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THESIS

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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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

CNATRANINST - 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.

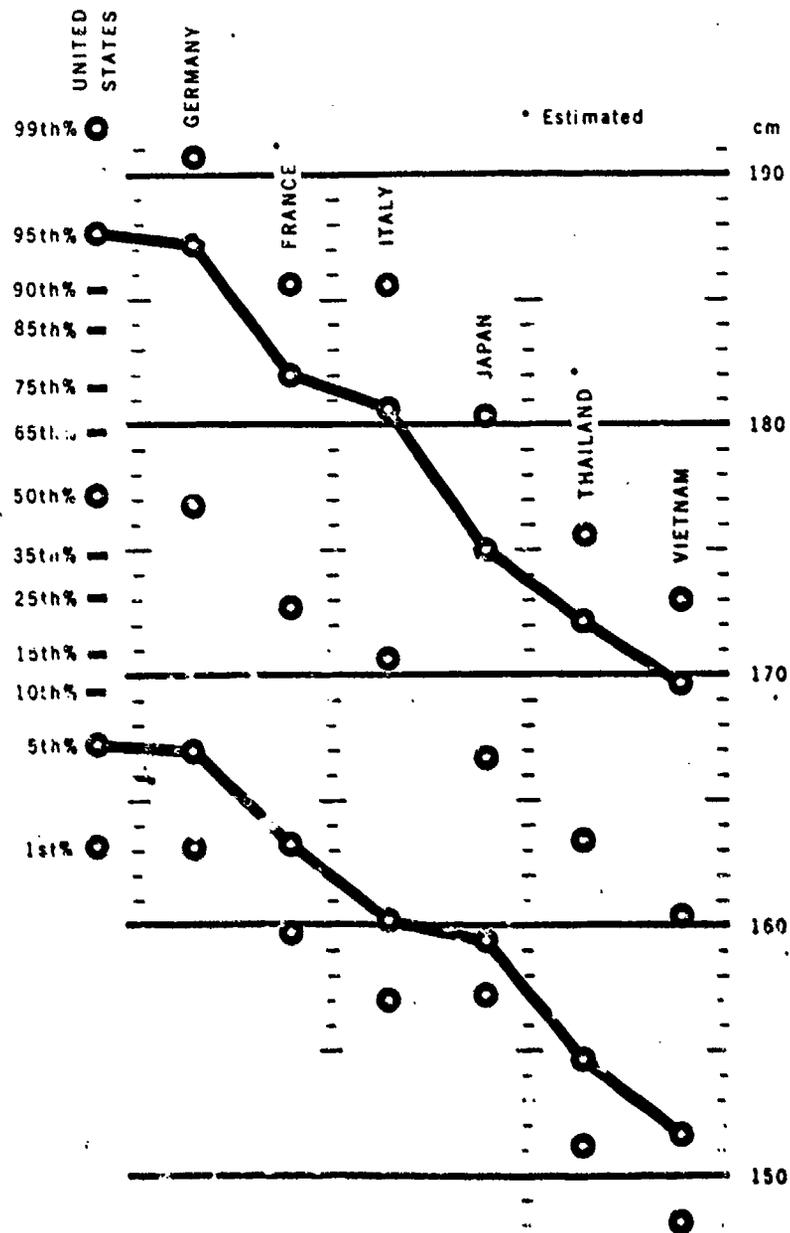
The Chief of Naval Aviation Training (CNATRA) is

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 [CNATRAININST 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.

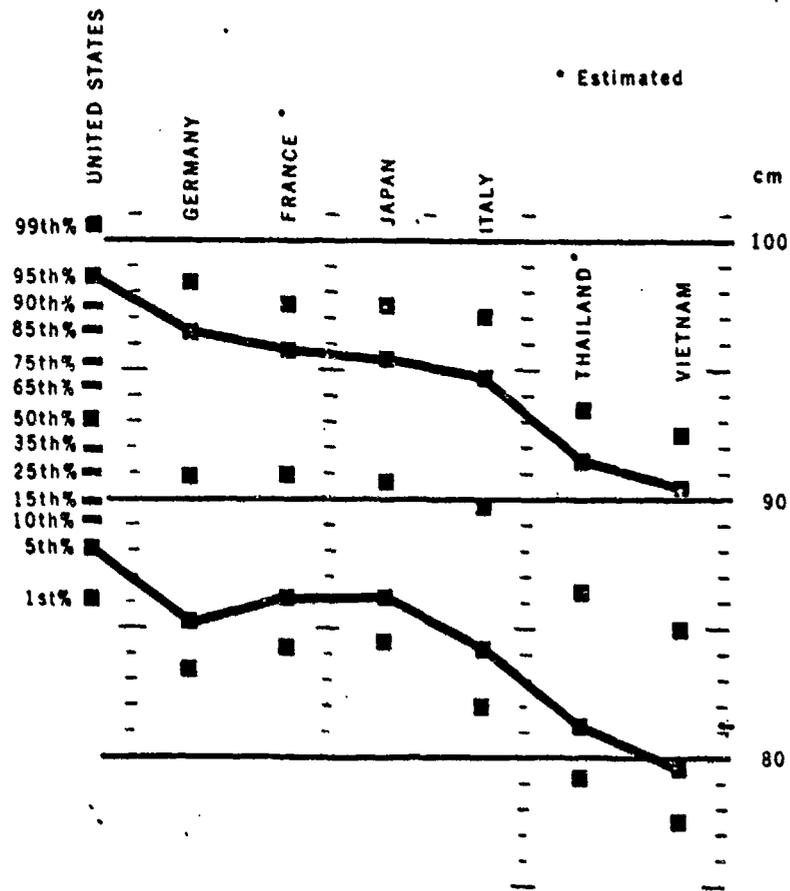
Figure 1
Heights of Seven Military Populations



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

Figure 2

Sitting 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. 71.

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 aircrewmembers 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 aviation 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, therefore, 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 1969 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

^aSchane, 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

^aSame as observed value for 1969 and 1975 samples.

^bChurchill, 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

^aChurchill, 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	.63 ^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

^aSame as observed value in 1975.

^bChurchill, 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

1964				
	Sitting Height	Functional Reach	Buttock- Knee Length	Leg Length
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 (LF)	06789 sit.ht.	5.0	9.6	4.0
	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	- fct.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 fct.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.	-	-	-
	- fct.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 fct.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 fct.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 (F)	09 sit.ht.	0.4	0.8	0.1
	- fct.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 (F)	0789 sit.ht.	2.0	3.9	1.7
	89 fct.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	89	0.7	1.6	0.4
(R)	-	-	-	-
	9	0.0	0.4	0.0
	-	-	-	-
	cumulative	0.7	2.0	0.4
RF-8	0789	2.0	3.9	1.7
	-	-	-	-
	9	0.0	0.4	0.0
	-	-	-	-
	cumulative	2.0	4.2	1.7
S-3	-	-	-	-
	-	-	-	-
	9	0.0	0.4	0.0
	-	-	-	-
	cumulative	0.0	0.4	0.0
T-2C	0	0.2	0.1	0.0
TA-4	9	0.6	2.6	0.3
TAV-8	9	0.0	0.4	0.0
	0	0.1	0.0	0.1
	cumulative	0.8	3.1	0.4
U-16	-	-	-	-
	-	-	-	-
	-	-	-	-
	0	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.

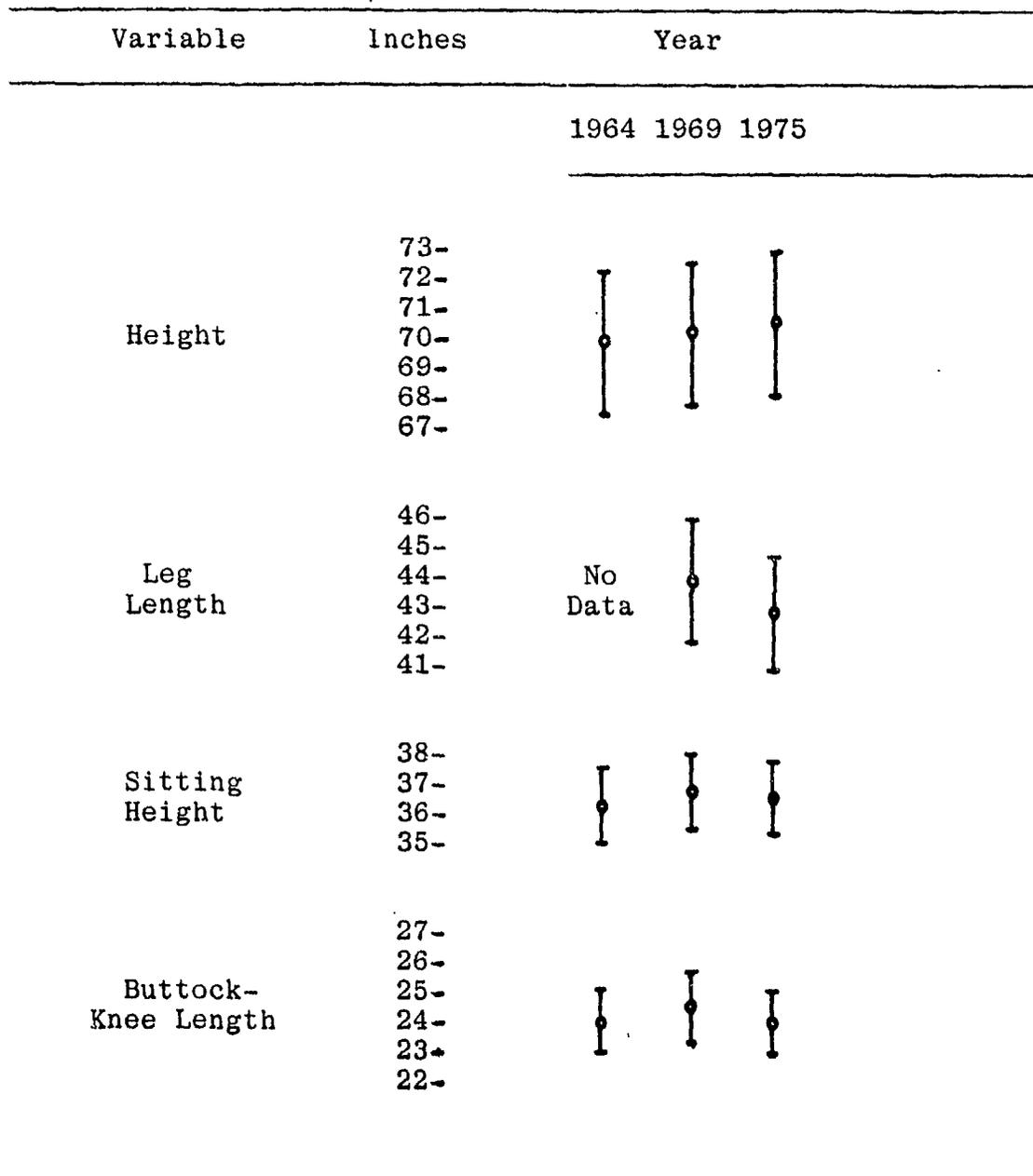
No aircraft type's coding eliminated as much as ten percent of the 1964 sample. The A-7 exclusion was 8.2 percent and was the worst case. The accommodation by all aircraft of more than 90 percent would seem to indicate that the cockpit designs included a margin of accommodation allowance in addition 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



NOTE: ● - mean

| - one standard deviation from mean

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 [CNATRINST 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

```

PROGRAM GENRAMP(FMEAS,UMEAS,SAMPLE,INPUT,OUTPUT,
1  TAPF1=FMEAS,TAPE2=UMEAS,TAPE3=SAMPLF,
2  TAPF5=INPUT,TAPF6=OUTPUT)

C
C      *** MODULE A - MONTE CARLO SIMULATION ***
C      *** MCSM READS IN FACTOR MATRIX OF REQUIRED ANTHROPOMETRIC
C      *** MEASUREMENTS FROM EITHER DISK FILES OR INTERACTIVE
C      *** TERMINAL. IT ALSO ALLOWS USFRS 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  SOROOT(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
C      DATA IOIN,IOOUT,NUCREW,NTEMP,NTMEAS,NIMEAS/5,6,8,3,4,7/
C      DATA MAXFUNC/4/
C      DATA NMFAS,NTMEAS,NIMEAS/12,2,4/
C      1,ICOUNT/0/
C      DATA ANTM/24*0/,CORR/78*0/,INAME/4*10H      /
C      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 (A,200)
      CALL INPT (1,1,NVALS7,NMEAS,XVAL,LEOF)
      GO TO (130,100,110,120,240,120), LEOF=1
110  CONTINUE
      CALL HELP (1)
      GO TO 100
120  CONTINUE
      WRITE (A,300)
      GO TO 100
170  CONTINUE
      IF (NMFAS.LT.1.OR.NMEAS.GT.NMFAS) GO TO 120
      KN=NMFAS*(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 (A,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
140 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 ERROR")
330 FORMAT (" UNABLE TO GENERATE SAMPLE - FATAL ERROR")
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")

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```

IF (NVALSZ.GT.IVALSZ) IEOF=5
RETURN
180 CONTINUE
C SEARCH FOR LAST NON-BLANK CHARACTER (END OF WORD)
IF (ICHR(IFIRST).EQ.1H?) IEOF=2
IF (ICHR(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 (ICHR(IFIRST).NE.1H".AND.ICHR(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 (ICHR(I).EQ.1H".OR.ICHR(I).EQ.1H*) GO TO 210
GO TO 220
200 CONTINUE
IF (ICHR(I).NE.1H .AND.ICHR(I).NE.1H.) GO TO 220
210 CONTINUE
ILAST=I-1
GO TO 230
220 CONTINUE
ILAST=I?
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 (ICHR(IFIRST).NE.1H-.AND.ICHR(IFIRST).NE.1H*) GO TO 240
IF (ICHR(IFIRST).EQ.1H-) ISIGN=-1
IFIRST=IFIRST+1
240 CONTINUE
INUM=0
IDEC=0
IDECF=0
DO 240 I=IFIRST,ILAST
IF (ICHR(I).NE.1H.) GO TO 250
IDECF=IDECF+1
IDEC=1
GO TO 240
250 CONTINUE
CALL ICNV (ICHR(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)=I1+XNUM

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        IF (IYPE.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=I1
        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/CORP(78),ANTH(2,12),V(25),NMEAS,KN,
1       SQROOT(78),X(25),IU,NMEAS,ICOUNT,
2       INAME(4),ITMEAS,NIMEAS,NTEMP
        COMMON/MISC/IOIN,IOOUT,ICARD
        DIMENSION BUFP(3),TEMP(12)
        DATA BUFP/3*0/
        ISAMP=0
        ICOUNT=0
        INLINE=0
        IOIN=5
C
C ***HEAD 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

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        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

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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 440
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 = ".12," ?---")
540 FORMAT (" MEASUREMENT = ".12)
550 FORMAT (" ENTER STANDARD DEVIATION ---")
560 FORMAT (" ENTER ANTHROPOMETRIC CORRELATION MATRIX DATA IN A ROWWIS
IE UPPER "/ " TRIANGULAR FORM."/ " NOTE: ALL DIAGONAL ELEMENTS MUST"
* " EQUAL 1.000")
570 FORMAT (5H ROW .12,"("".12," ELEMENTS, COLUMNS ".12,"-".12,")")
580 FORMAT (5H ROW .12,"("".12," ELEMENT, COLUMN ".12,")")
590 FORMAT (21H ENTER THE REMAINING .12,1MH ELEMENTS FOR ROW .12)
600 FORMAT (" THE LAST ".12," 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 ".12)
640 FORMAT (" RE-ENTER DATA FOR ROW ".13)
650 FORMAT (" INVALID RESPONSE")
660 FORMAT (" UNEXPECTED EOF ON FMEAS FOR MEAS ".12)
670 FORMAT (" FILE UMEAS IS NOT ATTACHED TO THE PROGRAM"/
* " UNFORMATTED READ ON THIS FILE IS ABORTED ---"/)
680 FORMAT (" TOTAL ERRORS ON INPUT DATA ".15)
690 FORMAT (" MEAN, STD DEV & CORRELATION DATA READ")
700 FORMAT (" INVALID DATA AT LINE ".15)
710 FORMAT (" UNEXPECTED END OF FILE")
END
SUBROUTINE EDIT
COMMON/MCS4/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
1 SQROOT(78),X(25),JUNTIMEAS,ICOUNT,
2 INAME(6),ITMEAS,NIMEAS,NTEMP
COMMON/MISC/IOIN,IOOUT,ICARD
DIMENSION BUFF(3)
DATA BUFF/1,0/

```

```

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 140
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 HFLP (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-MEAN;2-STU;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 (IFPROR)
    COMMON/NCS4/CORR(78),ANTN(2,12),V(25),NMEAS,KN,
1    SQROOT(78),X(25),IU,NMEAS,ICOUNT,
2    INAME(4),ITMEAS,NIMEAS,NTEMP
    COMMON/MISC/IOIN,IOOUT,ICAP0

```

```

C ***PROMPTS USER FOR NAME OF SAMPLE FILE
C
      DIMENSION IBUFF(4),XVAL(4)
      DATA IBUFF/4*10H
      IFRROR=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 HFLP (14)
      GO TO 110
130  CONTINUE
      WRITE (6,190)
      GO TO 110
140  CONTINUE
      WRITE (6,190)
      IFRROR=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/MCS4/CORR(78),ANTM(2,12),V(25),NMEAS,KN,
1      SOROOT(78),X(25),IU,NTMEAS,ICOUNT,
2      INAME(4),ITMEAS,NIMEAS,NTMP
      COMMON/MISC/IOIN,IOOUT,ICARD
      DIMENSION IRAN(9)
      DATA ((IRAN(I),I=1,9)/33333333,55555555,77777777,22222222,
1      44444444,66666666,88888888,99999999,123456789/
C
C ***LINEAR ARRAY CORR(78) IS LOADED INTO LINEAR
C ***DUMMY ARRAY SOROOT(78) BEFORE MATRIX TRANSFORM-
C ***ATIONS. ALL MATRIX TRANSFORMATIONS ARE
C ***PERFORMED ON SOROOT(78) TO PRESERVE CORR(78)
C ***AS IMPLEMENTED WITHIN THE EDITING PROCESS.
C
      IOIN=5
      DO 100 K=1,KN
      SOROOT(K)=CORR(K)
100  CONTINUE
C *** PERFORM MATRIX TRANSFORMATIONS
      CALL SOPMX (NERROR)
      IF (NERROR.EQ.1) RETURN
C *** ACCEPT OPERATOR SAMPLE SIZE
110  CONTINUE
      WRITE (A,J20)
      CALL INPT (1,1,NVALSZ,NSAMP,XVAL,IEOF)
      GO TO (150,170,130,140,790,140), IEOF+1

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```

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
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 240
250 CONTINUE
IU=67111133
260 CONTINUE
REWIND NTEMP
C
C ***WRITE 40 CHARACTER NAME FIELD INTO
C ***FILE SAMPLE (NTEMP)
WRITE (NTEMP) INAME,NMEAS
C
DO 280 I=1,NSAMP
C
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(I0),I0=1,NMEAS)
280 CONTINUE
C
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  SOROOT(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(IJ,IROW),J=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 160 IROW=1,NMEAS

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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 190
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
*20 FORMAT (" INVALID RESPONSE")
*30 FORMAT (" OUTPUT MODE:--")
*40 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 5)"/
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 (1F6.2,F5.2)
520 FORMAT (71(1H-))
530 FORMAT (1X,4A10,10X,A10)
540 FORMAT (10X,"OPERATOR NOS",I4," --",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
MEASUREMENT",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 (12F6.3)
620 FORMAT (1X,70(1H-))
630 FORMAT (" PRINT MODE(1-MEAN/STD;2-CORR MATRX;3-OPER MEAS;4-END)-")
640 FORMAT (19,5X,2F12.2)
650 FORMAT (" INVALID RESPONSE")
660 FORMAT (2X,11(A2,4X),A2)
END
SUBROUTINE RAND2 (RNORM,MTYPE,QUAN,IJ)

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C
C ***GENERATES A NORMAL DISTRIBUTION WITH MEAN OF ZERO AND
C ***STANDARD DEVIATION EQUAL TO ONE....
C ***METHODOLOGY --- MARSAGLIA - BRAY
C

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COMMON/MCS4/CORR(7A),ANT4(2,12),V(25),NMEAS,RN0
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*UNIFORM(MTYPE)-1.0
Y1=2.0*UNIFORM(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,INOW,TSTORE1,TSTORE2,IFATAL)

```

```

C
C *** CHECKS FOR REASONABLENESS OF INPUT VALUES
C

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COMMON/MCS4/CORR(7A),ANT4(2,12),V(25),NMEAS,RN0
1 SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
2 INAME(4),ITMEAS,NIMEAS,NTEMP
COMMON/MISC/IOIN,IOOUT,ICARD

```

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C
C ICALL = 1 MEANS AND STANDARD DEVIATIONS
C ICALL = 2 CORRELATION MATRIX VERIFICATION

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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=7
  IF (ICOL.LE.0.OP.ICOL.GT.NMEAS) GO TO 130
C *** IS THE NUMBER WITHIN THE UPPER TRIANGULAR REGION?
  IWRITE=1
  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 -.3")
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 SOROOT(78),X(25),IU,NYMEAS,ICOUNT,
2 INAME(4),ITMEAS,NYMEAS,NTEMP
COMMON/MISC/IOIN,IOOUT,ICARD
REWIND NYMEAS
C *** SAVE NO. OF MEAS., ELEMENTS IN CORR MATRIX, SEX FLAG
WRITE (NYMEAS) NMEAS,KN,INAME
C *** SAVE MEAN/STD. VECTOR.
WRITE (NYMEAS) ((ANTM(I0,JO),IO=1,2),JO=1,NMEAS)
C *** SAVE CORRELATION MATRIX
WRITE (NYMEAS) (CORR(I0),IO=1,KN)
REWIND NYMEAS
WRITE (6,100)
RETURN

C
100 FORMAT (" MEASUREMENT DATA SAVED ON FILE UMEAS OR TAPE2")
END
SUBROUTINE SINSUB (INTYPE)

C
C *** FOR A GIVEN SQUARE ROOT MATRIX R OF ORDER M IN UPPER
C *** TRIANGULAR FORM OF A CORRELATION OR A COVARIANCE
C *** MATRIX OF M COLUMNS, THIS ROUTINE COMPUTES A VECTOR
C *** V OF PSEUDO SCORES OF LENGTH M 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,NTYPE,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(I)=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=1,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(I5)=I1
DO 110 J2=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(I6)=J2
ZX(I7)=J2
110 CONTINUE
ZX(I1)=N
ZX(I2)=L
ZX(I3)=K
120 CONTINUE
130 CONTINUE
C   ***ABNORMAL EXIT FROM SUBROUTINE
NERROR=1
WRITE (A,180)
180 CONTINUE

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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 ' ' 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 NDJ(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 UNIFORM(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,
2INAME(4),ITMEAS,NIMEAS,NTMP
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
UNIFORM=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 UNIFORM=IU
UNIFORM=UNIFORM*.4656613E-09
RETURN
END
SUBROUTINE HELP (I)
RETURN
END#

```

APPENDIX D

Program Listing for CAPE Model
Modified for Use with FORTRAN IV

```
1      COMMON/MCSH/CORR (78) , ANTH (2, 12) , V (25) , NMEAS, KN,  
2      1 SQROOT (78) , X (25) , IU, NTMEAS, ICOUNT,  
3      2 INAME (10) , ITMEAS, NIMEAS, MAXSAM, NTEMP  
4      COMMON/MISC/IOIN, IOOUT, ICARD  
5      DATA NUCREW/8/  
6      DATA MAXFUN/4/  
7      DATA MAXOPT, MAXANT, MAXACT/3, 7, 3/  
8      IOOUT=0  
9      ISAMP=0  
10     MMEAS = 12  
11     100 CONTINUE  
12     IOIN=5  
13     WRITE (6, 290)  
14     CALL INPT (1, 1, NVALSZ, NMEAS, XVAL, IEOF)  
15     IEOP1=IEOP+1  
16     GO TO (130, 100, 110, 120, 280, 120) , IEOP1  
17     110 CONTINUE  
18     CALL HELP (1)  
19     GO TO 100  
20     120 CONTINUE  
21     WRITE (6, 340)  
22     GO TO 100  
23     130 CONTINUE  
24     IF (NMEAS.LT.1.OR.NMEAS.GT.MMEAS) GO TO 120  
25     KN=NMEAS*(NMEAS+1)/2  
26     IINPT=0  
27     140 CONTINUE  
28     IOIN=5  
29     150 CONTINUE  
30     WRITE (6, 300)  
31     CALL INPT (1, 1, NVALSZ, IOPT, XVAL, IEOF)  
32     IEOP1=IEOP+1  
33     GO TO (180, 140, 160, 170, 280, 170) , IEOP1  
34     160 CONTINUE  
35     CALL HELP (2)  
36     GO TO 150  
37     170 CONTINUE  
38     WRITE (6, 340)  
39     GO TO 150  
40     180 CONTINUE  
41     IF (IOPT.LT.1.OR.IOPT.GT.MAXANT) GO TO 170  
42     GO TO (190, 200, 220, 240, 260, 280, 225) , IOPT  
43     190 CONTINUE  
44     CALL ACCPT (ISAMP)  
45     IINPT=1  
46     GO TO 140  
47     200 CONTINUE  
48     IF (IINPT.EQ.1) GO TO 210  
49     WRITE (6, 350)  
50     GO TO 140
```

```

51      210 CONTINUE
52      CALL EDIT
53      GO TO 140
54      220 CONTINUE
55      IF (ISAMP.EQ.1) GO TO 230
56      222 WRITE (6,320)
57      GO TO 140
58      225 CONTINUE
59      IF (ISAMP.NE.1) GO TO 222
60      CALL PUNRT
61      GO TO 140
62      230 CONTINUE
63      CALL SAVE
64      GO TO 140
65      240 CONTINUE
66      IF (IINPT.EQ.1) GO TO 250
67      WRITE (6,360)
68      GO TO 140
69      250 CONTINUE
70      CALL PRINT
71      GO TO 140
72      260 CONTINUE
73      IF (ISAMP.NE.1) GO TO 270
74      CALL OPSAMP (ISAMP)
75      GO TO 140
76      270 CONTINUE
77      WRITE (6,330)
78      GO TO 140
79      280 CONTINUE
80      WRITE (6,310)
81      STOP
82      290 FORMAT (' ENTER NUMBER OF MEASUREMENTS (1-12) ?--')
83      300 FORMAT (' OPTIONS (1-INPUT;2-EDIT;3-SAVE;4-PRINT;5-GENERATE;'
84      1 , '6-END;7-PUNCH) ')
85      310 FORMAT (5X, 'END OF OPERATOR SAMPLE')
86      320 FORMAT (1X, '***MCSM140 UNABLE TO SAVE MEASUREMENT DATA - FATAL
87      1 ERRORS')
88      330 FORMAT (10X, '***MCSM165 UNABLE TO GENERATE SAMPLE - FATAL ERRORS')
89      340 FORMAT (/, '***MCSM024 INVALID RESPONSE')
90      350 FORMAT (10X, '***MCSM130 ANTHROPOMETRIC DATA MUST BE INPUT BEFORE',
91      1/,13X, 'THE EDIT FUNCTION.')
92      360 FORMAT (10X, '***MCSM150 ANTHROPOMETRIC DATA MUST BE INPUT BEFORE',
93      1/,13X, 'THE PRINT FUNCTION.')
94      END

```

```

1      SUBROUTINE INPT (ITYPE,IVALSZ,NVALSZ,IVAL,XVAL,IEOF)
2      COMMON/MISC/IOIN,IOOUT,ICARD
3      DIMENSION ICHAR(80),IVAL(IVALSZ),XVAL(IVALSZ)
4      C
5      DIMENSION NVAL(20)
6      LOGICAL * 1 NCHAR(80)
7      EQUIVALENCE (NVAL(1),NCHAR(1))
8      C
9      C
10     DATA IBLK,IQUES,IDOL,IQUO,IPOST,IPD,ICOM,IMIN,IPLUS/1H,1H?,
11     11H$,1H',1H.,1H.,1H.,1H-,1H+/,
12     DATA I4BLK/4H /
13     ISTOP=0
14     IF (IVALSZ.GE.0) GO TO 100
15     ISTOP=1
16     IVALSZ=IABS(IVALSZ)
17     100 CONTINUE
18     IQUTE=0
19     NVALSZ=0
20     IEOF=0
21     IF (IOOUT.EQ.1) GO TO 120
22     DO 110 I=1,80
23     ICHAR(I)=IBLK
24     110 CONTINUE
25     READ (IOIN,930,END=111) ICHAR, NCHAR
26     DO 109 J=1,80
27     IF (ICAR(J) .EQ. IBLK) GO TO 109
28     GO TO 190
29     109 CONTINUE
30     GO TO 113
31     111 CONTINUE
32     REWIND IOIN
33     113 IEOF = 1
34     RETURN
35     120 CONTINUE
36     I1=ICARD
37     GO TO 140
38     130 CONTINUE
39     I1=1
40     140 CONTINUE
41     I2=80
42     150 CONTINUE
43     C WRITE(6,501) IOEC,ISTOP,IVALSZ,NVALSZ, I1,I2, IEOF
44     IF (ISTOP.EQ.1.AND.IVALSZ.EQ.NVALSZ) RETURN
45     IF (I1.LE.I2) GO TO 160
46     IF (NVALSZ.LE.IVALSZ) RETURN
47     IEOF=5
48     RETURN
49     160 CONTINUE
50     DO 170 I=11,12

```

```

51      IF (ICAR(I).EQ.IBLK ) GO TO 170
52      IFIRST=1
53      GO TO 180
54 170  CONTINUE
55      IF (NVALSZ.EQ.0) IEOF=1
56      IF (NVALSZ.GT.IVALSZ) IEOF=5
57      RETURN
58 180  CONTINUE
59      IF (ICAR(IFIRST).EQ.IQUES) IEOF=2
60      IF (ICAR(IFIRST).EQ.IDOL) IEOF=4
61      IF (IEOF.NE.0) RETURN
62      IF (ITYPE.EQ.4) GO TO 300
63      IF (ITYPE.NE.3) GO TO 190
64      IF (ICAR(IFIRST).NE.IQUO.AND.ICAR(IFIRST).NE.IPOST) GO TO 190
65      IFIRST=IFIRST+1
66      IQUOTE=1
67 190  CONTINUE
68      DO 220 I=IFIRST,12
69      IF (IQUOTE.EQ.0) GO TO 200
70      IF (ICAR(I).EQ.IQUO.OR.ICAR(I).EQ.IPOST) GO TO 210
71      GO TO 220
72 200  CONTINUE
73      IF (ICAR(I).NE.IBLK.AND.ICAR(I).NE.ICOM) GO TO 220
74 210  CONTINUE
75      ILAST=I-1
76      GO TO 230
77 220  CONTINUE
78      ILAST=12
79 230  CONTINUE
80      NVALSZ=NVALSZ+1
81      I1=ILAST+2
82      IF (NVALSZ.GT.IVALSZ) GO TO 150
83      IF (ITYPE .EQ.9) GO TO 310
84      ISIGN=1
85      IF (ICAR(IFIRST).NE.IMIN.AND.ICAR(IFIRST).NE.IPLUS) GO TO 240
86      IF (ICAR(IFIRST).EQ.IMIN) ISIGN=-1
87      IFIRST=IFIRST+1
88 240  CONTINUE
89      INUM=0
90      IDEC=0
91      IOECF=0
92      DO 260 I=IFIRST,ILAST
93      IF (ICAR(I).NE.IPD) GO TO 250
94      IOECF=IOECF+1
95      IDEC=1
96      GO TO 260
97 250  CONTINUE
98      CALL ICONV (ICAR(I),IADD,IEOF)
99      IF (IEOF.EQ.9) RETURN
100     INUM=INUM+10+IADD

```

```

101      501 FORMAT(/ ' TEST ', 10110)
102      IF (IDEC.NE.0) IDEC=IDEC+1
103      260 CONTINUE
104      IF (IDECF.LT.2) GO TO 280
105      270 CONTINUE
106      C  WRITE (6,501) IDEC, IDECF
107      IEOF=3
108      RETURN
109      280 CONTINUE
110      INUM=INUM*ISIGN
111      XNUM=FLOAT(INUM)
112      CC  WRITE (6,501) IDEC, IDECF, INUM, IADD, ISIGN, ITYPE
113      IF ((ITYPE.EQ.1.AND.IDEC.LE.1).OR.(ITYPE.EQ.2)) GO TO 290
114      IEOF=9
115      RETURN
116      290 CONTINUE
117      IF (IDEC.NE.0) XNUM=XNUM/10.0** (IDEC-1)
118      IF (ITYPE.EQ.1) IVAL(NVALSZ)=IFIX(XNUM)
119      IF (ITYPE.EQ.2) XVAL(NVALSZ)=XNUM
120      ICARD=ILAST+1
121      C  WRITE (6,501) IDEC, IDECF, INUM, IADD, ISIGN, ITYPE, NVALSZ.
122      C  1  IVAL(NVALSZ), ICARD
123      GO TO 150
124      300 CONTINUE
125      ILAST=IVALSZ*4
126      909 FORMAT( 2X, 80A1)
127      910 FORMAT(2X, 20A4)
128      910 CONTINUE
129      DO 320 J=1,IVALSZ
130      IVAL(J)=I4BLK
131      320 CONTINUE
132      L=ILAST-IFIRST+1
133      NVALSZ=(L-1)/10+1
134      IF (L.GT.4*IVALSZ) GO TO 270
135      C  ENCODE (L,340,IVAL(I) ) (ICHAR(I),IFIRST,ILAST)
136      J = 0
137      904 FORMAT(' ENCODE ', 10110)
138      DO 311 I = IFIRST,ILAST
139      J = J + 1
140      NCHAR(J) = NCHAR(I)
141      911 CONTINUE
142      DO 319 I = 1,IVALSZ
143      IVAL(I) = NVAL(I)
144      913 CONTINUE
145      ICARD=11
146      RETURN
147      930 FORMAT (80A1, T1, 80A1)
148      940 FORMAT (80A1)
149      END

```

```
1      SUBROUTINE ICONV (JCHAR, I1, IEOF)
2      DIMENSION JNUM (10)
3      DATA JNUM/1H0, 1H1, 1H2, 1H3, 1H4, 1H5, 1H6, 1H7, 1H8, 1H9/
4      11 FORMAT (// ' AT. ICONV ', A2, 2110 /)
5      GO TO J=1, 10
6      IF (JCHAR.NE. JNUM (J)) GO TO 100
7      I1=J-1
8      RETURN
9      100 CONTINUE
10     IEOF = 3
11     WRITE (6, 11) JCHAR, I1, IEOF
12     RETURN
13     END
14
```

```

1      SUBROUTINE ACCPT (ISAMP)
2      COMMON/MCSM/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
3      1  SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
4      2  INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
5      COMMON/MISC/IOIN,IOOUT,ICARD
6      DIMENSION BUFF(3),TEMP(12)
7      DATA BUFF/3*0./
8      ISAMP=0
9      ICOUNT=0
10     INLINE=0
11     IOIN=5
12     100 CONTINUE
13     WRITE (6,610)
14     CALL INPT (1,1,NOINPT,IMODE,XINPT,IEOF)
15     IEOP1=IEOF+1
16     GO TO (130,110,120,110,490,110),IEOP1
17     110 WRITE (6,650)
18     GO TO 100
19     120 CALL HELP (4)
20     GO TO 100
21     130 IF (IMODE.EQ.1) GO TO 200
22     IF (IMODE.NE.2) GO TO 110
23     140 CONTINUE
24     WRITE (6,620)
25     CALL INPT (1,1,NOINPT,IFORM,XINPT,IEOF)
26     IEOP1=IEOF+1
27     GO TO (170,150,160,150,490,150), IEOP1
28     150 WRITE (6,650)
29     GO TO 140
30     160 CALL HELP (5)
31     GO TO 140
32     170 IF (IFORM.EQ.1) GO TO 190
33     IF (IFORM.NE.2) GO TO 150
34     REWIND NTMEAS
35     READ (NTMEAS,END=180) NMEAS,KN,INAME
36     READ (NTMEAS) ((ANTH(I0,J0),I0=1,2),J0=1,NMEAS)
37     READ (NTMEAS) (CORR(I0),I0=1,KN)
38     REWIND NTMEAS
39     WRITE (6,690)
40     ISAMP=1
41     RETURN
42     180 CONTINUE
43     WRITE (6,670)
44     GO TO 490
45     190 IOIN=1
46     200 CONTINUE
47     CALL NAMEFL (IERROR)
48     ICOUNT=ICOUNT+IERROR
49     C  WRITE (6,901) IMODE,IERROR,ICOUNT
50     901 FORMAT(/ ' ACCPT ', 10I10)

```

```

51      INLINE=INLINE+1
52      IF (IMODE.EQ.1) WRITE (6,500)
53      IF (IMODE.NE.1) WRITE (6,510) INAME
54      MAXINP=2
55      C   WRITE (6,901) IMODE, IERROR, ICOUNT, INLINE, MAXINP, IEOF
56          DO 320 IROW=1, NHEARS
57      210  CONTINUE
58          IF (IMODE.EQ.1) WRITE (6,530) IROW
59      220  NAMT=0
60      230  CONTINUE
61          ITOTIN=MAXINP-NAMT
62          ICOL=NAMT+1
63          CALL INPT (2, ITOTIN, NOINPT, IVAL, ANTM (ICOL, IROW), IEOF)
64          IF (IEOF.EQ.5.OR.IEOF.EQ.0) NAMT=NAMT+NOINPT
65      C   WRITE (6,901) IMODE, ITOTIN, MAXINP, NAMT, IEOF, ICOL, ICOL
66          IF (IMODE.EQ.1) GO TO 240
67          INLINE=INLINE+1
68          IF (NAMT.EQ.MAXINP) GO TO 290
69          IF (IEOF.EQ.1) GO TO 480
70          WRITE (6,540) IROW
71          IF (IEOF.EQ.5) GO TO 270
72          WRITE (6,700) INLINE
73          ICOUNT=ICOUNT+1
74          GO TO 320
75      240  CONTINUE
76          IEOFP1=IEOF+1
77          GO TO (280,210,250,260,490,270), IEOFP1
78      250  CONTINUE
79          CALL HELP (6)
80          GO TO 210
81      260  CONTINUE
82          WRITE (6,650)
83          GO TO 210
84      270  CONTINUE
85          IOLIST=NOINPT-ITOTIN
86          WRITE (6,600) IOLIST
87          IF (IMODE.NE.1) ICOUNT=ICOUNT+1
88          GO TO 290
89      280  CONTINUE
90          IF (NAMT.GE.2) GO TO 290
91          WRITE (6,550)
92          GO TO 290
93      290  CONTINUE
94          IF (NAMT.GT.2) NAMT=2
95          IERR=0
96          DO 300 ICOL=1, NAMT
97          CALL REASON (1, ICOL, IROW, ANTM (1, IROW), ANTM (2, IROW), IFATAL)
98          IERR=IERR+IFATAL
99      300  CONTINUE
100         IF (IERR.EQ.0) GO TO 320

```

```

101      IF (IMODE.NE.1) GO TO 310
102      WRITE (6,630) IROW
103      GO TO 220
104      310 ICOUNT=ICOUNT+IRERR
105      320 CONTINUE
106      IF (IMODE.EQ.1) WRITE (6,560)
107      IF (IMODE.NE.1) WRITE (6,520)
108      DO 460 IROW=1,NMEAS
109      330 CONTINUE
110      NAMT=0
111      MAXINP=NMEAS+1-IROW
112      340 CONTINUE
113      IF (IMODE.EQ.1.AND.IROW.EQ.NMEAS) WRITE (6,580) IROW,MAXINP,NMEAS
114      IF (IMODE.EQ.1.AND.IROW.NE.NMEAS) WRITE (6,570) IROW,MAXINP,IROW,
115      INMEAS
116      350 CONTINUE
117      ITOTIN=MAXINP-NAMT
118      ISTART=IROW+NAMT
119      CALL INPT (2,ITOTIN,NOINPT,IVAL,TEMP(ISTART),IEOF)
120      IF (IEOF.EQ.0.OR.IEOF.EQ.5) NAMT=NAMT+NOINPT
121      IF (IMODE.EQ.1) GO TO 360
122      INLINE=INLINE+1
123      IF (NAMT.EQ.MAXINP) GO TO 410
124      IF (IEOF.EQ.0) GO TO 350
125      IF (IEOF.EQ.1) WRITE (6,710)
126      IF (IEOF.EQ.1) GO TO 470
127      IF (IEOF.EQ.5) GO TO 390
128      ICOUNT=ICOUNT+1
129      WRITE (6,700) INLINE
130      GO TO 460
131      360 CONTINUE
132      IEOF=IEOF+1
133      GO TO (400,380,370,380,490,390),IEOF
134      370 CONTINUE
135      CALL HELP (7)
136      GO TO 340
137      380 CONTINUE
138      WRITE (6,650)
139      GO TO 340
140      390 CONTINUE
141      IOLIST=NOINPT-ITOTIN
142      WRITE (6,600) IOLIST
143      IF (IMODE.NE.1) ICOUNT=ICOUNT+1
144      NAMT=MAXINP
145      GO TO 410
146      400 CONTINUE
147      IF (NOINPT.EQ.ITOTIN) GO TO 410
148      ITOTIN=MAXINP-NAMT
149      WRITE (6,590) ITOTIN,IROW
150      GO TO 350

```

```

151      410 CONTINUE
152      ILAST=IROW+NAMT-1
153      IRERR=0
154      DO 420 ICOL=IROW,ILAST
155  CC   WRITE (6,902) IROW,ICOL,ILAST,IMODE, TEMP (ICOL)
156      902 FORMAT (' ACC', 4I10, 4F10.3)
157      CALL REASON (2,ICOL,IROW,TEMP (ICOL),0,IFATAL)
158      IRERR=IRERR+IFATAL
159  C    WRITE (6,901) IROW,ICOL,IRERR,IFATAL
160      420 CONTINUE
161      IF (IRERR.EQ.0) GO TO 440
162      IF (IMODE.EQ.2) GO TO 430
163      WRITE (6,640) IROW
164      GO TO 390
165      430 ICOUNT=ICOUNT+IRERR
166      GO TO 460
167      440 CONTINUE
168      DO 450 ICOL=IROW,NMEAS
169      N=NOX (IROW,ICOL)
170      CORR (N)=TEMP (ICOL)
171      450 CONTINUE
172      460 CONTINUE
173      470 CONTINUE
174      IF (ICOUNT.EQ.0) ISAMP=1
175      IF (IMODE.NE.1) WRITE (6,680) ICOUNT
176      GO TO 490
177      480 WRITE (6,680)
178      RETURN
179      490 CONTINUE
180      RETURN
181      500 FORMAT (5X,'ENTER PAIRS OF MEANS AND STANDARD DEVIATIONS--')
182      510 FORMAT (//,' DIAGNOSTICS OF FORMATTED READ ',/, ' OPER DESC: ',10RW
183      1,/)
184      520 FORMAT (//,1X,'CORRELATION/ANTHROPOMETRIC MEASUREMENTS:')
185      530 FORMAT (' MEASUREMENT - ',12,' ?---')
186      540 FORMAT (' MEASUREMENT - ',12)
187      550 FORMAT (5X,'ENTER STANDARD DEVIATION --')
188      560 FORMAT (5X,'ENTER ANTHROPOMETRIC CORRELATION MATRIX DATA IN A ROWW
189      11SE UPPER ',/,5X,'TRIANGULAR FORM.',/,5X,'NOTE: ALL DIAGONAL ELEM
190      2E4TS MUST EQUAL 1.000')
191      570 FORMAT (5X,4HR0W ,12,' ('.12.' ELEMENTS, COLUMNS ',12,'-'',12.' '))
192      580 FORMAT (5X,4HR0W ,12,' ('.12.' ELEMENT, COLUMN ',12.' '))
193      590 FORMAT (10X,29H===ENTER THE REMAINING ,12,18H ELEMENTS FOR ROW ,12
194      1)
195      600 FORMAT (10X,'===ACCP05) THE LAST ',12,' INPUTS HAVE BEEN IGNORED'
196      1)
197      610 FORMAT (5X,'INPUT MODE (1=INTERACTIVE,2=FILE) --')
198      620 FORMAT (5X,'READ MODE (1=FORMATTED,2=UNFORMATTED) --')
199      630 FORMAT (10X,'===ACCP060 RE-ENTER DATA FOR ',12)
200      640 FORMAT (10X,'===ACCP1300 RE-ENTER DATA FOR ROW ',13)

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201 650 FORMAT (10X, '***ACCT155 INVALID RESPONSE')
202 660 FORMAT (10X, '***ACCT UNEXPECTED EOF ON NIMEAS FOR MEAS ', I2)
203 670 FORMAT (10X, '***READFL4030 FILE ANTSTA IS NOT ATTACHED TO THE PROG
204 IRAM', /, 10X, '***UNFORMATTED READ ON THIS FILE IS ABORTED ---'//)
205 680 FORMAT (10X, '***ACCT3000 TOTAL ERRORS ON INPUT DATA ', I5)
206 690 FORMAT (' MEAN, STD DEV & CORRELATION DATA READ')
207 700 FORMAT (10X, '***ACCT150 INVALID DATA AT LINE ', I5)
208 710 FORMAT (10X, '***ACCT1200 UNEXPECTED END OF FILE')
209 END

```

1      SUBROUTINE EDIT
2      COMMON/HCSM/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
3      1  SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
4      2  INAME(10),ITMEAS,NIMEAS,MAXSAM,NTEMP
5      COMMON/MISC/IOIN, IOOUT, ICARD
6      DIMENSION BUFF(3)
7      DATA BUFF/3*0./
8      IOIN=5
9      100 CONTINUE
10     WRITE(6,350)
11     CALL INPT(1,1,NVALSZ,IOPT,XVAL,IEOF)
12     IEOPF1=IEOF+1
13     GO TO(130,100,110,120,340,120), IEOPF1
14     110 CONTINUE
15     CALL HELP(8)
16     GO TO 100
17     120 CONTINUE
18     WRITE(6,360)
19     GO TO 100
20     130 CONTINUE
21     IF (IOPT.LT.1.OR.IOPT.GT.5) GO TO 120
22     GO TO(140,140,240,330,340), IOPT
23     140 CONTINUE
24     ICOL=IOPT
25     150 CONTINUE
26     MAXINP=2
27     NANT=0
28     160 CONTINUE
29     IF (ICOL.EQ.1) WRITE(6,380)
30     IF (ICOL.EQ.2) WRITE(6,390)
31     170 CONTINUE
32     IVALSZ=MAXINP-NANT
33     J=NANT+1
34     CALL INPT(2,IVALSZ,MVALSZ,IVAL,BUFF(J),IEOF)
35     IEOPF1=IEOPF1
36     GO TO(220,180,200,190,100,210), IEOPF1
37     180 CONTINUE
38     WRITE(6,370)
39     GO TO 180
40     190 CONTINUE
41     WRITE(6,360)
42     GO TO 180
43     200 CONTINUE
44     IF (ICOL.EQ.1) CALL HELP(11)
45     IF (ICOL.EQ.2) CALL HELP(12)
46     GO TO 180
47     210 CONTINUE
48     IOLIST=MVALSZ-IVALSZ
49     WRITE(6,400) IOLIST
50     220 CONTINUE

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51      IROW=BUFF (1)
52      NAMT=NVALSZ+NAMT
53      IF (NAMT.GE.MAXINP) GO TO 230
54      IF (ICOL.EQ.1) WRITE (6,420) IROW
55      IF (ICOL.EQ.2) WRITE (6,430) IROW
56      GO TO 170
57  230 CONTINUE
58      CALL REASON (1,ICOL,IROW,BUFF (2),0,IFATAL)
59      IF (IFATAL.EQ.1) GO TO 150
60      ANTH(ICOL,IROW)=BUFF (2)
61      GO TO 100
62  240 CONTINUE
63      MAXINP=3
64      NAMT=0
65  250 CONTINUE
66      WRITE (6,410)
67  260 CONTINUE
68      IVALSZ=MAXINP+NAMT
69      J=NAMT+1
70      CALL INPT (2,IVALSZ,NVALSZ,IVAL,BUFF (J),IEOF)
71      IEOP1=IEOF+1
72      GO TO (310,270,290,280,100,300), IEOP1
73  270 CONTINUE
74      WRITE (6,370)
75      GO TO 250
76  280 CONTINUE
77      WRITE (6,360)
78      GO TO 250
79  290 CONTINUE
80      CALL HELP (13)
81      GO TO 250
82  300 CONTINUE
83      IOLIST=NVALSZ-IVALSZ
84      WRITE (6,400) IOLIST
85      GO TO 320
86  310 CONTINUE
87      ICOL=BUFF (1)
88      IROW=BUFF (2)
89      NAMT=NAMT+NVALSZ
90      IF (NAMT.GE.MAXINP) GO TO 320
91      IF (NAMT.EQ.1) WRITE (6,440) ICOL
92      IF (NAMT.EQ.2) WRITE (6,450) ICOL,IROW
93      GO TO 280
94  320 CONTINUE
95      CALL REASON (3,ICOL,IROW,BUFF (3),0,IFATAL)
96      IF (IFATAL.EQ.1) GO TO 240
97      CALL REASON (2,ICOL,IROW,BUFF (3),0,IFATAL)
98      IF (IFATAL.EQ.1) GO TO 240
99      N=NOX (IROW,ICOL)
100     CORR(N)=BUFF (3)

```

```

101      GO TO 100
102    330 CONTINUE
103      CALL PRINT
104      GO TO 100
105    340 CONTINUE
106      RETURN
107    350 FORMAT (5X, 'EDIT MODE (1-MEANS;2-STD;3-ANTH.CORR;4-PRINT;5-END) --')
108    360 FORMAT (10X, '***EDIT044 INVALID RESPONSE')
109    370 FORMAT (10X, '***EDIT095 NO INFORMATION ENCOUNTERED')
110    380 FORMAT (5X, 'INPUT INDEX AND MEAN VALUE')
111    390 FORMAT (5X, 'INPUT INDEX AND STANDARD DEVIATION')
112    400 FORMAT (10X, '***EDIT 042 THE LAST ',I2,' INPUTS HAVE BEEN IGNORED')
113    410 FORMAT (5X, 'INPUT COLUMN , ROW AND CORRELATION')
114    420 FORMAT (5X, 'INPUT MEAN VALUE FOR INDEX ',I3)
115    430 FORMAT (5X, 'INPUT STANDARD DEVIATION FOR INDEX ',I3)
116    440 FORMAT (5X, 'INPUT ROW AND CORRELATION FOR COLUMN ',I2)
117    450 FORMAT (5X, 'INPUT CORRELATION FOR ROW ',I2,' COLUMN ',I2)
118      END

```

```

1      SUBROUTINE NAMEFL (IERROR)
2      COMMON/MCSH/CORR (78) , ANTH (2, 12) , V (25) , NMEAS, KN,
3      1  SQROOT (78) , X (25) , IU, NTMEAS, ICOUNT,
4      2  INAME (10) , ITMEAS, NITMEAS, MAXSAM, NTEMP
5      COMMON/MISC/IOIN, IOOUT, ICARD
6      DIMENSION Ibuff (10) , XVAL (10)
7      DATA Ibuff/10*4H /
8      DATA I4BLK/4H /
9      IERROR=0
10     DO 100 J=1,4
11         Ibuff (J)=I4BLK
12     100 CONTINUE
13     110 CONTINUE
14         IF (IOIN.EQ.5) WRITE (6,180)
15         CALL INPT (4,10,NVALSZ,IBUFF,XVAL,IEOF)
16         IF (IEOF.LT.2.OR.IEOF.EQ.5) GO TO 150
17         IF (IOIN.NE.5) GO TO 140
18         IEOFMI=IEOF-1
19         GO TO (120,130,170), IEOFMI
20     120 CONTINUE
21         CALL HELP (14)
22         GO TO 110
23     130 CONTINUE
24         WRITE (6,190)
25         GO TO 110
26     140 CONTINUE
27         WRITE (6,190)
28         IERROR=1
29     150 CONTINUE
30         DO 160 J=1,10
31             INAME (J)=IBUFF (J)
32     160 CONTINUE
33     170 RETURN
34     180 FORMAT (5X, 'OPERATOR SAMPLE DESCRIPTION (40 CHAR MAX) ----')
35     190 FORMAT (10X, '====NAMEFLO27 INVALID RESPONSE')
36     END

```

```

0      SUBROUTINE OPSAMP (ISAMP)
1      COMMON/MCSM/CORR (78) , ANTH (2, 12) , V (25) , NMEAS, KN,
2      1  SQROOT (78) , X (25) , IU, NTMEAS, ICOUNT,
3      2  INAME (10) , ITMEAS, NIMEAS, MAXSAM, NTEMP
4      COMMON/MISC/IOIN, IOOUT, ICARD
5      DIMENSION IRAN (9)
6      DATA IRAN (1) , IRAN (2) , IRAN (3) , IRAN (4) , IRAN (5) , IRAN (6) , IRAN (7) ,
7      1IRAN (8) , IRAN (9) /99999999, 55555555, 77777777, 22222221,
8      1  444444443, 666666669, 888888889, 999999999, 123456789/
9      IOIN=5
10     DO 100 K=1, KN
11     SQROOT (K) =CORR (K)
12     100 CONTINUE
13     CALL SQRMX (NERROR)
14     IF (NERROR.EQ.1) RETURN
15     110 CONTINUE
16     WRITE (6, 320)
17     CALL INPT (1, 1, NVALSZ, NSAMP, XVAL, IEOF)
18     IEOFP1=IEOF+1
19     GO TO (150, 120, 130, 140, 290, 140) , IEOFP1
20     120 CONTINUE
21     WRITE (6, 330)
22     GO TO 110
23     130 CONTINUE
24     CALL HELP (15)
25     GO TO 110
26     140 CONTINUE
27     WRITE (6, 340)
28     GO TO 110
29     150 CONTINUE
30     IF (NSAMP.GT.0.AND.NSAMP.LE.MAXSAM) GO TO 160
31     WRITE (6, 350) MAXSAM
32     GO TO 110
33     160 CONTINUE
34     WRITE (6, 300)
35     CALL INPT (1, 1, NVALSZ, MTYPE, XVAL, IEOF)
36     IEOFP1=IEOF+1
37     GO TO (190, 180, 170, 180, 290, 180) , IEOFP1
38     170 CONTINUE
39     CALL HELP (20)
40     GO TO 160
41     180 CONTINUE
42     WRITE (6, 340)
43     GO TO 160
44     190 CONTINUE
45     IF (MTYPE.NE.92.AND.MTYPE.NE.60) GO TO 180
46     200 CONTINUE
47     WRITE (6, 310)
48     CALL INPT (1, 1, NVALSZ, IS, XVAL, IEOF)
49     IEOFP1=IEOF+1

```

```

50          GO TO (240,210,220,230,290,230), IEOFF1
51      210  CONTINUE
52          WRITE (6,330)
53          GO TO 200
54      220  CONTINUE
55          CALL HELP (21)
56          GO TO 200
57      230  CONTINUE
58          WRITE (6,340)
59          GO TO 200
60      240  CONTINUE
61          IF (IS.EQ.0) GO TO 250
62          IF (IS.LT.1.OR.IS.GT.9) GO TO 230
63          IU=IRAN(IS)
64          GO TO 260
65      250  CONTINUE
66          IU=67111133
67      260  CONTINUE
68          REWIND NTEMP
69          WRITE (NTEMP) INAME,NMEAS
70          DO 280 I=1,NSAMP
71          CALL SIMSUB (MTYPE)
72          DO 270 K=1,NMEAS
73          V(K)=V(K)+ANTM(2,K)+ANTM(1,K)
74      270  CONTINUE
75          WRITE (NTEMP) (V(I),I=1,NMEAS)
76      280  CONTINUE
77          ISAMP=I
78          END FILE NTEMP
79          REWIND NTEMP
80          REWIND NMEAS
81      C    WRITE (6,370)
82      370  FORMAT (10X, '*** SAMPLE DATA SAVED ON FILE 9')
83          WRITE (6,380)
84      290  CONTINUE
85          RETURN
86      300  FORMAT (5X, 'ENTER MACHINE WORD SIZE (32 OR 60 BIT) --')
87      310  FORMAT (5X, 'ENTER RANDOM NO SEED (0 IF NONE OR 1-9) --')
88      320  FORMAT (5X, 'INPUT SAMPLE SIZE --')
89      330  FORMAT (10X, '***OPSAMP215 NO INFORMATION ENCOUNTERED')
90      340  FORMAT (10X, '***OPSAMP411 INVALID RESPONSE')
91      350  FORMAT (10X, '***OPSAMP009 SAMPLE SIZE MUST BE BETWEEN 1 AND ',19)
92      360  FORMAT (10X, '***SAMPLE DATA SAVED ON FILE SAMPLE OR TAPE 9.')
93      END

```

```

1      SUBROUTINE PRINT
2      COMMON/MCSM/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
3      1  SQROOT(78),X(25),IU,NTMEAS,ICOUNT,
4      2  INAME(10),ITMEAS,NIMEAS,MAXSAH,NTEMP
5      COMMON/MISC/IOIN,IOOUT,ICARD
6      INTEGER FMT,FMT1
7      DIMENSION FMT(6),NUM(12),TEMP(12),INDEX(2),FMT1(5)
8      DATA FMT1 /'(1X,',' , '(2X,',' ,A2,2',' ,X) )'/
9      DATA FMT /'(1X,',' , '(6X) ',' , 'F6.3',' )'/
10     DATA NUM/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,2H10,2H11,2H12/
11     FMT1(2)=NUM(NMEAS)
12     ISTORE=0
13     IOFLAG=0
14     100 CONTINUE
15     WRITE (6,630)
16     CALL INPT (1,1,NVALSZ,IOPT,XVAL,IEOF)
17     IEOFP1=IEOF+1
18     GO TO (120,110,110,110,390,110),IEOFP1
19     110 CONTINUE
20     WRITE (6,650)
21     GO TO 100
22     120 CONTINUE
23     IF (IOPT.LT.1.OR.IOPT.GT.4) GO TO 110
24     IF (IOPT.EQ.1) GO TO 130
25     IF (IOPT.EQ.2) GO TO 150
26     IF (IOPT.EQ.4) GO TO 390
27     GO TO 190
28     130 CONTINUE
29     WRITE (6,580)
30     DO 140 IROW=1,NMEAS
31     WRITE (6,640) IROW,(ANTH(JO,IROW),JO=1,2)
32     140 CONTINUE
33     WRITE (6,620)
34     GO TO 100
35     150 CONTINUE
36     WRITE (6,590)
37     WRITE (6,FMT1) (NUM(10),IO=1,NMEAS)
38     WRITE (6,600)
39     DO 160 IROW=1,NMEAS
40     DO 160 ICOL=1,NMEAS
41     N=NDX(IROW,ICOL)
42     TEMP(ICOL)=CORR(N)
43     160 CONTINUE
44     IF (IROW.GT.1) GO TO 170
45     WRITE (6,610) (TEMP(ICOL),ICOL=IROW,NMEAS)
46     GO TO 180
47     170 FMT(2)=NUM(IROW-1)
48     FMT(4)=NUM(NMEAS+1-IROW)
49     WRITE (6,FMT) (TEMP(ICOL),ICOL=IROW,NMEAS)
50     180 CONTINUE

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```

51      WRITE (6,620)
52      GO TO 100
53  190  CONTINUE
54      WRITE (6,430)
55      IF (IOFLAG.LT.1) WRITE (6,440)
56      IOFLAG=1
57      CALL INPT (1,2,NVALSZ,INDEX,XVAL,IEOF)
58      IEOP1=IEOF+1
59      GO TO (290,270,200,210,100,220), IEOP1
60  200  CONTINUE
61      CALL HELP (19)
62      IOFLAG=0
63      GO TO 190
64  210  CONTINUE
65      WRITE (6,420)
66      GO TO 190
67  220  CONTINUE
68      IOLIST=NVALSZ-2
69      WRITE (6,450) IOLIST
70  230  CONTINUE
71      IF (INDEX(1).GT.0) GO TO 240
72      WRITE (6,480)
73      GO TO 190
74  240  CONTINUE
75      IF (ISTORE.GT.0.AND.INDEX(1).GT.ISTORE) GO TO 250
76      NRSKIP=INDEX(1)-1
77      GO TO 260
78  250  CONTINUE
79      NRSKIP=INDEX(1)-ISTORE-1
80  260  CONTINUE
81      ISTART=INDEX (1)
82      IF (NVALSZ.EQ.1) GO TO 280
83      IF (NVALSZ.GE.2) GO TO 290
84  270  CONTINUE
85      ISTORE=0
86      ISTART=1
87      IEND=999
88      NRSKIP=0
89      GO TO 920
90  280  CONTINUE
91      IEND=ISTART
92      GO TO 910
93  290  CONTINUE
94      IF (INDEX(1).LE.INDEX(2)) GO TO 300
95      WRITE (6,490)
96      GO TO 190
97  300  CONTINUE
98      IEND=INDEX(2)
99  310  CONTINUE
100     IF (INDEX(1).GT.ISTORE.AND.ISTORE.NE.0) GO TO 330

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```

101      320 CONTINUE
102      REWIND NTEMP
103      READ (NTEMP,END=410) INAME,NMEAS
104      330 CONTINUE
105      IF (NRSKIP.LT.1) GO TO 350
106      DO 340 I=1,NRSKIP
107      READ (NTEMP,END=400) (V(K),K=1,NMEAS)
108      340 CONTINUE
109      350 CONTINUE
110      WRITE (6,530) (INAME(I0),I0=1,I0)
111      IF (ISTART.EQ.IEND) WRITE (6,540) IEND
112      IF (ISTART.NE.IEND.AND.IEND.NE.999) WRITE (6,550) ISTART,IEND
113      WRITE (6,500)
114      WRITE (6,FMT1) (NUM(I0),I0=1,NMEAS)
115      WRITE (6,600)
116      ISKIP=0
117      NFOUND=0
118      DO 360 I=ISTART,IEND
119      IF (ISKIP.EQ.1) WRITE (6,460)
120      ISKIP=0
121      IF (ISTART.NE.IEND.AND.1.NE.IEND.AND.(I/5)≠S.EQ.1) ISKIP=1
122      READ (NTEMP,END=370) (V(K),K=1,NMEAS)
123      NFOUND=NFOUND+1
124      ISTORE=1
125      WRITE (6,510) (V(K),K=1,NMEAS)
126      360 CONTINUE
127      GO TO 380
128      370 CONTINUE
129      IF (IEND.NE.999.AND.ISTART.NE.IEND) WRITE (6,470) IEND
130      ISTORE=1
131      IF (NFOUND.LT.1) WRITE (6,560)
132      380 CONTINUE
133      WRITE (6,520)
134      GO TO 190
135      390 CONTINUE
136      REWIND NTEMP
137      RETURN
138      400 CONTINUE
139      IOLIST=1-2+ISTORE
140      WRITE (6,560)
141      GO TO 190
142      410 CONTINUE
143      WRITE (6,570)
144      GO TO 100
145      420 FORMAT (10X,'***PRINT195 INVALID RESPONSE')
146      430 FORMAT (5X,'OUTPUT MODE:--')
147      440 FORMAT (10X,'FOR ALL OPERATOR DATA (ENTER CARRIAGE RETURN) ',/,10X,
148      1'FOR INDIVIDUAL OPERATOR DATA (ENTER OPERATOR NUMBER) ',/,10X,'FOR
149      2A SEQUENCE OF OPERATORS (ENTER RANGE OF OPERATOR NUMBERS) ',/,10X,
150      SEND (ENTER 9: ')

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151 450 FORMAT (10X, '***PRINT119 THE LAST', I4, 'INPUTS HAVE BEEN IGNORED')
152 460 FORMAT (1H )
153 470 FORMAT (10X, '***PRINT211 ERROR IN UPPER INDEX ---', I4)
154 480 FORMAT (10X, '***PRINT120 INDEX NO. LESS THAN OR EQUAL', /, '***T
155 10 ZERO IS NOT VALID')
156 490 FORMAT (10X, '***PRINT160 FIRST INDEX MUST BE LESS THAN SECOND INDE
157 1X')
158 500 FORMAT (27X, 'OPERATOR SAMPLE', /, 71 (1H-))
159 510 FORMAT (11F6.2, F5.2)
160 520 FORMAT (71 (1H-))
161 530 FORMAT (1X, 10A4, 10X, A4)
162 540 FORMAT (10X, 'OPERATOR NO', I4)
163 550 FORMAT (10X, 'OPERATOR NOS', I4, ' ---', I4)
164 560 FORMAT (10X, '***PRINT1500 INDEX NUMBER EXCEEDS RECORDS IN OPERATOR
165 1 FILE***')
166 570 FORMAT (10X, '***PRINT1600 FILE SAMPLE IS NOT ATTACHED TO THE PROGR
167 1AM', /, 10X, '***OPERATOR OUTPUT REQUEST ABORTED ---', //)
168 580 FORMAT (/, 21X, 'MEANS AND STANDARD DEVIATIONS', /, 1X, 70 (1H-), /, 2X, 'M
169 1EASUREMENT', 6X, 'MEANS', 6X, 'STD DEV', /, 1X, 71 (1H-))
170 590 FORMAT (/, 7X, 'CORRELATION MATRIX FOR ANTHROPOMETRIC MEASUREMENTS',
171 1/, 1X, 70 (1H-))
172 600 FORMAT (1X, 70 (1H-))
173 610 FORMAT (1X, 12F6.9)
174 620 FORMAT (1X, 70 (1H-))
175 630 FORMAT (5X, 'PRINT MODE (1-MEAN/STD; 2-COOR MATRX; ', '9-OPER MEAS; 4-EN
176 1D) ---')
177 640 FORMAT (7X, 12, 5X, 2 (5X, F7.2))
178 650 FORMAT (10X, '***PRINT103 INVALID RESPONSE')
179 END

```

```

1      SUBROUTINE RAND2 (RNORM, MTYPE, QUAN, IJ)
2      COMMON/MCSM/CORR(78), ANTH(2, 12), V(25), NHEAS, KN,
3      SQROOT(78), X(25), IU, NTHEAS, ICOUNT,
4      INAME(10), ITHEAS, NIMEAS, MAXSAM, NTEMP
5      DIMENSION QUAN(2)
6      COMMON/MISC/IOIN, IOOUT, ICARD
7      IJ=IJ+1
8      IF (IJ.EQ.2) GO TO 110
9      100 CONTINUE
10     X1=2.0*UNIFORM(MTYPE)-1.0
11     Y1=2.0*UNIFORM(MTYPE)-1.0
12     S=X1*X1+Y1*Y1
13     IF (S.GE.1.0) GO TO 100
14     S=SQRT(-2.0*ALOG(S)/S)
15     QUAN(1)=X1*S
16     QUAN(2)=Y1*S
17     110 CONTINUE
18     RNORM=QUAN(IJ)
19     IF (IJ.EQ.2) IJ=0
20     RETURN
21     END

```

```

0      SUBROUTINE REASON (ICALL,ICOL,IROW,TSTOR1,TSTOR2,IFATAL)
1      COMMON/MCSM/CORR (78),ANTH (2,12),V (25),NMEAS,KN,
2      1  SQROOT (78),X (25),IU,NTHERS,ICOUNT,
3      2  INAME (10),ITHERS,NIMEAS,MAXSAM,NTEMP
4      COMMON/MISC/IOIN,IOOUT,ICARD
5      IFATAL=0
6      IAFLAG=0
7      C  WRITE (6,901) ICALL,ICOL,IROW,IFATAL,TSTOR1,TSTOR2
8      901 FORMAT (' REASON ', 4I10, 4F10.3)
9      IF (ICALL.LT.0) IAFLAG=1
10     ICALL=IABS(ICALL)
11     IF (ICALL.GT.1) GO TO 110
12     IWRITE=1
13     IF (IROW.LT.1.OR.IROW.GT.NMEAS) GO TO 120
14     IF (ICOL.EQ.2) GO TO 100
15     RETURN
16     100 CONTINUE
17     IWRITE=2
18     IF (TSTOR2.LT.0.) GO TO 120
19     IWRITE=3
20     IF (TSTOR1.LE.TSTOR2) GO TO 120
21     RETURN
22     110 CONTINUE
23     IWRITE=1
24     IF (IROW.LE.0.OR.IROW.GT.NMEAS) GO TO 130
25     IWRITE=2
26     IF (ICOL.LE.0.OR.ICOL.GT.NMEAS) GO TO 130
27     IWRITE=3
28     IF (IROW.GT.ICOL) GO TO 130
29     IF (ICOL.EQ.3) RETURN
30     IWRITE=4
31     IF (ICOL.EQ.IROW.AND.TSTOR1.NE.1.000) GO TO 130
32     IWRITE=5
33     IF (TSTOR1.LT.-1.000) GO TO 130
34     IWRITE=6
35     IF (TSTOR1.GT.1.000) GO TO 130
36     RETURN
37     120 CONTINUE
38     IF (IWRITE.NE.1.AND.IOIN.NE.5) WRITE (6,200) IROW
39     GO TO (190,140,150), IWRITE
40     130 CONTINUE
41     GO TO (190,200,210,160,170,180), IWRITE
42     140 CONTINUE
43     WRITE (6,230)
44     GO TO 220
45     150 CONTINUE
46     WRITE (6,240)
47     GO TO 220
48     160 CONTINUE
49     WRITE (6,250) IROW,ICOL

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50      GO TO 220
51      170 CONTINUE
52      WRITE (6,260) IROW,ICOL
53      GO TO 220
54      180 CONTINUE
55      WRITE (6,270) IROW,ICOL
56      GO TO 220
57      190 CONTINUE
58      WRITE (6,290) IRGE,NMEAS
59      GO TO 220
60      200 CONTINUE
61      WRITE (6,300) ICOL,NMEAS
62      GO TO 220
63      210 CONTINUE
64      WRITE (6,310) IROW,ICOL
65      GO TO 220
66      220 CONTINUE
67      IFATAL=1
68      RETURN
69      230 FORMAT (10X,'***REASON1150 STANDARD DEVIATIONS LESS THAN ZERO')
70      240 FORMAT (10X,'***REASON1200 STD. GREATER THAN MEAN VALUE.')
71      250 FORMAT (10X,'***REASON1250 DIAGONAL ELEMENT IN ROW ',12,/,10X,'***
72      ICOLUMN ',12,' IS NOT EQUAL TO 1.0')
73      260 FORMAT (10X,'***REASON1300 ENTRY IN COLUMN ',12,' ROW ',12,/,10X,'
74      I***IS LESS THAN -1.0')
75      270 FORMAT (10X,'***REASON1350 ENTRY IN COLUMN ',12,' ROW ',12,/,10X,'
76      I***IS GREATER THAN +1.0')
77      280 FORMAT (8X,12)
78      290 FORMAT (10X,'***REASON1500 ROW ',12,' IS LESS THAN ZERO OR GREATER
79      I THAN ',12)
80      300 FORMAT (10X,'***REASON1600 COLUMN ',12,' IS LESS THAN ZERO OR GREA
81      ITER THAN ',12)
82      310 FORMAT (10X,'***REASON1700 ROW ',12,' COLUMN ',12,' IS OUTSIDE OF
83      IUPPER',/,10X,'***TRIANGULAR REGION OF CORRELATION MATRIX.')
84      END

```

```
1      SUBROUTINE SAVE
2      COMMON/MCSM/CORR(78),ANTH(2,12),V(25),NMEAS,KN,
3      SQROOT(78),X(25),IU,NTHMRS,ICOUNT,
4      INAME(10),ITMRS,NIMEAS,MAXSAM,NTEMP
5      COMMON/MISC/IOIN,IOOUT,ICARD
6      REMIND NTHMRS
7      WRITE (NTHMRS) NMEAS,KN,INAME
8      WRITE (NTHMRS) ((ANTH(I0,J0),I0=1,2),J0=1,NTHMRS)
9      WRITE (NTHMRS) (CORR(I0),I0=1,KN)
10     REMIND NTHMRS
11     WRITE (6,100)
12     RETURN
13     100 FORMAT (' MEASEUREMENT DATA SAVED ON FILE ANTSTA OR TAPE 2')
14     END
```

```

1      SUBROUTINE SIMSUB (MTYPE)
2      COMMON/MCSM/CORR (78) ,ANTM (2, 12) , V (25) , NMEAS,KN.
3      1  SQROOT (78) , X (25) , IU, NTHEAS, ICOUNT.
4      2  INAME (10) , ITMEAS, NIMEAS, MAXSAM, NTEMP
5      COMMON/MISC/IOIN, IOOUT, ICARD
6      DIMENSION Y (45)
7      IJ=0
8      DO 100 I=1, NMEAS
9      V (I)=0.0
10     CALL RAND2 (RNORM, MTYPE, QUAN, I, J)
11     100 Y (I)=RNORM
12     DO 110 I=1, NMEAS
13     DO 110 J=1, I
14     K=NDX (J, I)
15     110 V (I)=V (I)+Y (J)*SQROOT (K)
16     RETURN
17     END

```

```

0      SUBROUTINE SQRMX (NERROR)
1      COMMON/HCSM/CORA (78) , ANTH (2, 12) , V (25) , NMEAS, KN.
2      1  SQROOT (78) , X (25) , IU, NTHEAS, ICOUNT,
3      2  INAME (10) , ITHEAS, NIMEAS, MAXSAM, NTEMP
4      COMMON/MISC/IOIN, IOOUT, ICARD
5      DIMENSION ZX (7)
6      INTEGER ZX
7      NERROR=0
8      DO 120 I=1, NMEAS
9      ZX (4) = 1
10     N=NOX (1, I)
11     IF (SQROOT (N) .LT. 0) GO TO 130
12     SQ=SQRT (SQROOT (N))
13     DO 100 J=1, NMEAS
14     N=NOX (1, J)
15     SQROOT (N) =SQROOT (N) /SQ
16     100 CONTINUE
17     IF (I.EQ.NMEAS) NERROR=0
18     IF (I.EQ.NMEAS) RETURN
19     I=I+1
20     >X(L) 11
21     DO 110 J2=11, NMEAS
22     DO 110 J2=12, NMEAS
23     N=NOX (12, J2)
24     L=NOX (1, 12)
25     K=NOX (1, J2)
26     SQROOT (N) =SQROOT (N) -SQROOT (L) =SQROOT (K)
27     ZX (6) =12
28     ZX (7) =J2
29     110 CONTINUE
30     ZX (1) =N
31     ZX (2) =L
32     ZX (3) =K
33     120 CONTINUE
34     130 CONTINUE
35     NERROR=1
36     WRITE (6, 180)
37     140 CONTINUE
38     WRITE (6, 190)
39     CALL INPT (4, 1, NVALSZ, IAMS, XVAL, IEOF)
40     IEOF1=IEOF+1
41     GO TO (170, 160, 150, 170, 160, 170), IEOF1
42     150 CONTINUE
43     WRITE (6, 200)
44     WRITE (6, 210) (ZX (1), I=1, 7), SQROOT (N)
45     160 CONTINUE
46     RETURN
47     170 CONTINUE
48     WRITE (6, 220)
49     GO TO 140

```

```

50 180 FORMAT (10X, '***SQRMX051 ANTHROPOMETRIC CORRELATION VALUES ARE INV
51      1ALID')
52 190 FORMAT (10X, '-- ENTER CARRIAGE RETURN TO CONTINUE PROCESSING',/,10
53      1X, '-- ENTER ? TO DISPLAY SQRMX VARIABLES.')
54 200 FORMAT (10X, '***SQRMX062 AN INDEFINITE QUANTITY HAS BEEN DETECTED
55      1BY',/,10X, '***SQRMX. VARIABLE LIST WITHIN SQRMX:',/,10X' N   L
56      2   K   I   11  12  J2  SQROOT',/,10X,44(1H-))
57 210 FORMAT (8X,4(3X,12),4X,3(12,3X),F6.3,/,10X,44(1H-),//)
58 220 FORMAT (10X, '***SQRMX060 INVALID RESPONSE***')
59      END

```

```
1      FUNCTION NDX(I,J)
2      IF (I.GT.J) GO TO 100
3      NDX=I+(J*I-J)/2
4      RETURN
5  100  NDX=J+(I*I-I)/2
6      RETURN
7      END
```

```

1      FUNCTION UNFORM(MTYPE)
2      COMMON /MCSM/ CORR(78), ANTH(2,12), V(25), NMEAS, KN,
3      1SOROOT(78), X(25), IU, NTMEAS, ICOUNT,
4      2INAME(10), ITMEAS, NIMEAS, MAXSAM, NTEMP
5      COMMON/MISC/IOIN, IOOUT, ICARD
6      DATA IX/16777213/, C/281474976710655./
7      IF (MTYPE.EQ.32) GO TO 100
8      IU=IU*IX
9      UNFORM=IU/C
10     RETURN
11     100 IU=IU*65539
12        IF (IU.GE.0) GO TO 110
13        IU=IU+2147483647+1
14     110 UNFORM=IU
15        UNFORM=UNFORM*.4656619E-09
16     RETURN
17     END

```

1
2
3

SUBROUTINE HELP (1)
RETURN
END

```
99999      1
100000     BLOCK DATA
100001     COMMON/MCSM/CORR (78) , ANTH (2, 12) , V (25) , NMEAS, KN.
100002     1  SQROOT (78) , X (25) , IU, NTMEAS, ICOUNT,
100003     2  INAME (10) , ITMEAS, NIMEAS, MAXSAM, NTEMP
100004     COMMON/MISC/I0IN, I0OUT, ICARD
100005     DATA I0IN, I0OUT, NTEMP, NTMEAS, NIMEAS/5, 6, 3, 4, 7/
100006     DATA MAXSAM/400/
100007     DATA NTMEAS, NIMEAS/2, 4/
100008     1, ICOUNT/0/
100009     DATA ANTH/24*0. /, CORR/78*0. /, INAME/4*4H /
100010     END
100011     1
```

```

0      SUBROUTINE PUNAT
1      COMMON/MCSM/CORA (78) ,QNTM (2,12) ,V (25) ,NMEAS ,KN,
2      1 SQROOT (78) ,X (25) ,IU ,NTHRS ,ICOUNT,
3      2 INAME (10) ,ITHRS ,NIMEAS ,MAXSAM ,NTEMP
4      COMMON/MISC/IOIN ,IOOUT ,ICARD
5      REWIND NTEMP
6      REWIND 9
7
8      C
9      2 CONTINUE
10     READ (NTEMP,END=140) INAME ,NMEAS
11     WRITE (9,271) INAME ,NMEAS
12
13     C
14     4 CONTINUE
15     READ (NTEMP,END=370) (V (K) ,K=1 ,NMEAS)
16     WRITE (9,271) (V (K) ,K=1 ,NMEAS)
17     271 FORMAT (20A4)
18     GO TO 4
19     370 CONTINUE
20     ENDFILE 9
21     WRITE (6,272)
22     272 FORMAT (10X, '**** DATA SAVED ON FILE 9')
23     REWIND NTEMP
24     RETURN
25
26     140 CONTINUE
27     WRITE (6,141)
28     141 FORMAT (10X, ' ERROR DATA SET DOES NOT EXIST')
29     RETURN
30     END

```

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