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The Effects of Multiple Anthropometric Constraints on the Accommodation of Personnel in Operational Naval Aircraft

by

James Clayton Bartholomew

September, 1980

Thesis Advisor: W. T. Moroney

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All Navy aircraft are required to accommodate, anthropometrically, ninety percent of the user population. Some designs have been criticized for their low accommodations but those accommodations have never been quantified. The purpose of this thesis was to quantify the accommodation, by each type of operational Naval aircraft, of populations of Naval aviation personnel of 1964, 1969, and →

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A

The Effects of Multiple Anthropometric Constraints on the Accommodation of Personnel in Operational Naval Aircraft

by

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ABSTRACT

All Navy aircraft are required to accommodate, anthropometrically, ninety percent of the user population. Some designs have been criticized for their low accommodations but those accommodations have never been quantified. The purpose of this thesis was to quantify the accommodation, by each type of operational Naval aircraft, of populations of Naval aviation personnel of 1964, 1969, and 1975. The Computerized Accommodation Percentage Evaluation (CAPE) model was used to generate data points since only summary statistics were available for two of the populations. Each subject of every population was checked against the requirements of the design specification, and against the limitations of each aircraft. All aircraft were found to accommodate more than ninety percent of the 1975 population. Time related changes in the populations were noted and unexplained inconsistencies in the data were discovered. Possible sources of error were discussed and potential solutions proposed.

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LIST OF ABBREVIATIONS

ACEL - Air Crew Equipment Laboratory

b-knee lnth. - buttock-knee length

BUMEDINST - Bureau of Medicine and Surgery Instruction

CAPE - Computerized Accommodation Percentage Evaluation Model

CNATRAINST - Chief of Naval Aviation Instruction

fnct.rch. - functional reach

MANMED - U.S. Navy Manual of the Medical Department

MIL-STD - Military Standard

NAEC - Naval Aviation Engineering Center

NAMI - Naval Aerospace Medical Institute

NAMRL - Naval Aerospace Medical Research Laboratory

NASA - National Aeronautics and Space Administration

NAVAIRINST - Naval Air Systems Command Instruction

NFO - Naval Flight Officer

NROTC - Naval Reserve Officer Training Corps

sit.ht. - sitting height

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I. INTRODUCTION

The Human Engineering Design Criteria for Military Systems, Equipment and Facilities [MIL-STD-1472B] states the requirement for anthropometric accommodation of equipment users:

> Design and sizing shall insure accommodation, compatibility, and maintainability by at least 90 percent of the user population. Generally, design limits shall be based upon a range from the 5th percentile to the 95th percentile values for critical body dimensions.

For the special case of Naval Aircraft cockpits, the accommodation criterion was enlarged in 1973 to include the central 95 percent of the user population [NAVAIR SD-24K, 1973]. The anthropometric description of the population is based on data collected in 1964. Although a future survey, scheduled for 1981, will provide a more current description of the anthropometric features of Naval aviation personnel, aircraft now being designed for production and use well into the future are being designed to accommodate the 1964 population. The F-18, projected to become operational in 1982 will be built to accommodate the pilots of 1964. Other designs, if they have advanced much beyond the concept stage, are committed to the same aircrew accommodation standards.

The anthropometric characteristics of the population are changing but the design specification is not. That the population is changing is reflected in efforts by the National Aeronautics and Space Administration and by the United States Air Force to predict the typical pilot size of the future. A 1978 study conducted by NASA concluded that stature (height) increases among pilot and potential astronaut males could be expected to amount to about 8 mm (1/3 inch) per decade [NASA 1024 Vol. I, 1978]. The U.S. Air Force predicted an increase in height of 0.418 inch per decade Roebuck, Kroemer, and Thompson, 1975 . These changes, since 1964 and into the future, affect pilot accommodation in operational Naval aircraft, but the exact nature of the effect is not known.

In 1977 the Navy implemented the Anthropometric Compatibility Assignment Program [OPNAVINST 3710.36], a system aimed at preventing the assignment of Naval Aviators and Naval Flight Officers to aircraft which are incompatible with their anthropometric features. Under the provisions of this program, pilots' and NFOs' anthropometric measurements are taken when they enter flight training [BUMEDINST 3710.1, 1977]. Values for sitting height, functional reach, buttock-knee length, and leg length (for descriptions of anthropometric terms, see Appendix A) are encoded and become part of their permanent records. For example, a man coded

6 4 2 3

would have a sitting height measurement between 38.5 and 38.9 inches, a functional reach of 30.5 to 30.9 inches, buttock-knee length of 23.0 to 23.9 inches and a leg length of 40.0 to 42.9 inches.

The cockpits of each operational aircraft type are measured to determine the limits of pilot size compatible with the cockpit [NAVAIRINST 3710.9, 1979]. The maximum and minimum acceptable dimensions for sitting height, functional reach, buttock-knee length, and leg length are determined for each cockpit. These maxima and minima are then converted to four coded descriptors, which signify dimensions of exclusion for pilots. For example, an A-4E is coded:

089 9 789 0

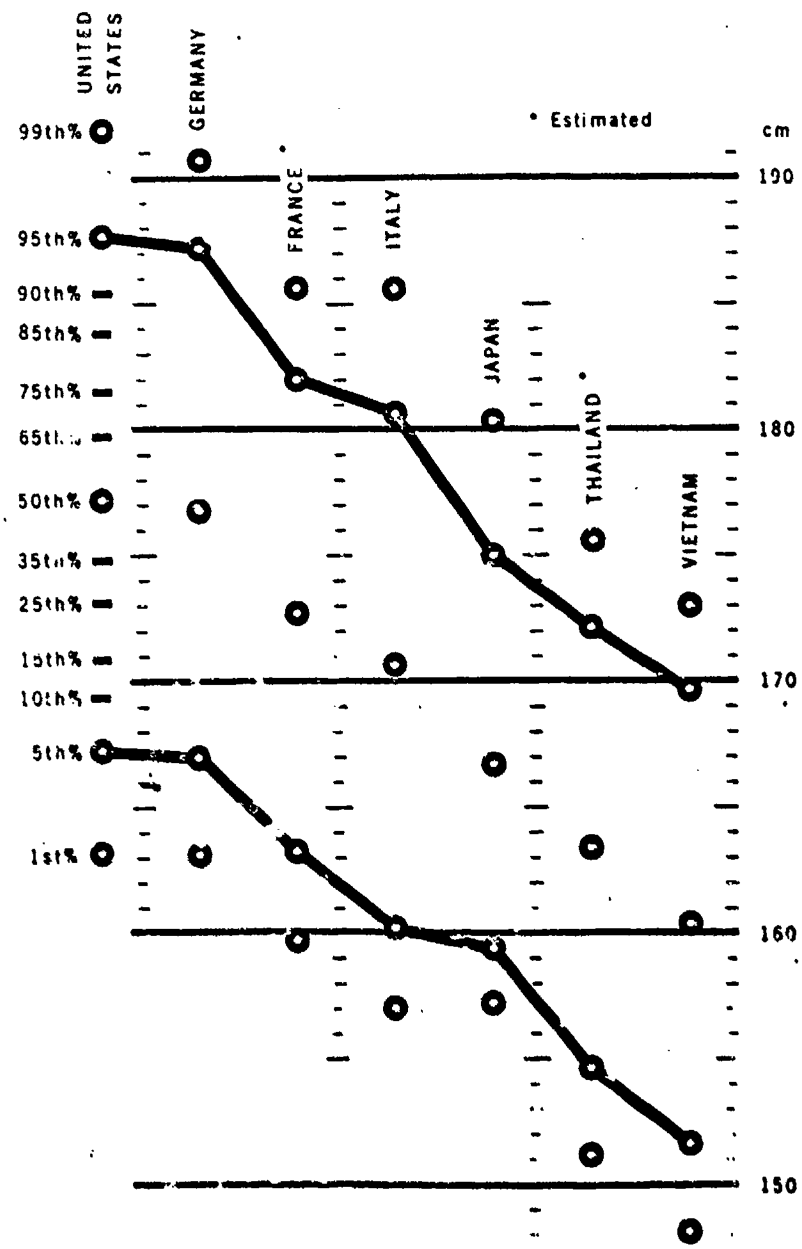
As with the personal anthropometric codes, the first of the four groups of numbers corresponds to sitting height. The second group corresponds to functional reach; the third to buttock-knee length, and the fourth to leg length. The code 089 9 789 0 indicates that a pilot with a sitting height code 0, 8, or 9 would not be eligible for assignment to an A-4E. Similarly any pilot with a functional reach code 9, buttock-knee length code 7, 8, or 9, or a leg length code 0 would be excluded.

The Chief of Naval Aviation Training (CNATRA) is required to utilize these codes early in each aviation student's training to exclude the student from training sequences leading to aircraft with which he is not compatible [CNATRAINST 13520.1, 1980]. The Navy Military Personnel Command uses the anthropometric codes in the process of assigning pilots and NFOs to aircraft squadrons.

Currently, a similar coding scheme is under consideration for use internationally among free world nations [Clauser, 1980]. The need for such a program was indicated by difficulties encountered by some foreign countries operating aircraft acquired from the United States and other foreign sources.

In Figure 1, it is apparent that the height of U.S. Air Force flight personnel is generally greater than that of other countries. The fifth percentile in U.S. height is greater than the 50th percentile of the samples from Japan, Thailand, and Vietnam. Figure 2 shows a similar relationship for sitting height.

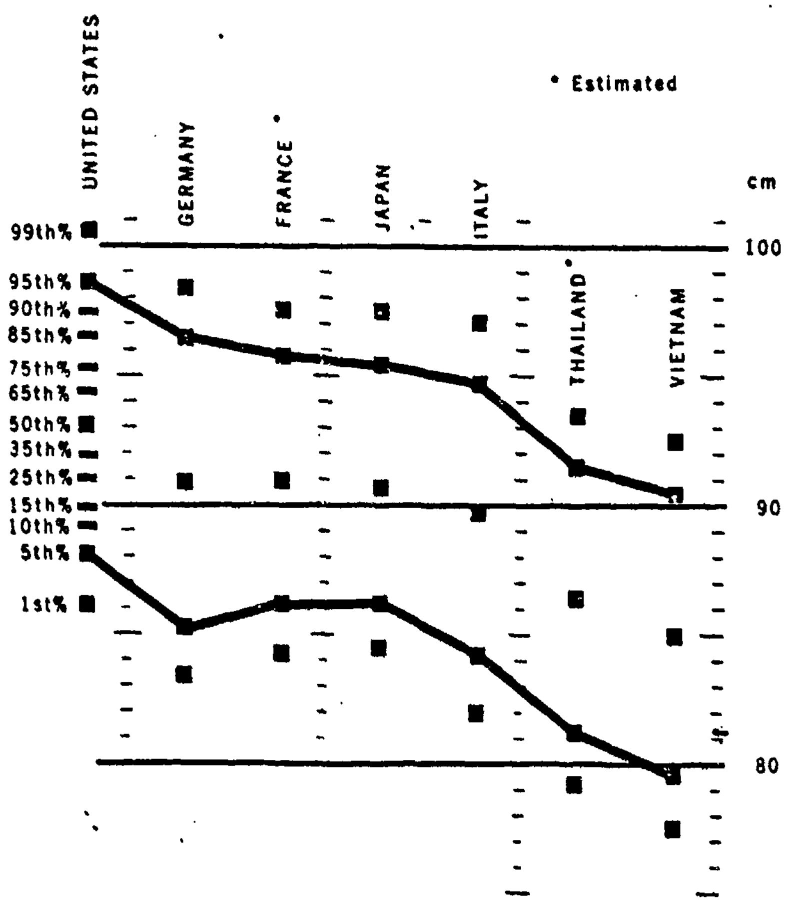
Figure 1
Heights of Seven Military Populations



SOURCE: Kennedy, K.W., 'Anthropometry and Kinematics in Crew Station Design,' Crew System Design: An Interagency Conference, Cross, K.D. and McGrath, J.J. (eds.), proceedings of an interagency conference, Los Angeles, 12-14 September, 1972, p. 70.

Figure 2

Sitting Heights of Seven Military Populations



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In this case the 5th percentile is larger than the 50th percentile of Thailand and Vietnam. Aircraft designed to accommodate people as small as the 5th percentile of the U.S. population can be expected to exclude about half of certain foreign populations and as much as 75 percent of the Vietnam aviation personnel [Kennedy, 1973].

Although design criteria require accommodation of the central ninety percent of the Naval aviation population, the existing population is imperfectly described by the 1964 sample. Changes in the selection process, trends in the United States general population were cited as factors contributing to the differences between the 1964 and the 1969 populations [Moroney, Kennedy, Gifford, and Provost, 1971]. In addition, designing to accommodate the fifth and ninety-fifth percentiles in each variable does not yield an accommodation of ninety percent of the total population. Since exclusion results from any one measurement being outside limits, accommodation is as much a function of the correlation between measurements as it is a function of each measurement. The correlation between measurements is appreciably less than 1.0 and accommodation is less than that indicated by any univariate estimate. When twelve measurements were considered, the exclusion of subjects who were outside the 5th and 95th percentile range in any measurement yielded a cumulative exclusion of 48 percent [Moroney and Smith, 1972]. As the existing population is altered further by expanding the acceptable range to include a greater percentage of the female population, user accommodation will be adversely affected. For example, a generalized cockpit built to male anthropometric standards excluded 22 percent of the male user population. The same cockpit excluded 90 percent of the females in the U.S. Air Force [Ketcham-Weidl and Bittner, 1976].

Before considering future changes in the population, the current anthropometric exclusion situation should be determined. However, the proportion of the Naval aviation population excluded by the existing design specification has not been quantitatively determined. Similarly the proportion excluded by each specific aircraft design is unknown. Some aircraft can be expected to exclude more than the ten percent designed out by the specification. Other aircraft will exclude less than the maximum allowable ten percent by virtue of design allowance or perhaps by chance.

The methods employed in measuring aircrew personnel have been found to be rather unreliable [Moroney, et. al., 1971]. These measurements, however, form the basis of the Anthropometric Compatibility Assignment Program and their accuracy is critical since they constitute a determining factor in an officer's career path starting point. Additionally, these same data will be used to help identify (or eliminate) subsequent aviation duty assignments. Considerable attention has been placed on determining the proper use of the data but the actual collection of the data appears to be an area where reliability could be improved. Currently, there is no systematic method of checking anthropometric measurements. Each student is measured once without any attempt at remeasurement or checking of the accuracy of the measurements. If a measurement is recorded in error, the error becomes part of the student's record, undetected until some independent event brings the error to light. Errors in measurement of as much as three inches have been found [O'Leary, 1980] subsequent to the erroneous measurement being used to determine anthropometric suitability and assignment of a student to an aircraft type. Some students have completed flight training before anthropometric measurement errors were detected, resulting in reassignment and expensive retraining.

The purpose of this thesis is to quantify the amount of incompatibility between aircraft and aircrewmen and to propose some alternatives to improve the reliability of the personal anthropometric measurements now being taken. By examining samples drawn from three Naval aviation populations, each of a different year, proportions of those populations excluded from Naval aircraft will be determined. The exclusions resulting from changes in the population will be quantified and the specific proportions excluded from each aircraft type, as a function of sample source, will be calculated. Those results will lead to a discussion of some inconsistent patterns in the data and recommended changes in the data collection procedure now used by the Navy.

Chapter 2, DATA SOURCES, describes the three data sets analyzed. For each of the three samples: the subjects were described, previous statistical analyses discussed, and methods of data collection compared. Chapter 3, DATA PREPARATION, describes the preparation of each data set to facilitate analysis. Preparations consisted primarily of the use of a segment of the Computerized Accommodation Percentage Evaluation (CAPE) model to generate data points from a statistical description of the population. Chapter 4, ANALYSIS OF DATA, describes the screening of each data set to determine the proportion of the sample excluded. Screening involves the elimination of any subject with an anthropometric measurement outside prescribed limits. The proportions excluded from each sample are then compared. Observations on the apparent shortcomings in data collection methods, errors in measurements, and unexplained inconsistencies were included. Chapter 5, SUMMARY AND CONCLUSIONS, includes inferences concerning interpretations of anthropometric data and recommendations in the area of data collection methods for use by the Navy.

II. DATA SOURCES

The data to be analyzed consisted of samples from three populations. Samples of Naval aviation personnel were taken in 1964, 1969, and 1975. Differences between populations other than the year of the sample exist and they will be discussed below.

A. THE 1964 SURVEY DATA

In 1964, a survey was conducted to determine the anthropometric characteristics of personnel flying in Naval aircraft. The survey was conducted in a manner to yield results sufficiently precise to be utilized subsequently for design of aircraft. The Bureau of Medicine and Surgery, tasked to collect data for use by the Bureau of Weapons, sent a trained anthropometric measuring team to ten different Naval and Marine Corps air stations to take measurements.

Included in the sample were pilots, Naval Aviation Observers, bombardier-navigators, radar observers, flight surgeons who were designated Naval Aviators, and enlisted personnel who were permanently designated aeronautical personnel and who were still eligible for assignment to subsequent duty involving flying. Naval Aviators included both U.S. Navy and the U.S. Marine Corps flyers.

The subjects in this survey comprised approximately ten percent of the Naval aviation population on active duty in 1964. The sample included personnel of various ages, ranks, ethnic backgrounds and sources (Naval Academy, NROTC, etc.). In that respect the sample undoubtedly provided an accurate representation of the Naval a·iation population. The composition of the sample is somewhat different from the later samples in the respect that enlisted men and older men were surveyed in 1964 but not in the later samples. The reliability of the measurements received special attention and was enhanced by the repeat measurement of randomly selected subjects, insuring rapid detection of measurement errors and encouraging the data collectors to be careful in their task. Each measurement was taken by personnel specifically trained for the job, using a technique of measurement recognized as the most accurate available.

Published results of the survey include means and standard deviations, as well as percentile listings for each variable [Gifford, Provost, and Lazo, 1965]. Subsequent analysis of the data led to publication of correlations between pairs of variables [Moroney, et. al., 1971].

The results of this survey were adopted by the Navy as the basis for aircraft design specifications. MIL-STD-1333A, Military Standard Aircrew Station Geometry for Military Aircraft, includes NAEC-ACEL-553 as part of the standard, thus specifying the 1964 data as the guideline for aircraft being built today (NAEC-ACEL-553 reported the results of the

1964 survey). In that sense, these results are recognized as the standard and they have become the yardstick against which other data can be compared.

This data set has two shortcomings with respect to this thesis, however. No measurements of leg length (or buttock-leg length) were taken. The components of leg length (buttock-knee length, knee height sitting and popliteal height sitting) were recorded but leg length had not yet been recognized as a critical selection dimension. Also, the results of data analysis are available, but the raw data are not. The importance of these two limitations will become apparent when procedures are discussed.

B. THE 1969 DATA

Subsequent to the introduction of an integrated anthropometric measuring device in 1964, the Navy required that the device be used to measure all aviation training candidates during their aviation training entrance physical examination, which was administered at the School of Aviation Medicine (now the Naval Aerospace Medical Institute). The collection of anthropometric data was thus institutionalized and became a routine process. Eight measurements were taken on each entering Student Naval Aviator and Student Naval Flight Officer. These measurements were:

weight	trunk height
height	buttock-knee length
sitting height	buttock-leg length
shoulder width	functional reach

Between January 1966 and August 1969, 6,534 students were measured. Their measurements comprise the data set herein called the 1969 data. The description of this data set was published in 1971 [Moroney, et. al., 1971] and includes the mean and standard deviation of six measurements (shoulder height and functional reach were deleted from the analysis), percentile listings for those measurements and correlations between variables.

No information on functional reach or shoulder height was published because of the discovery of measurement technique errors resulting in measurements uncorrectible by any means short of repeat measurement. This deviation from ideal procedure should not have been altogether surprising since measurements were taken by personnel whose level of training did not match that of the 1964 data collectors. In addition, measurements were taken and recorded with no subsequent checking, leaving procedural errors undetected and biasing the measurements of many subjects.

The size of the 1969 data set is quite large, consisting of virtually all of the student aviation input for over three years. As with the 1964 data set, no raw data is available, only analytical results. The absence of functional reach from the data analysis will present an obstacle to be discussed in Chapter 3.

C. THE 1975 DATA

Following the publication of the results of the 1969 data analysis, an improved integrated anthropometric measuring device was installed at NAMI and it was subsequently used to measure incoming students. That device is still in use today. It is operated by NAMI staff Hospital Corpsmen and it was used to measure the same eight dimensions as was its predecessor. A sample of 968 students who entered training in 1975 comprise the subjects of the 1975 data. The raw data is available and from an examination of the data points thirty-two subjects were found to be deficient in some respect and did not meet the entry requirements delineated by the Bureau of Medicine and Surgery [MANMED, 1978]. Most of these ineligibilities were based on excessive weight. However, all subjects were screened for minimum and maximum values of weight, height, sitting height, and buttock-leg length, as well as for height-weight relationship. The remaining 936 subjects comprise the acceptable sample.

The 1975 data were collected in a manner similar to that used for the 1969 data set: a routine execution of established procedures by Navy enlisted personnel. The 1975 data also manifest data collection deviations similar to those of the 1969 data. The number of subjects is smaller than either of the other samples but still large enough to lend itself to statistical analysis.

III. DATA PREPARATION

The goal of the analysis was to determine the proportions of the 1964, 1969, and 1975 samples excluded by the four anthropometric limitations (sitting height, functional reach, buttock-knee length, and leg length) required by OPNAVINST 3710.36A. This goal was achieved by screening each subject four times, once for each of his measurements, and eliminating every subject whose measurements were not all within limits.

This procedure required knowledge of the four individual measurements for each subject. In the 1975 data set, the four measurements (and more) were readily available. For the earlier data sets, only means, standard deviations, and correlations were available and no individual measurements were known. It was necessary, therefor, to generate data to simulate those measurements.

The Computerized Accommodated Percentage Evaluation (CAPE) model [Bittner, 1975] was used to generate the required data points. This model required as entering arguments the mean and standard deviation for each of the four variables, as well as a matrix of correlations between variables. The model used a Monte Carlo process to generate data points. A program listing is included in Appendix C (Appendix D presents the same program modified for use with the IBM 360-67 computer and other machines using Fortran IV). The CAPE model has been incorporated in the Computerized Accommodated Reach Model and is available at the Naval Aviation Development Center, Warminster, Pennsylvania.

Unfortunately, some of the values required for generating the data points were missing from the survey reports. Specifically, the 1964 data included no information on leg length and the 1969 data omitted functional reach. It was necessary to find values in similar populations and substitute them for those missing. Taking values from other populations required the assumption that concurrent populations, similar in cultural, racial, and demographic composition, and having passed similar anthropometric entrance requirements, will have comparable anthropometric features. That assumption was made and surrogate values for the missing means and standard deviations were taken from populations which matched the descriptions of the populations under analysis (1964 and 1975), both subjectively and numerically. Inter-variable correlations were determined on much the same basis: substituting correlations from similar populations. Ketcham-Weidl and Bittner [1976] had substituted correlations from a data set of male subjects into a set of female data and experienced little loss of precision.

For the 1964 data, the mean and standard deviation for leg length were assumed to be 43.82 and 2.01 inches, respectively. Those values were established in a 1968 survey of

U.S. Army helicopter students [Schane, Littell and Moultree, 1969]. Of the information available, the population of that survey, better than any other, approximated the 1964 Naval aviation population with respect to the factors which Moroney [1971] reported as influencing differences between the 1964 and 1969 Navy data sets. The Sitting height-Leg length correlation maintained the same value (0.45) for the 1969 and 1975 data sets so the same value was used for 1964. Functional reach-Leg length and Buttock knee-Leg length correlations (0.639 and 0.860) were extracted from a 1970 survey of U.S. Army aviators [Churchill, McConville, Laubach, and White, 1971], again because of the similarities in descriptions of the 1970 Army and 1964 Navy populations.

For the 1969 data, Functional reach values for USAF flight personnel reported by Churchill [1971] were used for the mean and standard deviation (31.24 and 1.62 inches). The sitting height-functional reach and the buttock knee-functional reach correlations were assumed to be the same as those found in the 1975 data, 0.44 and 0.63, respectively. These values were greater than those of the 1964 data and their use, rather than the 1964 values, would influence error in the conservative direction, that is, in the direction of lesser difference between univariate and multivariate exclusion. The Leg length-functional reach correlation was taken from Churchill's 1970 survey and is the same value assumed for the 1964 data.

Table I

CAPE INPUTS AND OUTPUTS
FOR THE 1964 DATA

Means, Standard Deviations and Ranges

Variable	Observed Data	Generated Data
Sitting Height		
mean	36.28	36.29
std.dev.	1.25	1.26
range	32.19-41.62	31.81-40.25
Functional Reach		
mean	31.51	31.47
std.dev.	1.42	1.40
range	27.26-36.31	26.35-35.38
Buttock-Knee Length		
mean	24.09	24.10
std.dev.	1.00	9.94
range	20.73-27.81	21.06-27.11
Leg Length[a]		
mean	43.82	43.82
std.dev.	2.01	1.99
range	-----	37.97-49.87

[a]Schane, W.P., Littell, D.E., and Moultree, C.G., Selected Anthropometric Measurements of 1,640 U.S. Army Warrant Officer Candidate Flight Trainees, U.S. Army Aeromedical Research Laboratory Report 69-2, as reported in: Anthropometric Source Book Volume II: A Handbook of Anthropometric Data, NASA Reference Publication 1024, 1978, p. 156.

Table II

CAPE INPUTS AND OUTPUTS
FOR THE 1964 DATA

Correlations

	Sitting Height	Functional Reach	Buttock-Knee Length	Leg Length
Observed Data				
Sitting Height	1.0	.376	.382	.45[a]
Functional Reach		1.0	.586	.639[b]
Buttock-Knee Length			1.0	.86[b]
Leg Length				1.0
Generated Data				
Sitting Height	1.0	.410	.374	.446
Functional Reach		1.0	.587	.650
Buttock-Knee Length			1.0	.867
Leg Length				1.0

[a]Same as observed value for 1969 and 1975 samples.

[b]Churchill, E., McConville, J.T., Laubach, L., and White, R.M., Anthropometry of U.S. Army Aviators-1970, U.S. Army Natick Laboratories Technical Report 72-52-CE, December 1971, p. 278.

Table III

CAPE INPUTS AND OUTPUTS
FOR THE 1969 DATA

Means, Standard Deviations, and Ranges

Variable	Observed Data	Generated Data
Sitting Height		
mean	36.76	36.77
std.dev.	1.21	1.22
range	31.70-41.0	32.43-40.61
Functional Reach[a]		
mean	31.24	31.20
std.dev.	1.62	1.60
range	-----	20.02-35.73
Buttock-Knee Length		
mean	24.54	24.55
std.dev.	1.26	1.25
range	20.40-29.90	20.67-28.31
Leg Length		
mean	43.86	43.86
std.dev.	2.08	2.05
range	32.50-50.70	38.14-50.02

[a]Churchill, E., McConville, J.T., Laubach, L., and White, R.M., Anthropometry of U.S. Army Aviators-1970, U.S. Army Natick Laboratories Technical Report 72-52-CE, December 1971, p. 91.

Table IV

CAPE INPUTS AND OUTPUTS
FOR THE 1969 DATA

Correlations

	Sitting Height	Functional Reach	Buttock-Knee-Length	Leg Length
Observed Data				
Sitting Height	1.0	.44[a]	.40	.45
Functional Reach		1.0	.63[a]	.639[b]
Buttock-Knee Length			1.0	.86
Leg Length				1.0
Generated Data				
Sitting Height	1.0	.473	.393	.449
Functional Reach		1.0	.629	.652
Buttock-Knee Length			1.0	.801
Leg Length				1.0

[a]Same as observed value in 1975.

[b]Churchill, E., McConville, J.T., Laubach, L., and White, R.M., Anthropometry of U.S. Army Aviators-1970, U.S. Army Natick Laboratories Technical Report 72-52-CE, December 1971, p. 278.

Table V

DATA SET COMPARISON

Means, Standard Deviations, and Ranges

Variable	1964	1969	1975
Sitting Height			
mean	36.28	36.76	36.61
std.dev.	1.25	1.21	1.15
range	32.19-41.62	32.43-40.61	32.90-40.00
Functional Reach			
mean	31.51	31.24	30.89
std.dev.	1.42	1.62	1.16
range	27.26-36.31	26.02-35.73	27.10-34.60
Buttock-Knee Length			
mean	24.09	24.54	24.05
std.dev.	1.00	1.26	1.07
range	20.73-27.81	20.67-28.31	20.70-26.80
Leg Length			
mean	43.82	43.86	42.89
std.dev.	2.01	2.08	1.89
range	37.97-49.87	38.15-50.02	37.10-48.20

Table VI

DATA SET COMPARISON

Correlations

	Sitting Height	Functional Reach	Buttock-Knee Length	Leg Length
1964				
Sitting Height	1.0	.376	.382	.45
Functional Reach		1.0	.586	.639
Buttock-Knee Length			1.0	.86
Leg Length				1.0
1969				
Sitting Height	1.0	.44	.40	.45
Functional Reach		1.0	.63	.639
Buttock-Knee Length			1.0	.86
Leg Length				1.0
1975				
Sitting Height	1.0	.44	.40	.45
Functional Reach		1.0	.63	.61
Buttock-Knee Length			1.0	.79
Leg Length				1.0

When the assumed values described above were included in the data analysis, the requirements for CAPE input were complete. The inputs to CAPE are listed in Tables I through IV under Observed Data. One thousand subjects were generated for the 1964 and for the 1969 data sets. Together with the 1975 data in its original, as observed form, the result was three similar data sets with sample sizes of 1000, 1000, and 936. The validity of this model's performance has been demonstrated with a correlation between empirical and generated results of 0.997 to 0.999 [Bittner, 1974]. For the 1964 and 1969 data sets, the CAPE generated output was analyzed to insure that the means, standard deviations, and correlations of the generated data were actually those sought. The values used as inputs to CAPE and those resulting from analysis of the generated data are shown in Tables I through IV. Tables V and VI compare the summary statistics for all three data sets.

IV. ANALYSIS OF DATA

As a result of the data generating procedure, all three data sets included a value for each of the four relevant measurements for each subject. The samples were then examined more closely to determine which subjects in each sample would be excluded, either by design constraints (5th to 95th percentiles or 3rd to 98th percentiles) or by aircraft constraints specified by NAVAIRINST 3710.9.

A. PERCENTAGES EXCLUDED

Fortran program SCREEN was used to count the subjects who were too large or too small to satisfy anthropometric requirements. For each of the three samples, identical screening operations were conducted. Each subject was examined and excluded if any one or more of the four measurements under consideration was outside prescribed limits. Each subject's anthropometric features were tested against each cutoff limit. Thus an individual might be excluded on both functional height and sitting height but not on buttock-knee length and leg length. For each elimination encountered, the subject was counted as being eliminated and each variable causing an elimination was tallied. At the end of each sample, the resultant totals were converted to percentages of the total sample, yielding a percentage eliminated by each of the four variables and a total exclusion resulting from the net effect of the four variables' eliminations.

The prescribed limits mentioned above were set equal to the percentile values in the design specification (5th and 95th or 3rd and 98th percentiles). Then the limits were set, successively, to the anthropometric limits of each aircraft for which anthropometric coding had been established [NAVAIRINST 3710.9].

1. Design Constraints

To screen the samples by design specification, the subjects were screened to eliminate those with any of the four measurements less than the 5th percentile or above the 95th percentile of the 1964 data, the design standard [MIL-STD-1472B]. Then the screening cutoff points were changed to correspond to the 3rd and 98th percentiles [NAVAIR SD-24K, 1973], and the screening process was repeated.

It is interesting to note at this point that percentile values for leg length of the 1964 data do not exist since that measurement was not taken in the 1964 survey. Still, the Navy considers leg length to be a critical dimension in that it is one of the measurements included in the Anthropometric Compatibility Assignment Program. Critical dimensions are also the basis of the design specification since '...design limits shall be based upon a range from the 5th percentile to the 95th percentile values for critical body dimensions' [MIL-STD-1472B]. Since the percentile values were not available, values used for leg length percentiles were determined from the CAPE generated sample of 1000 subjects, described in Chapter III, DATA PREPARATION.

The design specification percentile screens resulted in the maximum exclusion percentage to be expected if aircraft were designed to accommodate only the specified percentiles, and no more, for each dimension. This result amounts to a worst case exclusion and could occur only if a design exactly met the bare minimum accommodation in each variable, a very unlikely event, and one which would still not meet the requirement to accommodate 90 percent of the user population as specified by MIL-STD-1472B. The percentile screen results, shown in Table VII, show that cumulative exclusion can greatly exceed the maximum single variable elimination. For example, the 1969 data screened on the 5th to 95th percentiles shows a total exclusion of 40.4 percent but the highest single variable elimination is the 21 percent excluded by buttock-knee length.

Table VII

Design Specification Exclusions for
the 5-95 Percentiles and the 3-98 Percentiles

Variable	1964	1969	1975
	5th to 95th Percentile		
	Percentage Excluded		
Sitting Height	11.1	11.5	7.7
Functional Reach	8.7	14.6	8.4
Buttock-Knee Length	9.1	21.0	13.2
Leg Length	9.8	11.3	11.8
Cumulative	26.4	40.4	26.7
	3rd to 98th Percentile		
	Percentage Excluded		
Sitting Height	5.0	4.7	2.7
Functional Reach	4.8	9.4	5.9
Buttock-Knee Length	5.4	11.6	6.4
Leg Length	4.9	4.7	6.9
Cumulative	14.3	22.7	14.3

The difference between cumulative exclusion and the largest univariate exclusion figure, which could be taken falsely as an upper bound, is due to the non-unity correlation between variables. Although some anthropometric models have described all anthropometric dimensions as a specific multiple of height [Roozbazar, 1979] with the implicit assumption of intervariable correlation equal to 1.00, those models fail to recognize the variable proportions of people and would lead to the acceptance of the largest univariate exclusion as the net cumulative exclusion. The assumption of a correlation of 1.00 amounts to treating the population as if the man with 95th percentile height must also have 95th percentile leg length, 95th percentile shoulder width, and 95th percentile in all measurements, i.e., 'the 95th percentile man.' If that were the case, the percentile screens would have eliminated the same subjects on all variables, as well as on the cumulative exclusion. If, at the other extreme, intervariable correlation were zero, the single variable eliminations would be independent and their arithmetic sum would appear as the cumulative exclusion.

In reality, some subjects with leg lengths shorter than the 5th percentile also have sitting heights less than the 5th percentile. Others have short legs but sitting heights nearer the mean. The evidence of variable proportions along with variable sizes is found in the cumulative exclusion values. Generally, the cumulative exclusion is less than the sum of the single variable eliminations but is greater than any of the single value eliminations. Only rounding error could cause the cumulative exclusion to exceed the sum of the single variable eliminations. The cumulative exclusion is generally as small as the largest single variable when only one variable resulted in any elimination.

2. Aircraft Constraints

The specific aircraft screens were accomplished with the same technique as used on the design specification screens. The cut points for each variable were the values corresponding to each aircraft's anthropometric restrictions specified by NAVAIRINST 3710.9. Then, for each aircraft, the three samples were examined to eliminate subjects whose anthropometric measurements were large enough, or small enough, to be excluded by the aircraft's restrictions. The number of subjects eliminated by each measurement and the cumulative exclusions were totaled and converted to a percentage of the sample. Different aircraft with the same anthropometric restrictions were consolidated into eighteen groups and the screens were executed, resulting in the 1964, 1969, and 1975 samples being matched to all aircraft types. The percentage exclusions are shown in Table VIII, which lists aircraft types in alphabetical order.

Table VIII

Exclusion by Aircraft Type

Aircraft	Code	Variable	Exclusion Percentage 1964	1969	1975
A-3	-	sit.ht.	-	-	-
	9	fnct.rch.	0.6	2.6	0.3
	-	b-knee lnth.	-	-	-
	0	leg lnth.	0.1	0.0	0.1
		cumulative	0.6	2.6	0.4
A-4E	089	sit.ht.	0.9	1.7	0.4
A-4F	9	fnct.rch.	0.6	2.6	0.3
	789	b-knee lnth.	1.0	6.6	0.6
	0	leg length	0.1	0.0	0.1
		cumulative	2.5	10.3	1.5
A-4M	0	sit.ht.	0.2	0.1	0.0
	9	fnct.rch.	0.6	2.6	0.3
	789	b-knee lnth.	1.0	6.6	0.6
	0	leg length	0.1	0.0	0.1
		cumulative	1.8	9.3	1.1
A-6A	06789	sit.ht.	5.0	9.6	4.0
A-6B	-	fnct.rch.	-	-	-
A-6E	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	5.0	9.9	4.0
A-7A	089	sit.ht.	0.9	1.7	0.4
A-7C	6789	fnct.rch.	7.4	13.6	8.8
A-7E	9	b-knee lnth.	0.0	0.4	0.0
	0	leg length	0.1	0.0	0.1
		cumulative	8.2	15.6	9.2
AV-8A	09	sit.ht.	0.4	0.8	0.1
	9	fnct.rch.	0.6	2.6	0.3
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	1.0	3.8	0.4
C-118	-	sit.ht.	-	-	-
C-131	-	fnct.rch.	-	-	-
	-	b-knee lnth.	-	-	-
	0	leg length	0.1	0.0	0.1
		cumulative	0.1	0.7	1.6

Table VIII (Continued)

Exclusion by Aircraft Type

Aircraft	Code	Variable	Exclusion Percentage 1964	1969	1975
CH-53	-	sit.ht.	-	-	-
	-	fnct.rch.	-	-	-
	-	b-knee lnth.	-	-	-
	01	leg length	0.7	0.7	1.6
		cumulative	0.7	0.7	1.6
EA-3	-	sit.ht.	-	-	-
	9	fnct.rch.	0.6	2.6	0.3
	-	b-knee lnth.	-	-	-
	0	leg length	0.1	0.0	0.1
		cumulative	0.6	2.6	0.4
EA-6B	06789	sit.ht.	5.0	9.6	4.0
	-	fnct.rch.	-	-	-
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	5.0	9.9	4.0
EA-6B	06789	sit.ht.	5.0	9.6	4.0
(LF)	9	fnct.rch.	0.6	2.6	0.3
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	5.6	12.5	4.3
F-4B(F)	0789	sit.ht.	2.0	3.9	1.7
F-4J(F)	89	fnct.rch.	1.8	4.3	1.9
F-4N(F)	9	b-knee lnth.	0.0	0.4	0.0
F-4S(F)	0	leg length	0.1	0.0	0.1
		cumulative	3.8	8.4	3.6
F-4B(R)	89	sit.ht.	0.7	1.6	0.4
F-4J(R)	-	fnct.rch.	-	-	-
F-4N(R)	9	b-knee lnth.	0.0	0.4	0.0
F-4S(R)	-	leg length	-	-	-
		cumulative	0.7	2.0	0.4

Table VIII (Continued)

Exclusion by Aircraft Type

Aircraft	Code	Variable	Exclusion Percentage 1964	1969	1975
F-8D	0789	sit.ht.	2.0	3.9	1.7
F-8J	-	fnct.rch.	-	-	-
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	2.0	4.2	1.7
F-14(F)	0	sit.ht.	0.2	0.1	0.0
	9	fnct.rch.	0.6	2.6	0.3
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	0.8	3.1	0.3
F-14(R)	-	sit.ht.	-	-	-
	-	fnct.rch.	-	-	-
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	0.0	0.4	0.0
H-2	-	sit.ht.	-	-	-
	89	fnct.rch.	1.8	4.3	1.9
	-	b-knee lnth.	-	-	-
	0	leg length	0.1	0.0	0.1
		cumulative	1.8	4.3	1.9
OV-10	-	sit.ht.	-	-	-
	9	fnct.rch.	0.6	2.6	0.3
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	0.6	3.0	0.3
RA-5C	09	sit.ht.	0.4	0.8	0.1
(F)	-	fnct.rch.	-	-	-
	9	b-knee lnth.	0.0	0.4	0.0
	0	leg length	0.1	0.0	0.1
		cumulative	0.5	1.2	0.2
RF-4B	0789	sit.ht.	2.0	3.9	1.7
(F)	89	fnct.rch.	1.8	4.3	1.9
	9	b-knee lnth.	0.0	0.4	0.0
	0	leg length	0.1	0.0	0.0
		cumulative	3.8	8.4	3.6

Table VIII (Continued)

Exclusion by Aircraft Type

Aircraft	Code	Variable	Exclusion Percentage 1964	1969	1975
RF-4B (R)	89	sit.ht.	0.7	1.6	0.4
	-	fnct.rch.	-	-	-
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	0.7	2.0	0.4
RF-8	0789	sit.ht.	2.0	3.9	1.7
	-	fnct.rch.	-	-	-
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	2.0	4.2	1.7
S-3	-	sit.ht.	-	-	-
	-	fnct.rch.	-	-	-
	9	b-knee lnth.	0.0	0.4	0.0
	-	leg length	-	-	-
		cumulative	0.0	0.4	0.0
T-2C	0	sit.ht.	0.2	0.1	0.0
TA-4	9	fnct.rch.	0.6	2.6	0.3
TAV-8	9	b-knee lnth.	0.0	0.4	0.0
	0	leg length	0.1	0.0	0.1
		cumulative	0.8	3.1	0.4
U-16	-	sit.ht.	-	-	-
	-	fnct.rch.	-	-	-
	-	b-knee lnth.	-	-	-
	0	leg length	0.1	0.0	0.1
		cumulative	0.1	0.0	0.1

NOTE:

(F) - Front seat
(R) - Rear seat
(LF) - Left front seat

B. RESULTS

The design criterion requiring accommodation of the 5th and 95th percentiles results in exclusion of over 26 percent of the population. That result fails to meet the goal of 90 percent accommodation. Designing to the 3rd and 98th percentiles, instead of the 5th and 95th, reduced exclusion to 14 percent. That result still does not meet the 90 percent accommodation goal.

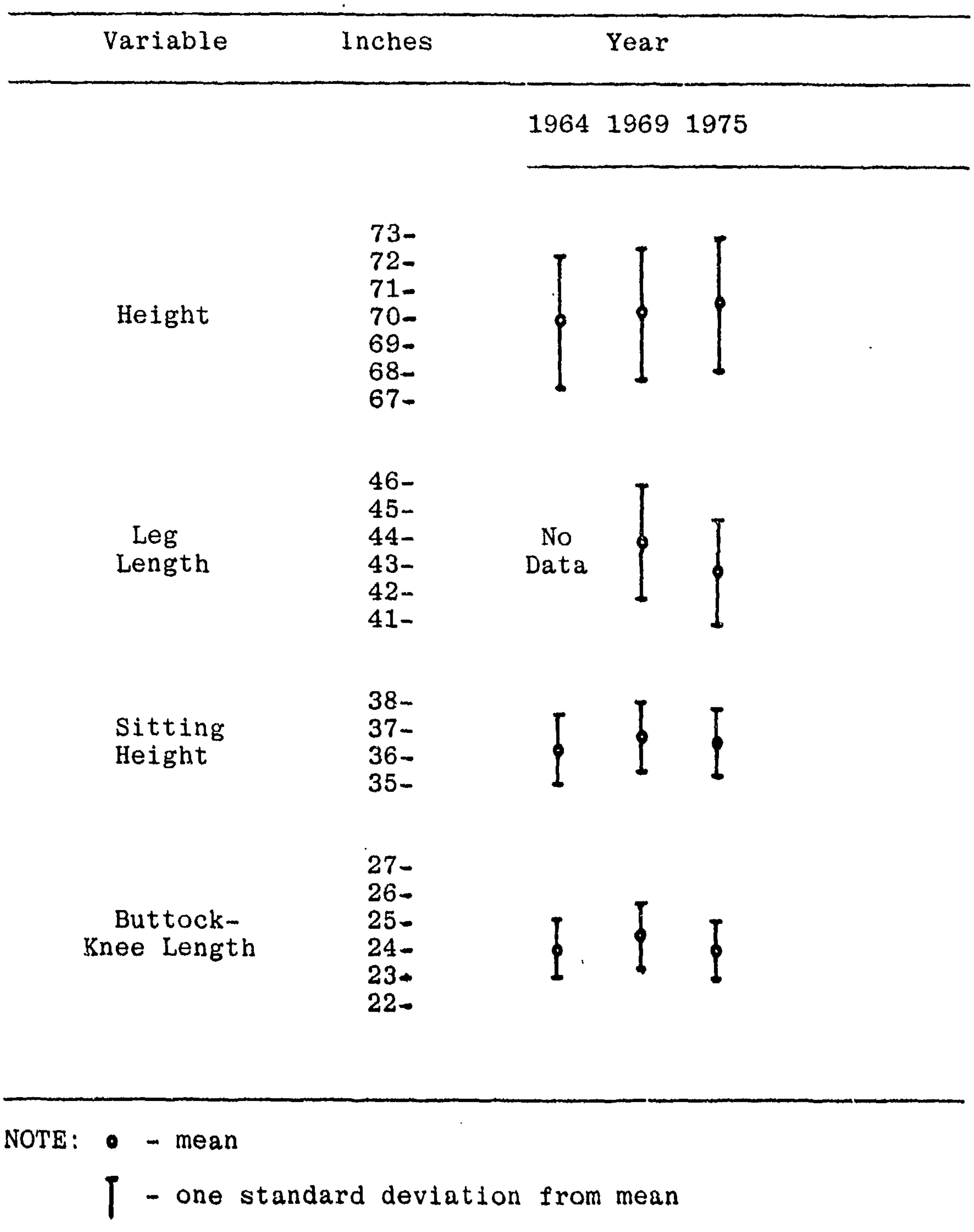
No aircraft type's coding eliminated as much as ten percent of the 1964 sample. The A-7 exclusion was 8.2 percent and was the worst case. The accommodation by all aircraft of more than 90 percent would seem to indicate that the cockpit designs included a margin of accommodation allowance in addition to the minimum required. Such a safety factor in design is not unexpected but is still technically an unrequired bonus.

The exclusion percentage was not constant, but changed from one sample to the next. The greatest exclusions were found in the 1969 data while the 1964 and 1975 cumulative exclusions were about the same. Although cumulative exclusions were nearly equal, the contributing factors had varying proportions. Sitting height eliminations decreased and eliminations due to buttock-knee length and leg length increased.

The 1969 data exhibited other features of incongruity which detracted from the credibility of the three data sets

Figure 3

Comparison of Selected Variables
and Standard Deviations



taken as a whole. These effects reflected the presence of unidentified factors, not entirely explained by the facts available. While height increased steadily from 1964 to 1975, its components did not. As seen in Figure 3, which shows mean values and one standard deviation on either side of the mean, mean height increased from 69.94 to 70.15 inches, a rate of 0.427 inches per decade. That rate confirms the USAF prediction of 0.418 inch per decade [Roebuck, et. al.]. However, the increased height does not appear as an increase in the other long bone measurements which are components of height. From 1969 to 1975, both mean sitting height and mean leg length appear to have decreased. The increase in height should be traceable to an increase in sitting height, an increase in leg length, or both, but neither was noted. Explanations other than erroneous data are possible, but not supported by knowledge of the population. It could be hypothesized that an increasing concentration of fat in the buttocks could increase both sitting height and leg length measurements while not affecting height. This effect has not been observed.

Another possible explanation, operator induced loss of precision, would be accompanied by increases in the variation. An examination of Table V and Figure 3 indicate that standard deviations remained relatively constant, indicating the absence of excessive random error by equipment operators.

The inclusion of a constant error in any of the measurements in one or more data sets could account for the apparent inconsistency. This kind of error should be precluded by the use of standard procedures and calibrated equipment. The 1969 data were collected from measurements taken with a device for which no calibration was provided. There was no calibration procedure or equipment associated with the integrated anthropometric measuring device until after the introduction of the improved device in 1971. Although a means of calibrating the improved anthropometric measuring device was provided after 1971, the calibration equipment is no longer available and the date of the last calibration is unknown.

The largest contributor to the apparent error is the diminished leg length in 1975. The reduction of nearly an inch is difficult to believe. Leg length is also a difficult measurement to take accurately [Moroney, 1980]. The position of the subject being measured (sitting erect with his right leg maximally extended horizontally in front of him) is difficult for some individuals to attain. The inflexibility of some muscular legs prevents the leg from being straightened completely. Methods aimed at straightening the leg can result in the hips rolling forward, causing the buttocks to move outward from the seat back. The measured leg length is then either too long (with the leg straight and buttocks forward) or too short (with the leg slightly bent).

The 1975 data also appeared to have been influenced by rounding. The frequency of whole inch and half inch measurements is greater than expected. The bias incurred in the mental rounding process is indeterminate and no effort was made to correct for it. The existence of the effect indicates a need for a procedural modification.

The exclusion determined here were based on the consideration of only four variables. Although, of the available measurements, they were considered to be the most important with respect to accidents, injuries, and aircraft controllability, [Moroney, 1980] they are not the only measurements relevant to accommodation. Administrative limitations set by NMPC established that no more than four variables would be used. The practice of collecting anthropometric data at the flight training entry point and the specific measurements taken there determined which measurements could be used. The inclusion of additional measurements, such as shoulder width, could only increase exclusions. The substitutions of other measurements could affect the exclusion results similarly.

V. SUMMARY AND CONCLUSIONS

The Navy requires airplane cockpit designs to accommodate ninety percent of the Naval aviation population. In support of that goal, designs are required to accommodate the 5th to 95th percentiles (or the 3rd to 98th percentiles) of critical body dimensions. The success or failure of aircraft designers in accommodating the population had not been quantified, heretofore. By examining anthropometric data from three populations (1964, 1969, and 1975), two of which were generated by the Computerized Accommodated Percentage Evaluation Model (CAPE), exclusions allowed by the design specification and exclusions associated with each aircraft type were determined. The numerical values corresponding to the percentiles named in the specification (5 to 95 or 3 to 98) were compared to the measurements of each subject in each population to determine the proportion of subjects of each population having at least one measurement outside the limits of accommodation and therefor excluded. The results were the exclusions expected from designing to the specified percentiles. The aircraft exclusions were found by comparing aircraft anthropometric exclusion codes, assigned by NAVAIR, and the measurements corresponding to those codes, to the three populations. That process resulted in an exclusion percentage for each aircraft and each population.

It was found that:

1. The design specification requiring accommodation of the 5th to 95th percentiles excluded 26 percent of the specified population.

2. Designing to the 3rd to 98th percentiles excluded 14 percent of the population.

3. Exclusions, both those allowed by the specification and those peculiar to each aircraft, varied over time.

4. All aircraft accommodate more than the required ninety percent of the most recent population sample.

5. The proportion of exclusion caused by a given variable changed over time.

6. There are inconsistencies in the data.

A. DESIGN SPECIFICATION

The design specification should result in at least ninety percent of the user population being accommodated by each aircraft. Reference to the 5th and 95th percentiles and to the 3rd and 98th percentiles of critical body dimensions serves only to fog the issue. The imaginary '95th percentile man,' consisting of a 95th percentile measurement for all variables, is assumed from the requirement to design to his dimensions. The tacit assumption that anthropometric features can be assembled and generalized to form a 95th percentile man is false and misleading since it assumes a correlation of 1.00 between anthropometric features. The specification would be more effective if it were to require accommodation of ninety percent of the population and remain silent on the accommodation of singular dimensions. Deletion of all reference to percentiles in the specification would be a productive change. However anthropometric data should still be reported in percentiles for use in univariate applications.

The Navy is currently enjoying the benefit of an unrequired bonus in the area of user accommodation. Ninety percent accommodation was required, more than that is delivered, at least for the four variables examined, based on the 1975 data. Although there appears to be nothing to indicate that this bonus will not continue, there is likewise nothing to guaranty that it shall. If a future aircraft design were successful in accommodating exactly the required ninety percent, the consequences would amount to exclusions greater than those being experienced on any current Navy aircraft and the design specification would still have been satisfied. Since there is feeling in the Navy that current user accommodation is insufficient and since the ninety percent accommodation requirement is being met, either the Navy must change the ninety percent requirement or adjust its attitude toward current accommodations. The answer may be found in partitioning the user population into groups, each of which currently flies in a particular type aircraft. Then specify the 'user population' to be one of those groups, rather than all flying personnel in the Navy, and require accommodation of the entire group. This solution, while easy to conceive, would be difficult to administer.

B. COCKPIT RESTRICTIONS

The exclusions enumerated in Table VIII indicate that the Navy has a minimal problem, on the global level, with incompatible planes and personnel. The attention that the problem has received would hardly seem justified by the miniscule exclusions indicated by the analysis. The expense in terms of money, man-hours, and effort reflected in the production of instructions by OPNAV, BUMED, CNATRA, and NAVAIR, together with the resultant effort necessary to comply with their requirements must have been justified by a judgement that a problem existed but the numbers in Table VIII do not reflect the magnitude of the problem. A reason that more impressive numbers don't appear in the table might be in the aircraft codes' inaccuracy, or in their failure to account for influential variables.

The accuracy of the aircraft codes is dependent on a judgement factor on the part of the people who measure aircraft cockpits. The anthropometric codes assigned to aircraft are based on cockpit measurements adjusted for clothing and equipment worn by the user. Those adjustments cannot allow for all variations. The codes assigned to aircraft can also be affected by forecasts of the consequences of the codes assigned. The prospect of excluding an unsuitably large portion of the user population could have influenced aircraft exclusion code assignments in the direction of minimal effect.

The high cost of error does not appear in the table but undoubtedly accounts for the attention given to such unimpressive exclusion figures. The cost of losing an airplane or an aircrew is considerable. That cost makes any erroneous assignment of personnel potentially disastrous and may account for the emphasis in the area of aircrew accommodation.

Additionally, anthropometric restrictions can affect an officer's career rather markedly by denying him assignment to the type aircraft he is motivated to fly. That fact makes the globally small exclusion problem a crisis on the individual level and explains why the attention level exceeds that expected from examining the exclusion figures.

C. DATA INCONSISTENCIES

The data indicate that the values associated with anthropometric features shifted over time. Although the exclusions by design specification in 1964 and those in 1975 were about the same (see Table VIII), the individual variables responsible for the exclusions were of varying influence. In 1964, sitting height caused more exclusions than it did in 1975, while buttock-knee length and leg length caused more in 1975 than in 1964. The 1969 data show higher exclusion than either of the other two data sets. Sitting height, buttock-knee length, and leg length all peaked in 1969, accounting for the corresponding peak in exclusions.

The exclusion results varied erratically over time. There are inconsistent effects in the data and the lack of continuity cannot be explained with the information available. The leg length measurement is the most likely source of the inconsistent effects and the discontinuance of leg length as a critical measurement might be beneficial if another measurement could be substituted. Buttock-knee length might be used as a substitute for leg length since the two variables are well correlated (r=.8). Alternatively, a measurement taken in a sitting position approximating a cockpit seating position could be substituted. Measuring from the heel to the seat back via the front edge of the seat would accomplish, more directly, the purpose presently being attempted by the leg length measurement. The problems encountered measuring leg length would be eliminated and the measurements of personnel and of aircraft cockpits would be more comparable and, consequently, more effective in matching personnel to airplanes. Such a measurement of 'functional leg throw' would be a special purpose dimension not included in previous surveys. Previous surveys, however, were not faced with the special problem now at hand and the cost of designing and implementing this new measurement could be recovered in the prevention of a single aircraft accident.

D. DATA LIMITATIONS

Of all the anthropometric dimensions which might be considered, the Navy collects data on eight anthropometric features (including weight) considered relevant to flight safety. Of those eight variables, only four are considered in the process of assigning personnel to aircraft. The limitation to four variables is not necessarily optimum with respect to flight safety since the administratively driven maximum of four variables was the effective constraint. The inclusion of additional variables, if they were found to be relevant, could only decrease accommodation further. The decrease could be dramatic if the additional variables were poorly correlated to those already considered.

The problems arising from variables in combination (but not visible in single variable evaluation) have been recognized [CNATRAINST 13520.1, 1980] but no description of the interaction between variables is included in the Anthropometric Compatibility Assignment Program. For example, the minimum functional reach and leg length necessary to reach controls varies as the position of the seat changes. The position of the seat is determined largely by the sitting height of its occupant. An individual with a short sitting height must raise the seat high enough to allow vision over the nose of the aircraft. As the seat rises, it also moves aft slightly, causing the rudder pedals to be adjusted aft and also requiring a longer functional reach to enable the man to reach the controls. Thus, sitting height determines in part the effective minima for leg length and functional reach values, making required leg length and functional reach distances functions of sitting height. The values used for anthropometric coding, however, are determined irrespective of seat position changes. An additional anthropometric code should be established to identify those personnel who meet all the limits but whose combination of anthropometric features could create problems.

The procedures used to take measurements in the 1969 and 1975 data sets were deficient in some respects. Most notably, the failure to calibrate the integrated anthropometric measuring device was unfortunate. The apparent rounding of measurements also induced error. The calibration deficiency can be corrected by instituting a requirement to document periodic calibration and adjustments, as is required by the Preventive Maintenance System. The rounding error could be eliminated by converting the measuring device to provide digital displays of measurements. Better, but also more expensive, an automated measuring device could record measurements without requiring the operator to read and record numbers. Such a device would also prevent the operator from rounding measurements or inserting any bias into the data.

The necessity to draw on outside sources for data concerning leg length, a critical body dimension about which there is no data in the design specification (1964 data), points out a basic deficiency in the specification. Designers do not consider leg length in the design of cockpits. Instead, they use buttock-knee length and popliteal height sitting, which are components of leg length. The assignment process would be more consistent if similar variables were used for exclusion codes.

E. CONCLUSIONS

The data collection system which supports the Anthropometric Compatibility Assignment Program consists of measurements taken on aircraft cockpits as well as the equipment and procedures used to measure aviation personnel. Many inconsistencies in personnel measurements have been noted even though those measurements are an essential ingredient in the successful operation of the program. The program will operate no more effectively than its weakest, or limiting, factor. That limiting factor appears to be the measurement of personnel. Inconsistencies in the data appear to be results of measurement bias. The appearance of larger personnel in 1969 and corresponding higher exclusions in that population are more likely the changes of measurement bias than any real effect in the population.

Measurement error could be reduced by:

1. Periodically calibrating the measurement equipment.
2. Randomly remeasuring personnel and comparing the original

and repeated measurement. If significant discrepancies are noted, corrective action should be taken.

3. Replacing the integrated anthropometric measuring device by one using digital measurement displays, or automated measurement recording.

The consequences of failing to improve the Navy's personnel anthropometric measuring procedure will amount to negating the Anthropometric Compatibility Assignment Program and accepting the aircraft accident rate, and ejection injury rate which were sufficiently undesirable to lead to the program's establishment. Additionally, erroneous measurement can adversely impact on officers' career development patterns and consequently on officer personnel retention.

APPENDIX A

Definitions of Measurements

1. Buttock-Heel Length -see Leg Length

2. Buttock-Knee Length -the horizontal distance from the rearmost surface of the buttocks to the front of the kneecaps, with the subject sitting erect.

3. Buttock-Heel Length -see Leg Length

4. Functional Reach -the distance from the wall to the tip of the thumb measured with the subject's shoulders against the wall, his arm extended forward, and his index finger touching the tip of his thumb.

5. Height -vertical distance from the floor to the top of the head with the subject standing erect in bare feet.

6. Knee Height Sitting -the height from the footrest surface to the musculature just above the knee.

7. Leg Length -the distance from the base of the heel to a wall against which the subject sits erect with his leg maximally extended forward along the sitting surface.

8. Sitting Height -the height, from the sitting surface, to the top of the head, with the subject sitting erect.

9. Stature -see height

10. Popliteal Height Sitting -the height of the underside of the upper leg above the footrest surface.

APPENDIX B

Anthropometric Codes as Percentiles of the 1964 Population

Variable	Code	Measurement Interval	Equivalent Percentile
SITTING HEIGHT	9	40.0-41.0	99+
	8	39.5-39.9	99+
	7	39.0-39.4	98-99
	6	38.5-38.9	96-97
	5	38.0-38.4	91-95
	4	35.0-37.9	15-90
	3	34.0-34.9	3-14
	2	33.0-33.9	<3
	1	32.5-32.9	<1
	0	32.0-32.4	<1
FUNCTIONAL REACH	9	≤27.9	<1
	8	28.0-28.4	<1
	7	28.5-28.9	1-2
	6	29.0-29.4	3-6
	5	29.5-30.4	7-25
	4	30.5-30.9	26-39
	3	31.0-31.4	40-50
	2	31.5-32.4	51-75
	1	32.5-33.9	76-94
	0	≥34.0	>95
BUTTOCK-KNEE LENGTH	9	>28.0	>99
	8	27.0-28.0	>99
	7	26.5-26.9	>98
	6	26.0-26.4	97-98
	5	25.5-25.9	91-96
	4	25.0-25.4	81-90
	3	24.0-24.9	50-80
	2	23.0-23.9	15-49
	1	22.0-22.9	2-14
	0	≤21.9	<2
LEG LENGTH	9	49.0-50.0	>99
	8	48.0-48.9	98-99
	7	47.0-47.9	95-97
	6	46.0-46.9	86-94
	5	45.0-45.9	71-85
	4	43.0-44.9	34-70
	3	40.0-42.9	3-34
	2	39.0-39.9	1-2
	1	38.0-38.9	<1
	0	36.0-37.9	<1

Appendix C

Program Listing for CAPE Model Used to Generate the 1964 and 1969 Data

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```
      PROGRAM GENSAMP(FMEAS,UMEAS,SAMPLE,INPUT,OUTPUT,
     1    TAPE1=FMEAS,TAPE2=UMEAS,TAPE3=SAMPLE,
     2    TAPE5=INPUT,TAPE6=OUTPUT)
C
C          *** MODULE A - MONTE CARLO SUMULATION ***
C     *** MCSM READS IN FACTOR MATRIX OF REQUIRED ANTHROPOMETRIC
C     *** MEASUREMENTS FROM EITHER DISK FILES OR INTERACTIVE
C     *** TERMINAL.  IT ALSO ALLOWS USERS TO PRINT, EDIT AND SAVE
C     *** FILES.  THE PROGRAM THEN COMPUTE RANDOM MULTIVARIATE NORMAL
C     *** FEATURE VECTORS.  AT THE END OF THE PROGRAM IT CALLS
C     *** SUBROUTINE TRANS TO PERFORM NECESSARY DATA TRANSFORMATION
C     *** OF ANTHROPOMETRIC SAMPLES AND STORES THE RESULTANT
C     *** MEASUREMENTS ON DISK FILES FOR CREWSTATION EVALUATION
C     *** MODULE.
C
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
C
C     NMEAS -  NUMBER OF ANTHROPOMETRIC MEASUREMENTS, CURRENTLY  12
C     NSAMP - NUMBER OF OPERATOR SAMPLES
C     DATA FILE DESCRIPTION:
C     NAME    PROGRAM REF.     TAPE#  FOR/UN          CONTENTS
C    FMEAS      -----           1      FOR      ANTM(2,NMEAS),CORR(KN)
C    UMEAS    NTMEAS            2      UN       NMEAS,KN,ANTM,CORR
C    SAMPLE    NTEMP            3      UN        INAME(4),V,X
C    INPUT      -----           5      --        ----------------
C    OUTPUT     -----           6      --        ----------------
C
      DATA IOIN,IOOUT,NUCREW,NTEMP,NTMEAS,NIMEAS/5,6,8,3,4,7/
      DATA MAXFUNC/4/
      DATA MMEAS,NTMEAS,NIMEAS/12,2,4/
     1,ICOUNT/0/
      DATA ANTM/24*0/,CORR/78*0/,INAME/4*10H          /
      DATA MAXOPT,MAXANTH,MAXACT/3,6,3/
C
C  ***COMPUTE (KN) THE LENGTH OF THE LINEAR ARRAY CORR(KN)
C
      IOOUT=0
      ISAMP=0
C  ***MCSM MAIN MENU
100   CONTINUE
      IOIN=5
      WRITE (6,290)
      CALL INPT (1,1,NVALSZ,NMEAS,XVAL,IEOF)
      GO TO (130,100,110,120,240,120), IEOF+1
110   CONTINUE
      CALL HELP (1)
      GO TO 100
120   CONTINUE
      WRITE (6,360)
      GO TO 100
130   CONTINUE
      IF (NMEAS.LT.1.OR.NMEAS.GT.MMEAS) GO TO 120
      KN=NMEAS*(NMEAS+1)/2
      IINPT=0
C
C *** GENERATE OPERATOR SAMPLE FROM MEANS,STD DEV & CORR MATRIX
C
140   CONTINUE
      IOIN=5
C  ***ANTHROPOMETRIC FUNCTIONS
150   CONTINUE
      WRITE (6,300)
```

```
      CALL INPT (1,1,NVALSZ,IOPT,XVAL,IEOF)
      GO TO (180,140,160,170,280,170), IEOF+1
160   CONTINUE
      CALL HELP (2)
      GO TO 150
170   CONTINUE
      WRITE (6,340)
      GO TO 150
180   CONTINUE
      IF (IOPT.LT.1.OR.IOPT.GT.MAXANTH) GO TO 170
C             INPUT,EDIT,SAVE,PRINT,GENERATE OPER SAME,END
      GO TO (190,200,220,240,260,280), IOPT
190   CONTINUE
C ***INPUT ANTHROPOMETRIC MEASUREMENTS
      CALL ACCPT (ISAMP)
      IINPT=1
      GO TO 140
200   CONTINUE
C  ***EDIT ANTHROPOMETRIC DATA FILE
      IF (IINPT.EQ.1) GO TO 210
      WRITE (6,350)
      GO TO 140
210   CONTINUE
      CALL EDIT
      GO TO 140
220   CONTINUE
C  ***SAVE ANTHROPOMETRIC DATA FILE ON UMEAS
      IF (ISAMP.EQ.1) GO TO 230
      WRITE (6,320)
      GO TO 140
230   CONTINUE
      CALL SAVE
      GO TO 140
240   CONTINUE
C  ***PRINT ANTHROPOMETRIC DATA
      IF (IINPT.EQ.1) GO TO 250
      WRITE (6,360)
      GO TO 140
250   CONTINUE
      CALL PRINT
      GO TO 140
C
C *** GENERATE OPERATOR SAMPLE FROM ANTH MEAS DATA
C
260   CONTINUE
      IF (ISAMP.NE.1) GO TO 270
      CALL OPSAMP (ISAMP)
      GO TO 140
270   CONTINUE
      WRITE (6,330)
      GO TO 140
C  ***TERMINATION OF MCSM
280   CONTINUE
      WRITE (6,310)
      STOP
C
290   FORMAT (" ENTER NUMBER OF MEASUREMENTS (1-12)?--")
300   FORMAT ("  GENERATE FUNCTIONS(1-INPUT!2-EDIT!3-SAVE!4-PRINT!",
     +  "5-GENERATE!6-END)--")
310   FORMAT (" END OF OPERATOR SAMPLE")
320   FORMAT (" UNABLE TO SAVE MEASUREMENT DATA - FATAL ERRORS")
330   FORMAT (" UNABLE TO GENERATE SAMPLE - FATAL ERRORS")
340   FORMAT (" INVALID RESPONSE")
350   FORMAT (" ANTHROPOMETRIC DATA MUST BE INPUT BEFORE THE EDIT ",
     +  "FUNCTION CAN BE USED")
360   FORMAT (" ANTHROPOMETRIC DATA MUST BE INPUT BEFORE THE PRINT",
```

```
     +  "FUNCTION CAN BE USED")
      END
      SUBROUTINE INPT (ITYPE,IVALSZ,NVALSZ,IVAL,XVAL,IEOF)
      COMMON/MISC/IOIN,IOOUT,ICARD
C     FREE FIELD INPUT ROUTINE -- READS IN INPUT FROM THE KEYBOARD IN
C                                 FREE FIELD INPUT
C          INPUT---
C                   ITYPE - SPECIFIES THE TYPE OF DATA TO BE ENTERED
C                           1=INTEGER  2=REAL  3=ALPHANUMERIC
C                   IVALSZ - THE NUMBER OF ITEMS EXPECTED TO BE ENTERED
C          OUTPUT---
C                   NVALSZ - THE NUMBER OF ITEMS ENTERED BY THE USER
C                   IVAL - ARRAY CONATINING INTEGER OR
C                          ALPHANUMERIC DATA SUPPLIED BY THE USER
C                   XVAL - ARRAY CONTAINING REAL DATA SUPPLIED BY THE
C                          USER
C                   IEOF - END OF FILE FLAG
C                          1=IF BLANKS OR A CARRIAGE CONTROL IS THE
C                            ONLY INPUT
C                          2= IF A QUESTION MARK IS ENTERED
C                          3=IF INPUT IS INVALID
C                          4=IF A $ HAS BEEN ENTERED
      DIMENSION ICHAR(80),IVAL(IVALSZ),XVAL(IVALSZ)
      ISTOP=0
      IF (IVALSZ.GE.0) GO TO 100
      ISTOP=1
      IVALSZ=IABS(IVALSZ)
100   CONTINUE
      IQUOTE=0
      NVALSZ=0
      IEOF=0
      IF (IOOUT.EQ.1) GO TO 120
      DO 110 I=1,80
      ICHAR(I)=1H
110   CONTINUE
C     READ IN THE INPUT
      READ (IOIN,330) ICHAR
      IF (IOIN.NE.5) WRITE (6,330) ICHAR
      IF (EOF(IOIN).NE.1) GO TO 130
      IEOF=1
      RETURN
120   CONTINUE
      I1=ICARD
      GO TO 140
130   CONTINUE
C     INITIALIZE THE CARD COLUMN COUNTERS
      I1=1
140   CONTINUE
      I2=80
150   CONTINUE
      IF (ISTOP.EQ.1.AND.IVALSZ.EQ.NVALSZ) RETURN
C     SEARCH FOR THE NEXT WORD
      IF (I1.LE.I2) GO TO 160
C     SEARCH FOR THE FIRST NON-BLANK CHARACTER (START OF WORD)
C     CHECK IF EXCESS HAS BEEN ENTERED
      IF (NVALSZ.LE.IVALSZ) RETURN
      IEOF=5
      RETURN
160   CONTINUE
      DO 170 I=I1,I2
      IF (ICHAR(I).EQ.1H ) GO TO 170
      IFIRST=I
      GO TO 180
170   CONTINUE
      IF (NVALSZ.EQ.0) IEOF=1
C     CHECK IF EXCESS HAS BEEN ENTERED
```

```
      IF (NVALSZ.GT.IVALSZ) IEOF=5
      RETURN
180   CONTINUE
C     SEARCH FOR LAST NON-BLANK CHARACTER (END OF WORD)
      IF (ICHAR(IFIRST).EQ.1H?) IEOF=2
      IF (ICHAR(IFIRST).EQ.1H$) IEOF=4
      IF (IEOF.NE.0) RETURN
      IF (ITYPE.EQ.4) GO TO 300
      IF (ITYPE.NE.3) GO TO 190
      IF (ICHAR(IFIRST).NE.1H".AND.ICHAR(IFIRST).NE.1H') GO TO 190
      IFIRST=IFIRST+1
      IQUOTE=1
190   CONTINUE
      DO 220 I=IFIRST,I2
      IF (IQUOTE.EQ.0) GO TO 200
      IF (ICHAR(I).EQ.1H".OR.ICHAR(I).EQ.1H') GO TO 210
      GO TO 220
200   CONTINUE
      IF (ICHAR(I).NE.1H .AND.ICHAR(I).NE.1H,) GO TO 220
210   CONTINUE
      ILAST=I-1
      GO TO 230
220   CONTINUE
      ILAST=I2
230   CONTINUE
      NVALSZ=NVALSZ+1
C     RESET THE FIRST CHARACTER TO BE SEARCHED FOR THE NEXT WORD
C     INCREMENT THE NUMBER OF WORDS FOUND
      I1=ILAST+2
      IF (NVALSZ.GT.IVALSZ) GO TO 150
C     CHECK IF INPUT IS ALPHA-NUMERIC
      IF (ITYPE.EQ.3) GO TO 310
C     INPUT IS NUMERIC
C     CHECK IF NUMBER IS SIGNED
      ISIGN=1
      IF (ICHAR(IFIRST).NE.1H-.AND.ICHAR(IFIRST).NE.1H+) GO TO 240
      IF (ICHAR(IFIRST).EQ.1H-) ISIGN=-1
      IFIRST=IFIRST+1
240   CONTINUE
      INUM=0
      IDEC=0
      IDECF=0
      DO 260 I=IFIRST,ILAST
      IF (ICHAR(I).NE.1H.) GO TO 250
      IDECF=IDECF+1
      IDEC=1
      GO TO 260
250   CONTINUE
      CALL ICONV (ICHAR(I),IADD,IEOF)
      IF (IEOF.EQ.3) RETURN
      INUM=INUM*10+IADD
      IF (IDEC.NE.0) IDEC=IDEC+1
260   CONTINUE
      IF (IDECF.LT.2) GO TO 280
270   CONTINUE
      IEOF=3
      RETURN
280   CONTINUE
      INUM=INUM*ISIGN
      XNUM=FLOAT(INUM)
      IF ((ITYPE.EQ.1.AND.IDEC.LE.1).OR.(ITYPE.EQ.2)) GO TO 290
      IEOF=3
      RETURN
290   CONTINUE
      IF (IDEC.NE.0) XNUM=XNUM/10.0**(IDEC-1)
      IF (ITYPE.EQ.1) IVAL(NVALSZ)=IFIX(XNUM)
```

```
      IF (ITYPE.EQ.2) XVAL(NVALSZ)=XNUM
      ICARD=ILAST+1
      GO TO 150
300   CONTINUE
      ILAST=IVALSZ*10
310   CONTINUE
C     INPUT IS ALPHANUMERIC
      DO 320 J=1,IVALSZ
      IVAL(J)=10H
320   CONTINUE
      L=ILAST-IFIRST+1
      NVALSZ=(L-1)/10+1
      IF (L.GT.10*IVALSZ) GO TO 270
      ENCODE (L,330,IVAL(1) )(ICHAR(I),I=IFIRST,ILAST)
      ICARD=II
      RETURN
C
330   FORMAT (80A1)
      END
      SUBROUTINE ICONV (JCHAR,II,IEOF)
C     THIS FUNCTION CONVERTS ALPHA NUMBERS TO NUMBER NUMBERS
      DIMENSION JNUM(10)
      DATA JNUM/1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9/
      DO 100 J=1,10
      IF (JCHAR.NE.JNUM(J)) GO TO 100
      II=J-1
      RETURN
100   CONTINUE
C     INVALID INPUT --- NOT A NUMBER
      IEOF=3
      RETURN
      END
      SUBROUTINE ACCPT (ISAMP)
C
C *** INPUT ANTHROPOMETRIC DATA
C *** MEANS, STD DEV, AND CORRELATION MATRIX
C
      COMMON/MCSM/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION BUFF(3),TEMP(12)
      DATA BUFF/3*0/
      ISAMP=0
      ICOUNT=0
      INLINE=0
      IOIN=5
C
C ***READ MODE - 1=INTERACTIVE 2=FILE
C
100   CONTINUE
      WRITE (6,610)
      CALL INPT (1,1,NOINPT,IMODE,XINPT,IEOF)
      GO TO (130,110,120,110,490,110), IEOF+1
C INVALID RESPONSE
110   WRITE (6,650)
      GO TO 100
C HELP
120   CALL HELP (4)
      GO TO 100
130   IF (IMODE.EQ.1) GO TO 200
      IF (IMODE.NE.2) GO TO 110
C
C *** FILE TYPE: 1=FORMATTED  2=UNFORMATTED
C
140   CONTINUE
```

```
      WRITE (6,620)
      CALL INPT (1,1,NOINPT,IFFORM,XINPT,IEOF)
      GO TO (170,150,160,150,490,150), IEOF+1
150   WRITE (6,650)
      GO TO 140
160   CALL HELP (5)
      GO TO 140
170   IF (IFFORM.EQ.1) GO TO 190
      IF (IFFORM.NE.2) GO TO 150
C
C     *** UNFORMATTED READ
      REWIND NTMEAS
C  ***READ THE NUMBER OF ANTHROPOMETRIC MEASUREMENTS,
C  ***CORRELATION COMPONENTS
      READ (NTMEAS) NMEAS,KN,INAME
      IF (EOF(NTMEAS).NE.1) GO TO 180
      WRITE (6,670)
      GO TO 490
C  ***READ THE MEAN AND STANDARD DEVIATION VALUES
180   READ (NTMEAS) ((ANTM(IO,JO),IO=1,2),JO=1,NMEAS)
C  ***READ THE CORRELATION MATRIX VALUES
      READ (NTMEAS) (CORR(IO),IO=1,KN)
      REWIND NTMEAS
      WRITE (6,690)
      ISAMP=1
      RETURN
C *** SET INPUT LOGICAL UNIT TO 1 FOR FILE FMEAS
190   IOIN=1
200   CONTINUE
C
C  ***ACCEPT OPERATOR SAMPLE FILE NAME
C
      CALL NAMEFL (IERROR)
      ICOUNT=ICOUNT+IERROR
      INLINE=INLINE+1
C     *** INPUTS MEANS AND STANDARD DEVIATIONS INTO ARRAY ANTM
      IF (IMODE.EQ.1) WRITE (6,500)
      IF (IMODE.NE.1) WRITE (6,510) INAME
      MAXINPT=2
      DO 320 IROW=1,NMEAS
210   CONTINUE
      IF (IMODE.EQ.1) WRITE (6,530) IROW
220   NAMT=0
230   CONTINUE
      ITOTIN=MAXINPT-NAMT
      ICOL=NAMT+1
      CALL INPT (2,ITOTIN,NOINPT,IVAL,ANTM(ICOL,IROW),IEOF)
      IF (IEOF.EQ.5.OR.IEOF.EQ.0) NAMT=NAMT+NOINPT
      IF (IMODE.EQ.1) GO TO 240
      INLINE=INLINE+1
      IF (NAMT.EQ.MAXINPT) GO TO 290
      IF (IEOF.EQ.1) GO TO 480
      WRITE (6,540) IROW
      IF (IEOF.EQ.5) GO TO 270
      WRITE (6,700) INLINE
      ICOUNT=ICOUNT+1
      GO TO 320
C*** INTERACTIVE IEOF PROCESSING
240   CONTINUE
      GO TO (280,210,250,260,490,270), IEOF+1
250   CONTINUE
      CALL HELP (6)
      GO TO 210
260   CONTINUE
      WRITE (6,650)
      GO TO 210
```

```
270   CONTINUE
      IOLIST=NOINPT-ITOTIN
      WRITE (6,600) IOLIST
      IF (IMODE.NE.1) ICOUNT=ICOUNT+1
      GO TO 290
280   CONTINUE
      IF (NAMT.GE.2) GO TO 290
      WRITE (6,550)
      GO TO 230
290   CONTINUE
      IF (NAMT.GT.2) NAMT=2
      IRERR=0
      DO 300 ICOL=1,NAMT
      CALL REASON (1,ICOL,IROW,ANTM(1,IROW),ANTM(2,IROW),IFATAL)
      IRERR=IRERR+IFATAL
300   CONTINUE
      IF (IRERR.EQ.0) GO TO 320
      IF (IMODE.NE.1) GO TO 310
      WRITE (6,630) IROW
      GO TO 220
310   ICOUNT=ICOUNT+IRERR
320   CONTINUE
C
C     *** ANTHROPOMETRIC CORRELATION MATRIX VALUES ARE ACCEPTED
C     *** AND PROCESSED.
C
      IF (IMODE.EQ.1) WRITE (6,560)
      IF (IMODE.NE.1) WRITE (6,520)
      DO 460 IROW=1,NMEAS
330   CONTINUE
      NAMT=0
      MAXINPT=NMEAS+1-IROW
340   CONTINUE
      IF (IMODE.EQ.1.AND.IROW.EQ.NMEAS) WRITE (6,580) IROW,MAXINPT,NMEAS
      IF (IMODE.EQ.1.AND.IROW.NE.NMEAS) WRITE (6,570) IROW,MAXINPT,IROW,
     1NMEAS
350   CONTINUE
      ITOTIN=MAXINPT-NAMT
      ISTART=IROW+NAMT
      CALL INPT (2,ITOTIN,NOINPT,IVAL,TEMP(ISTART),IEOF)
      IF (IEOF.EQ.0.OR.IEOF.EQ.5) NAMT=NAMT+NOINPT
      IF (IMODE.EQ.1) GO TO 360
      INLINE=INLINE+1
      IF (NAMT.EQ.MAXINPT) GO TO 410
      IF (IEOF.EQ.0) GO TO 350
      IF (IEOF.EQ.1) WRITE (6,710)
      IF (IEOF.EQ.1) GO TO 470
      IF (IEOF.EQ.5) GO TO 390
      ICOUNT=ICOUNT+1
      WRITE (6,700) INLINE
      GO TO 460
C *** INTERACTIVE INPUT ERROR PROCESSING
360   CONTINUE
      GO TO (400,380,370,380,490,390), IEOF+1
370   CONTINUE
      CALL HELP (7)
      GO TO 340
380   CONTINUE
      WRITE (6,650)
      GO TO 340
390   CONTINUE
      IOLIST=NOINPT-ITOTIN
      WRITE (6,600) IOLIST
      IF (IMODE.NE.1) ICOUNT=ICOUNT+1
      NAMT=MAXINPT
      GO TO 410
```

```
400   CONTINUE
      IF (NOINPT.EQ.ITOTIN) GO TO 410
      ITOTIN=MAXINPT-NAMT
      WRITE (6,590) ITOTIN,IROW
      GO TO 350
410   CONTINUE
      ILAST=IROW+NAMT-1
      IRERR=0
      DO 420 ICOL=IROW,ILAST
      CALL REASON (2,ICOL,IROW,TEMP(ICOL),0,IFATAL)
      IRERR=IRERR+IFATAL
420   CONTINUE
      IF (IRERR.EQ.0) GO TO 440
      IF (IMODE.EQ.2) GO TO 430
      WRITE (6,640) IROW
      GO TO 330
430   ICOUNT=ICOUNT+IRERR
      GO TO 460
440   CONTINUE
      DO 450 ICOL=IROW,NMEAS
      N=NDX(IROW,ICOL)
      CORR(N)=TEMP(ICOL)
450   CONTINUE
460   CONTINUE
470   CONTINUE
      IF (ICOUNT.EQ.0) ISAMP=1
      IF (IMODE.NE.1) WRITE (6,680) ICOUNT
      GO TO 490
480   WRITE (6,660)
      RETURN
490   CONTINUE
      RETURN
C
500   FORMAT (" ENTER PAIRS OF MEANS AND STANDARD DEVIATIONS--")
510   FORMAT (//" DIAGNOSTICS OF FORMATTED READ "/" OPEN DESC: ",4A10/)
520   FORMAT (//" CORRELATION/ANTHROPOMETRIC MEASUREMENTS:")
530   FORMAT (" MEASUREMENT - ",I2," ?---")
540   FORMAT (" MEASUREMENT -",I2)
550   FORMAT (" ENTER STANDARD DEVIATION --")
560   FORMAT (" ENTER ANTHROPOMETRIC CORRELATION MATRIX DATA IN A ROWWIS
     1E UPPER "/" TRIANGULAR FORM."/" NOTE: ALL DIAGONAL ELEMENTS MUST",
     +  " EQUAL 1.000")
570   FORMAT (5H ROW ,I2,"(",I2," ELEMENTS, COLUMNS ",I2,"-",I2,")")
580   FORMAT (5H ROW ,I2,"(",I2," ELEMENT, COLUMN ",I2,")")
590   FORMAT (21H ENTER THE REMAINING ,I2,14H ELEMENTS FOR ROW ,I2)
600   FORMAT ("  THE LAST ",I2," INPUTS HAVE BEEN IGNORED")
610   FORMAT (" INPUT MODE(1=INTERACTIVE;2=FILE)--")
620   FORMAT (" READ MODE(1=FORMATTED;2=UNFORMATTED)--")
630   FORMAT ("  RE-ENTER DATA FOR ",I2)
640   FORMAT (" RE-ENTER DATA FOR ROW ",I3)
650   FORMAT (" INVALID RESPONSE")
660   FORMAT (" UNEXPECTED EOF ON FMEAS FOR MEAS ",I2)
670   FORMAT (" FILE UMEAS IS NOT ATTACHED TO THE PROGRAM"/
     +  " UNFORMATTED READ ON THIS FILE IS ABORTED ---",//)
680   FORMAT (" TOTAL ERRORS ON INPUT DATA ",I5)
690   FORMAT ("  MEAN,STD DEV & CORRELATION DATA READ")
700   FORMAT (" INVALID DATA AT LINE ",I5)
710   FORMAT (" UNEXPECTED END OF FILE")
      END
      SUBROUTINE EDIT
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1     SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2     INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION BUFF(3)
      DATA BUFF/3*0/
```

```
C
C     *** MODIFICATIONS ON MEANS,STANDARD DEVIATIONS,
C     *** AND ANTHROPOMETRIC CORRELATIONS
C
      IOIN=5
100   CONTINUE
      WRITE (6,350)
      CALL INPT (1,1,NVALSZ,IOPT,XVAL,IEOF)
      GO TO (130,100,110,120,340,120), IEOF+1
110   CONTINUE
      CALL HELP (8)
      GO TO 100
120   CONTINUE
      WRITE (6,360)
      GO TO 100
130   CONTINUE
      IF (IOPT.LT.1.OR.IOPT.GT.5) GO TO 120
      GO TO (140,140,240,330,340), IOPT
C
C     *** ICOL=1 FOR MEAN PROCESSING
C     *** ICOL=2 FOR STANDARD DEVIATION PROCESSING
C
140   CONTINUE
      ICOL=IOPT
150   CONTINUE
      MAXINPT=2
      NAMT=0
160   CONTINUE
      IF (ICOL.EQ.1) WRITE (6,380)
      IF (ICOL.EQ.2) WRITE (6,390)
170   CONTINUE
      IVALSZ=MAXINPT-NAMT
      J=NAMT+1
      CALL INPT (2,IVALSZ,NVALSZ,IVAL,BUFF(J),IEOF)
      GO TO (220,180,200,190,100,210), IEOF+1
180   CONTINUE
      WRITE (6,370)
      GO TO 160
190   CONTINUE
      WRITE (6,360)
      GO TO 150
200   CONTINUE
      IF (ICOL.EQ.1) CALL HELP (11)
      IF (ICOL.EQ.2) CALL HELP (12)
      GO TO 160
210   CONTINUE
      IOLIST=NVALSZ-IVALSZ
      WRITE (6,400) IOLIST
220   CONTINUE
      IROW=BUFF(1)
      NAMT=NVALSZ+NAMT
      IF (NAMT.GE.MAXINPT) GO TO 230
      IF (ICOL.EQ.1) WRITE (6,420) IROW
      IF (ICOL.EQ.2) WRITE (6,430) IROW
      GO TO 170
230   CONTINUE
      CALL REASON (1,ICOL,IROW,BUFF(2),0,IFATAL)
      IF (IFATAL.EQ.1) GO TO 150
      ANTM(ICOL,IROW)=BUFF(2)
      GO TO 100
C
C     *** PROCESSING FOR ANTHROPOMETRIC CORRELATIONS
C
240   CONTINUE
      MAXINPT=3
      NAMT=0
```

```
250   CONTINUE
      WRITE (6,410)
260   CONTINUE
      IVALSZ=MAXINPT+NAMT
      J=NAMT+1
      CALL INPT (2,IVALSZ,NVALSZ,IVAL,BUFF(J),IEOF)
      GO TO (310,270,290,280,100,300), IEOF+1
270   CONTINUE
      WRITE (6,370)
      GO TO 250
280   CONTINUE
      WRITE (6,360)
      GO TO 250
290   CONTINUE
      CALL HELP (13)
      GO TO 250
300   CONTINUE
      IOLIST=NVALSZ-IVALSZ
      WRITE (6,400) IOLIST
      GO TO 320
310   CONTINUE
      ICOL=BUFF(1)
      IROW=BUFF(2)
      NAMT=NAMT+NVALSZ
      IF (NAMT.GE.MAXINPT) GO TO 320
      IF (NAMT.EQ.1) WRITE (6,440) ICOL
      IF (NAMT.EQ.2) WRITE (6,450) ICOL,IROW
      GO TO 260
320   CONTINUE
      CALL REASON (3,ICOL,IROW,BUFF(3),0,IFATAL)
      IF (IFATAL.EQ.1) GO TO 240
      CALL REASON (2,ICOL,IROW,BUFF(3),0,IFATAL)
      IF (IFATAL.EQ.1) GO TO 240
C   ***LOAD THE VALUE OF BUFF(3) INTO THE APPROPRIATE
C   ***POSITION WITHIN THE CORR(N) ARRAY
      N=NDX(IROW,ICOL)
      CORR(N)=BUFF(3)
      GO TO 100
C
C     *** PRINT OPTION
C
330   CONTINUE
      CALL PRINT
      GO TO 100
C     *** END OF EDIT MODE
340   CONTINUE
      RETURN
C
350   FORMAT (" EDIT MODE(1-MEANS!2-STD!3-ANTH.CORR!4-PRINT!5-END)--")
360   FORMAT (" INVALID RESPONSE")
370   FORMAT (" NO INFORMATION ENCOUNTERED")
380   FORMAT (" INPUT INDEX AND MEAN VALUE")
390   FORMAT (" INPUT INDEX AND STANDARD DEVIATION")
400   FORMAT (" THE LAST",I2," INPUTS HAVE BEEN IGNORED")
410   FORMAT (" INPUT   COLUMN , ROW   AND CORRELATION")
420   FORMAT (" INPUT MEAN VALUE FOR INDEX ",I3)
430   FORMAT (" INPUT STANDARD DEVIATION FOR INDEX ",I3)
440   FORMAT (" INPUT ROW AND CORRELATION FOR COLUMN ",I2)
450   FORMAT (" INPUT CORRELATION FOR ROW ",I2," COLUMN ",I2)
      END
      SUBROUTINE NAMEFL (IERROR)
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICAPO
```

```
C  ***PROMPTS USER FOR NAME OF SAMPLE FILE
C
      DIMENSION IBUFF(4),XVAL(4)
      DATA IBUFF/4*10H          /
      IERROR=0
C
C  ***INITIALIZE CONTENTS OF IBUFF(4) WITH
C  ***BLANK CHARACTERS
C
      DO 100 J=1,4
      IBUFF(J)=10H
100   CONTINUE
C
110   CONTINUE
      IF (IOIN.EQ.5) WRITE (6,180)
      CALL INPT (4,4,NVALSZ,IBUFF,XVAL,IEOF)
      IF (IEOF.LT.2.OR.IEOF.EQ.5) GO TO 150
      IF (IOIN.NE.5) GO TO 140
      GO TO (120,130,170), IEOF-1
120   CONTINUE
      CALL HELP (14)
      GO TO 110
130   CONTINUE
      WRITE (6,190)
      GO TO 110
140   CONTINUE
      WRITE (6,190)
      IERROR=1
C  ***LOAD CONTENTS OF IBUFF INTO INAME ARRAY
150   CONTINUE
      DO 160 J=1,4
      INAME(J)=IBUFF(J)
160   CONTINUE
170   RETURN
C
180   FORMAT (" OPERATOR SAMPLE DESCRIPTION(40 CHAR MAX)----")
190   FORMAT (" INVALID RESPONSE")
      END
      SUBROUTINE OPSAMP (ISAMP)
C  ***GENERATE OPERATOR SAMPLE
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION IRAN(9)
      DATA  (IRAN(I),I=1,9)/33333333,55555555,77777777,22222221,
     1           44444443,66666669,88888889,99999999,123456789/
C
C  ***LINEAR ARRAY CORR(78) IS LOADED INTO LINEAR
C  ***DUMMY ARRAY SQROOT(78) BEFORE MATRIX TRANSFOR-
C  ***MATIONS.  ALL MATRIX TRANSFORMATIONS ARE
C  ***PERFORMED ON SQROOT(78) TO PRESERVE CORR(78)
C  ***AS IMPLEMENTED WITHIN THE EDITING PROCESS.
C
      IOIN=5
      DO 100 K=1,KN
      SQROOT(K)=CORR(K)
100   CONTINUE
C     *** PERFORM MATRIX TRANSFORMATIONS
      CALL SQRMX (NERROR)
      IF (NERROR.EQ.1) RETURN
C     *** ACCEPT OPERATOR SAMPLE SIZE
110   CONTINUE
      WRITE (6,320)
      CALL INPT (1,1,NVALSZ,NSAMP,XVAL,IEOF)
      GO TO (150,120,130,140,290,140), IEOF+1
```

```
120   CONTINUE
      WRITE (6,330)
      GO TO 110
130   CONTINUE
      CALL HELP (15)
      GO TO 110
140   CONTINUE
      WRITE (6,340)
      GO TO 110
150   CONTINUE
      IF (NSAMP.GT.0) GO TO 160
      WRITE (6,350)
      GO TO 110
C
C  ***ASK USER FOR MACHINE TYPE (32 OR 60 BIT)
C
160   CONTINUE
      WRITE (6,300)
      CALL INPT (1,1,NVALSZ,MTYPE,XVAL,IEOF)
      GO TO (190,160,170,180,290,180), IEOF+1
170   CONTINUE
      CALL HELP (20)
      GO TO 160
180   CONTINUE
      WRITE (6,340)
      GO TO 160
190   CONTINUE
      IF (MTYPE.NE.32.AND.MTYPE.NE.60) GO TO 180
200   CONTINUE
      WRITE (6,310)
C     ***  OPTION FOR ACCEPTING A RANDOM SEED.
      CALL INPT (1,1,NVALSZ,IS,XVAL,IEOF)
      GO TO (240,210,220,230,290,230), IEOF+1
210   CONTINUE
      WRITE (6,330)
      GO TO 200
220   CONTINUE
      CALL HELP (21)
      GO TO 200
230   CONTINUE
      WRITE (6,340)
      GO TO 200
240   CONTINUE
      IF (IS.EQ.0) GO TO 250
      IF (IS.LT.1.OR.IS.GT.9) GO TO 230
      IU=IRAN(IS)
      GO TO 260
250   CONTINUE
      IU=67111133
260   CONTINUE
      REWIND NTEMP
C  ***WRITE 60 CHARACTER NAME FIELD INTO
C  ***FILE SAMPLE (NTEMP)
      WRITE (NTEMP) INAME,NMEAS
C
      DO 280 I=1,NSAMP
C     ***  SIMULATE A PSEUDO SAMPLE CASE.
      CALL SIMSUB (MTYPE)
      DO 270 K=1,NMEAS
      V(K)=V(K)*ANTM(2,K)+ANTM(1,K)
270   CONTINUE
      WRITE (NTEMP) (V(IO),IO=1,NMEAS)
280   CONTINUE
C  ***SET ISAMP TO 1 TO INDICATE OPERATOR SAMPLE HAS BEEN GENERATED
      ISAMP=1
      END FILE NTEMP
```

```
      REWIND NTEMP
      REWIND NTMEAS
      WRITE (6,360)
290   CONTINUE
      RETURN
C
300   FORMAT (" ENTER MACHINE WORD SIZE (32 OR 60 BIT) --")
310   FORMAT (" ENTER RANDOM NO SEED (0 IF NONE OR 1-9)--")
320   FORMAT (" INPUT SAMPLE SIZE --")
330   FORMAT (" NO INFORMATION ENCOUNTERED")
340   FORMAT (" INVALID RESPONSE")
350   FORMAT (" SAMPLE SIZE MUST BE GREATER THAN 0")
360   FORMAT (" SAMPLE DATA SAVED ON FILE SAMPLE OR TAPE 3.")
      END
      SUBROUTINE PRINT
C
C  ***OUTPUT OF SIMULATED OPERATORS
C
C ***NOTE: ALL OPERATOR MEASUREMENTS
C  ***ARE STORED ON FILE SAMPLE.  PRESENTLY EACH RECORD
C *** CONTAINS NMEAS ANTHROPOMETRIC MEASUREMENTS
C
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      INTEGER FMT
      DIMENSION FMT(6),NUM(12),TEMP(12),INDEX(2)
      DATA FMT/4H(    ,4H    ,4H(6X),4H    ,4H(F6.,4H3)) /
      DATA NUM/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,2H10,2H11,2H12/
      ISTORE=0
      IOFLAG=0
C
C     ***  MENU CHOICE OF OUTPUTS
C
100   CONTINUE
      WRITE (6,630)
      CALL INPT (1,1,NVALSZ,IOPT,XVAL,IEOF)
      GO TO (120,110,110,110,390,110), IEOF+1
110   CONTINUE
      WRITE (6,650)
      GO TO 100
120   CONTINUE
      IF (IOPT.LT.1.OR.IOPT.GT.4) GO TO 110
      IF (IOPT.EQ.1) GO TO 130
      IF (IOPT.EQ.2) GO TO 150
      IF (IOPT.EQ.4) GO TO 390
      GO TO 190
C
C     ***  PRINTOUT OF MEANS/STANDARD DEVIATIONS
C
130   CONTINUE
      WRITE (6,580)
      DO 140 IROW=1,NMEAS
      WRITE (6,640) IROW,(ANTM(JO,IROW),JO=1,2)
140   CONTINUE
      WRITE (6,620)
      GO TO 100
C
C     ***  PRINTOUT OF ANTHROPOMETRIC CORRELATIONS
C
150   CONTINUE
      WRITE (6,590)
      WRITE (6,660) (NUM(IO),IO=1,NMEAS)
      WRITE (6,600)
      DO 180 IROW=1,NMEAS
```

```
      DO 160 ICOL=1,NMEAS
      N=NDX(IROW,ICOL)
      TEMP(ICOL)=CORR(N)
160   CONTINUE
      IF (IROW.GT.1) GO TO 170
      WRITE (6,610) (TEMP(ICOL),ICOL=IROW,NMEAS)
      GO TO 180
170   FMT(2)=NUM(IROW-1)
      FMT(4)=NUM(NMEAS+1-IROW)
      WRITE (6,FMT) (TEMP(ICOL),ICOL=IROW,NMEAS)
180   CONTINUE
      WRITE (6,620)
      GO TO 100
C
C *** PRINT OF ANTHROPOMETRIC MEASUREMENTS
C
190   CONTINUE
      WRITE (6,430)
      IF (IOFLAG.LT.1) WRITE (6,440)
      IOFLAG=1
C
C  ***INPUT CARRIAGE RETURN -- ENTIRE SAMPLE LIST
C  ***INPUT SINGLE NUMBER   -- SINGLE OPERATOR
C  ***INPUT TWO NUMBERS     -- SEGMENT OF OPERATOR LIST
C
      CALL INPT (1,2,NVALSZ,INDEX,XVAL,IEOF)
      GO TO (230,270,200,210,100,220), IEOF+1
200   CONTINUE
      CALL HELP (19)
      IOFLAG=0
      GO TO 190
210   CONTINUE
      WRITE (6,420)
      GO TO 190
220   CONTINUE
      IOLIST=NVALSZ-2
      WRITE (6,450) IOLIST
230   CONTINUE
C  ***INDEX VALIDATION
      IF (INDEX(1).GT.0) GO TO 240
      WRITE (6,480)
      GO TO 190
240   CONTINUE
C
C  ***TO DETERMINE WHETHER FILES WILL BE REWOUND
C
      IF (ISTORE.GT.0.AND.INDEX(1).GT.ISTORE) GO TO 250
      NRSKIP=INDEX(1)-1
      GO TO 260
250   CONTINUE
      NRSKIP=INDEX(1)-ISTORE-1
260   CONTINUE
      ISTART=INDEX(1)
C  ***IF TWO INPUTS ENCOUNTERED - OUTPUT LIMITS
C  ***IF ONE INPUTS ENCOUNTERED - OUTPUT SINGLE OPERATOR
      IF (NVALSZ.EQ.1) GO TO 280
      IF (NVALSZ.GE.2) GO TO 290
270   CONTINUE
      ISTORE=0
      ISTART=1
      IEND=999
      NRSKIP=0
      GO TO 320
280   CONTINUE
      IEND=ISTART
      GO TO 310
```

```
290    CONTINUE
       IF (INDEX(1).LE.INDEX(2)) GO TO 300
       WRITE (6,490)
       GO TO 190
300    CONTINUE
       IEND=INDEX(2)
310    CONTINUE
       IF (INDEX(1).GT.ISTORE.AND.ISTORE.NE.0) GO TO 330
320    CONTINUE
C  ***REWIND FILE
       REWIND NTEMP
       READ (NTEMP) INAME,NMEAS
       IF (EOF(NTEMP).EQ.1) GO TO 410
330    CONTINUE
       IF (NRSKIP.LT.1) GO TO 350
C  ***WIND FILE FORWARD
       DO 340 I=1,NRSKIP
       READ (NTEMP) (V(K),K=1,NMEAS)
       IF (EOF(NTEMP).EQ.1) GO TO 400
340    CONTINUE
350    CONTINUE
C  ***OUTPUT HEADER
       WRITE (6,530) (INAME(IO),IO=1,4)
       IF (ISTART.EQ.IEND) WRITE (6,540) IEND
       IF (ISTART.NE.IEND.AND.IEND.NE.999) WRITE (6,550) ISTART,IEND
       WRITE (6,500)
       WRITE (6,660) (NUM(IO),IO=1,NMEAS)
       WRITE (6,600)
C
C  ***OUTPUT DATA FROM FILE
C
       ISKIP=0
       NFOUND=0
       DO 360 I=ISTART,IEND
C  ***SKIP LINE FEATURE
       IF (ISKIP.EQ.1) WRITE (6,460)
       ISKIP=0
       IF (ISTART.NE.IEND.AND.I.NE.IEND.AND.(I/5)*5.EQ.I) ISKIP=1
       READ (NTEMP) (V(K),K=1,NMEAS)
       IF (EOF(NTEMP).EQ.1) GO TO 370
       NFOUND=NFOUND+1
       ISTORE=I
       WRITE (6,510) (V(K),K=1,NMEAS)
360    CONTINUE
       GO TO 380
370    CONTINUE
       IF (IEND.NE.999.AND.ISTART.NE.IEND) WRITE (6,470) IEND
       ISTORE=I
       IF (NFOUND.LT.1) WRITE (6,560)
380    CONTINUE
       WRITE (6,520)
       GO TO 190
390    CONTINUE
       REWIND NTEMP
       RETURN
400    CONTINUE
       IOLIST=I-2+ISTORE
       WRITE (6,560)
       GO TO 190
410    CONTINUE
       WRITE (6,570)
       GO TO 100
C
420    FORMAT (" INVALID RESPONSE")
430    FORMAT (" OUTPUT MODE:--")
440    FORMAT (" FOR ALL OPERATOR DATA (ENTER CARRIAGE RETURN)",/,
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```
     1" FOR INDIVIDUAL OPERATOR DATA (ENTER OPERATOR NUMBER)",/
     2" FOR A SEQUENCE OF OPERATORS (ENTER RANGE OF OPERATOR NUMBERS)"/
     + " END (ENTER $)")
450   FORMAT (" THE LAST",I4," INPUTS HAVE BEEN IGNORED")
460   FORMAT (1H )
470   FORMAT (" ERROR IN UPPER INDEX -- ",I4)
480   FORMAT (" INDEX NUMBER CANNOT BE LESS THAN OR EQUAL TO 0")
490   FORMAT (" FIRST INDEX MUST BE LESS THAN SECOND INDEX")
500   FORMAT (27X,"OPERATOR SAMPLE",/,71(1H-),)
510   FORMAT (11F6.2,F5.2)
520   FORMAT (71(1H-))
530   FORMAT (1X,4A10,10X,A10)
540   FORMAT (10X,"OPERATOR NO",I4)
550   FORMAT (10X,"OPERATOR NOS",I4," --",I4)
560   FORMAT (" INDEX NUMBER EXCEEDS RECORDS IN OPERATOR FILE")
570   FORMAT (" FILE SAMPLE IS NOT ATTACHED TO THE PROGRAM"/
     + " OPERATOR OUTPUT REQUEST ABORTED ---",//)
580   FORMAT (/,21X,"MEANS AND STANDARD DEVIATIONS",/,1X,70(1H-),/,2X,"M
     1EASUREMENT",6X,"MEANS",6X,"STD DEV",/,1X,71(1H-))
590   FORMAT (/,7X,"CORRELATION MATRIX FOR ANTHOPOMETRIC MEASUREMENTS",/
     1,1X,70(1H-))
600   FORMAT (1X,70(1H-))
610   FORMAT (12F6.3)
620   FORMAT (1X,70(1H-))
630   FORMAT (" PRINT MODE(1-MEAN/STD:2-CORR MATRX:3-OPER MEAS:4-END)-")
640   FORMAT (I9,5X,2F12.2))
650   FORMAT (" INVALID RESPONSE")
660   FORMAT (2X,11(A2,4X),A2)
      END
      SUBROUTINE RAND2 (RNORM,MTYPE,QUAN,IJ)
C
C   ***GENERATES A NORMAL DISTRIBUTION WITH MEAN OF ZERO AND
C   ***STANDARD DEVIATION EQUAL TO ONE.***
C   ***METHODOLOGY --- MARSAGLIA - BRAY
C
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1     SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2     INAME(4),ITMEAS,NIMEAS,NTEMP
      DIMENSION QUAN(2)
      COMMON/MISC/IOIN,IOOUT,ICARD
      IJ=IJ+1
      IF (IJ.EQ.2) GO TO 110
100   CONTINUE
      X1=2.0*UNFORM(MTYPE)-1.0
      Y1=2.0*UNFORM(MTYPE)-1.0
      S=X1*X1+Y1*Y1
      IF (S.GE.1.0) GO TO 100
      S=SQRT(-2.0*ALOG(S)/S)
      QUAN(1)=X1*S
      QUAN(2)=Y1*S
110   CONTINUE
      RNORM=QUAN(IJ)
      IF (IJ.EQ.2) IJ=0
      RETURN
      END
      SUBROUTINE REASON (ICALL,ICOL,IROW,TSTORE1,TSTORE2,IFATAL)
C
C     ***  CHECKS FOR REASONABLENESS OF INPUT VALUES
C
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1     SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2     INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
C
C  ICALL = 1  MEANS AND STANDARD DEVIATIONS
C  ICALL = 2  CORRELATION MATRIX VERIFICATION
```

```
C  ICALL = 3  INDEX VERIFICATION
C
      IFATAL=0
      IAFLAG=0
      IF (ICALL.LT.0) IAFLAG=1
      ICALL=IABS(ICALL)
      IF (ICALL.GT.1) GO TO 110
C
C     ***  MEAN VALUES MUST BE WITHIN A THREE STANDARD DEVIATION
C     ***  NEIGHBORHOOD OF THE ACCEPTED MEAN VALUES
C
      IWRITE=1
      IF (IROW.LT.1.OR.IROW.GT.NMEAS) GO TO 120
      IF (ICOL.EQ.2) GO TO 100
      RETURN
C
C     ***  STANDARD DEVIATIONS MAY NOT BE NEGATIVE
C     ***  AND THE MEANS MUST BE GREATER THAN
C     ***  THE STANDARD DEVIATION.
C
100   CONTINUE
      IWRITE=2
      IF (TSTORE2.LT.0.) GO TO 120
      IWRITE=3
      IF (TSTORE1.LE.TSTORE2) GO TO 120
      RETURN
C
C     ***  CHECKS VALIDITY OF INDEX NUMBERS
C
110   CONTINUE
      IWRITE=1
      IF (IROW.LE.0.OR.IROW.GT.NMEAS) GO TO 130
      IWRITE=2
      IF (ICOL.LE.0.OR.ICOL.GT.NMEAS) GO TO 130
C  ***IS THE NUMBER WITHIN THE UPPER TRIANGULAR REGION?
      IWRITE=3
      IF (IROW.GT.ICOL) GO TO 130
      IF (ICALL.EQ.3) RETURN
C
C     ***  ALL DIAGONAL ELEMENTS MUST EQUAL 1.000
C     ***  MATRIX ELEMENTS MAY NOT BE LESS THAN (-1) OR GREATER
C     ***  THAN ONE.
C
      IWRITE=4
      IF (ICOL.EQ.IROW.AND.TSTORE1.NE.1.000) GO TO 130
      IWRITE=5
      IF (TSTORE1.LT.-1.000) GO TO 130
      IWRITE=6
      IF (TSTORE1.GT.1.000) GO TO 130
      RETURN
C
C  ***BRANCH TO APPROPRIATE ERROR MESSAGE
C
120   CONTINUE
      IF (IWRITE.NE.1.AND.IOIN.NE.5) WRITE (6,280) IROW
      GO TO (190,140,150), IWRITE
130   CONTINUE
      GO TO (190,200,210,160,170,180), IWRITE
140   CONTINUE
      WRITE (6,230)
      GO TO 220
150   CONTINUE
      WRITE (6,240)
      GO TO 220
160   CONTINUE
      WRITE (6,250) IROW,ICOL
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      GO TO 220
170   CONTINUE
      WRITE (6,260) IROW,ICOL
      GO TO 220
180   CONTINUE
      WRITE (6,270) IROW,ICOL
      GO TO 220
190   CONTINUE
      WRITE (6,290) IROW,NMEAS
      GO TO 220
200   CONTINUE
      WRITE (6,300) ICOL,NMEAS
      GO TO 220
210   CONTINUE
      WRITE (6,310) IROW,ICOL
      GO TO 220
220   CONTINUE
      IFATAL=1
      RETURN
C
230   FORMAT (" STANDARD DEVIATIONS LESS THAN ZERO")
240   FORMAT (" STANDARD DEVIATION GREATER THAN MEAN VALUE.")
250   FORMAT (" DIAGONAL ELEMENT IN ROW ",I2," COLUMN ",I2,
     +  " IS NOT EQUAL TO 1.0")
260   FORMAT (" ENTRY IN COLUMN ",I2," ROW ",I2,
     +  " IS LESS THAN -1.0")
270   FORMAT (" ENTRY IN COLUMN ",I2," ROW ",I2,
     +  " IS GREATER THAN +1.0")
280   FORMAT (I10)
290   FORMAT (" ROW ",I2," IS LESS THAN ZERO OR GREATER THAN ",I2)
300   FORMAT (" COLUMN ",I2," IS LESS THAN ZERO OR GREATER THAN ",I2)
310   FORMAT (" ROW ",I2," COLUMN ",I2," IS OUTSIDE OF UPPER",
     +  " TRIANGULAR REGION OF CORRELATION MATRIX.")
      END
      SUBROUTINE SAVE
C
C     ***  THIS ROUTINE SAVES INPUT DATA ON PERMANENT FILE TAPE2
C
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NTHEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      REWIND NTMEAS
C  ***SAVE NO. OF MEAS., ELEMENTS IN CORR MATRIX, SEX FLAG
      WRITE (NTMEAS) NMEAS,KN,INAME
C  *** SAVE MEAN/STD. VECTOR.
      WRITE (NTMEAS) ((ANTM(IO,JO),IO=1,2),JO=1,NMEAS)
C *** SAVE CORRELATION MATRIX
      WRITE (NTMEAS) (CORR(IO),IO=1,KN)
      REWIND NTMEAS
      WRITE (6,100)
      RETURN
C
100   FORMAT (" MEASUREMENT DATA SAVED ON FILE UMEAS OR TAPE2")
      END
      SUBROUTINE SIMSUB (NTYPE)
C
C     ***  FOR A GIVEN SQUAR ROOT MATRIX R OF ORDER N IN UPPER
C     ***  TRIANGULAR FORM OF A CORRELATION OR A COVARIANCE
C     ***  MATRIX OF N COLUMNS, THIS ROUTINE COMPUTES A VECTOR
C     ***  V OF PSEUDO SCORES OF LENGTH N SUCH THAT IT WILL
C     ***  BE A QUASI-RANDOM SAMPLE FROM A NORMAL POPULATION
C     ***  WITH A MEAN VECTOR OF ZEROS AND THE SAME CORRELATION
C     ***  OR COVARIANCE MATRIX, I.E. FROM AN N(0,R) MATRIX.
C
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
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```
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION Y(45)
      IJ=0
      DO 100 I=1,NMEAS
      V(I)=0.0
      CALL RAND2 (RNORM,MTYPE,QUAN,IJ)
100   Y(I)=RNORM
      DO 110 I=1,NMEAS
      DO 110 J=1,I
      K=NDX(J,I)
110   V(I)=V(I)+Y(J)*SQROOT(K)
      RETURN
      END
      SUBROUTINE SQRMX (NERROR)
C
C     ***  FOR A GIVEN SYMMETRIC MATRIX OF ORDER N STORED IN ITS
C     ***  UPPER TRIANGULAR FORM, COLUMNWISE IN THE VECTOR R OF
C     ***  LENGTH N*(N+1)/2, THIS ROUTINE TRANSFORMS IT INTO ITS
C     ***  "SQUARE ROOT" IN THE SAME FORM IN THE VECTOR SQROOT(78)
C
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1    SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2    INAME(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION ZX(7)
      INTEGER ZX
C  ***NERROR FLAG IS USED TO SIGNIFY A CONDITION
C  ***WHICH WILL PRODUCE A NEGATIVE SQROOT(N) VALUE
C  ***JUST BEFORE IMPLEMENTATION OF THE SQUARE ROOT
C  ***FUNCTION.
      NERROR=0
      DO 120 I=1,NMEAS
      ZX(4)=I
      N=NDX(I,I)
C  ***TEST FOR NEGATIVE RADICAL ARGUMENT
      IF (SQROOT(N).LT.0) GO TO 130
      SQ=SQRT(SQROOT(N))
      DO 100 J=I,NMEAS
      N=NDX(I,J)
      SQROOT(N)=SQROOT(N)/SQ
100   CONTINUE
C  ***NORMAL EXIT FROM SUBROUTINE
      IF (I.EQ.NMEAS) NERROR=0
      IF (I.EQ.NMEAS) RETURN
      I1=I+1
      ZX(5)=I1
      DO 110 I2=I1,NMEAS
      DO 110 J2=I2,NMEAS
      N=NDX(I2,J2)
      L=NDX(I,I2)
      K=NDX(I,J2)
      SQROOT(N)=SQROOT(N)-SQROOT(L)*SQROOT(K)
      ZX(6)=I2
      ZX(7)=J2
110   CONTINUE
      ZX(1)=N
      ZX(2)=L
      ZX(3)=K
120   CONTINUE
130   CONTINUE
C  ***ABNORMAL EXIT FROM SUBROUTINE
      NERROR=1
      WRITE (6,180)
140   CONTINUE
```

```
      WRITE (6,190)
      CALL INPT (4,1,NVALSZ,IANS,XVAL,IEOF)
      GO TO (170,160,150,170,160,170), IEOF+1
150   CONTINUE
      WRITE (6,200)
      WRITE (6,210)  (ZX(I),I=1,7),SQROOT(N)
160   CONTINUE
      RETURN
170   CONTINUE
      WRITE (6,220)
      GO TO 140
C
180   FORMAT (" ANTHROPOMETRIC CORRELATION VALUES ARE INVALID")
190   FORMAT (" -- ENTER CARRIAGE RETURN TO CONTINUE PROCESSING",/
     +  " -- ENTER  ?  TO DISPLAY SQRMX VARIABLES")
200   FORMAT (" AN INDEFINITE QUANTITY HAS BEEN DETECTED BY SQRMX"/
     +  " VARIABLE LIST WITHIN SQRMX:"/"   N     L",
     +"    K     I     I1    I2    J2    SQROOT",/,10X,44(1H-))
210   FORMAT (8X,4I5,1X,3I5,F9.3,/,10X,44(1H-),//)
220   FORMAT (/" INVALID RESPONSE ***"/)
      END
      FUNCTION NDX(I,J)
      IF (I.GT.J) GO TO 100
      NDX=I+(J*J-J)/2
      RETURN
100   NDX=J+(I*I-I)/2
      RETURN
      END
      FUNCTION UNFORM(MTYPE)
C
C   ***UNIFORM RANDOM NUMBER GENERATOR ON INTERVAL (0,1)
C
      COMMON /MCSM/ CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2INAMF(4),ITMEAS,NIMEAS,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
C      60 BIT UNIFORM RANDOM NUMBER GENERATOR
      DATA IX/16777213/,C/281474976710655./
      IF (MTYPE.EQ.32) GO TO 100
      IU=IU*IX
      UNFORM=IU/C
      RETURN
C      32 BIT UNIFORM RANDOM NUMBER GENERATOR
100   IU=IU*65539
      IF (IU.GE.0) GO TO 110
      IU=IU+2147483647+1
110   UNFORM=IU
      UNFORM=UNFORM*.4656613E-09
      RETURN
      END
      SUBROUTINE HELP (I)
      RETURN
      END#
```

APPENDIX D

Program Listing for CAPE Model
Modified for Use with FORTRAN IV

```
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1 SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2 INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DATA NUCREW/8/
      DATA MAXFUN/4/
      DATA MAXOPT,MAXANT,MAXACT/3,7,3/
      IOOUT=0
      ISAMP=0
      MMEAS = 12
  100 CONTINUE
      IOIN=5
      WRITE (6,290)
      CALL INPT (1,1,NVALSZ,NMEAS,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (130,100,110,120,280,120), IEOFP1
  110 CONTINUE
      CALL HELP (1)
      GO TO 100
  120 CONTINUE
      WRITE (6,340)
      GO TO 100
  130 CONTINUE
      IF (NMEAS.LT.1.OR.NMEAS.GT.MMEAS) GO TO 120
      KN=NMEAS*(NMEAS+1)/2
      IINPT=0
  140 CONTINUE
      IOIN=5
  150 CONTINUE
      WRITE (6,300)
      CALL INPT (1,1,NVALSZ,IOPT,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (180,140,160,170,280,170),IEOFP1
  160 CONTINUE
      CALL HELP (2)
      GO TO 150
  170 CONTINUE
      WRITE (6,340)
      GO TO 150
  180 CONTINUE
      IF (IOPT.LT.1.OR.IOPT.GT.MAXANT)GO TO 170
      GO TO (190,200,220,240,260,280,225),IOPT
  190 CONTINUE
      CALL ACCPT (ISAMP)
      IINPT=1
      GO TO 140
  200 CONTINUE
      IF(IINPT.EQ.1) GO TO 210
      WRITE (6,350)
      GO TO 140
```

```
210   CONTINUE
      CALL EDIT
      GO TO 140
220   CONTINUE
      IF (ISAMP.EQ.1) GO TO 230
222   WRITE (6,320)
      GO TO 140
225   CONTINUE
      IF(ISAMP.NE.1) GO TO 222
      CALL PUNRT
      GO TO 140
230   CONTINUE
      CALL SAVE
      GO TO 140
240   CONTINUE
      IF(IINPT.EQ.1) GO TO 250
      WRITE (6,360)
      GO TO 140
250   CONTINUE
      CALL PRINT
      GO TO 140
260   CONTINUE
      IF (ISAMP.NE.1) GO TO 270
      CALL OPSAMP(ISAMP)
      GO TO 140
270   CONTINUE
      WRITE (6,330)
      GO TO 140
280   CONTINUE
      WRITE (6,310)
      STOP
290   FORMAT (' ENTER NUMBER OF MEASUREMENTS (1-12)?--')
300   FORMAT (' OPTIONS(1-INPUT;2-EDIT;3-SAVE;4-PRINT;5-GENERATE;'
     1 ,'6-END;7-PUNCH) ')
310   FORMAT (5X,'END OF OPERATOR SAMPLE')
320   FORMAT (1X,'***MCSM140 UNABLE TO SAVE MEASUREMENT DATA - FATAL
     1 ERRORS')
330   FORMAT (10X,'***MCSM165 UNABLE TO GENERATE SAMPLE - FATAL ERRORS')
340   FORMAT (/,'***MCSM024 INVALID RESPONSE')
350   FORMAT (10X,'***MCSM130 ANTHROPOMETRIC DATA MUST BE INPUT BEFORE',
     1/,13X,'THE EDIT FUNCTION.')
360   FORMAT (10X,'***MCSM150 ANTHROPOMETRIC DATA MUST BE INPUT BEFORE',
     1/,13X,'THE PRINT FUNCTION.')
      END
```

```
      SUBROUTINE INPT (ITYPE,IVALSZ,NVALSZ,IVAL,XVAL,IEOF)
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION ICHAR(80),IVAL(IVALSZ),XVAL(IVALSZ)
C
      DIMENSION NVAL(20)
      LOGICAL * 1 NCHAR(80)
      EQUIVALENCE (NVAL(1),NCHAR(1))
C
C
      DATA IBLK,IQUES,IDOL,IQUO,IPOST,IPD,ICOM,IMIN,IPLUS/1H ,1H?,
     11H$,1H',1H:,1H.,1H,,1H-,1H+/
      DATA I4BLK/4H    /
      ISTOP=0
      IF (IVALSZ.GE.0) GO TO 100
      ISTOP=1
      IVALSZ=IABS(IVALSZ)
  100 CONTINUE
      IQUOTE=0
      NVALSZ=0
      IEOF=0
      IF (IOOUT.EQ.1) GO TO 120
      DO 110 I=1,80
      ICHAR(I)=IBLK
  110 CONTINUE
      READ (IOIN,330,END=111)ICHAR, NCHAR
      DO 109 J=1,80
      IF (ICHAR(J) .EQ. IBLK) GO TO 109
      GO TO 130
  109 CONTINUE
      GO TO 113
  111 CONTINUE
      REWIND IOIN
  113 IEOF = 1
      RETURN
  120 CONTINUE
      I1=ICARD
      GO TO 140
  130 CONTINUE
      I1=1
  140 CONTINUE
      I2=80
  150 CONTINUE
C     WRITE(6,501) IDEC,ISTOP,IVALSZ,NVALSZ, I1,I2, IEOF
      IF (ISTOP.EQ.1.AND.IVALSZ.EQ.NVALSZ) RETURN
      IF (I1.LE.I2) GO TO 160
      IF (NVALSZ.LE.IVALSZ) RETURN
      IEOF=5
      RETURN
  160 CONTINUE
      DO 170 I=I1,I2
```

```
      IF (ICHAR(I).EQ.IBLK ) GO TO 170
      IFIRST=I
      GO TO 180
  170 CONTINUE
      IF (NVALSZ.EQ.0) IEOF=1
      IF (NVALSZ.GT.IVALSZ) IEOF=5
      RETURN
  180 CONTINUE
      IF (ICHAR(IFIRST).EQ.IQUES) IEOF=2
      IF (ICHAR(IFIRST).EQ.IDOL) IEOF=4
      IF (IEOF.NE.0) RETURN
      IF (ITYPE.EQ.4) GO TO 300
      IF (ITYPE.NE.3) GO TO 190
      IF (ICHAR(IFIRST).NE.IQUO.AND.ICHAR(IFIRST).NE.IPOST) GO TO 190
      IFIRST=IFIRST+1
      IQUOTE=1
  190 CONTINUE
      DO 220 I=IFIRST,I2
      IF (IQUOTE.EQ.0) GO TO 200
      IF (ICHAR(I).EQ.IQUO.OR.ICHAR(I).EQ.IPOST)GO TO 210
      GO TO 220
  200 CONTINUE
      IF (ICHAR(I).NE.IBLK.AND.ICHAR(I).NE.ICOM) GO TO 220
  210 CONTINUE
      ILAST=I-1
      GO TO 230
  220 CONTINUE
      ILAST=I2
  230 CONTINUE
      NVALSZ=NVALSZ+1
      I1=ILAST+2
      IF (NVALSZ.GT.IVALSZ) GO TO 150
      IF (ITYPE .EQ.3) GO TO 310
      ISIGN=1
      IF (ICHAR(IFIRST).NE.IMIN.AND.ICHAR(IFIRST).NE.IPLUS) GO TO 240
      IF (ICHAR(IFIRST).EQ.IMIN) ISIGN=-1
      IFIRST=IFIRST+1
  240 CONTINUE
      INUM=0
      IDEC=0
      IDECF=0
      DO 260 I=IFIRST,ILAST
      IF (ICHAR(I).NE.IPD) GO TO 250
      IDECF=IDECF+1
      IDEC=1
      GO TO 260
  250 CONTINUE
      CALL ICONV (ICHAR(I),IADD,IEOF)
      IF (IEOF.EQ.9) RETURN
      INUM=INUM*10+IADD
```

```
  501 FORMAT(/ '  TEST ', 10I10)
      IF (IDEC.NE.0) IDEC=IDEC+1
  260 CONTINUE
      IF (IDECF.LT.2) GO TO 280
  270 CONTINUE
C     WRITE(6,501) IDEC, IDECF
      IEOF=3
      RETURN
  280 CONTINUE
      INUM=INUM*ISIGN
      XNUM=FLOAT(INUM)
CC    WRITE(6,501) IDEC, IDECF, INUM, IADD, ISIGN, ITYPE
      IF ((ITYPE.EQ.1.AND.IDEC.LE.1).OR.(ITYPE.EQ.2)) GO TO 290
      IEOF=3
      RETURN
  290 CONTINUE
      IF (IDEC.NE.0) XNUM=XNUM/10.0**(IDEC-1)
      IF (ITYPE.EQ.1) IVAL(NVALSZ)=IFIX(XNUM)
      IF (ITYPE.EQ.2) XVAL(NVALSZ)=XNUM
      ICARD=ILAST+1
C     WRITE(6,501) IDEC,IDECF,INUM,IADD, ISIGN,ITYPE,NVALSZ,
C    1  IVAL(NVALSZ), ICARD
      GO TO 150
  300 CONTINUE
      ILAST=IVALSZ*4
  909 FORMAT( 2X, 80A1)
  910 FORMAT(2X, 20A4)
  310 CONTINUE
      DO 320 J=1,IVALSZ
      IVAL(J)=I4BLK
  320 CONTINUE
      L=ILAST-IFIRST+1
      NVALSZ=(L-1)/10+1
      IF (L.GT.4*IVALSZ) GO TO 270
C     ENCODE (L,340,IVAL(1) )(ICHAR(I),IFIRST,ILAST)
      J = 0
  904 FORMAT('  ENCODE ', 10I10)
      DO 311 I = IFIRST,ILAST
      J = J + 1
      NCHAR(J) = NCHAR(I)
  311 CONTINUE
      DO 313 I = 1,IVALSZ
      IVAL(I) = NVAL(I)
  313 CONTINUE
      ICARD=I1
      RETURN
  330 FORMAT (80A1, T1, 80A1)
  340 FORMAT (80A1)
      END
```

```
      SUBROUTINE ICONV (JCHAR,I1,IEOF)
      DIMENSION JNUM(10)
      DATA JNUM/1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9/
   11 FORMAT(//'  AT. ICONV  ', A2,2I10 /)
      DO 100 J=1,10
      IF (JCHAR.NE.JNUM(J)) GO TO 100
      I1=J-1
      RETURN
  100 CONTINUE
      IEOF = 3
      WRITE(6,11) JCHAR, I1, IEOF
      RETURN
      END
```

```
      SUBROUTINE ACCPT (ISAMP)
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION BUFF(3),TEMP(12)
      DATA BUFF/3*0./
      ISAMP=0
      ICOUNT=0
      INLINE=0
      IOIN=5
  100 CONTINUE
      WRITE (6,610)
      CALL INPT (1,1,NOINPT,IMODE,XINPT,IEOF)
      IEOFP1=IEOF+1
      GO TO (130,110,120,110,490,110),IEOFP1
  110 WRITE (6,650)
      GO TO 100
  120 CALL HELP (4)
      GO TO 100
  130 IF (IMODE.EQ.1) GO TO 200
      IF (IMODE.NE.2) GO TO 110
  140 CONTINUE
      WRITE (6,620)
      CALL INPT (1,1,NOINPT,IFFORM,XINPT,IEOF)
      IEOFP1=IEOF+1
      GO TO (170,150,160,150,490,150), IEOFP1
  150 WRITE (6,650)
      GO TO 140
  160 CALL HELP (5)
      GO TO 140
  170 IF (IFFORM.EQ.1) GO TO 190
      IF (IFFORM.NE.2) GO TO 150
      REWIND NTMEAS
      READ (NTMEAS,END=180) NMEAS,KN,INAME
      READ (NTMEAS) ((ANTM(IO,JO),IO=1,2),JO=1,NMEAS)
      READ (NTMEAS) (CORR(IO),IO=1,KN)
      REWIND NTMEAS
      WRITE (6,690)
      ISAMP=1
      RETURN
  180 CONTINUE
      WRITE(6,670)
      GO TO 490
  190 IOIN=1
  200 CONTINUE
      CALL NAMEFL (IERROR)
      ICOUNT=ICOUNT+IERROR
C     WRITE(6,901) IMODE,IERROR,ICOUNT
  901 FORMAT(/ ' ACCPT ', 10I10)
```

```
      INLINE=INLINE+1
      IF (IMODE.EQ.1) WRITE (6,500)
      IF (IMODE.NE.1) WRITE (6,510) INAME
      MAXINP=2
C     WRITE(6,901) IMODE, IERROR,ICOUNT,INLINE,MAXINP,IEOF
      DO 320 IROW=1,NMEAS
  210 CONTINUE
      IF (IMODE.EQ.1) WRITE (6,530) IROW
  220 NAMT=0
  230 CONTINUE
      ITOTIN=MAXINP-NAMT
      ICOL=NAMT+1
      CALL INPT (2,ITOTIN,NOINPT,IVAL,ANTM(ICOL,IROW),IEOF)
      IF (IEOF.EQ.5.OR.IEOF.EQ.0) NAMT=NAMT+NOINPT
C     WRITE(6,901) IMODE, ITOTIN, MAXINP,NAMT,IEOF,ICOL,ICOL
      IF (IMODE.EQ.1) GO TO 240
      INLINE=INLINE+1
      IF (NAMT.EQ.MAXINP) GO TO 290
      IF (IEOF.EQ.1) GO TO 480
      WRITE (6,540) IROW
      IF (IEOF.EQ.5) GO TO 270
      WRITE (6,700) INLINE
      ICOUNT=ICOUNT+1
      GO TO 320
  240 CONTINUE
      IEOFP1=IEOF+1
      GO TO (280,210,250,260,490,270), IEOFP1
  250 CONTINUE
      CALL HELP (6)
      GO TO 210
  260 CONTINUE
      WRITE (6,650)
      GO TO 210
  270 CONTINUE
      IOLIST=NOINPT-ITOTIN
      WRITE (6,600) IOLIST
      IF (IMODE.NE.1) ICOUNT=ICOUNT+1
      GO TO 290
  280 CONTINUE
      IF (NAMT.GE.2) GO TO 290
      WRITE (6,550)
      GO TO 230
  290 CONTINUE
      IF (NAMT.GT.2) NAMT=2
      IRERR=0
      DO 300 ICOL=1,NAMT
      CALL REASON (1,ICOL,IROW,ANTM(1,IROW),ANTM(2,IROW),IFATAL)
      IRERR=IRERR+IFATAL
  300 CONTINUE
      IF (IRERR.EQ.0) GO TO 320
```

```
      IF (IMODE.NE.1) GO TO 310
      WRITE (6,630) IROW
      GO TO 220
  310 ICOUNT=ICOUNT+IRERR
  320 CONTINUE
      IF (IMODE.EQ.1) WRITE (6,560)
      IF (IMODE.NE.1) WRITE (6,520)
      DO 460 IROW=1,NMEAS
  330 CONTINUE
      NAMT=0
      MAXINP=NMEAS+1-IROW
  340 CONTINUE
      IF (IMODE.EQ.1.AND.IROW.EQ.NMEAS) WRITE (6,580) IROW,MAXINP,NMEAS
      IF (IMODE.EQ.1.AND.IROW.NE.NMEAS) WRITE (6,570) IROW,MAXINP,IROW,
     1NMEAS
  350 CONTINUE
      ITOTIN=MAXINP-NAMT
      ISTART=IROW+NAMT
      CALL INPT (2,ITOTIN,NOINPT,IVAL,TEMP(ISTART),IEOF)
      IF (IEOF.EQ.0.OR.IEOF.EQ.5) NAMT=NAMT+NOINPT
      IF (IMODE.EQ.1) GO TO 360
      INLINE=INLINE+1
      IF (NAMT.EQ.MAXINP) GO TO 410
      IF (IEOF.EQ.0) GO TO 350
      IF (IEOF.EQ.1) WRITE (6,710)
      IF (IEOF.EQ.1) GO TO 470
      IF (IEOF.EQ.5) GO TO 390
      ICOUNT=ICOUNT+1
      WRITE (6,700) INLINE
      GO TO 460
  360 CONTINUE
      IEOFP1=IEOF+1
      GO TO (400,380,370,380,490,390),IEOFP1
  370 CONTINUE
      CALL HELP (7)
      GO TO 340
  380 CONTINUE
      WRITE (6,650)
      GO TO 340
  390 CONTINUE
      IOLIST=NOINPT-ITOTIN
      WRITE (6,600) IOLIST
      IF (IMODE.NE.1) ICOUNT=ICOUNT+1
      NAMT=MAXINP
      GO TO 410
  400 CONTINUE
      IF (NOINPT.EQ.ITOTIN) GO TO 410
      ITOTIN=MAXINP-NAMT
      WRITE (6,590) ITOTIN,IROW
      GO TO 350
```

```
  410 CONTINUE
      ILAST=IROW+NAMT-1
      IRERR=0
      DO 420 ICOL=IROW,ILAST
CC    WRITE(6,902) IROW,ICOL,ILAST,IMODE, TEMP(ICOL)
  902 FORMAT(' ACC', 4I10, 4F10.3)
      CALL REASON (2,ICOL,IROW,TEMP(ICOL),0,IFATAL)
      IRERR=IRERR+IFATAL
C     WRITE(6,901) IROW,ICOL,IRERR,IFATAL
  420 CONTINUE
      IF (IRERR.EQ.0) GO TO 440
      IF (IMODE.EQ.2) GO TO 430
      WRITE (6,640) IROW
      GO TO 330
  430 ICOUNT=ICOUNT+IRERR
      GO TO 460
  440 CONTINUE
      DO 450 ICOL=IROW,NMEAS
      N=NDX(IROW,ICOL)
      CORR(N)=TEMP(ICOL)
  450 CONTINUE
  460 CONTINUE
  470 CONTINUE
      IF (ICOUNT.EQ.0) ISAMP=1
      IF (IMODE.NE.1) WRITE (6,680) ICOUNT
      GO TO 490
  480 WRITE (6,660)
      RETURN
  490 CONTINUE
      RETURN
  500 FORMAT (5X,'ENTER PAIRS OF MEANS AND STANDARD DEVIATIONS--')
  510 FORMAT (//,' DIAGNOSTICS OF FORMATTED READ ',/,' OPER DESC: ',10A4
     1,/)
  520 FORMAT (//,1X,'CORRELATION/ANTHROPOMETRIC MEASUREMENTS:')
  530 FORMAT (' MEASUREMENT - ',I2,' ?---')
  540 FORMAT (' MEASUREMENT -',I2)
  550 FORMAT (5X,'ENTER STANDARD DEVIATION --')
  560 FORMAT (5X,'ENTER ANTHROPOMETRIC CORRELATION MATRIX DATA IN A ROWW
     1ISE UPPER ',/,5X,'TRIANGULAR FORM.',/,5X,'NOTE: ALL DIAGONAL ELEM
     2ENTS MUST EQUAL 1.000')
  570 FORMAT (5X,4HROW ,I2,'(',I2,' ELEMENTS, COLUMNS ',I2,'-',I2,')')
  580 FORMAT (5X,4HROW ,I2,'(',I2,' ELEMENT, COLUMN ',I2,')')
  590 FORMAT (10X,23H***ENTER THE REMAINING ,I2,18H ELEMENTS FOR ROW ,I2
     1)
  600 FORMAT (10X,'***ACCPT051 THE LAST ',I2,' INPUTS HAVE BEEN IGNORED'
     1)
  610 FORMAT (5X,'INPUT MODE(1=INTERACTIVE;2=FILE)--')
  620 FORMAT (5X,'READ MODE(1=FORMATTED;2=UNFORMATTED)--')
  630 FORMAT  (10X,'***ACCPT060 RE-ENTER DATA FOR ',I2)
  640 FORMAT (10X,'***ACCPT1300 RE-ENTER DATA FOR ROW ',I3)
```

```
  650 FORMAT (10X,'***ACCPT155 INVALID RESPONSE')
  660 FORMAT (10X,'***ACCPT UNEXPECTED EOF ON NIMEAS FOR MEAS ',I2)
  670 FORMAT (10X,'***READFL4030 FILE ANTSTA IS NOT ATTACHED TO THE PROG
     1RAM',/,10X,'***UNFORMATTED READ ON THIS FILE IS ABORTED ---'//)
  680 FORMAT (10X,'***ACCPT3000 TOTAL ERRORS ON INPUT DATA ',I5)
  690 FORMAT (' MEAN,STD DEV &CORRELATION DATA READ')
  700 FORMAT (10X,'***ACCPT150 INVALID DATA AT LINE ',I5)
  710 FORMAT (10X,'***ACCPT1200 UNEXPECTED END OF FILE')
      END
```

```
      SUBROUTINE EDIT
      COMMON/MCSM/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN, IOOUT, ICARD
      DIMENSION BUFF (3)
      DATA BUFF/3*0./
      IOIN=5
  100 CONTINUE
      WRITE (6,350)
      CALL INPT (1,1,NVALSZ,IOPT,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (130,100,110,120,340,120), IEOFP1
  110 CONTINUE
      CALL HELP (8)
      GO TO 100
  120 CONTINUE
      WRITE (6,360)
      GO TO 100
  130 CONTINUE
      IF (IOPT.LT.1.OR.IOPT.GT.5) GO TO 120
      GO TO (140,140,240,330,340),IOPT
  140 CONTINUE
      ICOL=IOPT
  150 CONTINUE
      MAXINP=2
      NAMT=0
  160 CONTINUE
      IF (ICOL.EQ.1) WRITE (6,380)
      IF (ICOL.EQ.2) WRITE (6,390)
  170 CONTINUE
      IVALSZ=MAXINP-NAMT
      J=NAMT+1
      CALL INPT (2,IVALSZ,NVALSZ,IVAL,BUFF(J),IEOF)
      IEOFP1=IEOFP1
      GO TO (220,180,200,190,100,210), IEOFP1
  180 CONTINUE
      WRITE (6,370)
      GO TO 160
  190 CONTINUE
      WRITE (6,360)
      GO TO 160
  200 CONTINUE
      IF (ICOL.EQ.1) CALL HELP (11)
      IF (ICOL.EQ.2) CALL HELP (12)
      GO TO 160
  210 CONTINUE
      IOLIST=NVALSZ-IVALSZ
      WRITE (6,400) IOLIST
  220 CONTINUE
```

```
      IROW=BUFF (1)
      NAMT=NVALSZ+NAMT
      IF (NAMT.GE.MAXINP) GO TO 230
      IF (ICOL.EQ.1) WRITE (6,420) IROW
      IF (ICOL.EQ.2) WRITE (6,430) IROW
      GO TO 170
  230 CONTINUE
      CALL REASON (1,ICOL,IROW,BUFF(2),0,IFATAL)
      IF (IFATAL.EQ.1) GO TO 150
      ANTH(ICOL,IROW)=BUFF(2)
      GO TO 100
  240 CONTINUE
      MAXINP=3
      NAMT=0
  250 CONTINUE
      WRITE (6,410)
  260 CONTINUE
      IVALSZ=MAXINP+NAMT
      J=NAMT+1
      CALL INPT (2,IVALSZ,NVALSZ,IVAL,BUFF(J),IEOF)
      IEOFP1=IEOF+1
      GO TO (310,270,290,280,100,300), IEOFP1
  270 CONTINUE
      WRITE (6,370)
      GO TO 250
  280 CONTINUE
      WRITE (6,360)
      GO TO 250
  290 CONTINUE
      CALL HELP (13)
      GO TO 250
  300 CONTINUE
      IOLIST=NVALSZ-IVALSZ
      WRITE (6,400) IOLIST
      GO TO 320
  310 CONTINUE
      ICOL=BUFF(1)
      IROW=BUFF(2)
      NAMT=NAMT+NVALSZ
      IF (NAMT.GE.MAXINP) GO TO 320
      IF (NAMT.EQ.1) WRITE (6,440) ICOL
      IF (NAMT.EQ.2) WRITE (6,450) ICOL,IROW
      GO TO 260
  320 CONTINUE
      CALL REASON (3,ICOL,IROW,BUFF(3),0,IFATAL)
      IF (IFATAL.EQ.1) GO TO 240
      CALL REASON (2,ICOL,IROW,BUFF(3),0,IFATAL)
      IF (IFATAL.EQ.1) GO TO 240
      N=NDX(IROW,ICOL)
      CORR(N)=BUFF(3)
```

```
      GO TO 100
  330 CONTINUE
      CALL PRINT
      GO TO 100
  340 CONTINUE
      RETURN
  350 FORMAT (5X,'EDIT MODE(1-MEANS;2-STD;3-ANTH.CORR;4-PRINT;5-END)--')
  360 FORMAT (10X,'***EDIT044 INVALID RESPONSE')
  370 FORMAT (10X,'***EDIT095 NO INFORMATION ENCOUNTERED')
  380 FORMAT (5X,'INPUT INDEX AND MEAN VALUE')
  390 FORMAT (5X,'INPUT INDEX AND STANDARD DEVIATION')
  400 FORMAT (10X,'***EDIT 042 THE LAST',I2,' INPUTS HAVE BEEN IGNORED')
  410 FORMAT (5X,'INPUT   COLUMN , ROW   AND CORRELATION')
  420 FORMAT (5X,'INPUT MEAN VALUE FOR INDEX ',I3)
  430 FORMAT (5X,'INPUT STANDARD DEVIATION FOR INDEX ',I3)
  440 FORMAT (5X,'INPUT ROW AND CORRELATION FOR COLUMN ',I2)
  450 FORMAT (5X,'INPUT CORRELATION FOR ROW ',I2,' COLUMN ',I2)
      END
```

```
      SUBROUTINE NAMEFL (IERROR)
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION IBUFF(10),XVAL(10)
      DATA IBUFF/10*4H    /
      DATA I4BLK/4H    /
      IERROR=0
      DO 100 J=1,4
      IBUFF(J)=I4BLK
  100 CONTINUE
  110 CONTINUE
      IF (IOIN.EQ.5) WRITE (6,180)
      CALL INPT (4,10,NVALSZ,IBUFF,XVAL,IEOF)
      IF (IEOF.LT.2.OR.IEOF.EQ.5) GO TO 150
      IF (IOIN.NE.5) GO TO 140
      IEOFM1=IEOF-1
      GO TO (120,130,170), IEOFM1
  120 CONTINUE
      CALL HELP (14)
      GO TO 110
  130 CONTINUE
      WRITE (6,190)
      GO TO 110
  140 CONTINUE
      WRITE (6,190)
      IERROR=1
  150 CONTINUE
      DO 160 J=1,10
      INAME(J)=IBUFF(J)
  160 CONTINUE
  170 RETURN
  180 FORMAT (5X,'OPERATOR SAMPLE DESCRIPTION(40 CHAR MAX)----')
  190 FORMAT (10X,'***NAMEFL027 INVALID RESPONSE')
      END
```

```
      SUBROUTINE OPSAMP (ISAMP)
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION IRAN(9)
      DATA IRAN(1),IRAN(2),IRAN(3),IRAN(4),IRAN(5),IRAN(6),IRAN(7),
     1IRAN(8),IRAN(9)/33333333,55555555,77777777,222222221,
     1          444444443,666666669,888888889,999999999,123456789/
      IOIN=5
      DO 100 K=1,KN
      SQROOT(K)=CORR(K)
  100 CONTINUE
      CALL SQRMX (NERROR)
      IF (NERROR.EQ.1) RETURN
  110 CONTINUE
      WRITE (6,320)
      CALL INPT (1,1,NVALSZ,NSAMP,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (150,120,130,140,290,140),IEOFP1
  120 CONTINUE
      WRITE (6,330)
      GO TO 110
  130 CONTINUE
      CALL HELP (15)
      GO TO 110
  140 CONTINUE
      WRITE (6,340)
      GO TO 110
  150 CONTINUE
      IF (NSAMP.GT.O.AND.NSAMP.LE.MAXSAM) GO TO 160
      WRITE (6,350) MAXSAM
      GO TO 110
  160 CONTINUE
      WRITE (6,300)
      CALL INPT (1,1,NVALSZ,MTYPE,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (190,160,170,180,290,180),IEOFP1
  170 CONTINUE
      CALL HELP (20)
      GO TO 160
  180 CONTINUE
      WRITE (6,340)
      GO TO 160
  190 CONTINUE
      IF (MTYPE.NE.32.AND.MTYPE.NE.60) GO TO 180
  200 CONTINUE
      WRITE (6,310)
      CALL INPT (1,1,NVALSZ,IS,XVAL,IEOF)
      IEOFP1=IEOF+1
```

```
      GO TO (240,210,220,230,290,230), IEOFP1
  210 CONTINUE
      WRITE (6,330)
      GO TO 200
  220 CONTINUE
      CALL HELP (21)
      GO TO 200
  230 CONTINUE
      WRITE (6,340)
      GO TO 200
  240 CONTINUE
      IF (IS.EQ.0) GO TO 250
      IF (IS.LT.1.OR.IS.GT.9) GO TO 230
      IU=IRAN(IS)
      GO TO 260
  250 CONTINUE
      IU=67111133
  260 CONTINUE
      REWIND NTEMP
      WRITE (NTEMP) INAME,NMEAS
      DO 280 I=1,NSAMP
      CALL SIMSUB (MTYPE)
      DO 270 K=1,NMEAS
      V(K)=V(K)*ANTM(2,K)+ANTM(1,K)
  270 CONTINUE
      WRITE (NTEMP)    (V(IO),IO=1,NMEAS)
  280 CONTINUE
      ISAMP=1
      END FILE NTEMP
      REWIND NTEMP
      REWIND NTMEAS
C     WRITE(6,370)
  370 FORMAT( 10X, '** SAMPLE DATA SAVED ON FILE 9')
      WRITE (6,360)
  290 CONTINUE
      RETURN
  300 FORMAT (5X,'ENTER MACHINE WORD SIZE (32 OR 60 BIT) --')
  310 FORMAT (5X,'ENTER RANDOM NO SEED (0 IF NONE OR 1-9)--')
  320 FORMAT (5X,'INPUT SAMPLE SIZE --')
  330 FORMAT (10X,'***OPSAMP215 NO INFORMATION ENCOUNTERED')
  340 FORMAT (10X,'***OPSAMP411 INVALID RESPONSE')
  350 FORMAT (10X,'***OPSAMP009 SAMPLE SIZE MUST BE BETWEEN 1 AND ',I5)
  360 FORMAT (10X,'***SAMPLE DATA SAVED ON FILE SAMPLE OR TAPE 9.')
      END
```

```
      SUBROUTINE PRINT
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      INTEGER FMT,FMT1
      DIMENSION FMT(6),NUM(12),TEMP(12),INDEX(2),FMT1(5)
      DATA FMT1 /'(1X,', '    ', '(2X,', 'A2,2', 'X))'/
      DATA FMT /'(1X,', '    ', '(6X)', '    ', 'F6.3',')'/
      DATA NUM/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,2H10,2H11,2H12/
      FMT1(2)=NUM(NMEAS)
      ISTORE=0
      IOFLAG=0
  100 CONTINUE
      WRITE (6,630)
      CALL INPT (1,1,NVALSZ,IOPT,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (120,110,110,110,390,110),IEOFP1
  110 CONTINUE
      WRITE (6,650)
      GO TO 100
  120 CONTINUE
      IF (IOPT.LT.1.OR.IOPT.GT.4)GO TO 110
      IF (IOPT.EQ.1) GO TO 130
      IF (IOPT.EQ.2) GO TO 150
      IF (IOPT.EQ.4) GO TO 390
      GO TO 190
  130 CONTINUE
      WRITE (6,580)
      DO 140 IROW=1,NMEAS
      WRITE (6,640) IROW,(ANTM(JO,IROW),JO=1,2)
  140 CONTINUE
      WRITE (6,620)
      GO TO 100
  150 CONTINUE
      WRITE (6,590)
      WRITE (6,FMT1) (NUM(IO),IO=1,NMEAS)
      WRITE (6,600)
      DO 180 IROW=1,NMEAS
      DO 160 ICOL=1,NMEAS
      N=NDX(IROW,ICOL)
      TEMP(ICOL)=CORR(N)
  160 CONTINUE
      IF (IROW.GT.1) GO TO 170
      WRITE (6,610) (TEMP(ICOL),ICOL=IROW,NMEAS)
      GO TO 180
  170 FMT(2)=NUM(IROW-1)
      FMT(4)=NUM(NMEAS+1-IROW)
      WRITE (6,FMT) (TEMP(ICOL),ICOL=IROW,NMEAS)
  180 CONTINUE
```

```
      WRITE (6,620)
      GO TO 100
  190 CONTINUE
      WRITE (6,430)
      IF (IOFLAG.LT.1) WRITE (6,440)
      IOFLAG=1
      CALL INPT (1,2,NVALSZ,INDEX,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (230,270,200,210,100,220), IEOFP1
  200 CONTINUE
      CALL HELP (19)
      IOFLAG=0
      GO TO 190
  210 CONTINUE
      WRITE (6,420)
      GO TO 190
  220 CONTINUE
      IOLIST=NVALSZ-2
      WRITE (6,450) IOLIST
  230 CONTINUE
      IF (INDEX(1).GT.0) GO TO 240
      WRITE (6,480)
      GO TO 190
  240 CONTINUE
      IF (ISTORE.GT.0.AND.INDEX(1).GT.ISTORE) GO TO 250
      NRSKIP=INDEX(1)-1
      GO TO 260
  250 CONTINUE
      NRSKIP=INDEX(1)-ISTORE-1
  260 CONTINUE
      ISTART=INDEX (1)
      IF (NVALSZ.EQ.1) GO TO 280
      IF (NVALSZ.GE.2) GO TO 290
  270 CONTINUE
      ISTORE=0
      ISTART=1
      IEND=999
      NRSKIP=0
      GO TO 320
  280 CONTINUE
      IEND=ISTART
      GO TO 310
  290 CONTINUE
      IF (INDEX(1).LE.INDEX(2)) GO TO 300
      WRITE (6,490)
      GO TO 190
  300 CONTINUE
      IEND=INDEX(2)
  310 CONTINUE
      IF (INDEX(1).GT.ISTORE.AND.ISTORE.NE.0) GO TO 330
```

```
  320 CONTINUE
      REWIND NTEMP
      READ (NTEMP,END=410) INAME,NMEAS
  330 CONTINUE
      IF (NRSKIP.LT.1) GO TO 350
      DO 340 I=1,NRSKIP
      READ (NTEMP,END=400) (V(K),K=1,NMEAS)
  340 CONTINUE
  350 CONTINUE
      WRITE (6,530) (INAME(IO),IO=1,10)
      IF (ISTART.EQ.IEND) WRITE (6,540) IEND
      IF (ISTART.NE.IEND.AND.IEND.NE.999) WRITE (6,550) ISTART,IEND
      WRITE (6,500)
      WRITE (6,FMT1) (NUM(IO),IO=1,NMEAS)
      WRITE (6,600)
      ISKIP=0
      NFOUND=0
      DO 360 I=ISTART,IEND
      IF (ISKIP.EQ.1) WRITE (6,460)
      ISKIP=0
      IF (ISTART.NE.IEND.AND.I.NE.IEND.AND.(I/5)*5.EQ.I) ISKIP=1
      READ (NTEMP,END=370) (V(K),K=1,NMEAS)
      NFOUND=NFOUND+1
      ISTORE=1
      WRITE (6,510) (V(K),K=1,NMEAS)
  360 CONTINUE
      GO TO 380
  370 CONTINUE
      IF (IEND.NE.999.AND.ISTART.NE.IEND) WRITE (6,470) IEND
      ISTORE=1
      IF (NFOUND.LT.1) WRITE (6,560)
  380 CONTINUE
      WRITE (6,520)
      GO TO 190
  390 CONTINUE
      REWIND NTEMP
      RETURN
  400 CONTINUE
      IOLIST=1-2*ISTORE
      WRITE (6,560)
      GO TO 190
  410 CONTINUE
      WRITE (6,570)
      GO TO 100
  420 FORMAT (10X,'***PRINTISS INVALID RESPONSE')
  430 FORMAT (5X,'OUTPUT MODE:--')
  440 FORMAT (10X,'FOR ALL OPERATOR DATA (ENTER CARRIAGE RETURN)',/,10X,
     1'FOR INDIVIDUAL OPERATOR DATA (ENTER OPERATOR NUMBER)',/,10X,'FOR
     2A SEQUENCE OF OPERATORS (ENTER RANGE OF OPERATOR NUMBERS)',/,10X,'
     3END (ENTER $)')
```

```
  450 FORMAT (10X,'***PRINT119 THE LAST',I4,'INPUTS HAVE BEEN IGNORED')
  460 FORMAT (1H )
  470 FORMAT (10X,'***PRINT211 ERROR IN UPPER INDEX --',I4)
  480 FORMAT (10X,'***PRINT120 INDEX NO. LESS THAN OR EQUAL',/,'***T
     1O ZERO IS NOT VALID')
  490 FORMAT (10X,'***PRINT160 FIRST INDEX MUST BE LESS THAN SECOND INDE
     1X')
  500 FORMAT (27X,'OPERATOR SAMPLE',/,71(1H-))
  510 FORMAT (11F6.2,F5.2)
  520 FORMAT (71(1H-))
  530 FORMAT (1X,10A4,10X,A4)
  540 FORMAT (10X,'OPERATOR NO',I4)
  550 FORMAT (10X,'OPERATOR NOS',I4,' --',I4)
  560 FORMAT (10X,'***PRINT1500 INDEX NUMBER EXCEEDS RECORDS IN OPERATOR
     1 FILE***')
  570 FORMAT (10X,'***PRINT1600 FILE SAMPLE IS NOT ATTACHED TO THE PROGR
     1AM',/,10X,'***OPERATOR OUTPUT REQUEST ABORTED ---',//)
  580 FORMAT (/,21X,'MEANS AND STANDARD DEVIATIONS',/,1X,70(1H-),/,2X,'M
     1EASUREMENT',6X,'MEANS',6X,'STD DEV',/,1X,71(1H-))
  590 FORMAT (/,7X,'CORRELATION MATRIX FOR ANTHROPOMETRIC MEASUREMENTS',
     1/,1X,70(1H-))
  600 FORMAT (1X,70(1H-))
  610 FORMAT (1X,12F6.3)
  620 FORMAT (1X,70(1H-))
  630 FORMAT (5X,'PRINT MODE(1-MEAN/STD;2-CORR MATRX;','3-OPER MEAS;4-EN
     1D)--')
  640 FORMAT (7X,I2,5X,2(5X,F7.2))
  650 FORMAT (10X,'***PRINT103 INVALID RESPONSE')
      END
```

```
      SUBROUTINE RAND2 (RNORM,MTYPE,QUAN,IJ)
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      DIMENSION QUAN(2)
      COMMON/MISC/IOIN,IOOUT,ICARD
      IJ=IJ+1
      IF (IJ.EQ.2) GO TO 110
  100 CONTINUE
      X1=2.0*UNFORM(MTYPE)-1.0
      Y1=2.0*UNFORM(MTYPE)-1.0
      S=X1*X1+Y1*Y1
      IF (S.GE.1.0) GO TO 100
      S=SQRT(-2.0*ALOG(S)/S)
      QUAN(1)=X1*S
      QUAN(2)=Y1*S
  110 CONTINUE
      RNORM=QUAN(IJ)
      IF (IJ.EQ.2) IJ=0
      RETURN
      END
```

```
      SUBROUTINE REASON (ICALL,ICOL,IROW,TSTOR1,TSTOR2,IFATAL)
      COMMON/MCSM/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      IFATAL=0
      IAFLAG=0
C     WRITE(6,901) ICALL,ICOL,IROW,IFATAL,TSTOR1,TSTOR2
  901 FORMAT('  REASON ', 4I10, 4F10.3)
      IF (ICALL.LT.0) IAFLAG=1
      ICALL=IABS(ICALL)
      IF (ICALL.GT.1) GO TO 110
      IWRITE=1
      IF (IROW.LT.1.OR.IROW.GT.NMEAS) GO TO 120
      IF (ICOL.EQ.2) GO TO 100
      RETURN
  100 CONTINUE
      IWRITE=2
      IF (TSTOR2.LT.0.) GO TO 120
      IWRITE=3
      IF (TSTOR1.LE.TSTOR2) GO TO 120
      RETURN
  110 CONTINUE
      IWRITE=1
      IF (IROW.LE.0.OR.IROW.GT.NMEAS) GO TO 130
      IWRITE=2
      IF (ICOL.LE.0.OR.ICOL.GT.NMEAS) GO TO 130
      IWRITE=3
      IF (IROW.GT.ICOL) GO TO 130
      IF (ICOL.EQ.3) RETURN
      IWRITE=4
      IF (ICOL.EQ.IROW.AND.TSTOR1.NE.1.000) GO TO 130
      IWRITE=5
      IF (TSTOR1.LT.-1.000) GO TO 130
      IWRITE=6
      IF (TSTOR1.GT.1.000) GO TO 130
      RETURN
  120 CONTINUE
      IF (IWRITE.NE.1.AND.IOIN.NE.5) WRITE (6,260) IROW
      GO TO (190,140,150), IWRITE
  130 CONTINUE
      GO TO (190,200,210,160,170,180), IWRITE
  140 CONTINUE
      WRITE (6,230)
      GO TO 220
  150 CONTINUE
      WRITE (6,240)
      GO TO 220
  160 CONTINUE
      WRITE (6,250) IROW,ICOL
```

```
      GO TO 220
  170 CONTINUE
      WRITE (6,260) IROW,ICOL
      GO TO 220
  180 CONTINUE
      WRITE (6,270) IROW,ICOL
      GO TO 220
  190 CONTINUE
      WRITE (6,290) IROE,NMEAS
      GO TO 220
  200 CONTINUE
      WRITE (6,300) ICOL,NMEAS
      GO TO 220
  210 CONTINUE
      WRITE (6,310) IROW,ICOL
      GO TO 220
  220 CONTINUE
      IFATAL=1
      RETURN
  230 FORMAT (10X,'***REASON1150 STANDARD DEVIATIONS LESS THAN ZERO')
  240 FORMAT (10X,'***REASON1200 STD. GREATER THAN MEAN VALUE.')
  250 FORMAT (10X,'***REASON1250 DIAGONAL ELEMENT IN ROW ',I2,/,10X,'***
     1COLUMN ',I2,' IS NOT EQUAL TO 1.0')
  260 FORMAT (10X,'***REASON1300 ENTRY IN COLUMN ',I2,' ROW ',I2,/,10X,'
     1***IS LESS THAN -1.0')
  270 FORMAT (10X,'***REASON1350 ENTRY IN COLUMN ',I2,' ROW ',I2,/,10X,'
     1***IS GREATER THAN +1.0')
  280 FORMAT (8X,I2)
  290 FORMAT (10X,'***REASON1500 ROW ',I2,' IS LESS THAN ZERO OR GREATER
     1 THAN ',I2)
  300 FORMAT (10X,'***REASON1600 COLUMN ',I2,' IS LESS THAN ZERO OR GREA
     1TER THAN ',I2)
  310 FORMAT (10X,'***REASON1700 ROW ',I2,'COLUMN ',I2,' IS OUTSIDE OF
     1UPPER',/,10X,'***TRIANGULAR REGION OF CORRELATION MATRIX.')
      END
```

```
      SUBROUTINE SAVE
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      REWIND NTMEAS
      WRITE (NTMEAS) NMEAS,KN,INAME
      WRITE (NTMEAS) ((ANTM(IO,JO),IO=1,2),JO=1,NMEAS)
      WRITE (NTMEAS) (CORR(IO),IO=1,KN)
      REWIND NTMEAS
      WRITE (6,100)
      RETURN
  100 FORMAT(' MEASEUREMENT DATA SAVED ON FILE ANTSTA OR TAPE 2')
      END
```

```
      SUBROUTINE SIMSUB (MTYPE)
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1   SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION Y(45)
      IJ=0
      DO 100 I=1,NMEAS
      V(I)=0.0
      CALL RAND2 (RNORM,MTYPE,QUAN,IJ)
  100 Y(I)=RNORM
      DO 110 I=1,NMEAS
      DO 110 J=1,I
      K=NDX(J,I)
  110 V(I)=V(I)+Y(J)*SQROOT(K)
      RETURN
      END
```

```
      SUBROUTINE SQRMX (NERROR)
      COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1  SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2   INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION ZX(7)
      INTEGER ZX
      NERROR=0
      DO 120 I=1,NMEAS
      ZX(4)=I
      N=NDX(I,I)
      IF (SQROOT(N).LT.0) GO TO 130
      SQ=SQRT(SQROOT(N))
      DO 100 J=I,NMEAS
      N=NDX(I,J)
      SQROOT(N)=SQROOT(N)/SQ
  100 CONTINUE
      IF (I.EQ.NMEAS) NERROR=0
      IF (I.EQ.NMEAS) RETURN
      [illegible]=I+1
      [illegible]1
      DO 110 I2=I1,NMEAS
      DO 110 J2=I2,NMEAS
      N=NDX(I2,J2)
      L=NDX(I,I2)
      K=NDX(I,J2)
      SQROOT(N)=SQROOT(N)-SQROOT(L)*SQROOT(K)
      ZX(6)=I2
      ZX(7)=J2
  110 CONTINUE
      ZX(1)=N
      ZX(2)=L
      ZX(3)=K
  120 CONTINUE
  130 CONTINUE
      NERROR=1
      WRITE (6,180)
  140 CONTINUE
      WRITE (6,190)
      CALL INPT (4,1,NVALSZ,IANS,XVAL,IEOF)
      IEOFP1=IEOF+1
      GO TO (170,160,150,170,160,170), IEOFP1
  150 CONTINUE
      WRITE (6,200)
      WRITE (6,210) (ZX(I),I=1,7),SQROOT(N)
  160 CONTINUE
      RETURN
  170 CONTINUE
      WRITE (6,220)
      GO TO 140
```

```
180 FORMAT (10X,'***SQRMX051 ANTHROPOMETRIC CORRELATION VALUES ARE INV
   1ALID')
190 FORMAT (10X,'-- ENTER CARRIAGE RETURN TO CONTINUE PROCESSING',/,10
   1X,'-- ENTER  ?  TO DISPLAY SQRMX VARIABLES.')
200 FORMAT (10X,'***SQRMX062 AN INDEFINITE QUANTITY HAS BEEN DETECTED
   1BY',/,10X,'***SQRMX.  VARIABLE LIST WITHIN SQRMX:',/,10X'  N    L
   2    K    I    I1   I2   J2   SQROOT',/,10X,44(1H-))
210 FORMAT (8X,4(3X,I2),4X,3(I2,3X),F6.3,/,10X,44(1H-),//)
220 FORMAT (10X,'***SQRMX060 INVALID RESPONSE***')
    END
```

```
      FUNCTION NDX(I,J)
      IF (I.GT.J) GO TO 100
      NDX=I+(J*J-J)/2
      RETURN
  100 NDX=J+(I*I-I)/2
      RETURN
      END
```

```
      FUNCTION UNFORM(MTYPE)
      COMMON /MCSM/ CORR(78),ANTM(2,12),V(25),NMEAS,KN,
     1SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DATA IX/16777213/,C/281474976710655./
      IF (MTYPE.EQ.32) GO TO 100
      IU=IU*IX
      UNFORM=IU/C
      RETURN
  100 IU=IU*65539
      IF (IU.GE.0) GO TO 110
      IU=IU+2147483647+1
  110 UNFORM=IU
      UNFORM=UNFORM*.4656613E-09
      RETURN
      END
```

```
      SUBROUTINE HELP (I)
      RETURN
      END
```

```
      1
        BLOCK DATA
        COMMON/MCSM/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
       1  SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
       2  INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
        COMMON/MISC/IOIN,IOOUT,ICARD
        DATA IOIN,IOOUT,NTEMP,NTMEAS,NIMEAS/5,6,3,4,7/
        DATA MAXSAM/400/
        DATA  NTMEAS,NIMEAS/2,4/
       1,ICOUNT/0/
        DATA ANTM/24*0./,CORR/78*0./,INAME/4*4H    /
        END
      1
```

```
      SUBROUTINE PUNRT
      COMMON/MCSM/CORR(78),QNTM(2,12),V(25),NMEAS,KN,
     1  SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
     2  INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      REWIND NTEMP
      REWIND 9
C
    2 CONTINUE
      READ (NTEMP,END=140) INAME,NMEAS
      WRITE(9,271) INAME,NMEAS
C
    4 CONTINUE
      READ(NTEMP,END=370) (V(K),K=1,NMEAS)
      WRITE(9,271) (V(K),K=1,NMEAS)
  271 FORMAT(20A4)
      GO TO 4
  370 CONTINUE
      ENDFILE 9
      WRITE(6,272)
  272 FORMAT(10X, '****  DATA SAVED ON FILE 9')
      REWIND NTEMP
      RETURN
  140 CONTINUE
      WRITE(6,141)
  141 FORMAT(10X, ' ERROR DATA SET DOES NOT EXIST')
      RETURN
      END
```

REFERENCES

Bittner, A.C., Computerized Accommodated Percentage Evaluation (CAPE) Model for Cockpit Analysis and Other Exclusion Studies, Pacific Missile Test Center Technical Publication TP-75-49, (AD-B008 984L), 31 December 1975.

Bittner, A.C., Reduction in Potential User Population as the Result of Imposed Anthropometric Limits: Monte Carlo Estimation, Naval Missile Test Center Technical Publication TP-74-6, (AD-919 319L), 1 March 1974.

Bureau of Medicine and Surgery Instruction 3710.1, 'Anthropometric Compatibility Assignment Program,' 11 July 1977.

Chief of Naval Aviation Training Instruction 13520.1, 'Anthropometric Limitations in Naval Aircraft,' 1 April 1980.

Chief of Naval Operations Instruction 3710.36A, 'Anthropometric Incompatibilities in Naval Aircraft,' 10 January 1980.

Churchill, E., McConville, J.T., Laubach, L., and White, R.W., Anthropometry of U.S. Army Aviators-1970, U.S. Army Natick Laboratories Technical Report 73-52-CE, Natick, Massachusetts, (AD-743 528), 1971.

Clauser, C., Chief, Anthropology Branch, Human Engineering Division, USAF AMRL, personal communication, July 1980.

Department of Defense Military Standard 1333A, Aircrew Station Geometry for Military Aircraft, 30 June 1976.

Department of Defense Military Standard 1472B, Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, 31 December 1974.

Gifford, E.C., Provost, J.R., and Lazo, J., Anthropometry of Naval Aviators-1964, U.S. Naval Air Engineering Center Report NAEC-ACEL-553, Philadelphia, Pennsylvania, (AD-777 996), 8 October 1965.

Kennedy, K.W., Anthropometry and Kinematics in Crew Station Design, Crew System Design: An Interagency Conference, Cross, K.D. and McGrath, J.J. (eds.), proceedings of an interagency conference, Los Angeles, 12-14 September 1972, p. 67-82, (AD-777 996), July 1973.

Ketcham-Weidl, M.A., and Bittner, A.C., Anthropometric Accommodation of a Female Population in a Workplace Designed to Male Standards, Pacific Missile Test Center Technical Publication TP-76-3, Point Mugu, California, (AD-B022 540L), 31 December 1976.

Moroney, W.F., CDR, MSC, USN, Naval Postgraduate School, Monterey, California, personal communication, August, 1980.

Moroney, W.F., Kennedy, R.S., Gifford, E.C., and Provost, J.R., Selected Anthropometric Dimensions of Naval Aviation Personnel, Naval Aerospace Medical Research Laboratory Report NAMRL-1141, Pensacola Florida, (AD-735 101), August 1971.

Moroney, W.F., and Smith, M.J., Empirical Reduction in Potential User Population as the Result of Imposed Anthropometric Limits, Naval Aerospace Medical Research Laboratory Report NAMRL-1164, Pensacola Florida, (AD-752 032), September 1972.

National Aeronautics and Space Administration Reference Publication 1024, Anthropometric Source Book Volume I: Anthropometry for Designers, Houston, Texas, 1978.

National Aeronautics and Space Administration Reference Publication 1024, Anthropometric Source Book Volume II: A Handbook of Anthropometric Data, Houston, Texas, 1978.

Naval Air Systems Command Instruction 3710.9, 'Anthropometric Incompatibilities in Naval Aircraft,' 19 September 1979.

Naval Air Systems Command Publication SD-24K, General Specification for Design and Construction of Aircraft Weapons Systems Volume I: Fixed Wing Aircraft, Washington, D.C., 13 June 1973.

O'Leary, T., LCDR, MSC, USN, Naval Regional Medical Center (code 08), Corpus Christy, Texas, personal communication, July 1980.

Roebuck, J.A., Kroemer, K.H.E., and Thompson, W.G., Engineering Anthropometry Methods, Wiley, 1975.

Roozbazar, A., Bowker, G.W., and Richerson, M.E., 'A Theoretical Model to Estimate Some Ergonomic Parameters from Age, Height and Weight,' Ergonomics, v.22, p.43-58, January 1979.

Schane, W.P., Littell, D.E., and Moultree, C.G., Selected Anthropometric Measurements of 1,640 U.S. Army Warrant Officer Candidate Flight Trainees, U.S. Army Aeromedical Research Laboratory Report No. 69-2, (AD-688 856), 1969.

U.S. Navy Manual of the Medical Department, NAVMED P-117 (change 94), 30 October 1978.

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