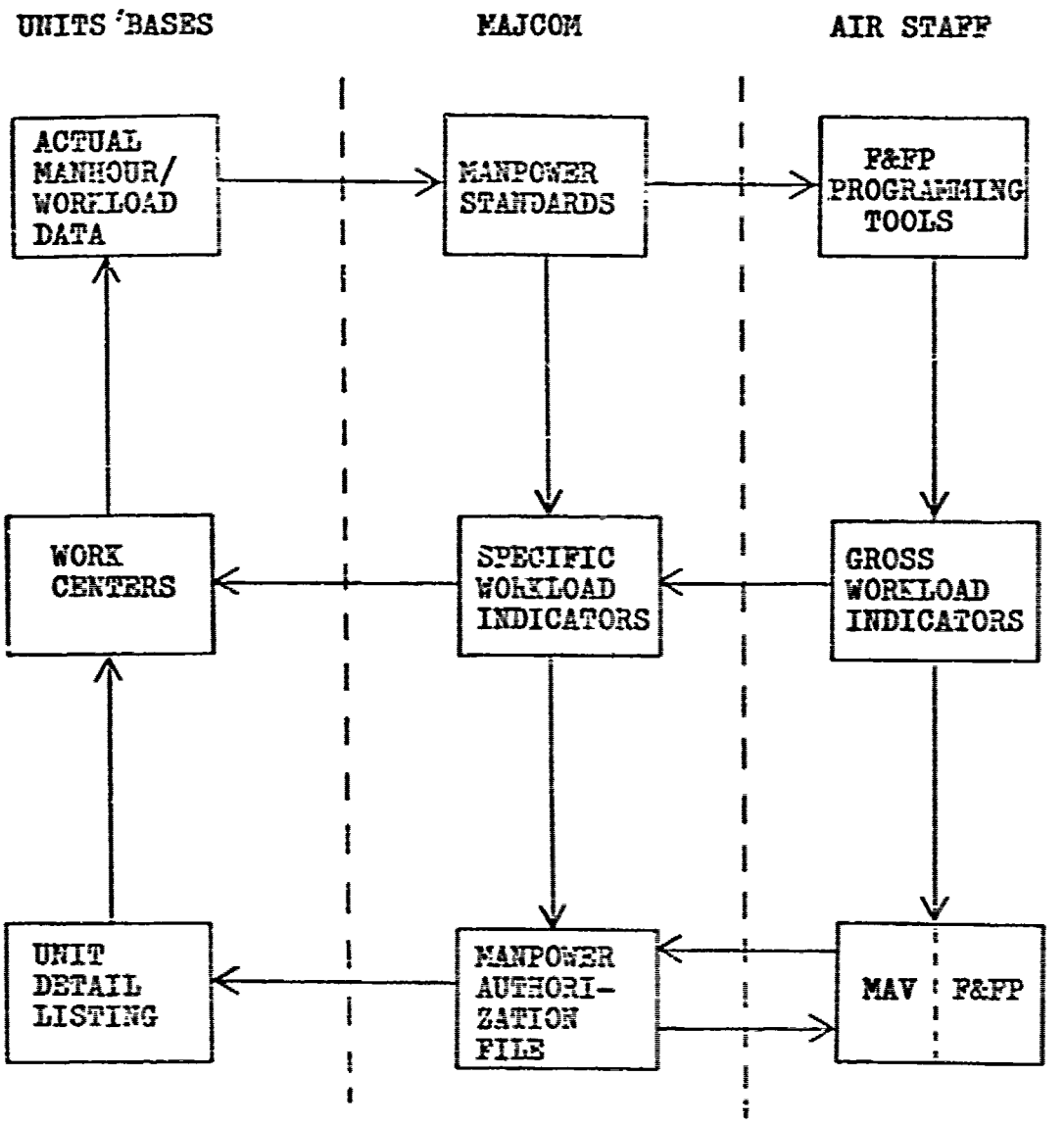

Figure 4-2 MANPOWER PROGRAMMING FLOW

input reflects a man-hour or manpower requirement at a given workload value. The standard reflects the manpower requirements at any given workload level within the limits of the model. It is developed primarily through correlation and regression analysis.(34) The standard may be applicable to two or more commands, one command, or one unique work center.

The manpower standards provide the data used to develop Program Estimating Equations (PEE). The PEE describes and quantifies the relationship between manpower requirements and program variables.(16:6-38) It bridges the gap between workload factors and program estimating factors. The procedure for developing the PEE is as follows:(16:6-38)

(1) The functions, subfunctions, and work centers to be covered by the PEE are selected, along with the program variables to be considered in regression analysis as program estimating factors (PEF). The PEF is similar to the workload factor; however, a PEF is programmed in official programming documents, whereas a workload factor may not be. Examples of PEFs are aircraft, flying hours, dollars, inventory, et cetera.

(2) An appropriate historical time period is selected to serve as a baseline.

(3) The baseline time period is stratified for regression analysis.

(4) Work centers, functional accounts, and organi-

zational elements which are to be covered by the PEE and are also covered by current manpower standards are identified. Workload factors applicable to the standards are identified, and actual volumes of the workload factors and candicate PEFs by location for each time period is obtained.

(5) The manpower required for each location by time period is determined by applying the appropriate standards and criteria using the actual workload volumes.

(6) The PEE is developed by correlating the required manpower with the selected program estimating factor from the same historical time period.

The manpower standards, and corresponding PEEs, are forwarded to HQ USAF where they are aggregated into programming tools. There programming tools are then applied to gross workload indicators (aircraft, planned utilization, number of bases, total manpower, and policy direction as to course lengths, headquarters levels, etc.) to produce manpower requirements for input to the P&FP.(39:20-1) The gross workload indicators are also used to assist MAJCOMs in the development of more specific workload requirements which are used to build and revise the manpower authorization file. Changes in the manpower authorization file result in changes to the Unit Detail Listing, which affect actual work center authorizations. After authorization requirements are determined, they must be allocated to major commands and bases.

THE AUTHORIZATION ALLOCATION SYSTEM

The Manpower Resource Allocation System (MRAS) is the automated HQ USAF system for processing and transmitting manpower allocations to major commands. The MRAS interfaces with the Manpower Allocation and Accounting System (MAAS), and MAJCOM standard system for allocating and accounting for manpower.(17:A2-1) The Manpower Authorization Voucher (MAV) is the document used to advise MAJCOMs of Manpower Authorizations. Actual allocation occurs through tapes which are authenticated by printed reports.

Each Major Commander must allocate manpower authorizations within the limits of the MRAS. Manpower can, however, be redistributed between units if ceilings are not exceeded. Typically, specific programs identified by HQ USAF and those which the commander considers critical receive 100% manning. After manning of the critical programs, remaining authorizations are allocated using established manpower standards as a guide.(34) This procedure could result in low manning in some areas. As an example, if 85% of determined requirements is allocated to a major command, an additional five percent reduction due to manning of critical positions could occur. Allocations to base level would then be 80% of determined authorizations. If only 20 of a determined 25 authorizations are received, and yet a work center mission is still accomplished, some doubt is created as to the validity of the determination process.

The allocation system, as outlined on pages 61 through 63 by Figures 4-3, 4-4, and 4-5, begins with a HQ USAF manpower allocation. The system is transaction oriented and will accept USAF manpower allocations on an as occurs basis.(19:1-6) The data received from AF is added to the Allocation File and used to produce the USAF allocation register. The register constitutes official notification of an allocation. Data is then removed from the allocation file to cause increases or decreases in the baseline file. Any data not moved to the baseline file is printed out as the unextended allocation register. Manpower also receives an Extended Allocation Register depicting all allocation actions taken against the allocation and baseline files and a Manpower Recapitulation Register showing the total command resources derived through a combination of baseline and unextended allocations.

Within the system two types of actions occur in the allocation process.(19:1-7)

(1) Unit actions consisting of activations, discontinuances, and reorganizations which add or delete packages of authorizations to a given unit. These actions make up the Unit Control File (UCF). From the UCF is produced the Unit Control Master Register which lists all command units with corresponding basic authorizations packages, and the Unit Control Change Register which contains all changes processed against the Unit Control File in a cycle.

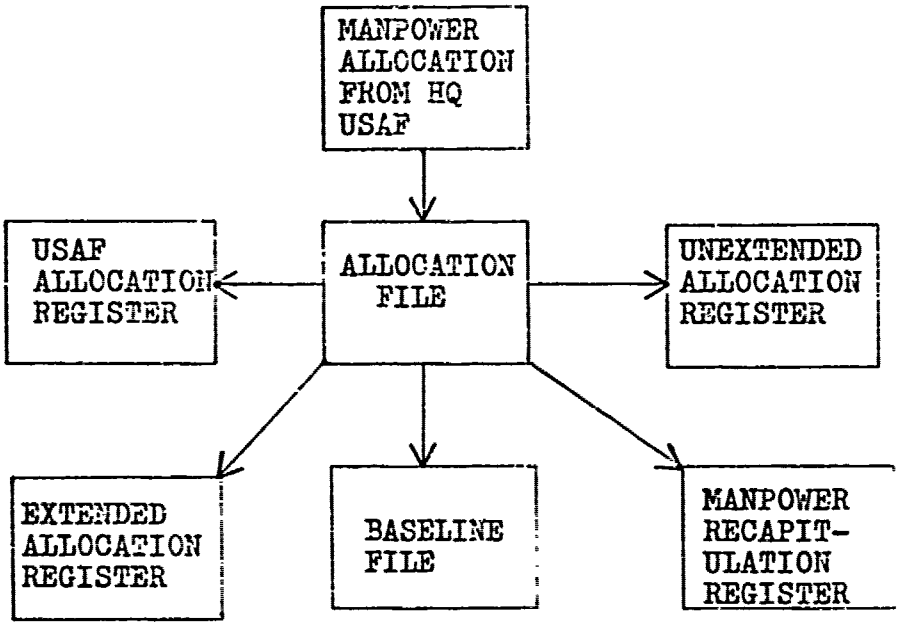

Figure 4-3 MAJCOM GENERAL ALLOCATION INFORMATION FLOW

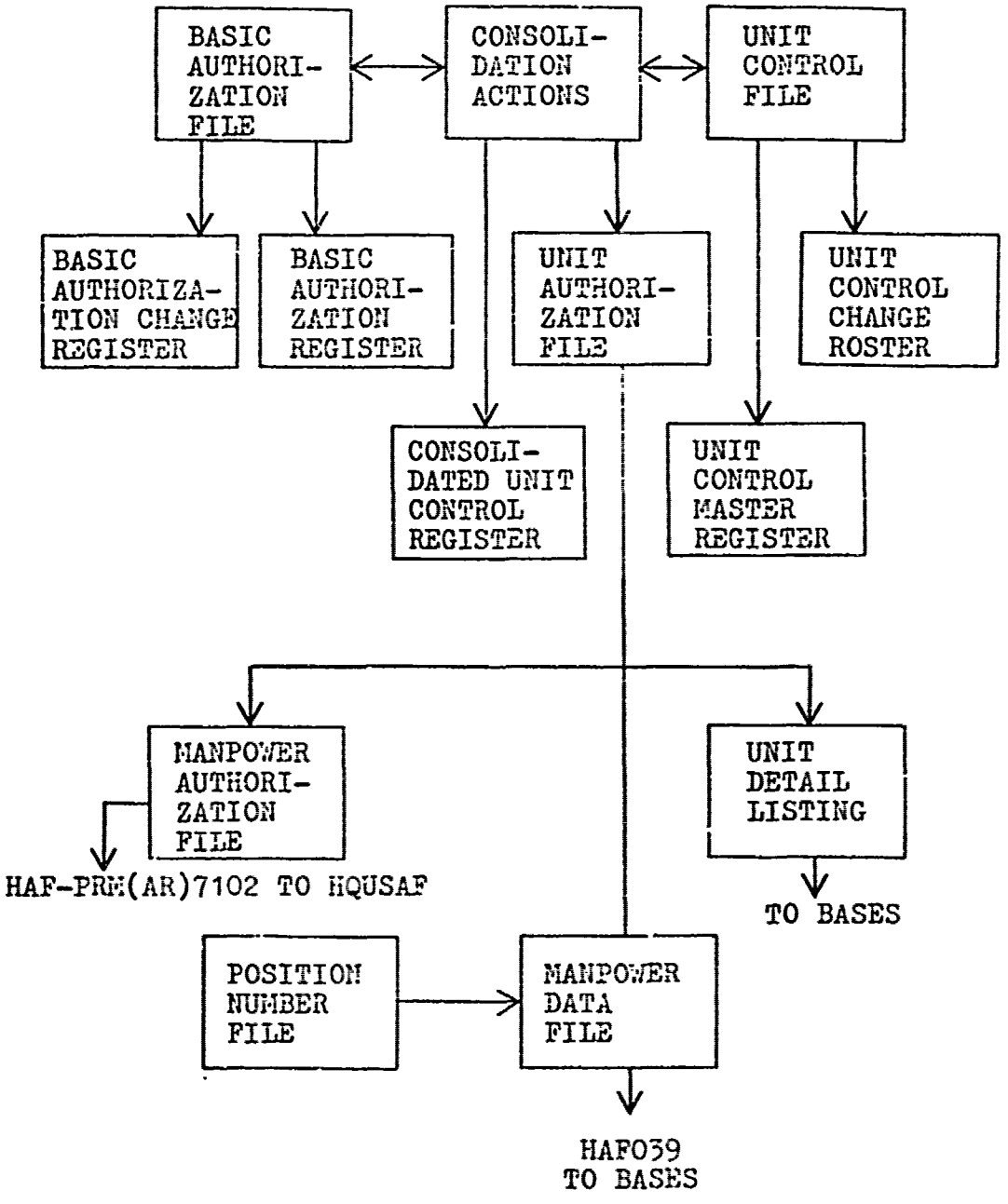

Figure 4-4 MAJCOM AUTHORIZATION/ALLOCATION SYSTEM

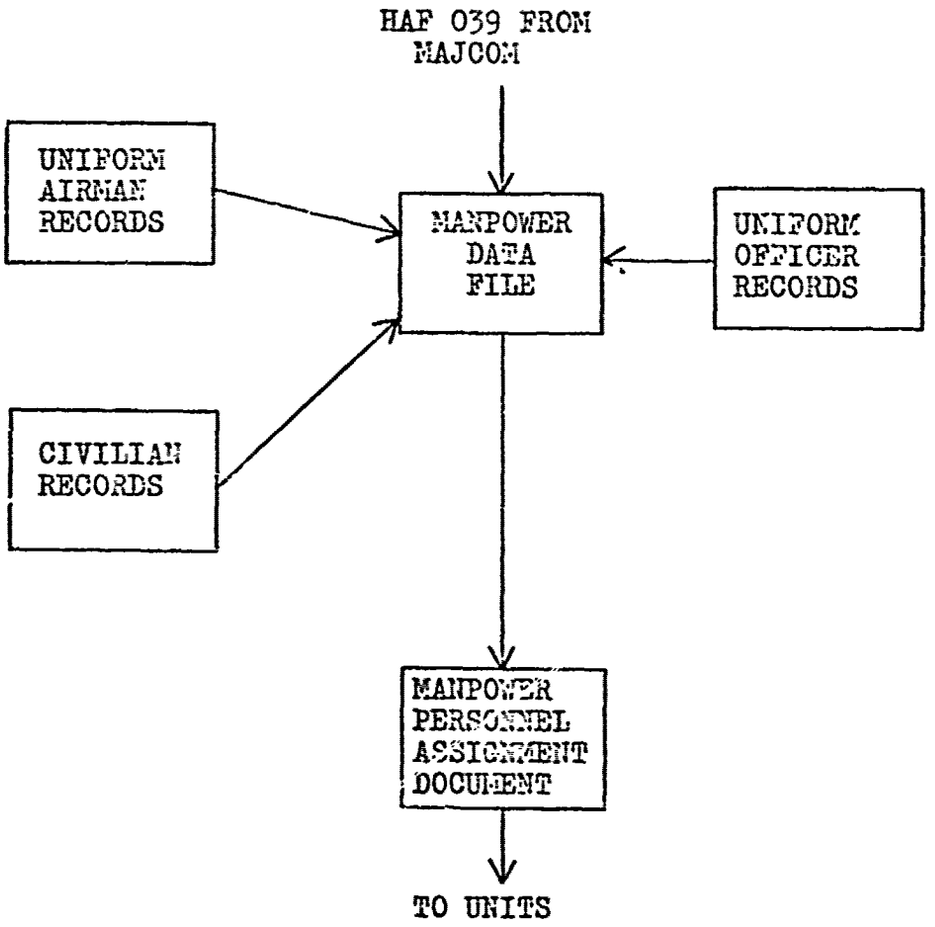

Figure 4-5 BASE LEVEL ALLOCATION SYSTEM

(2) Basic authorization actions representing the actual construction and update of the Basic Authorization packages. These actions make up the Basic Authorization File (BAF). From the BAF the Basic Authorization Change Register is produced which lists all changes affecting the Basic Authorization Packages in the cycle, and the Basic Authorization Register, which contains all command developed Basic Authorization packages.

The unit and basic authorization actions are then merged to produce a composite Unit Authorization File (UAF). The UAF is compared to the Baseline File to assure that all intended allocation actions have occurred. From the UAF is derived the Manpower Authorization File which contains detailed identification of allocated manpower that has been distributed to units. This data is sent to HQ USAF in the HAF-7102, a report required for determination of manpower posture by command, and for transmission to the military personnel center, where manning actions are taken against the manpower authorizations.(18:A2-1) In addition, the UAF is used to compile the Unit Detail Listing (UDL) which is distributed as commands determine. The Manpower Data File (MDF), also produced from the UAF, is transmitted to base level in the HAF-059 report. The MDF contains manpower authorization data by unit. A position number is affixed at command level to each group of like authorizations to facilitate man/job matching at base level.

The Consolidated Unit Control Register (CUCR) is

compiled from the BAF and the UCF. It contains officer, airmen, and civilian strengths by each Basic Authorization Package for each unit. Also included is a recapitulation by grade and program element for each unit and each base. The CUCR is the document against which UCF actions are taken in the succeeding cycles of the system.(19:1-10)

Base level actions are outlined in Figure 4-5. Personnel data extracted from officer, airmen and civilian records are merged to produce the Manpower and Personnel Assignment Document (MPAD).(19:1-12) The MPAD is designed to inform the unit commander of the positions authorized for his unit, and the individuals assigned or projected to be assigned to the positions.

Thus, the manpower programming/allocation cycle is completed. It is emphasized; however, that it is a complex system with ever-changing inputs. Factors such as the budgetary ceilings imposed by Congress, the need for advanced weapon systems, personnel costs, the complexity of new weapons systems, and manpower ceilings imposed by Congress and DOD all have a significant impact upon the programming cycle. The point to be remembered; however, is that within existing constraints the manpower standard is the primary basis for the programming and allocation of manpower authorizations. Therefore, any errors existing in manpower standards will result in erroneous authorizations.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Two major findings contribute to the conclusion that manpower standards contain some error due to the computations involving worker availability. The first concerns the assumption of homogeneity with respect to nonavailable time.

The data indicates a significant difference between the availability of officers and enlisted personnel. Within each of these classifications it can be shown that a significant difference exists between availability of different grades. It can be further demonstrated that there is a significant statistical dependent relationship between military grade and nonavailable time. Therefore, the conclusion can be made that the use of a constant estimate of available time for all military work centers is incorrect.

With regard to civilian employees, the data is significant to establish a statistical dependent relationship between pay grade and nonavailable time, and between

pay grade and length of service. Based on this finding the hypothesis that civilians are homogeneous with respect to nonavailable time can be rejected. It can therefore be concluded that application of a constant estimate for availability of civilian work centers is incorrect.

The application of a constant estimate of availability to all work centers when in fact availability is not a homogeneous variable results in erroneous requirements determination. Some work centers will receive more authorizations than they require while others will receive less.

The second finding which contributes to the conclusion that manpower standards are in error is the strong implication that current measurements of nonavailable time are not accurate. This implication is supported by the following:

(1) The nonavailable time measured by AFLC work sampling studies is significantly different from the nonavailable time estimates determined through surveys, civilian timecards, medical records, et cetera, which are currently used to determine military and civilian availability.

(2) Measurement of nonavailable time for six AFLC bases by work sampling techniques is shown to have a negative correlation to measurements of nonavailability for the same bases using different techniques.

(3) Estimates of portions of nonavailable time, computed through identical analysis, two years apart, display wide differences. Policy changes within the two year

period do not explain the disparity of the results.

The effect of an erroneous measurement of availability was demonstrated through simulation. The model indicates that an error in the estimate for available time of a given percent causes an error in the average computed requirements by approximately the same percent for large work centers. The error becomes larger as the size of the work center decreases. The significance of error in manpower standards is that the error will be reflected to some degree in the number of manpower authorizations received.

Manpower standards are the primary input in the development of the program estimating equations used to determine overall Air Force manpower requirements. Once overall manpower authorizations are obtained through the PPBS cycle they are allocated to MAJCOMS, bases and work centers using the manpower standards as a guide. Due to the aggregation procedures and the complexity of the process the exact error in authorizations resulting from an error in the manpower standard cannot be determined. However, because the manpower standards are the primary basis for requirements determination and allocation, an error in the standards will be reflected to some degree in the allocation of manpower resources.

The discussion in Chapter IV also indicates that in today's environment many functional areas consistently receive manpower authorizations which are considerably

below their determined requirements. Yet these work centers are operating today with little or no visible impact due to a shortage of manpower. This indicates one of three things:

(1) The procedures for computing manpower requirements may be so inaccurate that in reality the work center may have an adequate work force even though their authorizations are well below their computed requirement.

(2) Necessity is the basis for innovation. Managers may have been forced to learn to use the available manpower more efficiently. This increase would compensate for the difference between required and authorized manpower.

(3) It is possible that the mission is not being accomplished at the desired level, but the impact is insignificant. This could happen for two reasons. The output of the work center may actually not be required at all or the mission may have been accomplished at a level of performance higher than actually required.

RECOMMENDATIONS

A credible measurement technique is a prerequisite to meaningful manpower requirements determination. A modification of present work sampling procedures would provide the means to obtain the estimate. Nonavailable time should be recorded by grade, sex, length of service, AFSC, and any other variables which could possibly influence nonavailable time. The data, compiled over a period of time, would

provide the information necessary to tailor the application of manpower standards to specific work centers eliminating the requirement for the assumption of homogeneity of non-available time for broad classifications of the work force.

When the variables which impact nonavailable time have been identified and their effect determined, they could be applied to successively higher levels of the Air Force organizational structure to more precisely predict future manpower requirements.

Once the data base has been established, an accurate description of the distribution of nonavailable time would be possible. The distribution could then be used to perform numerous types of analysis with the aim of improving the manpower determination process. Prime candidates for analysis are:

a. The development of a rounding rule which results in the greatest probability of correctly determining manpower requirements for any size work center.

b. The effect that combination of small work centers has on the accuracy of requirements determination using current rounding rules.

GLOSSARY OF TERMS

GLOSSARY OF TERMS

1. Basic Authorization (BA): An authorization or group of authorizations which have been defined to perform a given volume of programmed work under approved conditions. The authorization(s) contained in a basic authorization is (are) codified by Air Force Specialty, functional account, grade (military or civilian), rated identity, duty title, and related data elements. Normally a BA is not identified with a specific unit or location, hence, the basic authorization has multiple applicability within a major command.(19:12-2)

2. Engineered Manpower Standard: A HQ USAF approved, quantitative expression of manpower by Air Force Specialty Code, and grade required to accomplish prescribed tasks and activities at varying levels of workload volume.(16:A2-2)

3. Idle Time: Any time expended by the worker in either an avoidable delay status, or accomplishing unnecessary work, when work is available. It does not include time for personal requirements, fatigue, and unavoidable delays. Idle time is not included in a manning standard. An individual going to the base exchange, commissary, barbershop, et cetera, with the above conditions met, would be classified as being in an idle time status.(16:A2-4)

4. Management Engineering Program (MEP): A primary capability for accurately determining manpower requirements for the Air Force. The objective of the MEP is to systematically improve distribution/utilization of the manpower resource by:

a. Developing and maintaining manpower determinants.

b. Providing management engineering services, such as methods improvement studies from which solutions to management problems may be derived.(16:1-1)

5. Man-Hour: A unit for measuring work. It is equivalent to one man working at a normal pace for 60 minutes, two men working at a normal pace for 30 minutes, or a similar combination of men working at a normal pace for a period of time.(16:A2-2)

6. Nonavailable Time: Assigned man-hour losses allowed for participation in those activities directed, recognized, and approved by the Air Force, which render the individual unavailable for assigned primary duties. Examples of nonavailable causatives are leave or pass, sick call or hospitalization, education and training, squadron duties (external to the work center) and taking a skill knowledge test. Transient (PCS move) activity is not included in nonavailable time.(16:A2-4)

7. Operational Audit: The integration of four techniques--directed requirement, good operator, historical experience, and best judgment--into a systematic method for measuring work activity.(16:5-35)

8. Program Budget Decision: A Secretary of Defense decision, in prescribed format, authorizing changes to a submitted budget estimate and the FYDP.(12:66)

9. Program Change Decision: A Secretary of Defense decision authorizing changes to the FYDP.(12:66)

10. Program Change Request: A formal document submitted by HQ USAF to the office of the Secretary of Defense which proposes an adjustment to the FYDP.(12:66)

11. Program Estimating Equation: A mathematical equation that uses a broadly based, program-oriented, independent variable (DEF) to forecast and/or program manpower requirements into future time periods.(16:A2-3)

12. Program Estimating Factor (PEF): A statistically derived factor (linear or curvilinear regression formula) for the computation of the number of manpower authorizations to be increased/decreased because of a change in the Air Force program.(19:12-6)

13. Projected Workload: An amount of work proposed or anticipated to meet the requirement of a program.(16:A2-3)

14. Time Study: A work measurement method for recording the time a worker expends on each element of an operation and the pace at which he works, under specific conditions. It includes the analysis of the data so as to determine the time necessary for carrying out the operation at a defined standard of performance from a limited number of observations.(16:5-3)

15. Unit Control File (UCF): An electronic data processing file which contains pertinent information about each unit of the command. Additionally, the file identifies the Basic Authorizations that are assigned to each unit.(19:12-7)

16. Workload Factor: (1) An index or unit of measure which is consistently expressive of, or relatable to, the manpower required to accomplish the quantitatively and qualitatively defined responsibilities of a work center. (2) An end-product, or combination thereof, that is representative of the work performed in the work center. It may be either something physically produced in the work center (referred to as a production-type workload factor), or something that is external to, but served by, the work center (referred to as a work generator-type workload factor).(16:A2-5)

17. Work Center: A grouping of personnel using similar machines, processes, methods, and operations, and performing homogeneous type work, usually located in a centralized area. The term is used to identify a relatively small activity within a broad functional segment. Personnel within a work center perform work that basically contributes to the same end product or result, and their duties are similar or closely related.(16:A2-5)

18. Work Sampling: A statistical sampling procedure wherein "At random intervals, the workers are observed, and the state or condition of each worker's activity is noted and classified into predetermined categories." (16:5-10)

APPENDIX A

SUMMARY OF AFLC CIVILIAN AVAILABILITY STUDY

APPENDIX A

SUMMARY OF AFLC CIVILIAN AVAILABILITY STUDY

Normal Work Week

	Hill	Kelly	McClellan	Robins	Tinker	W-P	Newark	Command Nonavailable Hours
Annual Leave	15.29	16.13	15.56	14.58	15.54	13.93	13.02	15.29
Sick Leave	8.55	9.91	9.63	7.90	8.57	7.01	6.22	8.99
LWOP/AWOL	.07	.84	1.92	.15	1.30	.03	1.65	.82
Training	1.19	1.34	1.11	1.11	1.92	2.49	.34	1.56
Special Absences	.40	1.18	.39	1.68	1.19	.57	.45	.99
Total Nonavailable Hours	25.50	29.40	28.61	25.42	28.52	24.03	21.68	27.65
Monthly Hours Available to Primary Duty	142.50	138.60	139.39	142.58	139.48	143.97	146.32	140.35

APPENDIX B

DATA FROM AIR FORCE SURVEY

APPENDIX B

SURVEY QUESTIONS CONCERNING
NONAVAILABLE TIME

Each year military personnel are engaged for a significant amount of time in Air Force directed, recognized, and approved activities which are not related to their primary duty. The questions in this part will assist the Air Force in properly planning manning levels to compensate for time spent in leave and additional duties. If you were NOT ON ACTIVE DUTY BEFORE 1 JULY 1973, DO NOT ANSWER THESE QUESTIONS. SKIP TO QUESTION #67.

In questions #41 through #57, estimate the number of normal duty hours spent in the activities shown below during the past fiscal year (July 1972 through June 1973).

41. Commander's Call.

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

42. Aerobics Physical Fitness Program (Male) or XBX Plan for Physical Fitness (Female). (Include time for testing only.)

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

43. Studies and tests for the following General Military Training (GMT) subjects: Code of Conduct, First Aid, Security, Disaster Preparedness, and Communications Security.

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

44. Counseling and reviews (includes receiving directed personal affairs counseling, obtaining career information and counseling from the CBPO, and performing directed personnel records reviews).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

45. Boards or Councils (includes airman personnel classification boards, Junior Officer Council, Airman/NCO of the Month/Quarter Boards, and Outstanding Airman of the Year Boards, etc.).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

46. Retreats, parades, awards, retirement ceremonies, and decorations presentations. (Do not include practice time.)

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

47. Unit or base details such as Staff Duty Officer/NCO, Officer/NCO-of-the-Day, Charge of Quarter, Airdrome Officer, Barracks Orderly, etc. (Include time off from normal duty because of performing as Staff Duty Officer/NCO, etc., the night before.)

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

48. Additional duty (include inventory duty in other than the organization to which you are normally assigned such as commissary or BX, sponsor duties, fund drives, and voting officer).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

49. Military Court (official court membership, witness, or defendant) and Civil Court (juror, witness, or defendant).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

50. In/out processing in conjunction with a PCS move. Include time spent processing through such stations as CBPO, Finance Office, Transportation, Officer/NCO club, Base Housing, Library, Mail Room, etc.

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

51. Personal or family settlement in conjunction with a PCS move. (Indicate time-off from normal duty to look for a house or apartment and time spent in the physical movement of dependents in and out of quarters).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

52. Driver Education (indicate normal duty time spent in Air Force-directed driver education courses).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

53. Drug Abuse Education (include time spent in special briefings and/or reading drug abuse educational literature).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

54. Race Relations Education (include time spent in Race Relations courses, briefings, rap sessions, etc.).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

55. Project Transition (include time spent away from your normal duty learning job skills or about job opportunities prior to separation from the service).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

56. Answering surveys (include time spent away from your normal duty answering the Tri-Annual or other special surveys).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

57. Voting (include normal duty time spent registering to vote, getting absentee ballot, or voting).

A. None	F. 13-15 hrs	J. 25-27 hrs
B. 1-3 hrs	G. 16-18	K. 28-30
C. 4-6	H. 19-21	L. 31-33
D. 7-9	I. 22-24	M. 34 or more hrs
E. 10-12		

60. How many days of chargeable leave did you take at the place mentioned in the above question #58 during the period 1 July 1972 through 30 June 1973? (Do not include PCS leave en route to a new station, leave while TDY, or graduation leave.)

A. None	F. 13-15 days	K. 28-30 days
B. 1-3 days	G. 16-18	L. 31-33
C. 4-6	H. 19-21	M. 34-36
D. 7-9	I. 22-24	N. 37-39
E. 10-12	J. 25-27	O. 40 days or more

62. How many days of chargeable leave did you take in conjunction with TDY during the period 1 July 1972 through 30 June 1973?

A. None or not applicable	I. 22-24 days
B. 1-3 days	J. 25-27
C. 4-6	K. 28-30
D. 7-9	L. 31-33
E. 10-12	M. 34-36
F. 13-15	N. 37-39
G. 16-18	O. 40 days or more

65. If you were stationed in Vietnam or Thailand at any time during the period 1 July 1972 through 30 June 1973, how many days of out-of-country R&R (rest and recuperation) did you take?

A. Not applicable	E. 3
B. 0	F. 4
C. 1	G. 5
D. 2	H. 6 days or more

66. If you were stationed in Vietnam, Thailand, or Korea during the period 1 July 1972 through 30 June 1973, how many days of in-country R&R did you take?

A. Not applicable	E. 3
B. 0	F. 4
C. 1	G. 5
D. 2	H. 6 days or more

EXAMPLE OF AIRMEN DATA FROM AIR FORCE SURVEY

QUESTION 41 RESPONSES

		CMSGT	MSGT	TECH	STAFF	SGT	A1C	AMN	BASIC	TOTAL
A	F	12	76	119	184	193	226	116	274	1200
	C	4.72	4.74	3.88	3.83	3.77	6.71	8.17	42.55	5.92
B	F	7	64	144	304	495	383	245	159	1801
	C	2.76	3.99	4.70	6.33	9.68	11.38	17.25	24.69	8.88
C	F	8	58	106	147	247	230	250	74	1120
	C	3.15	3.62	3.46	3.06	4.83	6.83	17.61	11.49	5.52
D	F	13	53	111	196	291	169	185	31	1149
	C	5.12	3.31	3.62	4.08	5.69	7.99	13.03	4.81	5.67
E	F	76	346	718	1052	1106	701	272	29	4300
	C	29.92	21.58	23.43	21.89	21.62	20.83	19.15	4.50	21.21
F	F	54	352	639	971	902	516	132	27	3593
	C	21.26	21.96	20.86	20.20	17.63	15.33	9.30	4.19	17.72
G	F	25	208	404	518	476	260	62	5	1958
	C	9.84	12.98	13.19	10.78	9.31	7.72	4.37	0.78	9.66
H	F	8	75	128	218	235	127	26	2	819
	C	3.15	4.68	4.18	4.54	4.59	3.77	1.83	0.31	4.04
I	F	23	201	393	661	621	330	67	20	2316
	C	9.06	12.54	12.83	13.75	12.14	9.80	4.72	3.11	11.42
J	F	7	68	122	219	199	113	26	2	756
	C	2.76	4.24	3.98	4.56	3.89	3.36	1.83	0.31	3.73
K	F	5	28	47	85	77	49	6	2	299
	C	1.97	1.75	1.53	1.77	1.51	1.46	0.42	0.31	1.47
L	F	5	7	9	30	34	21	2	2	110
	C	1.97	0.44	0.29	0.62	0.66	0.62	0.14	0.31	0.54
M	F	11	67	124	221	239	141	31	17	851
	C	4.33	4.18	4.05	4.60	4.67	4.19	2.18	2.64	4.20
TOTAL	F	254	1603	3064	4806	5115	3366	1420	644	20272

EXAMPLE OF OFFICER DATA FROM AIR FORCE SURVEY

QUESTION 41 RESPONSES

		COL	LTC	MAJOR	CAPT	1LT	2LT	TOTAL
A	F	99	174	199	214	40	42	768
	C	21.57	17.38	13.14	7.54	4.20	5.61	10.21
B	F	48	91	147	264	79	87	718
	C	10.46	9.09	9.70	9.30	8.30	11.63	9.54
C	F	31	104	149	235	85	107	711
	C	6.75	10.39	9.83	8.28	8.93	14.30	9.45
D	F	35	79	117	242	68	71	613
	C	7.63	7.89	7.72	8.53	7.14	9.49	8.15
E	F	102	243	356	651	209	179	1741
	C	22.22	24.28	23.50	22.94	21.95	23.93	23.14
F	F	53	112	206	448	170	110	1100
	C	11.55	11.19	13.60	15.79	17.86	14.71	14.62
G	F	15	56	96	207	95	44	515
	C	3.27	5.59	6.34	7.29	9.98	5.88	6.84
H	F	8	23	34	108	34	21	230
	C	1.74	2.30	2.24	3.81	3.57	2.81	3.06
I	F	27	54	84	203	72	38	480
	C	5.88	5.39	5.54	7.15	7.56	5.08	6.38
J	F	7	15	46	85	36	21	210
	C	1.53	1.50	3.04	3.00	3.78	2.81	2.79
K	F	4	10	12	39	9	6	80
	C	0.87	1.00	0.79	1.37	0.95	0.80	1.06
L	F	0	3	4	11	4	2	24
	C	0.00	0.30	0.26	0.39	0.42	0.27	0.32
M	F	30	37	65	131	51	20	334
	C	6.54	3.70	4.29	4.62	5.36	2.67	4.44
TOTAL	F	459	1001	1515	2838	952	748	7524

SURVEY DATA SUMMARY

	COL		LTC		MAJOR		CAPT	
QUESTION	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)
41	.8676	.6482	.8575	.5154	.9332	.5315	1.0482	.5197
42	.3966	.6164	.3937	.5595	.3457	.3878	.3243	.3579
43	.4489	.3682	.4576	.3686	.4624	.3427	.4294	.3452
44	.5516	.5810	.5270	.4567	.5062	.3501	.4922	.3116
45	.9889	1.3237	.6060	.8730	.4436	.6293	.4490	.6552
46	.6960	.5102	.4775	.3293	.3729	.2662	.3055	.1952
47	.7445	1.3233	.9764	1.5236	1.0348	1.6161	1.0290	1.5845
48	.4592	.6992	.6863	.9671	.8687	1.1677	1.1622	1.4565
49	.2878	.4890	.2998	.5164	.2016	.3306	.1243	.2144
50	.5148	.5175	.6613	.8099	.7465	.8473	.7055	.8157
51	.9240	1.3017	.9638	1.4336	1.0385	1.4682	.9928	1.4159
52	.1510	.1904	.1125	.1129	.1190	.0852	.1627	.1420
53	.6043	.6416	.5038	.4755	.4514	.3744	.4045	.3141
54	1.0773	1.0943	1.0246	.9687	.8856	.8927	.9273	.8563
55	.0821	.1343	.0474	.0554	.0329	.0385	.0183	.0250
56	.2707	.1242	.2587	.0859	.2691	.1081	.2310	.0733
57	.1736	.1085	.1517	.0491	.1625	.0733	.1402	.0453
60	8.0350	26.4987	9.0255	22.5358	8.4925	24.5382	7.5537	23.7135
62	1.2666	8.2990	.8640	4.2438	.8831	4.7622	.9588	5.5083
65	.1064	.1832	.0893	.1991	.1022	.2186	.0910	.2216
66	.0606	.0854	.0578	.1085	.0830	.1579	.0964	.2046
TOTAL	18.7017	45.7380	19.0422	37.1908	18.4354	39.1866	17.6263	38.9758

	1LT		2LT		TOTAL	
QUESTION	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)
41	1.1263	.5042	.9260	.4218	.9866	.5254
42	.3669	.3849	.8071	1.0895	.3964	.5028
43	.5651	.5011	.7735	.8283	.4924	.4272
44	.4687	.2549	.5253	.2880	.5036	.3460
45	.5000	.7228	.3699	.5403	.5005	.7359
46	.2996	.1771	.6113	.6084	.3952	.3001
47	.9837	1.5161	.6741	1.1184	.9645	1.5252
48	1.2121	1.5089	.5980	.9474	.9472	1.3059
49	.1026	.1562	.0483	.0675	.1634	.2794
50	.7769	.8406	.8331	.4933	.7180	.7795
51	.9162	1.2336	.8959	1.0324	.9743	1.3629
52	.4192	.3674	.8964	.5722	.2514	.2542
53	.4190	.3295	.4123	.2957	.4425	.3713
54	.8982	.7362	.5601	.5787	.9015	.8667
55	.0440	.0944	.0307	.0390	.0339	.0494
56	.2927	.1068	.2520	.1462	.2549	.0973
57	.1570	.0522	.1177	.0380	.1482	.0557
60	5.8686	23.0709	3.3342	16.0431	7.3314	25.5920
62	1.1064	7.3422	.7369	5.0211	.9464	5.5537
65	.0838	.1988	.0132	.0211	.0852	.1936
66	.0711	.1445	.0239	.0449	.0764	.1528
TOTAL	16.6781	40.2433	13.4399	30.2353	17.5139	41.2770

	CMSGT		MSGT		TECH		STAFF		SGT	
QUESTION	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)
41	1.2257	.4378	1.2676	.4343	1.2560	.4202	1.2710	.4691	1.1939	.5084
42	.3333	.3409	.3509	.3478	.3138	.2739	.3490	.3278	.3294	.2770
43	.5840	.4913	.5146	.3993	.5908	.5131	.6079	.5540	.6233	.5843
44	.6432	.5551	.5455	.3989	.4952	.3497	.4947	.3387	.4801	.3294
45	1.3907	1.2258	.7278	.9052	.3234	.4262	.2513	.3516	.2425	.3002
46	.5310	.5299	.3732	.3319	.3205	.2953	.3210	.2956	.3441	.3252
47	.5784	1.0188	.9580	1.4269	1.3400	1.5842	1.5440	1.5684	1.4464	1.4759
48	.8468	.9096	.7362	.9465	.5612	.7850	.4507	.6876	.3359	.5280
49	.1637	.2763	.0893	.1465	.0630	.0963	.0770	.1182	.1000	.1514
50	.7110	.7954	.7687	.9509	.8677	1.0631	.9405	1.0357	.8599	.8858
51	.8858	1.2297	.8624	1.2104	.9404	1.3250	.9791	1.3042	.6040	.9013
52	.1965	.2083	.2204	.2091	.2783	.3147	.4646	.5355	.7686	.7322
53	.6758	.5712	.6207	.5028	.5450	.4403	.5183	.4304	.4709	.3628
54	1.3625	1.0239	1.1959	.9683	1.0403	.9422	.8997	.8853	.7461	.7718
55	.1011	.1706	.0741	.1371	.0724	.1512	.1066	.2104	.1537	.2760
56	.2980	.1340	.2524	.1103	.2483	.1189	.2482	.1325	.2720	.1951
57	.1311	.0460	.1253	.0617	.1088	.0441	.1265	.0683	.1465	.1213
60	5.4692	22.7005	5.9088	23.3366	5.8115	25.9881	5.9114	29.4845	6.2740	32.6429
62	.8413	5.4873	.5092	3.5366	.5107	4.0626	.6225	5.3357	.9851	9.1835
65	.0797	.1467	.0659	.1387	.0453	.1053	.0522	.1195	.0850	.1770
66	.0722	.1238	.0771	.1405	.0815	.1664	.1098	.2278	.1742	.3393
TOTAL	17.1210	38.4229	16.3440	36.6403	15.8104	39.4658	15.8421	44.4808	16.6356	51.0688

	A1C		AMN		BASIC		TOTAL	
QUESTION	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)	$\bar{X}$	V(X)
41	1.0774	.5367	.7731	.4012	.3865	.4113	1.1533	.5092
42	.4132	.4293	.5284	.6489	.8191	.9971	.3767	.3783
43	.8369	.8001	1.0555	.9955	1.2820	1.0564	.6914	.6599
44	.4721	.3480	.4541	.3128	.5479	.4404	.4920	.3491
45	.2258	.2587	.1618	.1736	.2319	.2665	.3009	.4074
46	.4375	.3558	.4390	.3122	.4564	.2740	.3654	.3220
47	1.3692	1.4677	1.0659	1.3406	.6633	.9113	1.3398	1.5274
48	.2700	.3985	.2535	.3730	.3012	.3874	.4175	.6272
49	.1005	.1313	.1135	.1563	.2102	.2706	.0934	.1379
50	.7392	.6581	.6711	.5747	.5328	.4285	.8277	.8862
51	.4518	.6640	.3458	.5275	.3049	.4227	.7154	1.0651
52	1.0608	.7569	1.0497	.6156	.6228	.5304	.6350	.6526
53	.4647	.3349	.4451	.2992	.4727	.2874	.5051	.3955
54	.7398	.6819	.6037	.5560	.6159	.3522	.8554	.8295
55	.1480	.2497	.1370	.2082	.2577	.3347	.1244	.1829
56	.2566	.1641	.2254	.1558	.2676	.2410	.2556	.1550
57	.1494	.1281	.0918	.0803	.1875	.2138	.1322	.0929
60	5.4809	27.2465	3.5593	20.0543	1.1910	8.6183	5.6131	28.5595
62	.7764	6.5235	.6643	5.2620	.7280	5.6454	.7226	6.2089
65	.0712	.1324	.0676	.0942	.1373	.2471	.0676	.1382
66	.0923	.1712	.0668	.0929	.1150	.1613	.1130	.2192
TOTAL	15.6337	42.4371	12.7734	33.2348	10.3317	22.4978	15.7975	44.3059

APPENDIX C

SUMMARY OF DATA FROM WORK SAMPLING STUDIES

APPENDIX C

SUMMARY OF DATA FROM WORK SAMPLING STUDIES

For Total Sample $\bar{X}$=29.6726 Std Dev=14.0271

By Base

Hill	Tinker	W-P	McClellan	Robins	Kelly	Griffiss
28.728	57.792	52.584	61.320	68.376	47.040	31.584
62.664	32.424	40.824	28.224	26.376	18.480	16.968
97.272	39.480	32.760	33.600	29.064	6.384	22.680
9.912	55.944	18.984	26.544	19.992	1.512	28.728
27.048	36.960	27.384	16.296	11.928	14.784	
30.072	13.104	21.840	22.008	8.400	16.296	$\bar{X}$=24.990
29.568	19.320	24.528	25.368	33.936	21.000	Std Dev=
28.224	22.680	34.944	24.360	29.904	32.592	6.5100
30.072	21.672	31.584	28.728	15.792	33.768	
32.424	23.856	34.776	38.472	19.152	26.880	
9.912	35.280	30.072	40.152	26.544	7.056	
3.864	40.824	25.536	37.968	24.360	18.816	
38.606	15.456	34.104	13.440	17.976	30.744	
50.165	52.080	42.840	25.872	33.936	19.488	
41.278	17.808	65.520	22.176	11.256	24.024	
46.452	52.752	17.640	34.272	24.192	30.912	
46.553	22.848	44.016		37.128	34.776	
30.744	36.960	30.240	$\bar{X}$=29.925	31.248		
20.328	34.440	22.176	Std Dev=	14.952	$\bar{X}$=22.6207	
27.048		25.872	11.3271	13.440	Std Dev=	
	$\bar{X}$=33.2463	19.488		22.512	11.7780	
$\bar{X}$=34.5467	Std Dev=	37.464		28.056		
Std Dev=	14.1015	37.464		45.360		
20.4477		16.296				
		28.560		$\bar{X}$=25.8209		
		19.992		Std Dev=		
		27.216		13.0578		
		35.616				
		37.968				
		$\bar{X}$=31.6651				
		Std Dev=				
		10.9128				

APPENDIX D

LISTING OF PERSONNEL INTERVIEWED

APPENDIX D

LISTING OF PERSONNEL INTERVIEWED

Interviews were conducted with the following manpower and management engineering personnel:

Major William Biliunas
Systems Research Branch
Directorate of Manpower Organization
DCS/Plans and Operations
Headquarters Air Force Logistics Command
Wright-Patterson AFB, Ohio

Mr. Edward Conus
Manpower Technician
MET 30, AFLC
Wright-Patterson AFB, Ohio

LtCol Jack Cosgrove
Director of Manpower and Organization
DCS/Plans and Operations
Headquarters Air Force Logistics Command
Wright-Patterson AFB, Ohio

Mr. Donald Logan
Civilian Personnel Supervisor
2750th Air Base Wing
Wright-Patterson AFB, Ohio

Capt. Edward Moore
MET Staff Officer
Management Engineering Division
DCS/Plans and Operations
Headquarters Air Force Logistics Command
Wright-Patterson AFB, Ohio

Lt. Gerald Riley
Management Engineering Team Chief
MET 30, AFLC
Wright-Patterson AFB, Ohio

APPENDIX E

SIMULATION MODEL AND RESULTS

APPENDIX E

THE MODEL

Civilian Work Center

```
0010 DIMENSION XOVER(10),XSHORT(10)
0020 PRINT:"WHAT IS THE AVAILABLE TIME"
0030 READ:PF
0040 SEED=123.0
0050 DO 100 K=1,25
0060 Q=K
0065 PRINT:"..."
0070 PRINT:"WORK CENTER SIZE   ",K
0080 N=Q
0090 SUM=0.
0100 DO 10 I=1,1000
0105 SUM=0.
0110 DO 20 J=1,K
0120 X=RND(SEED)
0130 20 SUM=SUM+TIME(X)
0140 AUTH =((168*Q)-SUM)/PF
0150 NUM=AUTH +1.
0160 NE=N-NUM
0170 IF(NE)1,2,3
0180 1 NE=(-1)*NE
0190 XOVER(NE)=XOVER(NE)+1.
0195 GOTO 10
0200 2 XON=XON+1.
0210 GOTO 10
0220 3 XSHORT(NE)=XSHORT(NE)+1.
```

Modifications for Military Work Center

```
0150 NUM=AUTH
0151 OVER=AUTH-NUM
0152 CK=.077*NUM
0153 IF(OVER.GT.CK)NUM=NUM+1
```

```
0230 10 CONTINUE
0240 DO 30 I=1,10
0250 IF(XOVER(I))30,30,31
0260 31 XOVER(I)=XOVER(I)/1000.
0270 PRINT:"PROB OVER BY   ",I,XOVER(I)
0280 30 CONTINUE
0290 DO 40 I=1,10
0300 IF(XSHORT(I))40,40,41
0310 41 XSHORT(I)=XSHORT(I)/1000.
0320 PRINT:"PROB SHORT BY   ",I,XSHORT(I)
0330 40 CONTINUE
0340 XON=XON/1000.
0350 PRINT:"PROB RIGHT ON   ",XON
0351 DO 60 I=1,10
0352 XSHORT(I)=0.
0353 60 XOVER(I)=0.
0354 XON=0.
0360 100 CONTINUE
0370 END
0380 FUNCTION TIME(X
0390 IF(X.GT. .78) GOT  500
0400 IF(X.GT. .40) GOTO 501
0410 IF(X.GT. .35) GOTO 613
0420 IF(X.GT. .30)GOTO 612
0430 IF(X.GT. .23) GOTO 611
0440 IF(X.GT. .20) GOTO 610
0450 IF(X.GT. .17) GOTO 609
0460 IF(X.GT. .15) GOTO 608
0470 IF(X.GT. .11) GOTO 607
0480 IF(X.GT. .09) GOTO 606
0490 IF(X.GT. .06) GOTO 605
0500 IF(X.GT. .05) GOTO 604
0510 IF(X.GT. .02) GOTO 603
0520 IF(X.GT. .01) GOTO 601
0530 TIME=0.
0540 RETURN
```

```
0550 501 IF(X.GT. .77) GOTO 625
0560 IF(X.GT. .75) GOTO 624
0570 IF(X.GT. .73) GOTO 623
0580 IF(X.GT. .70) GOTO 622
0590 IF(X.GT. .66) GOTO 621
0600 IF(X.GT. .63) GOTO 620
0610 IF(X.GT. .61) GOTO 619
0620 IF(X.GT. .57) GOTO 618
0630 IF(X.GT. .51) GOTO 617
0640 IF(X.GT. .49) GOTO 616
0650 IF(X.GT. .44) GOTO 615
0660 TIME = 14
0670 RETURN
0680 500 IF(X.GT. .93) GOTO 502
0690 IF(X.GT. .926) GOTO 635
0700 IF(X.GT. .92) GOTO 634
0705 IF(X.GT. .91) GOTO 633
0710 IF(X.GT. .89) GOTO 632
0720 IF(X.GT. .87) GOTO 631
0730 IF(X.GT. .85) GOTO 630
0740 IF(X.GT. .84) GOTO 629
0750 IF(X.GT. .83) GOTO 628
0760 IF(X.GT. .82) GOTO 627
0770 TIME = 26.
0780 RETURN
0790 502 IF(X.GT. .98) GOTO 651
0800 IF(X.GT. .975) GOTO 646
0810 IF(X.GT. .97) GOTO 644
0820 IF(X.GT. .96) GOTO 642
0830 IF(X.GT. .95) GOTO 641
0840 IF(X.GT. .94) GOTO 638
0850 TIME=36.
0860 RETURN
0870 601 TIME=1.
0880 RETURN
0890 602 TIME=2.
```

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0550 501 IF(X.GT. .77) GOTO 625
0560 IF(X.GT. .75) GOTO 624
0570 IF(X.GT. .73) GOTO 623
0580 IF(X.GT. .70) GOTO 622
0590 IF(X.GT. .66) GOTO 621
0600 IF(X.GT. .63) GOTO 620
0610 IF(X.GT. .61) GOTO 619
0620 IF(X.GT. .57) GOTO 618
0630 IF(X.GT. .51) GOTO 617
0640 IF(X.GT. .49) GOTO 616
0650 IF(X.GT. .44) GOTO 615
0660 TIME = 14
0670 RETURN
0680 500 IF(X.GT. .93) GOTO 502
0690 IF(X.GT. .926) GOTO 635
0700 IF(X.GT. .92) GOTO 634
0705 IF(X.GT. .91) GOTO 633
0710 IF(X.GT. .89) GOTO 632
0720 IF(X.GT. .87) GOTO 631
0730 IF(X.GT. .85) GOTO 630
0740 IF(X.GT. .84) GOTO 629
0750 IF(X.GT. .83) GOTO 628
0760 IF(X.GT. .82) GOTO 627
0770 TIME = 26.
0780 RETURN
0790 502 IF(X.GT. .98) GOTO 651
0800 IF(X.GT. .975) GOTO 646
0810 IF(X.GT. .97) GOTO 644
0820 IF(X.GT. .96) GOTO 642
0830 IF(X.GT. .95) GOTO 641
0840 IF(X.GT. .94) GOTO 638
0850 TIME=36.
0860 RETURN
0870 601 TIME=1.
0880 RETURN
0890 602 TIME=2.
```

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0900 RETURN
0910 603 TIME=3.
0920 RETURN
0930 604 TIME=4.
0940 RETURN
0950 605 TIME=5.
0960 RETURN
0970 606 TIME=6.
0980 RETURN
0990 607 TIME=7.
1000 RETURN
1010 608 TIME =8.
1020 RETURN
1030 609 TIME=9.
1040 RETURN
1050 610 TIME=10.
1060 RETURN
1070 611 TIME=11.
1080 RETURN
1090 612 TIME=12.
1100 RETURN
1110 613 TIME=13.
1120 RETURN
1130 615 TIME=15.
1140 RETURN
1150 616 TIME=16.
1160 RETURN
1170 617 TIME=17.
1180 RETURN
1190 618 TIME=18.
1200 RETURN
1210 619 TIME=19.
1220 RETURN
1230 620 TIME=20.
1240 RETURN
1250 621 TIME=21.
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1260 RETURN
1270 622 TIME=22.
1280 RETURN
1290 623 TIME=23.
1300 RETURN
1310 624 TIME=24.
1320 RETURN
1330 625 TIME=25.
1340 RETURN
1350 627 TIME=27.
1360 RETURN
1370 628 TIME=28.
1380 RETURN
1390 629 TIME=29.
1400 RETURN
1410 630 TIME=30.
1420 RETURN
1430 631 TIME=31.
1440 RETURN
1450 632 TIME=32.
1460 RETURN
1470 633 TIME=33.
1480 RETURN
1490 634 TIME=34.
1500 RETURN
1510 635 TIME=35.
1520 RETURN
1530 638 TIME=38.
1540 RETURN
1550 641 TIME=41.
1560 RETURN
1570 642 TIME=42.
1580 RETURN
1590 643 TIME=43.
1600 RETURN
1610 644 TIME=44.
```

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1626 RETURN
163C 646 TIME=46.
1640 RETURN
1650 651 TIME=51.
1660 RETURN
1670 END

READY

*
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EFFECTS OF ERROR IN THE ESTIMATE OF AVAILABLE TIME
MILITARY WORK CENTER

(Entries in the chart are the average computed requirements expressed as a % of actual requirements.)

Actual Reqmnt	Error in Availability Estimate						
	-10%	-5%	-1%	0	+1%	+5%	+10%
1	175.70	148.80	120.70	114.50	110.50	100.00	100.00
2	139.95	122.20	105.45	103.45	101.85	100.00	100.00
3	127.40	113.17	101.73	100.73	100.23	100.00	100.00
4	121.10	108.53	100.93	100.20	100.10	100.00	99.93
5	117.75	107.42	100.40	100.08	100.02	99.98	99.24
6	115.17	105.48	100.22	100.02	100.00	99.80	96.62
7	113.07	104.11	100.11	99.99	99.97	98.79	91.84
8	111.64	103.31	99.96	99.89	99.76	97.30	89.36
9	110.41	102.89	99.96	99.81	99.40	95.09	89.17
10	109.43	102.26	99.79	99.40	98.95	93.46	89.96
11	108.86	102.39	99.72	99.17	98.35	92.71	90.69
12	108.08	101.84	99.34	98.63	97.48	92.23	90.51
13	107.85	101.94	99.23	98.33	96.96	92.40	89.82
14	108.09	102.19	98.83	97.72	96.24	92.73	88.57
15	108.38	102.27	98.92	97.87	96.39	92.93	87.87
16	108.74	103.00	99.03	97.92	96.64	93.18	88.19
17	109.07	103.19	99.06	98.15	96.83	93.36	88.53
18	109.31	103.42	99.14	98.19	96.98	93.48	88.88
19	109.49	103.62	99.37	98.35	97.09	93.64	89.28
20	109.67	103.84	99.48	98.58	97.31	93.82	89.52
21	109.53	103.88	99.53	98.51	97.40	93.78	89.73
22	109.60	103.88	99.60	98.70	97.57	93.93	89.80
23	109.76	104.00	99.73	98.78	97.63	93.93	89.86
24	110.04	104.01	99.72	98.84	97.79	94.10	89.93
25	110.07	104.02	99.78	98.84	97.84	94.17	89.91

EFFECTS OF ERROR IN THE ESTIMATE OF AVAILABLE TIME

CIVILIAN WORK CENTER

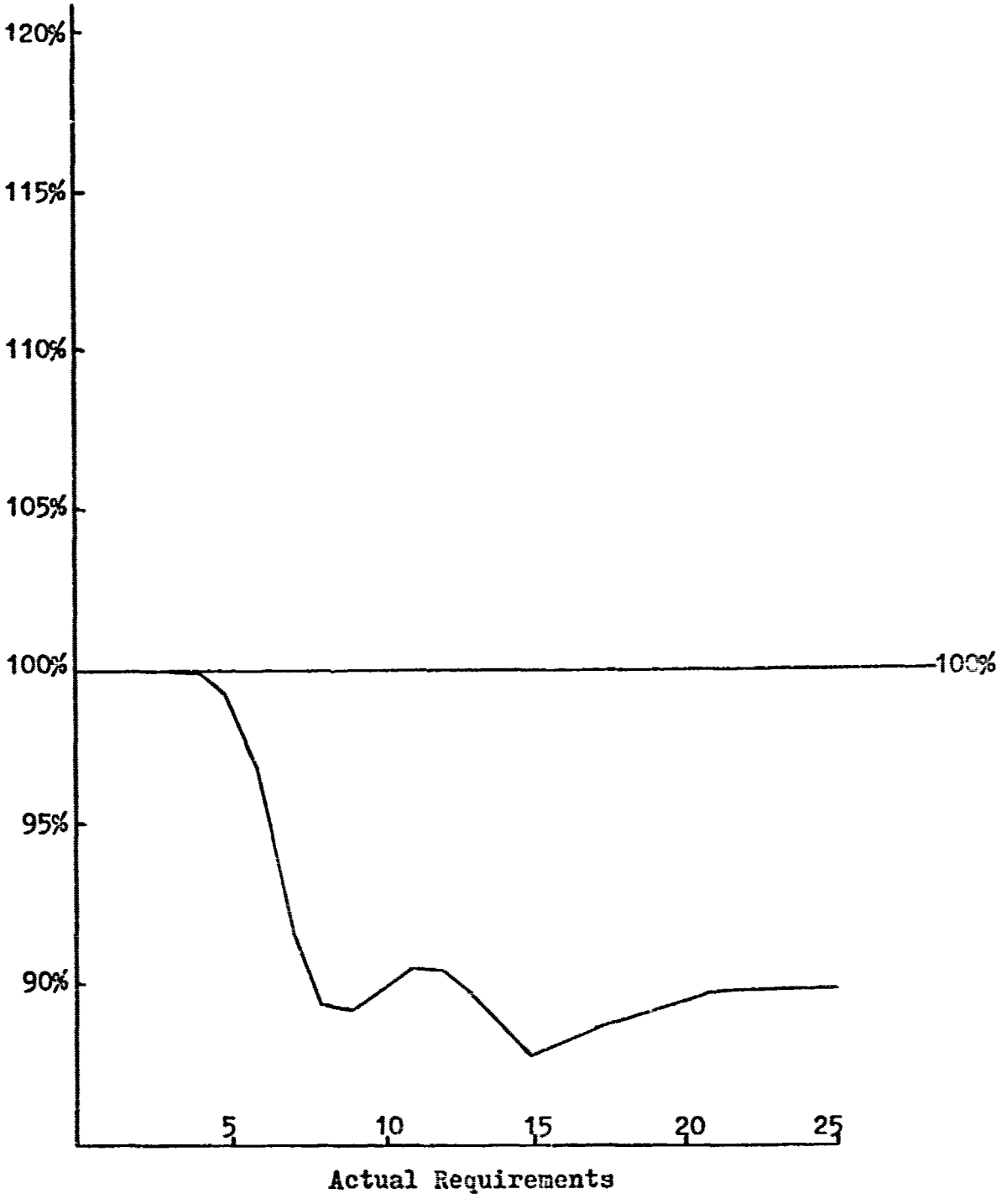
(Entries in the chart are the average computed requirements expressed as a % of actual requirements.)

Actual Reqmnt	Error in Availability Estimate						
	-10%	-5%	-1%	0	+1%	+5%	+10%
1	192.70	182.50	165.80	162.10	156.60	129.80	105.50
2	149.05	143.45	135.00	131.55	127.70	111.20	100.65
3	132.93	129.93	122.43	120.27	117.17	104.90	100.07
4	124.88	123.28	117.60	115.30	112.55	102.70	100.00
5	120.06	118.92	114.82	112.32	110.20	101.78	100.00
6	117.77	116.38	112.22	110.42	108.28	101.10	99.98
7	117.69	113.91	110.23	108.69	106.67	100.77	99.80
8	118.06	111.95	109.80	108.14	106.15	100.28	99.39
9	118.32	111.12	108.69	107.21	105.24	100.30	98.67
10	117.81	110.29	107.81	106.43	104.72	100.17	97.74
11	117.17	109.98	107.37	106.30	104.55	100.06	97.08
12	116.21	109.45	106.67	105.44	103.81	99.93	95.63
13	115.54	109.62	106.52	105.21	103.75	99.85	95.16
14	115.23	109.33	105.84	104.91	103.38	99.72	94.39
15	115.05	109.32	105.59	104.61	103.06	99.59	94.27
16	114.99	109.25	105.29	104.17	102.89	99.43	94.20
17	114.95	109.08	104.95	103.96	102.72	99.24	94.23
18	114.86	108.99	104.69	103.75	102.54	99.03	94.27
19	114.75	108.88	104.63	103.62	102.35	98.90	94.38
20	114.63	108.84	104.48	103.61	102.31	98.83	94.37
21	114.30	108.64	104.30	103.32	102.16	98.54	94.19
22	114.15	108.43	104.14	103.29	102.12	98.48	94.13
23	114.10	108.34	104.07	103.16	101.97	98.29	93.85
24	114.21	108.18	103.89	103.01	101.95	98.27	93.79
25	114.07	108.02	103.78	102.84	101.85	98.07	93.60

COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS

Military Work Center

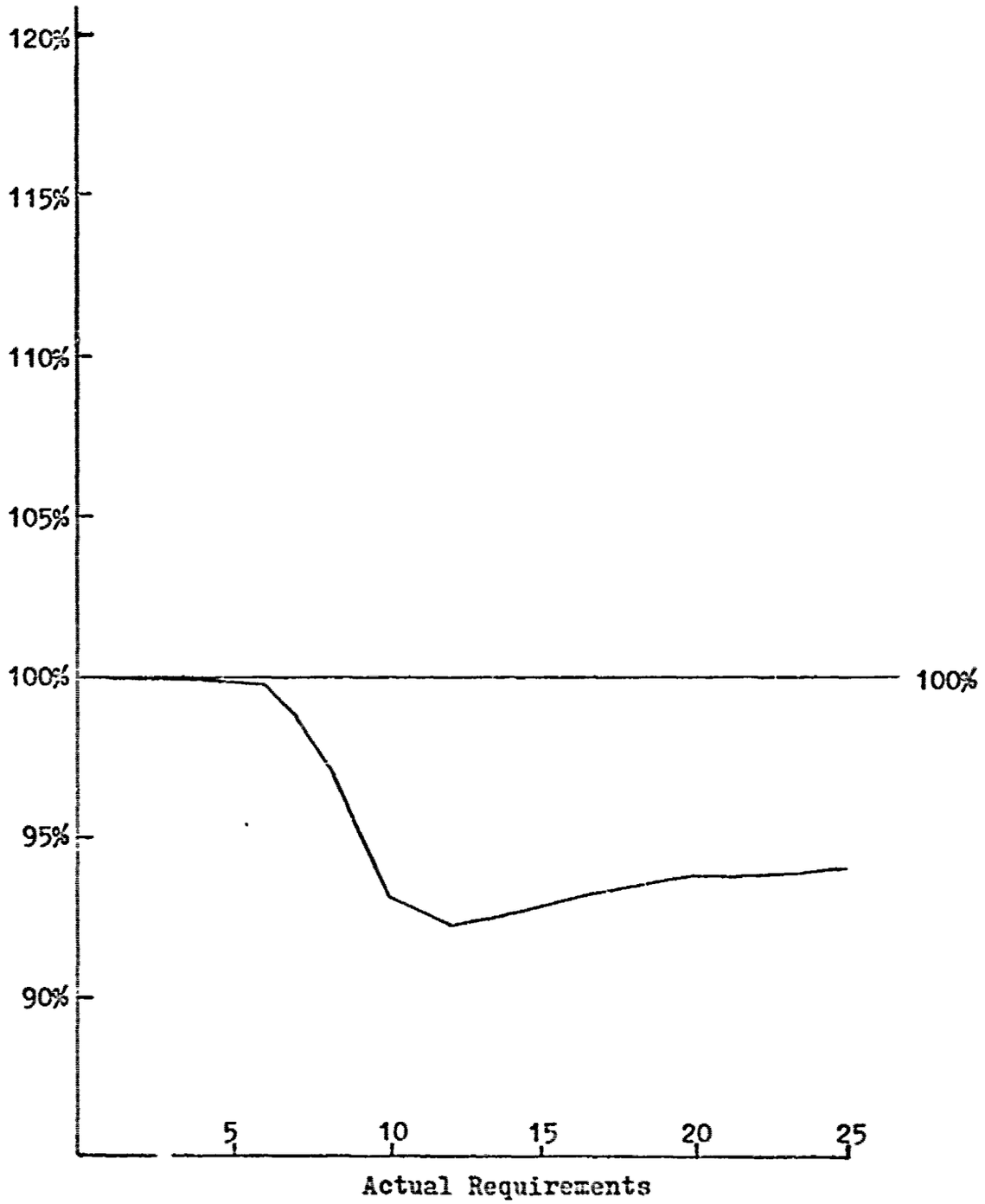
For availability estimate 10% above actual mean of distribution.



COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS

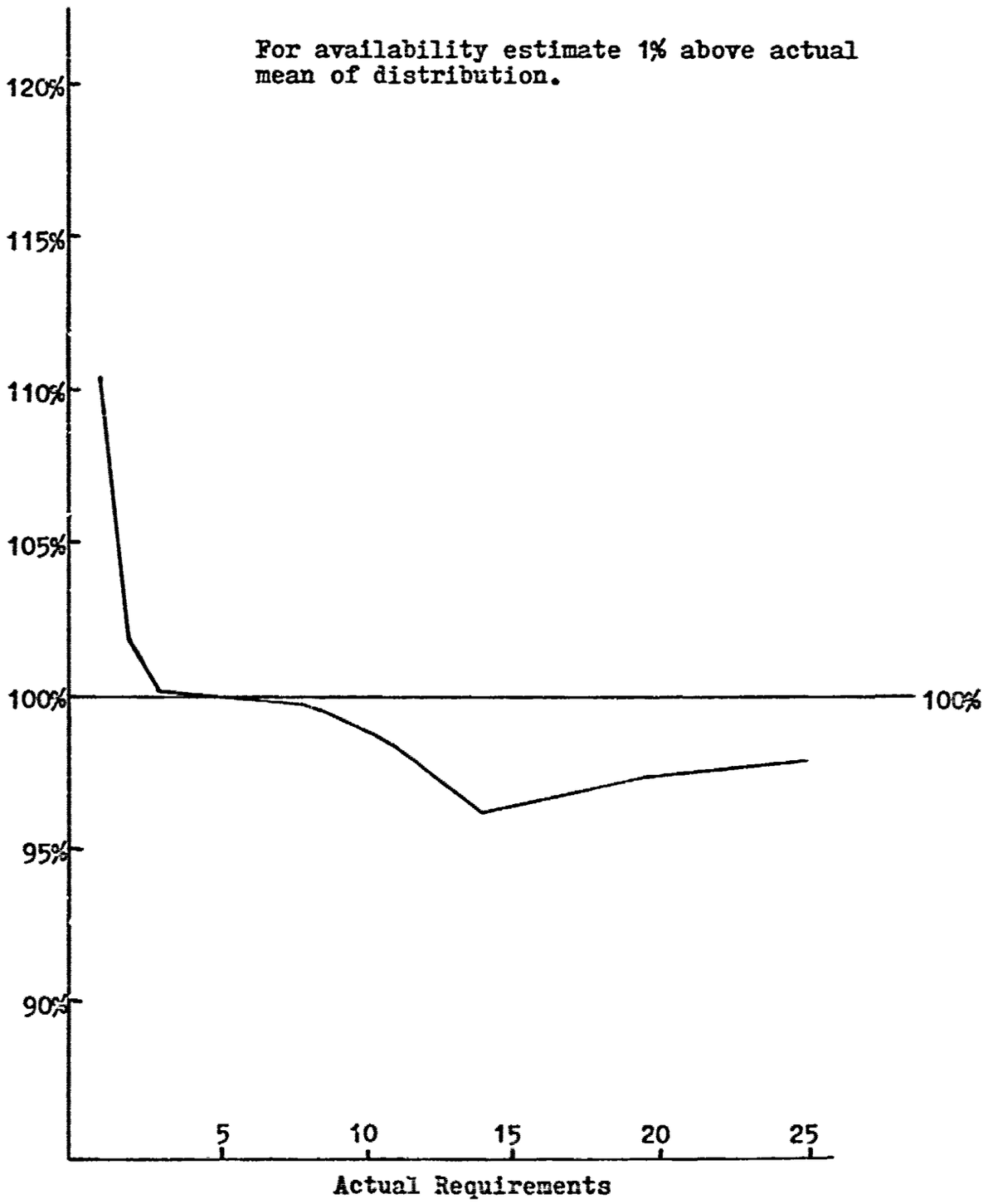
Military Work Center

For availability estimate 5% above the actual mean of the distribution.



COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS

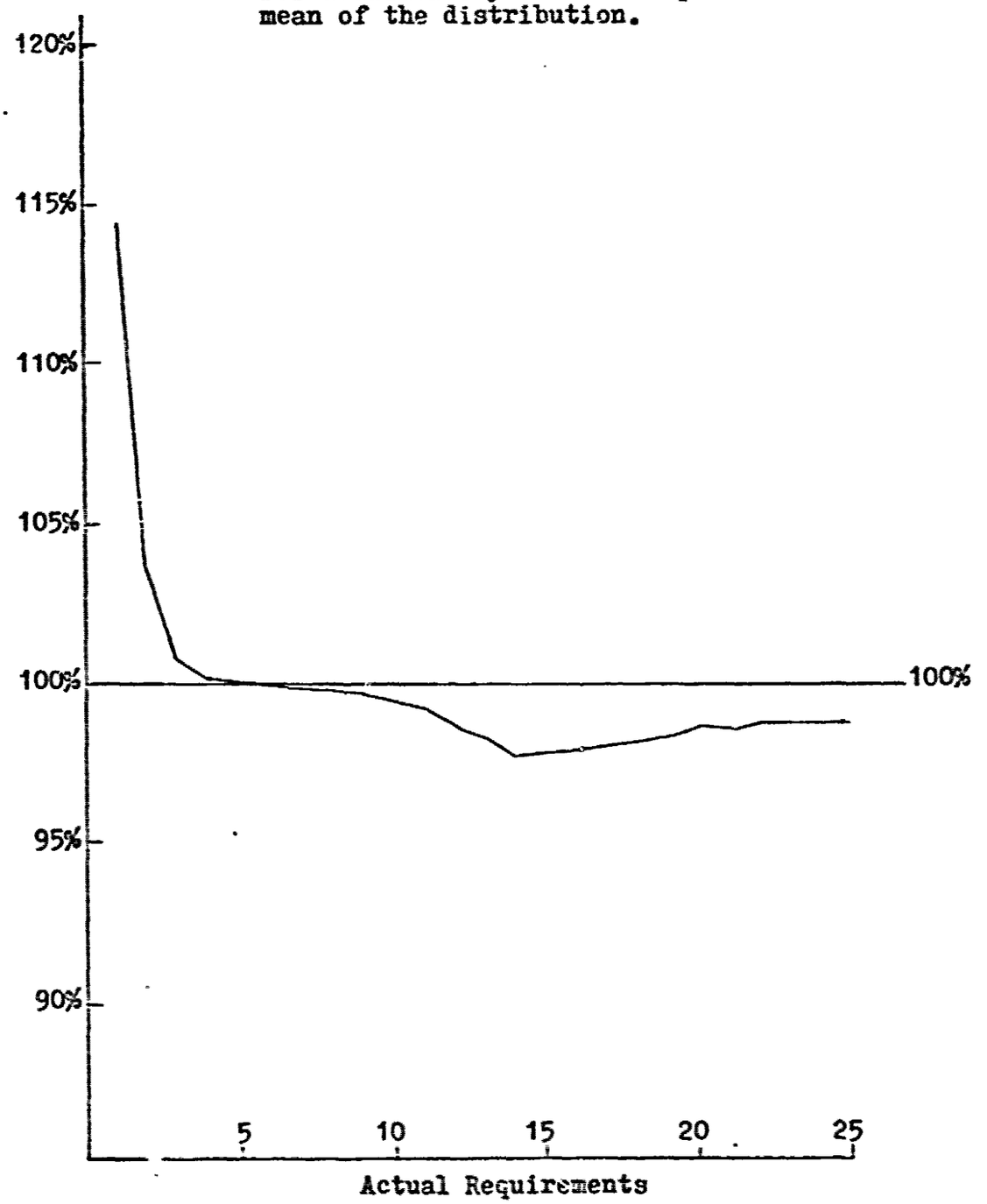
Military Work Center



COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS

Military Work Center

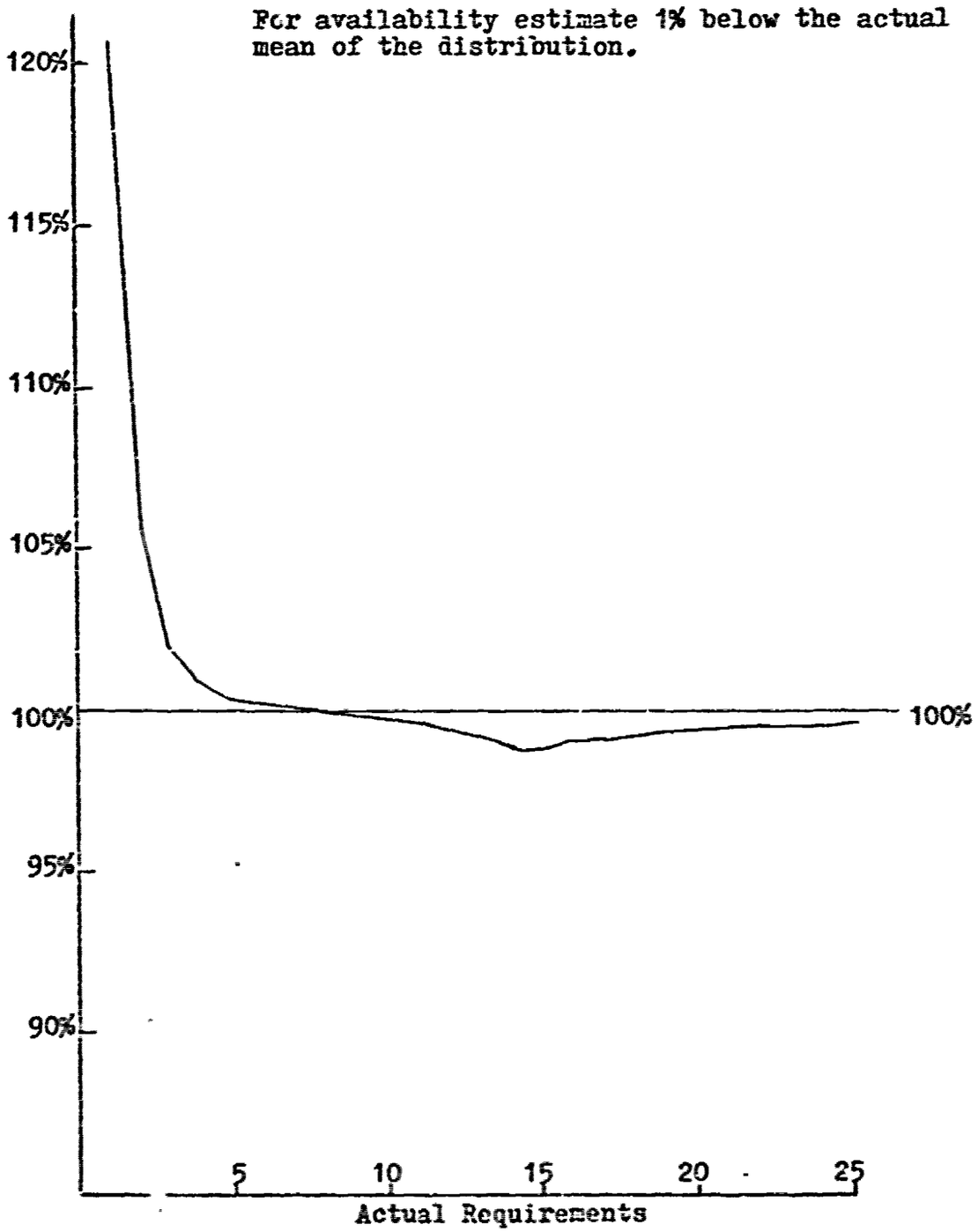
For availability estimate equal to the actual mean of the distribution.

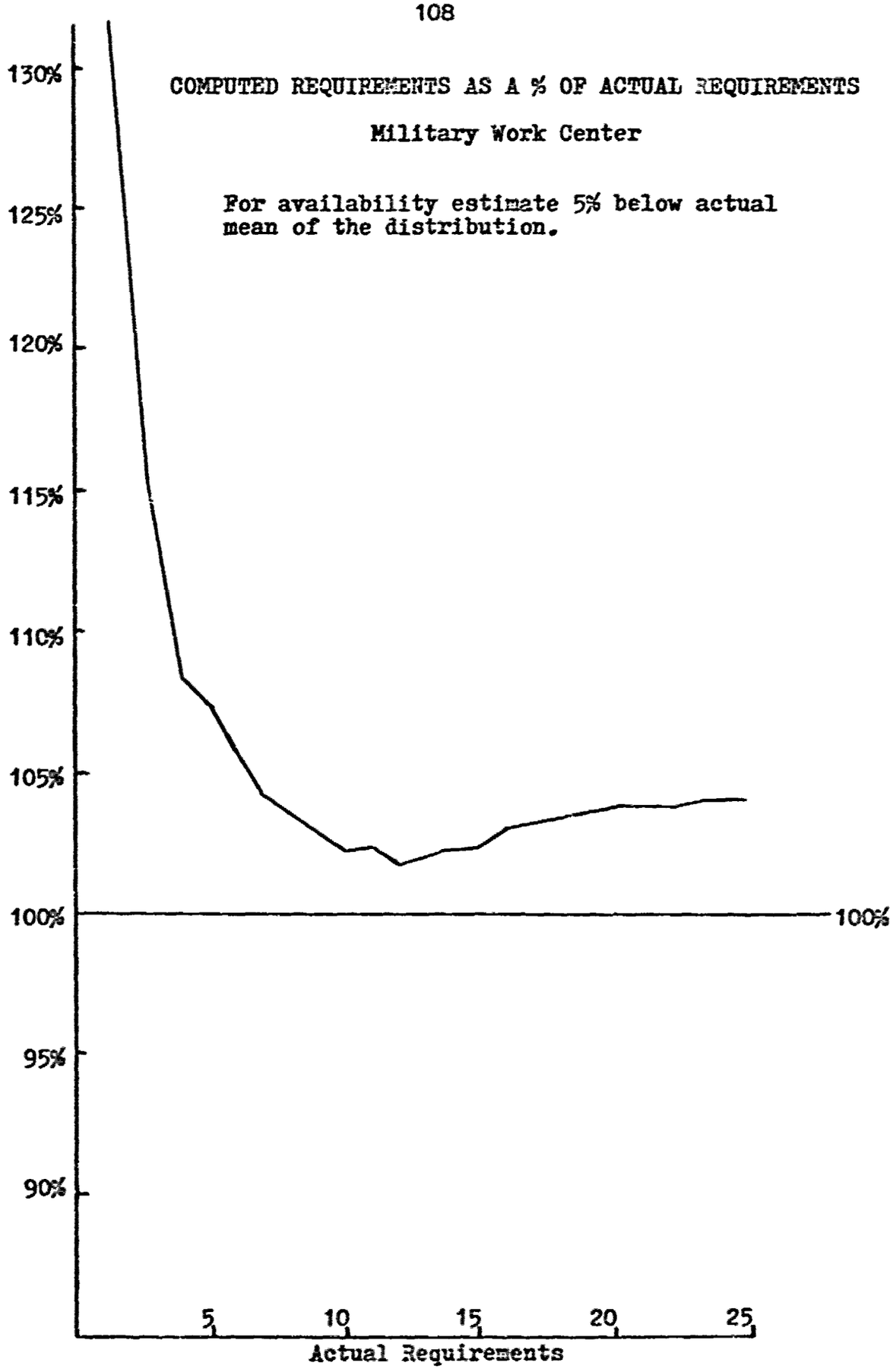


COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS

Military Work Center

For availability estimate 1% below the actual mean of the distribution.




COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS
Military Work Center
For availability estimate 5% below actual mean of the distribution.
130%
125%
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115%
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100%
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100%
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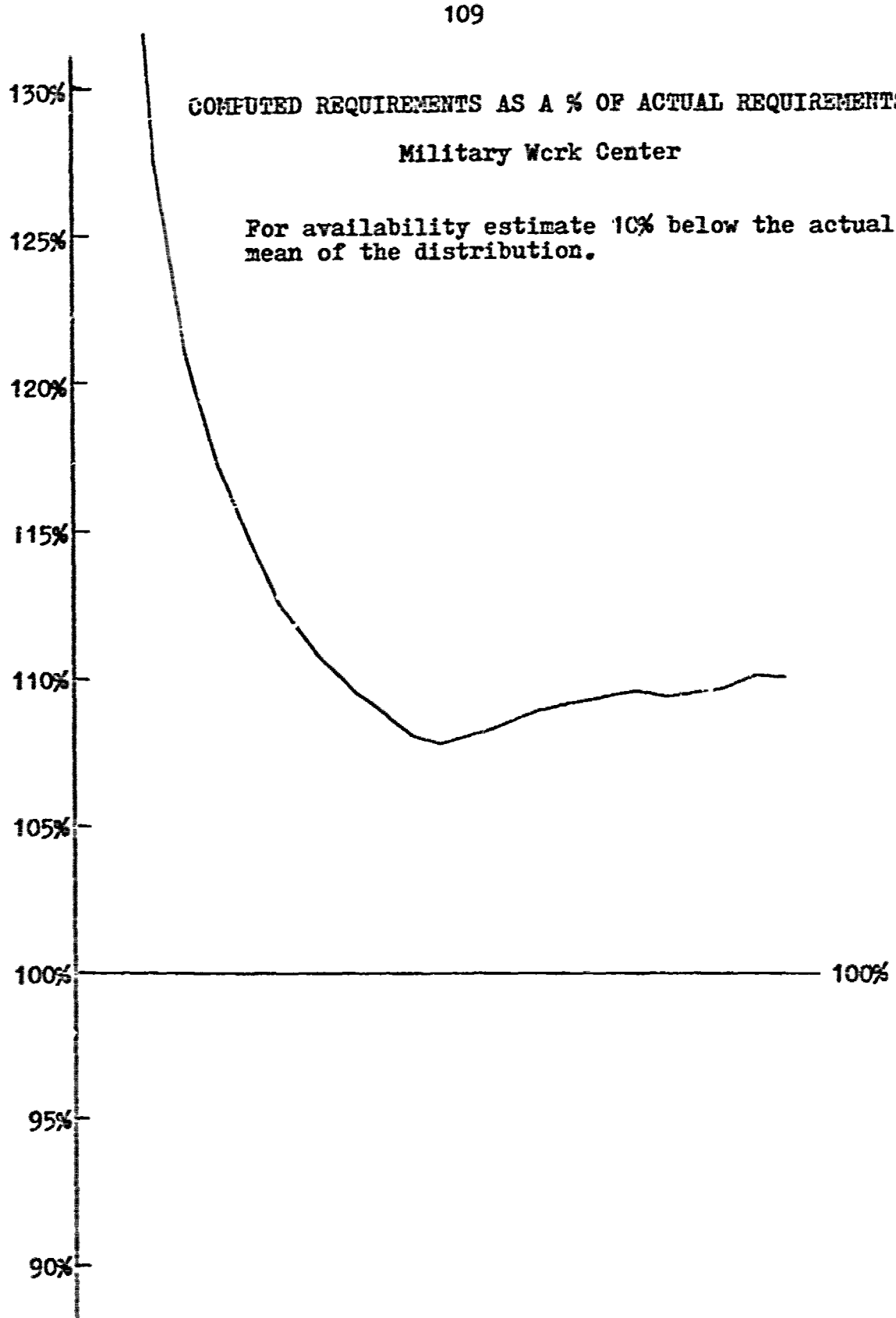
Actual Requirements


COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS
Military Wcrk Center
For availability estimate 10% below the actual mean of the distribution.
130%
125%
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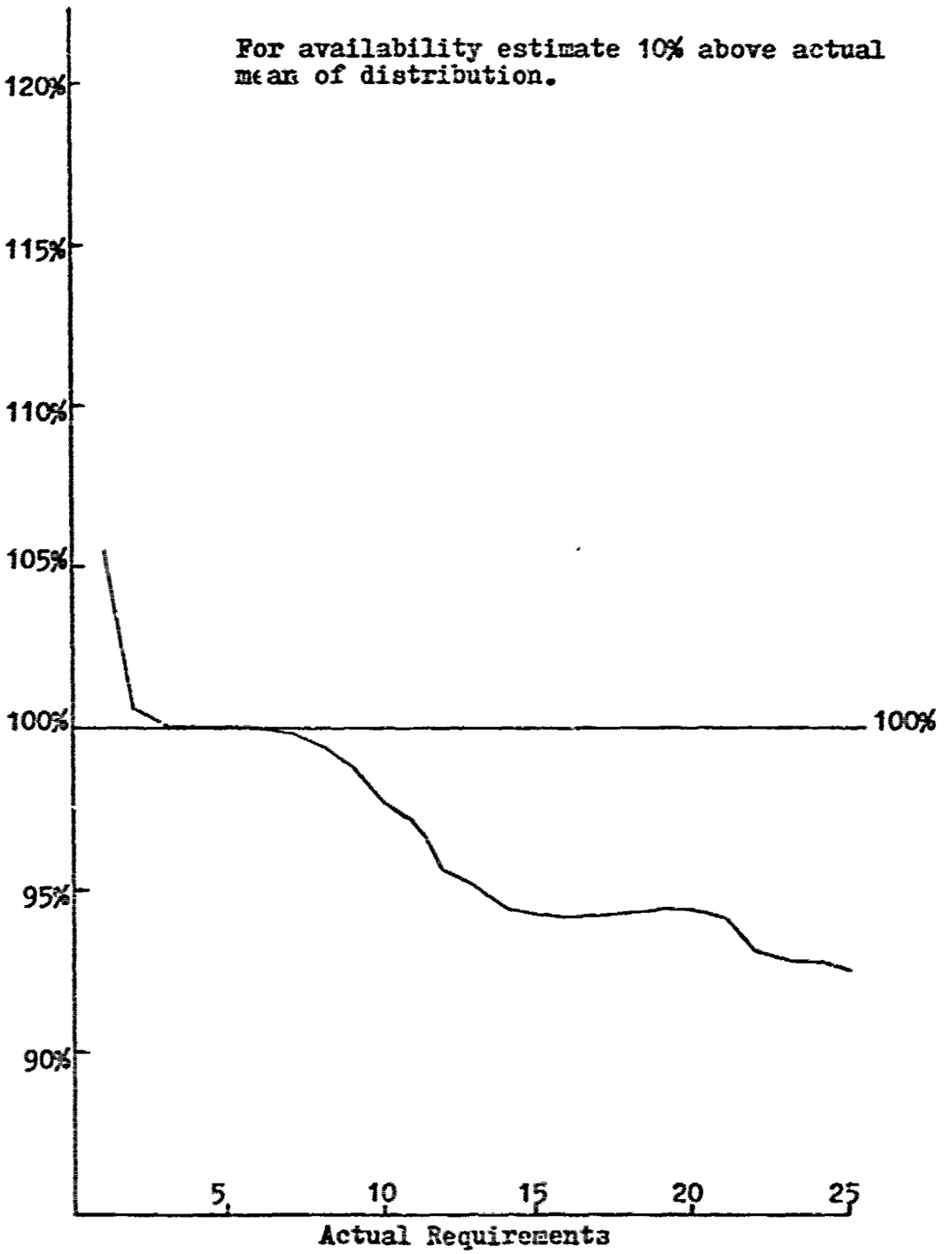
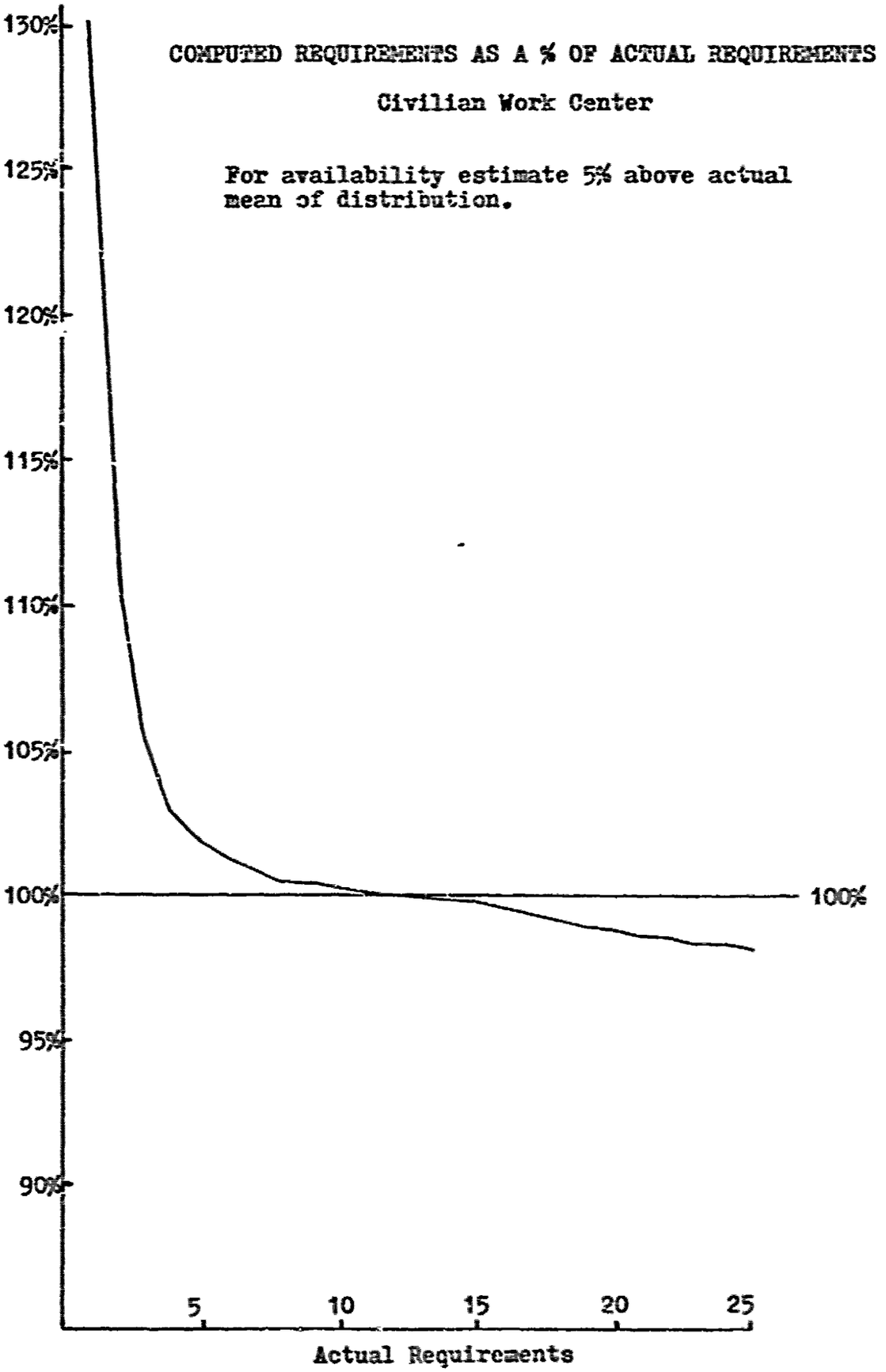
Actual Requirements

COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS

Civilian Work Center




COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS
Civilian Work Center
For availability estimate 5% above actual mean of distribution.
130%
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100%
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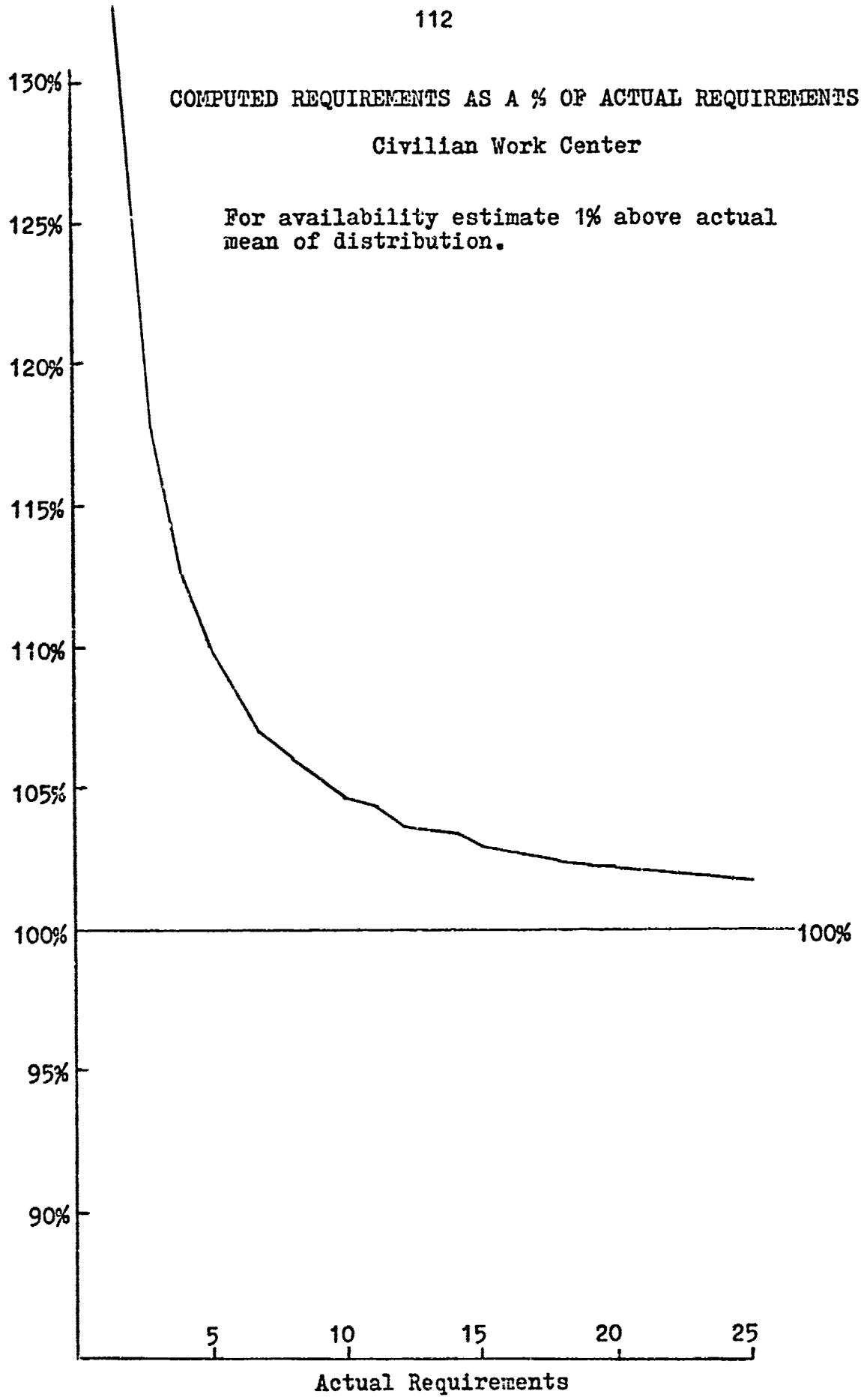
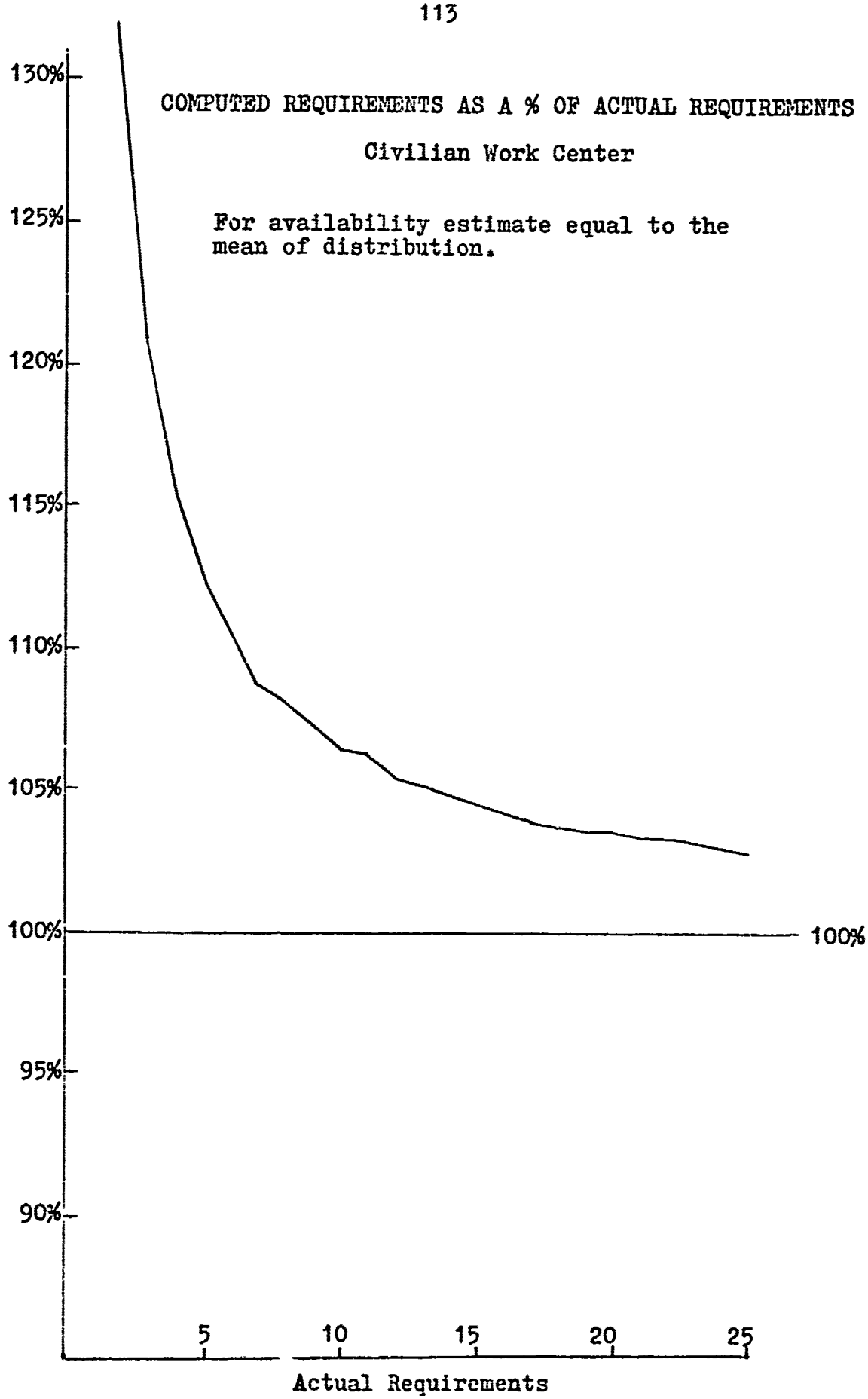
Actual Requirements

COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS

Civilian Work Center

For availability estimate 1% above actual mean of distribution.




COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS
Civilian Work Center
For availability estimate equal to the mean of distribution.
130%
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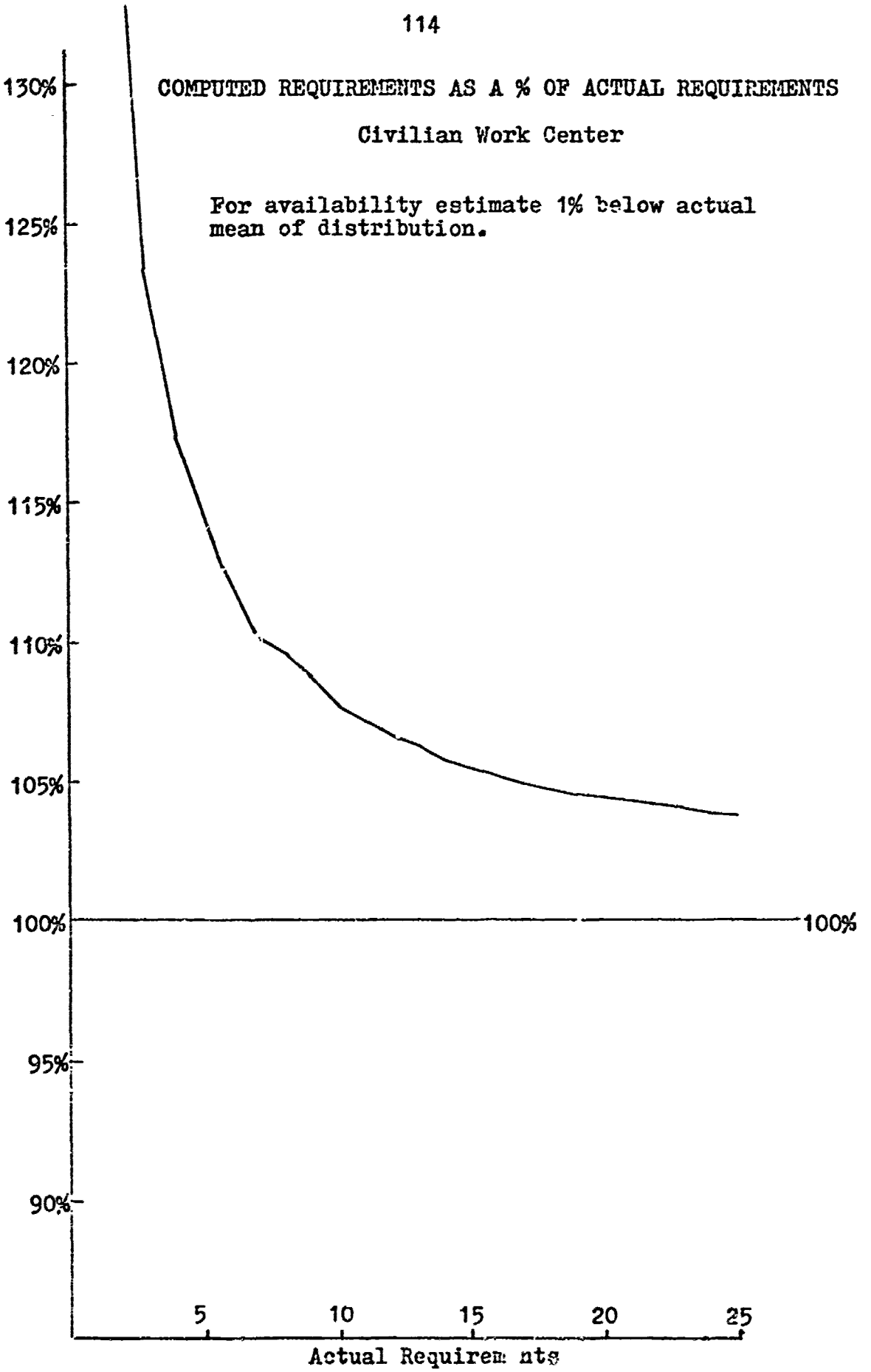
Actual Requirements


COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS
Civilian Work Center
For availability estimate 1% below actual mean of distribution.
130%
125%
120%
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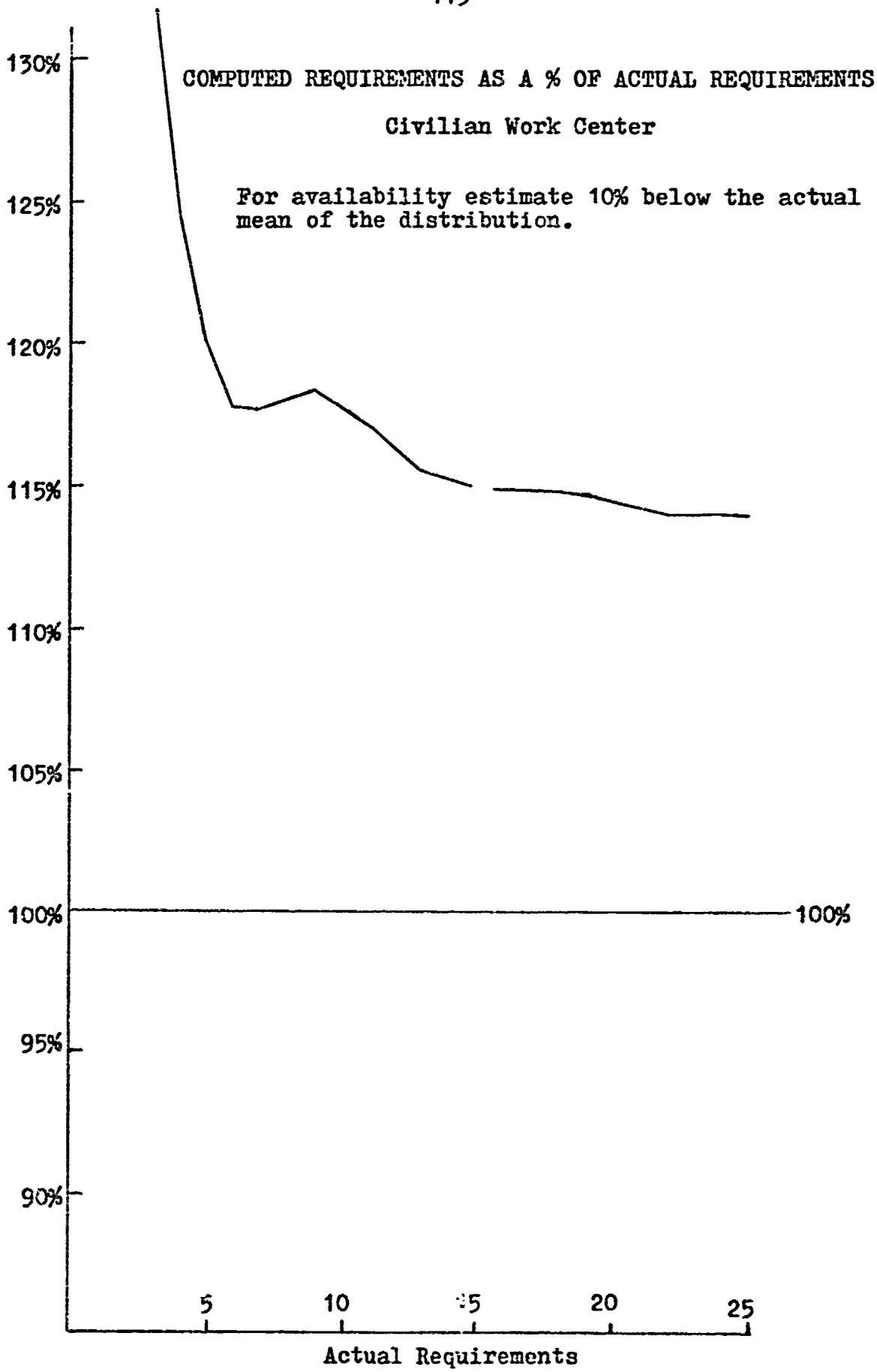
Actual Requirements


COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS
Civilian Work Center
For availability estimate 10% below the actual mean of the distribution.
130%
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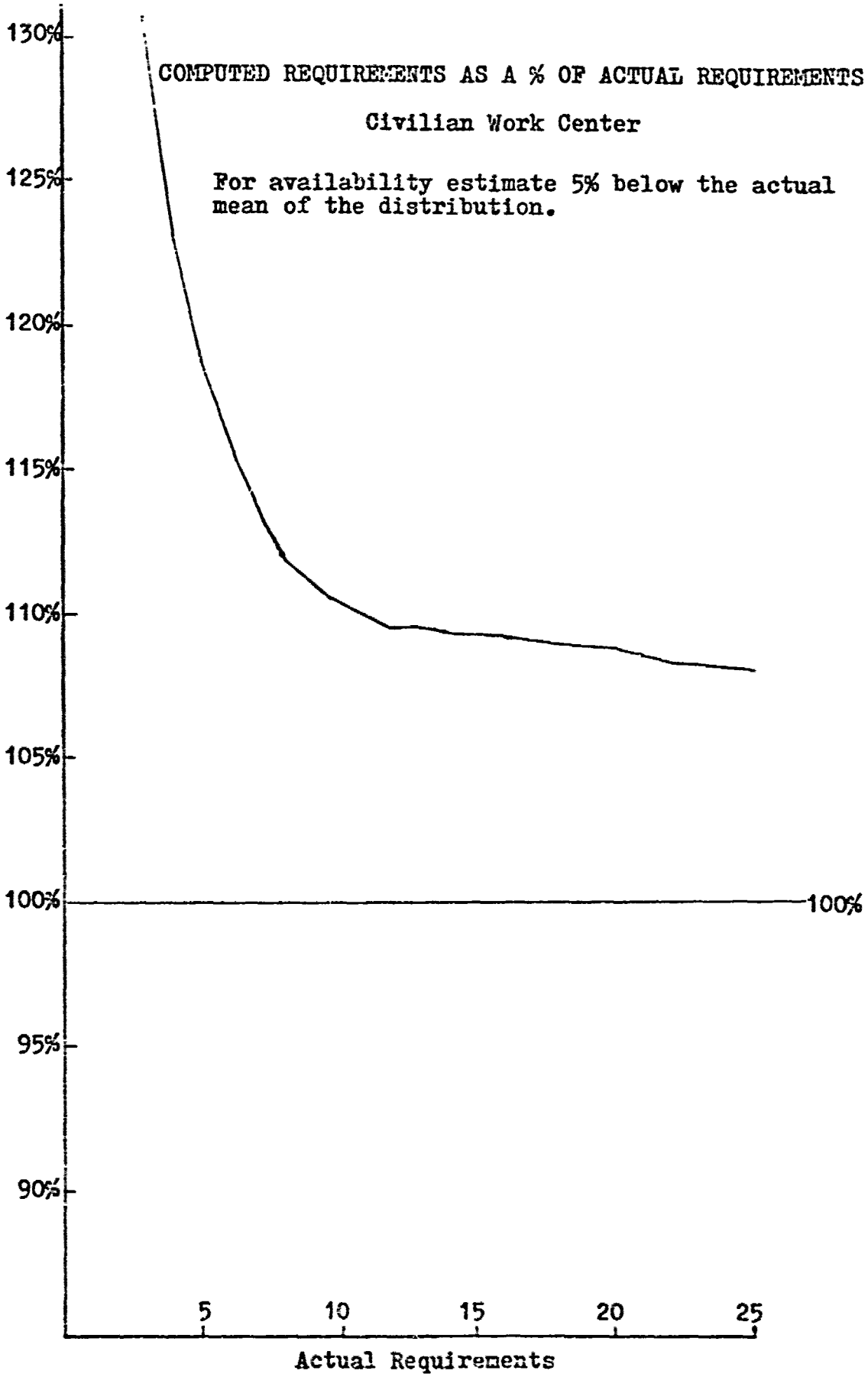
Actual Requirements


COMPUTED REQUIREMENTS AS A % OF ACTUAL REQUIREMENTS
Civilian Work Center
For availability estimate 5% below the actual mean of the distribution.
130%
125%
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100%
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100%
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Actual Requirements

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