NOTICE OF CHANGE

METRIC

MIL-HDBK-759C
NOTICE 1
28 February 1997

DEPARTMENT OF DEFENSE
HANDBOOK

HUMAN ENGINEERING DESIGN GUIDELINES

TO ALL HOLDERS OF MIL-HDBK-759C:
1. THE FOLLOWING PAGES OF MIL-HDBK-759C HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
i	28 February 1997	i	31 July 1995
ii	28 February 1997	ii	31 July 1995
vii	28 February 1997	vii	31 July 1995
viii	28 February 1997	viii	31 July 1995
ix	28 February 1997	ix	31 July 1995
x	31 July 1995	x	Reprinted without change
135	28 February 1997	135	31 July 1995
135a	28 February 1997	NEW PAGE	
135b	28 February 1997	NEW PAGE	
135c	28 February 1997	NEW PAGE	
135d	28 February 1997	NEW PAGE	
135e	28 February 1997	NEW PAGE	
135f	28 February 1997	NEW PAGE	
135g	28 February 1997	NEW PAGE	
135h	28 February 1997	NEW PAGE	
135i	28 February 1997	NEW PAGE	
135j	28 February 1997	NEW PAGE	
135k	28 February 1997	NEW PAGE	
135l	28 February 1997	NEW PAGE	
135m	28 February 1997	NEW PAGE	
135n	28 February 1997	NEW PAGE	
135o	28 February 1997	NEW PAGE	
135p	28 February 1997	NEW PAGE	
135q	28 February 1997	NEW PAGE	
135r	28 February 1997	NEW PAGE	
135s	28 February 1997	NEW PAGE	
135t	28 February 1997	NEW PAGE	
135u	28 February 1997	NEW PAGE	
135v	28 February 1997	NEW PAGE	

AMSC N/A AREA HFAC

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
135w	28 February 1997	NEW PAGE	
135x	28 February 1997	NEW PAGE	
136	28 February 1997	136	31 July 1995
137	28 February 1997	137	31 July 1995
138	28 February 1997	138	31 July 1995
139	28 February 1997	139	31 July 1995
140	28 February 1997	140	31 July 1995
141	28 February 1997	141	31 July 1995
142	28 February 1997	142	31 July 1995
143	28 February 1997	143	31 July 1995
144	28 February 1997	144	31 July 1995

2. MAKE THE FOLLOWING PEN AND INK CHANGES:

a. Page 335, Bivariate tables, change "135" to "136".

b. Page 335, Body movements, change "138" to "139".

c. Page 335, Human strength and handling capacity, change "138" to "139".

3. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

4. Holders of MIL-HDBK-759C will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the handbook is completely revised or canceled.

Custodians:
Army - MI
Navy - AS
Air Force - 11
DISA - DC

Preparing activity:
Army - MI
(Project HFAC 0082)

Review activities:
Army - AL, AM, AR, AT, AV, CR, EA, GL, ME, MD, PT, SC, TE, TM
Navy - EC, MC, OS, PE, SH, TD, YD
Air Force - 13, 19
DoD - HS, IQ, WS

Industry associations and professional societies:
AAMI, AIA, ASTM, EIA, HFES, SAE

Civil Agency Coordinating Activities:
NASA - MFSC
DOT - FAA

METRIC

MIL-HDBK-759C
31 JULY 1995
SUPERSEDING
MIL-HDBK-759B
30 October 1991

DEPARTMENT OF DEFENSE HANDBOOK

HUMAN ENGINEERING DESIGN GUIDELINES



This handbook is for guidance only. Do not cite this document as a requirement.

AMSC N/A **AREA HFAC**

SUPERSEDES COVER OF MIL-HDBK-759C

FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense.

2. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

3. This document provides basic guidelines and data on human engineering design for military systems, equipment, and facilities. This handbook has been designed to supplement MIL-STD-1472E. To cue the MIL-STD-1472E user to such supplementary information, this handbook has been formatted to follow the same paragraph numbering, down to the third indenture level, as in MIL-STD-1472E, e.g., paragraph 5.4.5 of both MIL-STD-1472E and this handbook deal with miniature controls. Some paragraphs, necessarily, do not contain any information, but are reserved to accommodate new information that may become available. Additional paragraphs are added to accommodate information that does not appropriately fit elsewhere.

4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Commander, U.S. Army Missile Command, ATTN: AMSMI-RD-SE-TD-ST, Redstone Arsenal, AL 35898-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

SUPERSEDES PAGE ii OF MIL-HDBK-759C

CONTENTS

FIGURE		PAGE
1.	Control-display relationship	16
2.	Scale graduation, pointer position and scale numbering alternatives	26
3.	Fixed-scale azimuth dials	27
4.	Examples of shape- and color-coding	28
5.	Zero position and pointer movement for circular dial displays	30
6.	Aligned pointers for rapid check-reading	31
7.	Relative position of scale marks, numerals and pointers on arc and straight-line scales	32
8.	Selection of dot and segmented matrix characters	48
9.	Digit light counter arrays	50
10.	Drum-type counter arrays	53
11.	Rotating knob separation	78
12.	Keylock mounting criteria	79
13.	Keylock switch criteria	81
14.	Thumbwheel orientation and movement	82
15.	Set screws for control knobs	84
16.	Recommended knob shapes	85
17.	Easily recognizable knob shapes	85
18.	Proper mounting of rapidly operated cranks	87
19.	Multi-function keyset format examples	98
20.	Menu selector types and format examples	99
21.	Toggle switch orientation for ON	105
22.	Location and position of labels	124
23.	Close proximity character height criteria	128
24.	Extended distance character height criteria	129
25.	Label-size hierarchy	131
25a.	Standing body dimensions	135a
25b.	Seated body dimensions	135e
25c.	Depth and breadth dimensions	135i
25d.	Circumferences and surface dimensions	135m
25e.	Hand and foot dimensions	135q
25f.	Head and face dimensions	135u
26.	Range of human motion	140
27.	Standing workspace dimensions	147
28.	Seated workspace dimensions	149
29.	Swing-away seat for short-term operations	151
30.	Mobile workspace dimensions	153
31.	Seated optimum manual control space	156
32.	Guardrail and handrail dimensions	160
33.	Step-ladder dimensions	162
34.	Rung-ladder and ladder-cage dimensions	162
35.	Ramp dimensions	163
36.	Walkway and passageway dimensions	166
37.	Door dimensions	167
38.	Windchill chart	173
39.	Workspace reflectance values	179
40.	Hinged units	190

SUPERSEDES PAGE vii OF MIL-HDBK-759C

CONTENTS

FIGURE		PAGE
41.	Component placement	190
42.	Tube socket orientation	191
43.	Access opening dimensions	197
44.	Covers and accesses	199
45.	Cover and case design examples	201
46.	Fastener examples	206
47.	Use of spring clamps	216
48.	Pull-out, roll-out, and slide-out drawers	220
49.	Fold-out construction for electronic chassis	221
50.	Hinged assemblies	221
51.	Use of maintenance stands	222
52.	Routing cables	223
53.	Cable connections	223
54.	Cable bends	223
55.	Methods for recoiling service loops	225
56.	Cable winder	225
57.	Cable inspection	230
58.	Performed cables	230
59.	Quick-disconnect cable connections	234
60.	Coding of connectors	238
61.	Identifying plugs and receptacles to prevent mismatching	239
62.	Alignment guides and guide pins	241
63.	Equipment removal	241
64.	Use of side-alignment brackets	242
65.	Types of AN connectors	243
66.	Alternate methods for grouping test points	250
67.	Test points on replaceable units	251
68.	Hand-held testers	260
69.	Performance decrement at different ambient temperatures	268
70.	Visible seals	279
71.	Connectors for fluid lines	281
72.	Burn criteria for human skin	294
73.	Door interlock switch	299
74.	Automatic shorting bars	301
75.	Grounding methods	302
76.	Cabinet grounding system	302
77.	Correct instrument-type fuse holder wiring	303
78.	Effects of incline on center of gravity location of equipment	305
79.	Retainers fro floor mounted vertical ammunition and missile ready racks	325
80.	Dimensions guidance for rifles and machine guns	331

SUPERSEDES PAGE viii OF MIL-HDBK-759C

CONTENTS

TABLE		PAGE
1.	Inch-pound equivalents, abbreviations, and prefixes	8
2.	Scale of markings	25
3.	Character sizes for mechanical counters (mm)	51
4.	Control selection criteria	66
5.	Recommended manual controls	67
6.	Conventional control movement stereotypes	69
7.	Knob detent placement	74
8.	Rotary selector controls	75
9.	Representative push button switch applications	89
10.	Push button switches	90
11.	Nominal keyboard characteristics	95
12.	Toggle switches	100
13.	Levers	107
14.	Two-axis controllers for display system applications	113
15.	Foot-operated controls	116
16.	Grip switches	119
16a.	Standing body dimensions	135b
16b.	Seated body dimensions	135f
16c.	Depth and breath dimensions	135j
16d.	Circumferences and surface dimensions	135n
16e.	Hand and foot dimensions	135r
16f.	Head and face dimensions	135v
17.	A bivariate frequency table	137
18.	Range of human motion	141
19.	Standing workplace dimensions	146
20.	Seated workspace dimensions	150
21.	Mobile workspace dimensions	154
22.	Illumination criteria for representative tasks	159
23.	Equivalent chill temperature	175
24.	Brightness ratios	177
25.	Equipment units design checklist	192
26.	Equipment units access checklist	205
27.	Electrical cable coding	226
28.	Hydraulic and pneumatic coding	227
29.	Cable checklist	244
30.	Connector checklist	245
31.	Test points checklist	252
32.	Weight and dimension limits of portable test equipment	259
33.	Test equipment checklist	261
34.	General comparison of fuses and circuit breakers	263
35.	Shock current intensities and their probable effects	298
36.	Constants for predicting COHb blood	309
37.	Noxious exhaust products of engine fuels	310
38.	Safety checklist	313

SUPERSEDES PAGE ix OF MIL-HDBK-759C

This page left intentionally blank.

REPRINTED WITHOUT CHANGE

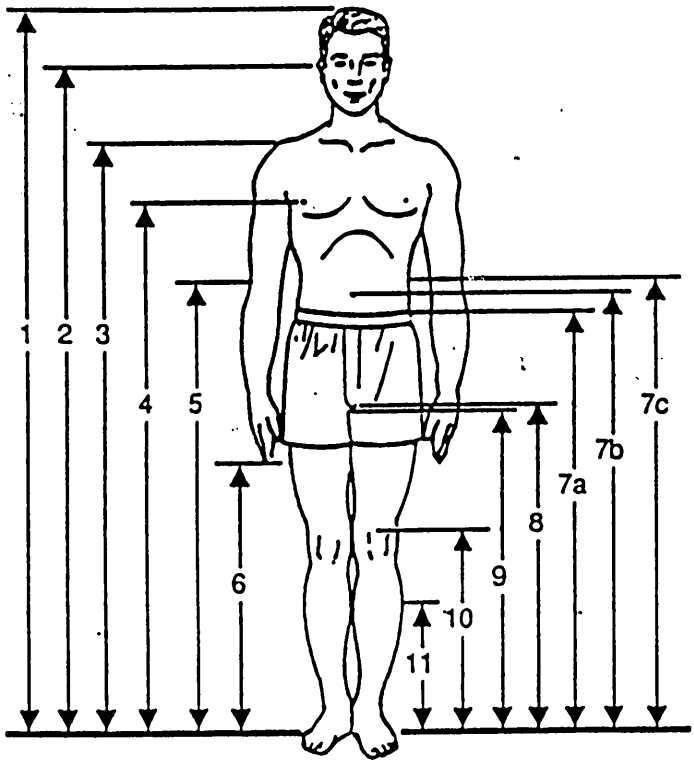
5.6 Anthropometry.

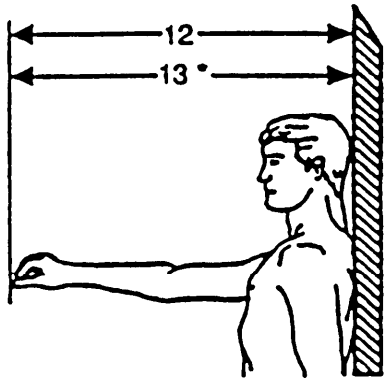
5.6.1 General. In design work, human engineering, or any other application of anthropometric data, measurements of a single body dimension are seldom used alone. Usually, two or more measurements should be considered together. Stature and chest circumference, as well as waist circumference, are utilized in the sizing of many items of clothing, while neck circumference and sleeve length are needed for shirts, and waist circumference and crotch height are required for trousers. Similarly, in human engineering applications, sitting height and functional reach, for example, are used in the design of vehicles and aircraft, while hip breadth, sitting and popliteal height are required for the design of seating.

5.6.2 Anthropometric data. The anthropometric data presented in Tables 25a through 25f and illustrated in Figures 16a through 16f are nude body dimensions; data are given in centimeters, with equivalent values in inches beneath in parentheses. The anthropometric data shown in these tables were compiled and collated from several sources. The data on "General Forces - Male" were compiled from the 1988 Anthropometric Survey of U.S. Army Personnel (ANSUR), the 1966 Anthropometric Survey of U.S. Marines and the 1965 Anthropometric Survey of U.S. Air Force male officers and enlisted personnel. The data on "General Forces - Female" were compiled from the ANSUR and the 1968 Anthropometric Survey of U.S. Air Force female officers and enlisted personnel. The data on "Army Pilots - Male" were compiled from a subset of pilots from the ANSUR data pool. The data on "Army Pilots - Female" were compiled from a subset of women, adjusted to match the demographic distribution of current female Army pilots, from the ANSUR data pool who met the body size requirements for entry in pilot training. The data on "Air Force -Male" were compiled from the 1967 Survey of USAF male rated officers. The data on "Air Force - Female" were compiled from a subset of the 1968 Survey of USAF female officers and enlisted personnel who met the body size requirements for entry into USAF Undergraduate Pilot Training. Data voids and omitted line numbers within these tables represent measurements which were not taken or for data not available.

5.6.2.1 Highly-correlated measurements. In general, height measurements (waist height, crotch height, sitting height) and the lengths of the arms or legs are highly correlated with stature. Circumference measurements or body girths are more likely correlated with weight. Breadth measurements tend to be more highly correlated with weight than with stature.

5.6.2.2 Relationship between measurements. The degree of relationship may be expressed by a correlation coefficient or "r" value. The "r" value describes the degree to which two variables vary together (positive correlation) or vary inversely (negative





*Same as 12: However, right shoulder is extended as far forward as possible while keeping the back of the left shoulder firmly against the back wall.

FIGURE 25a. Standing Body Dimensions

NEW PAGE

TABLE 16a. Standing body dimensions

A. General forces

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
WEIGHT, kgs (lbs)	61.6 (135.8)	46.4 (102.3)	98.1 (216.3)	77.0 (169.8)
1 STATURE	164.5 (64.8)	152.4 (60.0)	187.1 (73.7)	173.7 (68.4)
2 EYE HEIGHT (STANDING)	152.8 (60.2)	141.5 (55.7)	174.3 (68.6)	162.1 (63.8)
3 SHOULDER (ACROMIALE) HEIGHT	134.2 (52.8)	123.0 (48.4)	154.6 (60.9)	143.2 (56.4)
4 CHEST (NIPPLE) HEIGHT *	118.6 (46.7)	108.9 (42.9)	137.3 (54.1)	127.3 (50.1)
5 ELBOW (RADIALE) HEIGHT	102.3 (40.3)	96.1 (37.8)	119.9 (47.2)	111.0 (43.7)
6 FINGERTIP (DACTYLION) HEIGHT	59.1 (23.3)	55.1 (21.7)	72.4 (28.5)	67.0 (26.4)
7a WAIST (ILIOCRISTALE) HEIGHT	95.3 (37.5)	91.1 (35.9)	115.9 (45.6)	107.1 (42.2)
7b WAIST (OMPHALION) HEIGHT	97.7 (38.5)	90.3 (35.6)	114.3 (45.0)	106.5 (41.9)
7c WAIST (NATURAL INDENTATION) HEIGHT	104.3 (41.1)	97.3 (38.3)	121.3 (47.8)	114.3 (45.0)
8 CROTCH HEIGHT	75.3 (29.6)	68.1 (26.8)	91.8 (36.1)	84.6 (33.3)
9 GLUTEAL FURROW HEIGHT	73.6 (29.0)	66.4 (26.1)	89.2 (35.1)	81.7 (32.2)
10 KNEE (MID-PATELLA) HEIGHT	46.1 (18.1)	41.7 (16.4)	55.2 (21.7)	50.3 (19.8)
11 CALF HEIGHT	31.6 (12.4)	27.8 (10.9)	40.6 (16.0)	35.7 (14.1)
12 FUNCTIONAL (THUMBTIP) REACH	71.7 (28.2)	67.7 (26.7)	88.6 (34.9)	80.5 (31.7)
13 FUNCTIONAL REACH, EXTENDED	80.5 (31.7)	73.5 (28.9)	94.2 (37.1)	92.3 (36.3)

*Bustpoint height for women

NEW PAGE

TABLE 16a. Standing body dimensions (continued)

B. Army pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
WEIGHT, kgs (lbs)	64.5 (142.2)	51.2 (112.9)	97.3 (214.5)	81.1 (178.8)
1 STATURE	165.9 (65.3)	160.9 (63.3)	188.4 (74.2)	175.7 (69.2)
2 EYE HEIGHT (STANDING)	153.7 (60.5)	149.9 (59.0)	176.2 (69.4)	164.1 (64.6)
3 SHOULDER (ACROMIALE) HEIGHT	135.7 (53.4)	131.3 (51.7)	155.7 (61.3)	144.4 (56.9)
4 CHEST (NIPPLE) HEIGHT *	119.3 (47.0)	115.1 (45.3)	137.2 (54.0)	128.2 (50.5)
5 ELBOW (RADIALE) HEIGHT	104.8 (41.3)	101.0 (39.8)	120.4 (47.4)	112.7 (44.4)
6 FINGERTIP (DACTYLION) HEIGHT	60.2 (23.7)	58.3 (23.0)	72.0 (28.3)	68.7 (27.0)
7a WAIST (ILIOCRISTALE) HEIGHT	100.0 (39.4)	97.5 (38.4)	116.3 (45.8)	107.7 (42.4)
7b WAIST (OMPHALION) HEIGHT	98.6 (38.8)	96.3 (37.9)	114.9 (45.2)	107.2 (42.2)
7c WAIST (NATURAL INDENTATION) HEIGHT	105.3 (41.5)	102.8 (40.5)	121.4 (47.8)	115.5 (45.5)
8 CROTCH HEIGHT	77.4 (30.5)	75.5 (29.7)	92.1 (36.3)	83.9 (33.0)
9 GLUTEAL FURROW HEIGHT	74.6 (29.4)	72.5 (28.5)	88.7 (34.9)	81.2 (32.0)
10 KNEE (MID-PATELLA) HEIGHT	46.5 (18.3)	44.8 (17.6)	54.8 (21.6)	50.3 (19.8)
11 CALF HEIGHT	31.9 (12.6)	29.3 (11.5)	38.5 (15.2)	35.1 (13.8)
12 FUNCTIONAL (THUMBTIP) REACH	74.0 (29.1)	71.1 (28.0)	86.3 (34.0)	79.7 (31.4)
13 FUNCTIONAL REACH, EXTENDED	80.2 (31.6)	77.4 (30.5)	92.8 (36.6)	86.0 (33.9)

*Bustpoint height for women

NEW PAGE

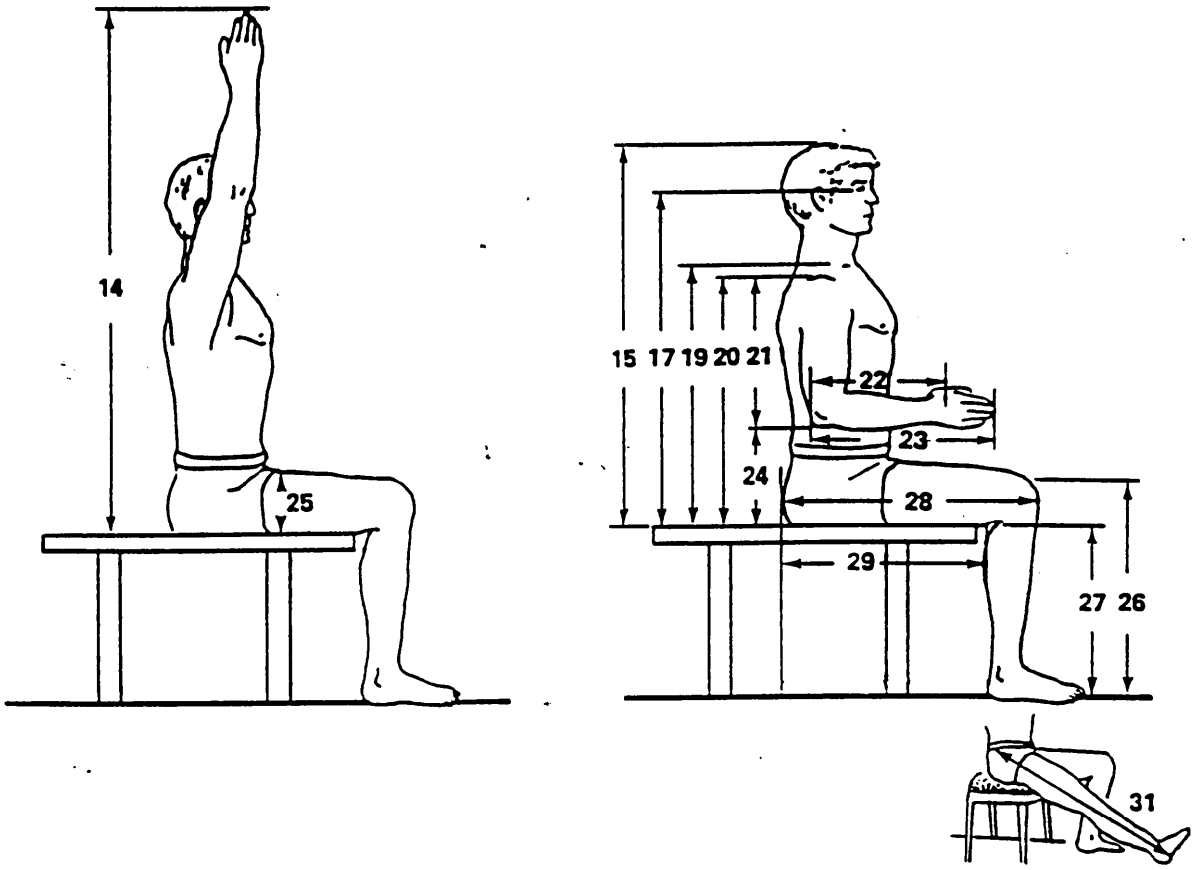
TABLE 16a. Standing body dimensions (concluded)

C. Air Force pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
WEIGHT, kgs (lbs)	63.6 (140.2)	51.0 (112.4)	95.6 (210.8)	67.1 (147.9)
1 STATURE	167.2 (65.8)	163.3 (64.3)	187.7 (73.9)	175.8 (69.2)
3 SHOULDER (ACROMIALE) HEIGHT	135.7 (53.4)	131.6 (51.8)	154.8 (60.9)	143.9 (56.7)
4 CHEST (NIPPLE) HEIGHT *	120.8 (47.6)	117.5 (46.3)	138.1 (54.4)	130.4 (51.3)
5 ELBOW (RADIALE) HEIGHT	104.8 (41.3)		120.0 (47.2)	
6 FINGERTIP (DACTYLION) HEIGHT	61.5 (24.2)		73.2 (28.8)	
7a WAIST (ILIOCRISTALE) HEIGHT	101.3 (39.9)		117.2 (46.1)	
7b WAIST (OMPHALION) HEIGHT	98.7 (38.9)		114.3 (45.0)	
7c WAIST (NATURAL INDENTATION) HEIGHT		99.3 (39.1)		110.5 (43.5)
8 CROTCH HEIGHT	78.3 (30.8)	72.6 (28.6)	92.0 (36.2)	83.4 (32.8)
9 GLUTEAL FURROW HEIGHT	74.6 (29.4)	70.4 (27.7)	87.9 (34.6)	81.5 (32.1)
10 KNEE (MID-PATELLA) HEIGHT	45.7 (18.0)		53.9 (21.2)	
11 CALF HEIGHT	32.0 (12.6)		39.3 (15.5)	
12 FUNCTIONAL (THUMBTIP) REACH	73.9 (29.1)	71.1 (28.0)	87.0 (34.3)	81.9 (32.2)
13 FUNCTIONAL REACH, EXTENDED	82.3 (32.4)	79.8 (31.4)	97.3 (38.3)	94.0 (37.0)

*Bustpoint height for women

NEW PAGE



Dimension 16 - Sitting eye height (relaxed) is not shown on figure.

Dimension 30 - not used

FIGURE 25b. Seated body dimensions

NEW PAGE

TABLE 16b. Seated body dimensions

A. General forces

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
14 VERTICAL ARM REACH, SITTING	128.6 (50.6)	123.3 (48.5)	153.2 (60.3)	141.8 (55.8)
15 SITTING HEIGHT, ERECT	85.2 (33.5)	79.5 (31.3)	97.2 (38.3)	91.0 (35.8)
16 SITTING HEIGHT, RELAXED		78.9 (31.1)		89.7 (35.3)
17 EYE HEIGHT SITTING, ERECT	72.9 (28.7)	68.5 (27.0)	85.2 (33.5)	79.4 (31.3)
19 MID-SHOULDER HEIGHT	57.2 (22.5)	53.9 (21.2)	68.6 (27.0)	63.1 (24.8)
20 SHOULDER HEIGHT, SITTING	54.9 (21.6)	50.9 (20.0)	64.6 (25.4)	60.4 (23.8)
21 SHOULDER-ELBOW LENGTH	34.0 (13.4)	28.3 (11.1)	40.2 (15.8)	36.5 (14.4)
22 ELBOW-GRIP LENGTH	33.2 (13.1)	30.0 (11.8)	39.1 (15.4)	35.8 (14.1)
23 ELBOW-FINGERTIP LENGTH	44.4 (17.5)	40.6 (16.0)	52.4 (20.6)	48.3 (19.0)
24 ELBOW REST HEIGHT	18.4 (7.2)	17.6 (6.9)	28.6 (11.3)	26.9 (10.6)
25 THIGH CLEARANCE HEIGHT	13.7 (5.4)	10.4 (4.1)	19.0 (7.5)	18.0 (7.1)
26 KNEE HEIGHT, SITTING	50.0 (19.7)	47.4 (18.7)	60.6 (23.9)	56.0 (22.0)
27 POPLITEAL HEIGHT	39.5 (15.6)	35.1 (13.8)	50.0 (19.7)	44.1 (17.4)
28 BUTTOCK-KNEE LENGTH	55.2 (21.7)	53.2 (20.9)	66.7 (26.3)	64.0 (25.2)
29 BUTTOCK-POPLITEAL LENGTH	45.6 (18.0)	43.5 (17.1)	54.6 (21.5)	52.8 (20.8)
31 FUNCTIONAL LEG LENGTH	100.2 (39.4)	93.3 (36.7)	116.9 (46.0)	109.4 (43.1)

NEW PAGE

TABLE 16b. Seated body dimensions (continued)

B. Army pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
14 VERTICAL ARM REACH, SITTING	135.0 (53.1)	129.7 (51.1)	153.8 (60.6)	143.3 (56.4)
15 SITTING HEIGHT, ERECT	87.1 (34.3)	83.7 (33.0)	98.1 (38.6)	92.7 (36.5)
17 EYE HEIGHT SITTING, ERECT	75.3 (29.6)	72.2 (28.4)	86.1 (33.9)	81.2 (32.0)
19 MID-SHOULDER HEIGHT	59.7 (23.5)	57.0 (22.4)	68.5 (27.0)	64.5 (25.4)
20 SHOULDER HEIGHT, SITTING	56.4 (22.2)	54.1 (21.3)	65.6 (25.8)	61.9 (24.4)
21 SHOULDER-ELBOW LENGTH	34.3 (13.5)	33.0 (13.0)	40.0 (15.7)	36.8 (14.5)
22 ELBOW-GRIP LENGTH	33.3 (13.1)	31.6 (12.4)	38.5 (15.2)	35.5 (14.0)
23 ELBOW-FINGERTIP LENGTH	45.1 (17.8)	43.1 (17.0)	51.8 (20.4)	47.6 (18.7)
24 ELBOW REST HEIGHT	19.9 (7.8)	19.7 (7.8)	28.4 (11.2)	26.6 (10.5)
25 THIGH CLEARANCE HEIGHT	14.9 (5.9)	14.1 (5.6)	18.7 (7.4)	18.1 (7.1)
26 KNEE HEIGHT, SITTING	51.9 (20.4)	50.3 (19.8)	60.6 (23.9)	56.0 (22.0)
27 POPLITEAL HEIGHT	39.6 (15.6)	37.7 (14.8)	47.5 (18.7)	42.8 (16.9)
28 BUTTOCK-KNEE LENGTH	57.7 (22.7)	56.8 (22.4)	66.5 (26.2)	63.6 (25.0)
29 BUTTOCK-POPLITEAL LENGTH	46.3 (18.2)	46.3 (18.2)	55.0 (21.7)	52.3 (20.6)
31 FUNCTIONAL LEG LENGTH	100.9 (39.7)	99.1 (39.0)	117.1 (46.1)	109.8 (43.2)

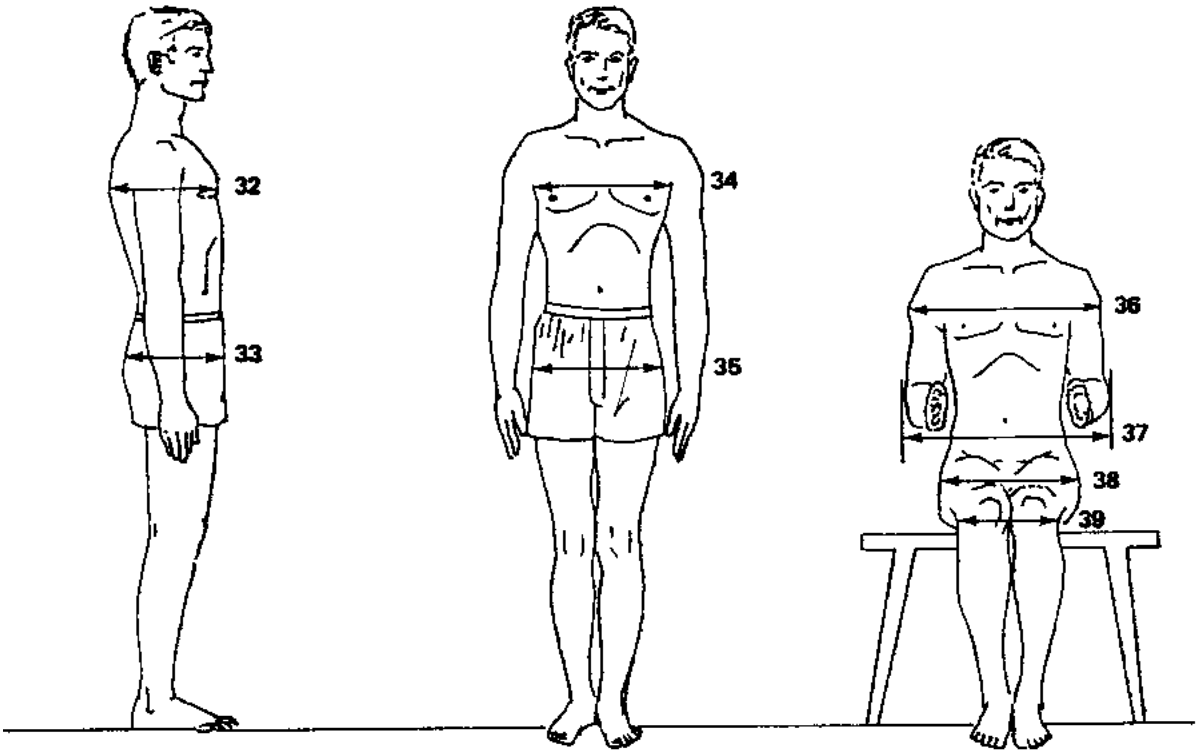
NEW PAGE

TABLE 16b. Seated body dimensions (concluded)

C. Air Force pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
15 SITTING HEIGHT, ERECT	88.1 (34.7)	86.6 (34.1)	98.6 (38.8)	90.9 (35.8)
16 SITTING HEIGHT, RELAXED		84.9 (33.4)		89.7 (35.9)
17 EYE HEIGHT SITTING, ERECT	76.2 (30.0)	73.5 (28.9)	86.1 (33.9)	80.2 (31.6)
19 MID-SHOULDER HEIGHT	60.2 (23.7)	57.5 (22.6)	69.2 (27.2)	63.7 (25.1)
20 SHOULDER HEIGHT, SITTING	56.5 (22.2)		65.9 (25.9)	
21 SHOULDER-ELBOW LENGTH	33.2 (13.1)		38.8 (15.3)	
22 ELBOW-GRIP LENGTH	32.6 (12.8)		37.9 (14.9)	
24 ELBOW REST HEIGHT	20.9 (8.2)	20.3 (8.0)	29.5 (11.6)	27.8 (10.9)
25 THIGH CLEARANCE HEIGHT	14.3 (5.6)	10.7 (4.2)	18.8 (7.4)	14.5 (5.7)
26 KNEE HEIGHT, SITTING	51.7 (20.4)		59.9 (23.6)	
27 POPLITEAL HEIGHT	40.1 (15.8)	39.9 (15.7)	47.5 (18.7)	45.2 (17.8)
28 BUTTOCK-KNEE LENGTH	56.1 (22.1)	55.7 (21.9)	65.0 (25.6)	62.5 (24.6)
29 BUTTOCK-POPLITEAL LENGTH	46.1 (18.1)	45.2 (17.8)	54.6 (21.5)	53.2 (20.9)

NEW PAGE



Dimension 39 — not used

FIGURE 25c. Depth and breadth dimensions

NEW PAGE

TABLE 16c. Depth and breadth dimensions (concluded)

A. General forces

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
32 CHEST DEPTH*	20.4 (8.0)	20.9 (8.2)	28.0 (11.0)	27.8 (10.9)
33 BUTTOCK DEPTH	21.2 (8.3)	18.4 (7.2)	28.6 (11.3)	26.5 (10.4)
34 CHEST BREADTH	27.8 (10.9)	25.0 (9.8)	36.7 (14.4)	31.5 (12.4)
35 HIP BREADTH, STANDING	30.5 (12.0)	30.8 (12.1)	38.3 (15.1)	38.8 (15.3)
36 SHOULDER (BIDELTOID) BREADTH	41.8 (16.5)	38.2 (15.0)	53.5 (21.1)	47.2 (18.6)
37 FOREARM-FOREARM BREADTH	47.7 (18.8)	41.5 (16.3)	62.1 (24.4)	52.8 (20.8)
38 HIP BREADTH, SITTING	31.1 (12.2)	33.8 (13.3)	41.3 (16.3)	43.3 (17.0)

B. Army pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
32 CHEST DEPTH	21.7 (8.5)	20.7 (8.1)	28.4 (11.2)	28.2 (11.1)
33 BUTTOCK DEPTH	21.6 (8.5)	19.5 (7.7)	27.7 (10.9)	27.5 (10.8)
34 CHEST BREADTH	29.7 (11.7)	25.7 (10.1)	36.8 (14.5)	32.2 (12.7)
35 HIP BREADTH, STANDING	32.2 (12.7)	31.9 (12.6)	38.0 (15.0)	39.2 (15.4)
36 SHOULDER (BIDELTOID) BREADTH	46.0 (18.1)	40.3 (15.9)	53.4 (21.0)	47.6 (18.7)
37 FOREARM-FOREARM BREADTH	49.2 (19.4)	42.4 (16.7)	62.3 (24.5)	54.2 (21.3)
38 HIP BREADTH, SITTING	33.8 (13.3)	35.5 (14.0)	41.0 (16.1)	44.6 (17.6)

* Bust depth for women

NEW PAGE

TABLE 16c. Depth and breadth dimensions (concluded)

C. Air Force pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
32 CHEST DEPTH	21.3 (8.4)	20.9 (8.2)	27.7 (10.9)	26.1 (10.3)
33 BUTTOCK DEPTH	20.7 (8.1)	18.8 (7.4)	27.5 (10.8)	23.3 (9.2)
34 CHEST BREADTH	29.5 (11.6)	25.6 (10.1)	36.5 (14.4)	30.7 (12.1)
35 HIP BREADTH, STANDING	32.3 (12.7)	32.5 (12.8)	38.5 (15.2)	38.2 (15.0)
36 SHOULDER (BIDELTOID) BREADTH	44.1 (17.4)	38.8 (15.3)	52.6 (20.7)	45.0 (17.7)
37 FOREARM-FOREARM BREADTH	48.2 (19.0)		60.7 (23.9)	
38 HIP BREADTH, SITTING	34.2 (13.5)	34.5 (13.6)	41.8 (16.5)	41.9 (16.5)

NEW PAGE

This page left intentionally blank.

NEW PAGE

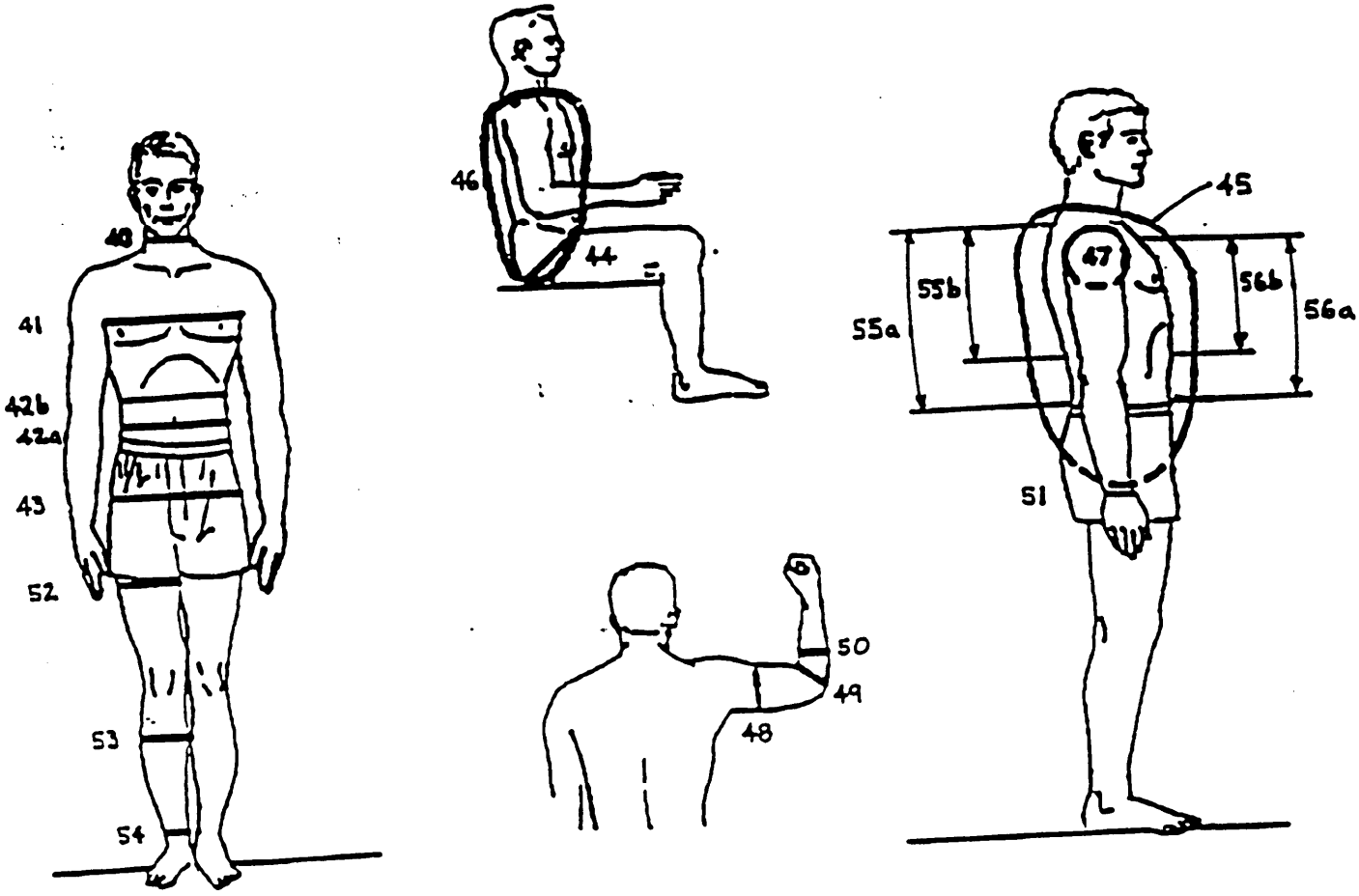


FIGURE 25d. Circumferences and surfaces dimensions

NEW PAGE

TABLE 16d. Circumferences and surface dimensions

A. General forces

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
40 NECK CIRCUMFERENCE	34.7 (13.7)	29.2 (11.5)	41.6 (16.4)	36.7 (14.4)
41 CHEST CIRCUMFERENCE*	85.5 (33.7)	81.4 (32.0)	111.3 (43.8)	102.2 (40.2)
42a WAIST CIRCUMFERENCE (OMPHALION)	70.2 (27.6)	67.6 (26.6)	101.6 (40.0)	94.6 (37.2)
42b WAIST CIRCUMFERENCE (NATURAL INDENTATION)	71.9 (28.3)	59.5 (23.4)	98.4 (38.7)	84.3 (33.2)
43 HIP (BUTTOCK) CIRCUMFERENCE, STANDING	86.7 (34.1)	85.8 (33.8)	109.0 (42.9)	107.0 (42.1)
45 VERTICAL TRUNK CIRCUM-FERENCE, STANDING	150.6 (59.3)	142.0 (55.9)	180.7 (71.1)	166.3 (65.5)
47 ARM SCYE CIRCUMFERENCE	39.9 (15.7)	33.6 (13.2)	49.8 (19.6)	41.2 (16.2)
48 BICEPS CIRCUMFERENCE, FLEXED	27.7 (10.9)	23.3 (9.2)	38.5 (15.2)	32.1 (12.6)
49 ELBOW CIRCUMFERENCE, FLEXED	25.3 (10.0)	21.8 (8.6)	35.0 (13.8)	30.0 (11.8)
50 FOREARM CIRCUMFERENCE, FLEXED	26.5 (10.4)	23.0 (9.1)	33.6 (13.2)	27.9 (11.0)
51 WRIST CIRCUMFERENCE	15.7 (6.2)	13.8 (5.4)	18.8 (7.4)	16.3 (6.4)
52 UPPER THIGH CIRCUMFERENCE	49.1 (19.3)	48.7 (19.2)	67.9 (26.7)	65.7 (25.9)
53 CALF CIRCUMFERENCE	32.7 (12.9)	31.5 (12.4)	42.1 (16.6)	39.1 (15.4)
54 ANKLE CIRCUMFERENCE	20.0 (7.9)	18.6 (7.3)	25.0 (9.8)	23.3 (9.2)
55a WAIST (OMPHALION) - BACK LENGTH	43.5 (17.1)	40.4 (15.9)	52.3 (20.6)	48.5 (19.1)
55b WAIST (NATURAL INDENTATION) - BACK LENGTH	37.4 (14.7)	32.7 (12.9)	45.1 (17.8)	44.3 (17.4)
56a WAIST (OMPHALION) - FRONT LENGTH	35.9 (14.1)	35.5 (14.0)	45.7 (18.0)	42.8 (16.9)
56b WAIST (NATURAL INDENTATION) - FRONT LENGTH	31.0 (12.2)	27.5 (10.8)	38.1 (15.0)	36.9 (14.5)

*Bust circumference for women

NEW PAGE

TABLE 16d. Circumferences and surface dimensions (continued)

B. Army pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
40 NECK CIRCUMFERENCE	35.2 (13.9)	29.3 (11.5)	41.2 (16.2)	34.5 (13.6)
41 CHEST CIRCUMFERENCE*	91.6 (36.1)	82.3 (32.4)	111.0 (43.7)	103.5 (40.7)
42a WAIST CIRCUMFERENCE (OMPHALION)	76.7 (30.2)	68.7 (27.0)	101.7 (40.0)	97.9 (38.5)
42b WAIST CIRCUMFERENCE (NATURAL INDENTATION)	75.3 (29.6)	64.7 (25.5)	96.7 (38.1)	87.6 (34.5)
43 HIP (BUTTOCK) CIRCUMFERENCE, STANDING	90.5 (35.6)	88.7 (34.9)	109.4 (43.1)	109.4 (43.1)
45 VERTICAL TRUNK CIRCUM-FERENCE, STANDING	154.5 (60.8)	147.8 (58.2)	177.2 (69.8)	168.5 (66.3)
47 ARM SCYE CIRCUMFERENCE	40.8 (16.1)	34.5 (13.6)	48.5 (19.1)	42.2 (16.6)
48 BICEPS CIRCUMFERENCE, FLEXED	29.9 (11.8)	24.7 (9.7)	37.5 (14.8)	32.7 (12.9)
49 ELBOW CIRCUMFERENCE, FLEXED	25.4 (10.0)	22.3 (8.8)	30.1 (11.9)	26.5 (10.4)
50 FOREARM CIRCUMFERENCE, FLEXED	27.3 (10.7)	23.1 (9.1)	32.9 (13.0)	28.0 (11.0)
51 WRIST CIRCUMFERENCE	16.2 (6.4)	14.4 (5.7)	18.6 (7.3)	16.3 (6.4)
52 UPPER THIGH CIRCUMFERENCE	52.5 (20.7)	51.4 (20.2)	66.7 (26.3)	67.5 (26.6)
53 CALF CIRCUMFERENCE	34.2 (13.5)	32.0 (12.6)	41.6 (16.4)	39.6 (15.6)
54 ANKLE CIRCUMFERENCE	20.2 (8.0)	19.1 (7.5)	24.3 (9.6)	22.8 (9.0)
55a WAIST (OMPHALION) - BACK LENGTH	44.7 (17.6)	42.5 (16.7)	52.8 (20.8)	49.7 (19.6)
55b WAIST (NATURAL INDENTATION) - BACK LENGTH	38.7 (15.2)	34.8 (13.7)	45.7 (18.0)	42.2 (16.6)
56a WAIST (OMPHALION) - FRONT LENGTH	38.4 (15.1)	37.0 (14.6)	45.6 (18.0)	44.4 (17.5)
56b WAIST (NATURAL INDENTATION) - FRONT LENGTH	32.0 (12.6)	29.1 (11.5)	38.5 (15.2)	36.6 (14.4)

*Bust circumference for women

NEW PAGE

TABLE 16d. Circumferences and surface dimensions (concluded)

C. Air Force pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
40 NECK CIRCUMFERENCE	34.9 (13.7)	31.6 (12.4)	41.6 (16.4)	36.5 (14.4)
41 CHEST CIRCUMFERENCE*	88.6 (34.9)	82.7 (32.6)	109.4 (43.1)	96.1 (37.8)
42a WAIST CIRCUMFERENCE (OMPHALION)	75.7 (29.8)		100.1 (39.4)	
42b WAIST CIRCUMFERENCE (NATURAL INDENTATION)		60.8 (23.9)		73.0 (28.7)
43 HIP (BUTTOCK) CIRCUMFERENCE, STANDING	89.7 (35.3)	88.7 (34.9)	107.9 (42.5)	102.7 (40.4)
44 HIP (BUTTOCK) CIRCUMFERENCE, SITTING	97.1 (38.2)	93.9 (37.0)	119.3 (47.0)	107.4 (42.3)
45 VERTICAL TRUNK CIRCUMFERENCE, STANDING	156.7 (61.7)	150.6 (59.3)	180.2 (70.9)	166.0 (65.4)
46 VERTICAL TRUNK CIRCUMFERENCE, SITTING	150.4 (59.2)	147.6 (58.1)	173.2 (68.2)	161.8 (63.7)
47 ARM SCYE CIRCUMFERENCE	43.8 (17.2)	34.3 (13.5)	53.0 (20.9)	40.4 (15.9)
48 BICEPS CIRCUMFERENCE, FLEXED	29.1 (11.5)	23.6 (9.3)	36.6 (14.4)	29.1 (11.5)
49 ELBOW CIRCUMFERENCE, FLEXED	28.5 (11.2)	25.0 (9.8)	34.2 (13.5)	30.1 (11.9)
50 FOREARM CIRCUMFERENCE, FLEXED	27.2 (10.7)	23.0 (9.1)	32.4 (12.8)	27.1 (10.7)
51 WRIST CIRCUMFERENCE	16.2 (6.4)	14.2 (5.6)	19.2 (7.6)	16.3 (6.4)
52 UPPER THIGH CIRCUMFERENCE	51.5 (20.3)	49.5 (19.5)	66.2 (26.1)	60.8 (23.9)
53 CALF CIRCUMFERENCE	33.5 (13.2)	31.2 (12.3)	41.0 (16.1)	37.4 (14.7)
54 ANKLE CIRCUMFERENCE	20.4 (8.0)	19.7 (7.8)	24.6 (9.7)	23.5 (9.3)
55a WAIST (OMPHALION) - BACK LENGTH	43.1 (17.0)	39.3 (15.5)	50.9 (20.0)	45.4 (17.9)
56a WAIST (OMPHALION) - FRONT LENGTH	36.9 (14.5)	31.6 (12.4)	44.2 (17.4)	37.7 (14.8)

*Bust circumference for women

NEW PAGE

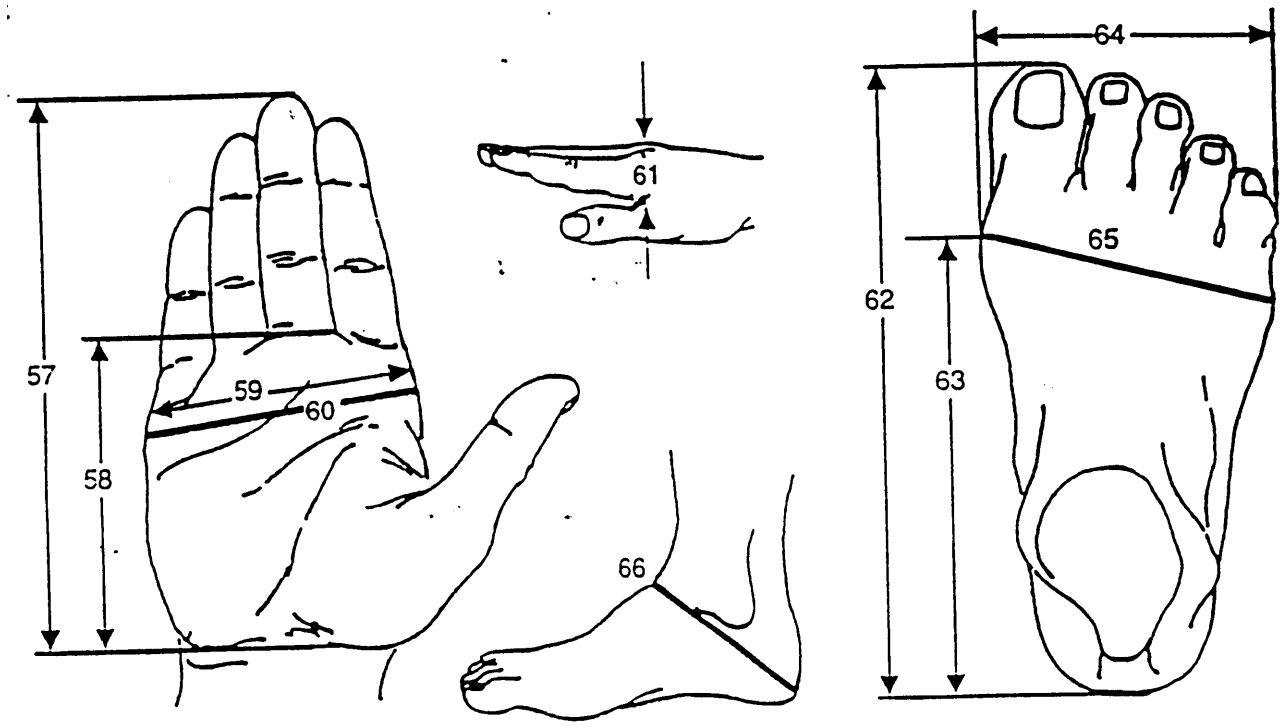


FIGURE 25e. Hand and foot dimensions

NEW PAGE

TABLE 16e. Hand and foot dimensions

A. General forces

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
57 HAND LENGTH	17.5 (6.9)	16.5 (6.5)	21.1 (8.3)	20.1 (7.9)
58 PALM LENGTH*	9.6 (3.8)	9.0 (3.5)	11.7 (4.6)	10.8 (4.3)
59 HAND BREADTH	8.2 (3.2)	6.9 (2.7)	9.8 (3.9)	8.6 (3.4)
60 HAND CIRCUMFERENCE	19.9 (7.8)	16.8 (6.6)	23.5 (9.3)	20.0 (7.9)
62 FOOT LENGTH	24.6 (9.7)	22.2 (8.7)	29.2 (11.5)	26.5 (10.4)
63 INSTEP LENGTH	17.9 (7.0)	16.4 (6.5)	21.4 (8.4)	19.5 (7.7)
64 FOOT BREADTH	9.0 (3.5)	8.0 (3.1)	11.0 (4.3)	9.8 (3.9)
65 FOOT CIRCUMFERENCE	22.9 (9.0)	20.5 (8.1)	27.3 (10.7)	24.2 (9.5)
66 HEEL-ANKLE CIRCUMFERENCE	31.3 (12.3)	28.1 (11.1)	36.9 (14.5)	33.0 (13.0)

* Data for males were compiled from the 1966 survey of U.S. Army Men, the 1966 survey of U.S. Marines, and the 1965 survey of U.S. Air Force Men. Data for females were complied from the 1977 survey of U.S. Army Women and the 1968 survey of U.S. Air Force Women.

B. Army pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
57 HAND LENGTH	18.1 (7.1)	17.2 (6.8)	20.9 (8.2)	19.5 (7.7)
59 HAND BREADTH	8.4 (3.3)	7.5 (3.0)	9.7 (3.8)	8.6 (3.4)
60 HAND CIRCUMFERENCE	19.9 (7.8)	17.6 (6.9)	22.8 (9.0)	20.1 (7.9)
62 FOOT LENGTH	25.0 (9.8)	23.2 (9.1)	28.9 (11.4)	26.5 (10.4)
63 INSTEP LENGTH	18.2 (7.2)	17.0 (6.7)	21.4 (8.4)	19.6 (7.7)
64 FOOT BREADTH	9.2 (3.6)	8.4 (3.3)	10.8 (4.3)	9.8 (3.9)
65 FOOT CIRCUMFERENCE	23.1 (9.1)	21.0 (8.3)	26.9 (10.6)	24.4 (9.6)
66 HEEL-ANKLE CIRCUMFERENCE	31.3 (12.3)	28.9 (11.4)	36.4 (14.3)	32.7 (12.9)

NEW PAGE
Supersedes page 139 of 14 March 1989

TABLE 16e. Hand and foot dimensions (concluded)

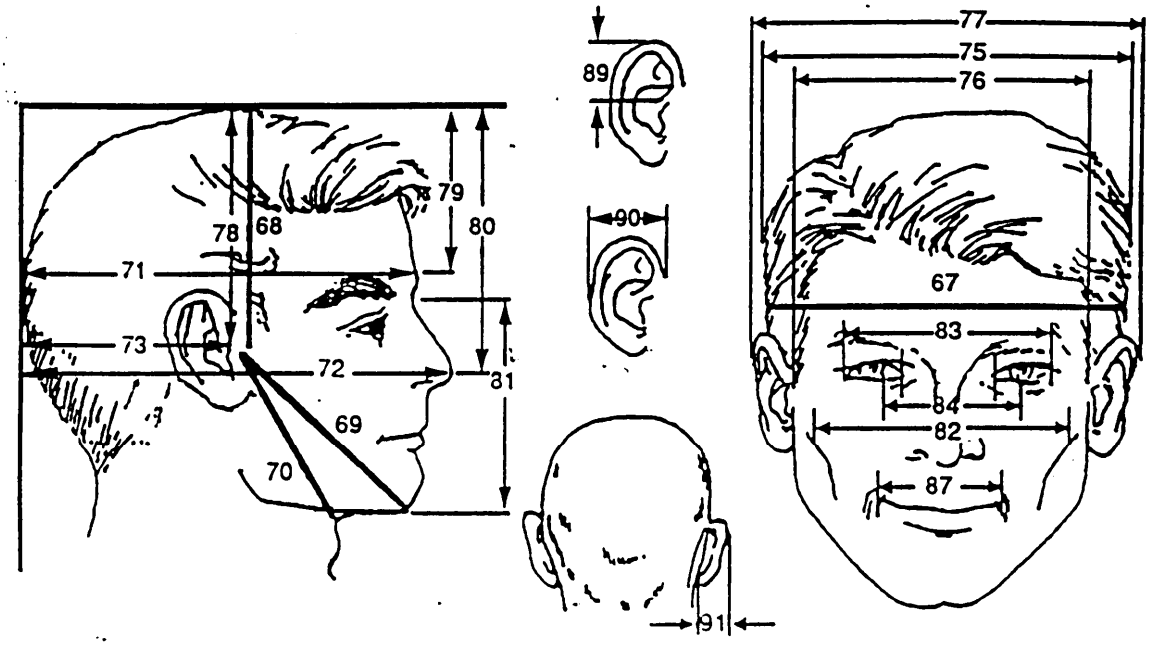
C. Air Force pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
57 HAND LENGTH	17.8 (7.0)	17.6 (6.9)	20.5 (8.1)	20.4 (8.0)
58 PALM LENGTH	10.0 (3.9)		11.8 (4.6)	
59 HAND BREADTH	8.2 (3.2)	7.1 (2.8)	9.6 (3.8)	8.3 (3.3)
60 HAND CIRCUMFERENCE	20.0 (7.9)	17.2 (6.8)	23.1 (9.1)	19.9 (7.8)
61 HAND THICKNESS	2.4 (0.9)		3.1 (1.2)	
62 FOOT LENGTH	25.1 (9.9)	23.2 (9.1)	29.0 (11.4)	26.3 (10.4)
63 INSTEP LENGTH	18.3 (7.2)		21.4 (8.4)	
64 FOOT BREADTH	9.0 (3.5)	8.2 (3.2)	10.6 (4.2)	9.9 (3.9)
65 FOOT CIRCUMFERENCE	22.9 (9.0)		27.0 (10.6)	
66 HEEL-ANKLE CIRCUMFERENCE	31.7 (12.5)		36.3 (14.3)	

NEW PAGE

This page left intentionally blank.

NEW PAGE



Dimension 74 - not used

Dimension 85 - not used

Dimension 86 - not used

Dimension 88 - not used

FIGURE 25f. Head and face dimensions

NEW PAGE

TABLE 16f. Head and face dimensions

A. General forces

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
67 HEAD CIRCUMFERENCE	53.6 (21.1)	52.3 (20.6)	59.7 (23.5)	57.6 (22.7)
68 BITRAGION-CORONAL CURVATURE	33.2 (13.1)	31.6 (12.4)	38.0 (15.0)	36.3 (14.3)
69 BITRAGION-MENTON CURVATURE	30.4 (12.0)	28.2 (11.1)	34.8 (13.7)	32.6 (12.8)
70 BITRAGION-SUBMANDIBULAR CURVATURE	27.8 (10.9)	25.6 (10.1)	33.0 (13.0)	29.7 (11.7)
71 HEAD LENGTH	18.3 (7.2)	17.3 (6.8)	21.0 (8.3)	19.8 (7.8)
72 PRONASALE TO WALL	20.5 (8.1)	19.7 (7.8)	23.6 (9.3)	22.9 (9.0)
73 TRAGION TO WALL	8.6 (3.4)	8.6 (3.4)	12.6 (5.0)	11.8 (4.6)
75 HEAD BREADTH	14.3 (5.6)	13.5 (5.3)	16.5 (6.5)	15.5 (6.1)
76 BITRAGION BREADTH	12.6 (5.0)	12.1 (4.8)	15.5 (6.1)	14.5 (5.7)
77 BIAURICULAR BREADTH	17.4 (6.9)	14.2 (5.6)	21.0 (8.3)	19.5 (7.7)
78 HEAD HEIGHT (TRAGION TO TOP OF HEAD)	12.1 (4.8)	11.3 (4.4)	14.5 (5.7)	14.1 (5.6)
79 GLABELLA TO TOP OF HEAD	7.6 (3.3)	7.7 (3.0)	10.8 (4.3)	10.0 (3.9)
80 PRONASALE TO TOP OF HEAD	13.8 (5.4)	12.8 (5.0)	16.6 (6.5)	16.8 (6.6)
81 FACE LENGTH (MENTON-SELLION)	10.7 (4.2)	9.6 (3.8)	13.3 (5.2)	12.4 (4.9)
82 FACE (BIZYGOMATIC) BREADTH	13.1 (5.2)	11.9 (4.7)	15.0 (5.9)	14.0 (5.5)
83 BIOCULAR BREADTH	11.3 (4.4)	11.1 (4.4)	13.1 (5.2)	12.9 (5.1)
84 INTERPUPILLARY BREADTH	5.4 (2.1)	5.1 (2.0)	7.1 (2.8)	6.9 (2.7)
87 LIP LENGTH (MOUTH BREADTH)	4.4 (1.7)	3.7 (1.5)	6.3 (2.5)	6.2 (2.4)
89 EAR LENGTH ABOVE TRAGION	2.5 (1.0)	2.5 (1.0)	3.6 (1.4)	3.3 (1.3)
90 EAR BREADTH	3.2 (1.3)	2.4 (0.9)	4.2 (1.7)	3.9 (1.5)
91 EAR PROTRUSION	1.7 (0.7)	1.7 (0.7)	3.0 (1.2)	2.7 (1.1)

NEW PAGE

TABLE 16f. Head and face dimensions (continued)

B. Army pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
67 HEAD CIRCUMFERENCE	54.8 (21.6)	52.6 (20.7)	59.2 (23.3)	56.8 (22.4)
68 BITRAGION-CORONAL CURVATURE	33.3 (13.1)	31.7 (12.5)	37.3 (14.7)	35.8 (14.1)
69 BITRAGION-MENTON CURVATURE	31.0 (12.2)	28.3 (11.1)	34.9 (13.7)	32.0 (12.6)
70 BITRAGION-SUBMANDIBULAR CURVATURE	28.8 (11.3)	25.8 (10.2)	33.1 (13.0)	29.9 (11.8)
71 HEAD LENGTH	18.8 (7.4)	17.6 (6.9)	20.9 (8.2)	19.8 (7.8)
72 PRONASALE TO WALL	20.9 (8.2)	19.9 (7.8)	23.2 (9.1)	22.3 (8.8)
73 TRAGION TO WALL	9.1 (3.6)	8.8 (3.5)	10.8 (4.3)	10.6 (4.2)
75 HEAD BREADTH	14.5 (5.7)	13.8 (5.4)	16.3 (6.4)	15.3 (6.0)
76 BITRAGION BREADTH	13.5 (5.3)	12.8 (5.0)	15.4 (6.1)	14.5 (5.7)
77 BIAURICULAR BREADTH	17.9 (7.0)	16.7 (6.6)	21.1 (8.3)	19.7 (7.8)
78 HEAD HEIGHT (TRAGION TO TOP OF HEAD)	12.1 (4.8)	11.6 (4.6)	13.9 (5.5)	13.5 (5.3)
79 GLABELLA TO TOP OF HEAD	8.6 (3.4)	7.8 (3.1)	10.8 (4.3)	10.1 (4.0)
80 PRONASALE TO TOP OF HEAD	14.0 (5.5)	13.1 (5.2)	16.5 (6.5)	15.8 (6.2)
81 FACE LENGTH (MENTON-SELLION)	11.2 (4.4)	10.5 (4.1)	13.2 (5.2)	12.5 (4.9)
82 FACE (BIZYGOMATIC) BREADTH	13.3 (5.2)	12.3 (4.8)	15.1 (5.9)	14.0 (5.5)
83 BIOCULAR BREADTH	11.4 (4.5)	11.0 (4.3)	13.0 (5.1)	12.7 (5.0)
84 INTERPUPILLARY BREADTH	5.9 (2.3)	5.6 (2.2)	7.0 (2.8)	6.6 (2.6)
87 LIP LENGTH (MOUTH BREADTH)	5.1 (2.0)	4.8 (1.9)	6.3 (2.5)	6.0 (2.4)
89 EAR LENGTH ABOVE TRAGION	2.8 (1.1)	2.6 (1.0)	3.6 (1.4)	3.3 (1.3)
90 EAR BREADTH	3.4 (1.3)	3.1 (1.2)	4.2 (1.7)	3.9 (1.5)
91 EAR PROTRUSION	2.0 (0.8)	1.7 (0.7)	3.0 (1.2)	2.8 (1.1)

NEW PAGE

TABLE 16f. Head and face dimensions (continued)

C. Air Force pilots

Percentile Values in Centimeters (Inch Equivalents in Parentheses)				
	5th Percentile		95th Percentile	
	Male	Female	Male	Female
67 HEAD CIRCUMFERENCE	55.2 (21.7)	52.9 (20.8)	59.9 (23.6)	57.9 (22.8)
68 BITRAGION-CORONAL CURVATURE	33.7 (13.3)	32.0 (12.6)	37.9 (14.9)	36.7 (14.4)
69 BITRAGION-MENTON CURVATURE	30.6 (12.0)		34.7 (13.7)	
70 BITRAGION-SUBMANDIBULAR CURVATURE	28.4 (11.2)		33.6 (13.2)	
71 HEAD LENGTH	18.8 (7.4)	17.5 (6.9)	21.0 (8.3)	19.7 (7.8)
72 PRONASALE TO WALL	21.4 (8.4)	20.0 (7.9)	23.9 (9.4)	23.0 (9.1)
73 TRAGION TO WALL	9.3 (3.7)	9.0 (3.5)	11.4 (4.5)	11.9 (4.7)
75 HEAD BREADTH	14.8 (5.7)	13.6 (5.4)	16.5 (6.5)	15.5 (6.1)
76 BITRAGION BREADTH	13.4 (5.3)	12.2 (4.8)	15.2 (6.0)	13.8 (5.4)
77 BIAURICULAR BREADTH	17.5 (6.9)	14.4 (5.7)	20.2 (8.0)	17.5 (6.9)
78 HEAD HEIGHT (TRAGION TO TOP OF HEAD)	12.4 (4.9)	11.7 (4.6)	14.5 (5.7)	14.2 (5.6)
79 GLABELLA TO TOP OF HEAD	7.7 (3.0)		10.9 (4.3)	
80 PRONASALE TO TOP OF HEAD	13.0 (5.1)	13.3 (5.2)	16.6 (6.5)	17.1 (6.7)
81 FACE LENGTH (MENTON-SELLION)	11.0 (4.3)	9.8 (3.9)	13.0 (5.1)	11.8 (4.6)
82 FACE (BIZYGOMATIC) BREADTH	13.4 (5.3)	12.0 (4.7)	15.1 (5.9)	13.8 (5.4)
83 BIOCULAR BREADTH	8.4 (3.3)	9.0 (3.5)	10.0 (3.9)	10.6 (4.2)
84 INTERPUPILLARY BREADTH	5.7 (2.2)		6.9 (2.7)	
87 LIP LENGTH (MOUTH BREADTH)	4.6 (1.8)	3.7 (1.5)	5.8 (2.3)	5.1 (2.0)
89 EAR LENGTH ABOVE TRAGION	2.5 (1.0)		3.5 (1.4)	
90 EAR BREADTH	3.3 (1.3)	2.4 (0.9)	4.3 (1.7)	3.5 (1.4)
91 EAR PROTRUSION	1.7 (0.7)		2.8 (1.1)	

NEW PAGE

correlation). The correlation coefficient, "r", has a range of values from +1.0 (perfect positive correlation) through -1.0 (perfect negative correlation).

5.6.2.3 Bivariate tables. The variability of two body measurements and their interrelationship with each other may be shown graphically in a bivariate table. The bivariate table shows the ranges of two measurements and the numbers or frequencies of individuals who have the various possible combinations of values of the two measurements. The values indicating the ranges of the two measurements represent the midpoints of the intervals in those ranges. The frequencies or numbers of individuals may be given as actual numbers or may be expressed as percentages of the sample. While the relationship between two measurements is summarized by the coefficient of correlation, or "r" value, the extent or degree of correlation may also be estimated from the appearance or general shape of the bivariate distribution. A bivariate table, which shows a fairly well-defined band sloping from the lower left to upper right indicates a high degree of correlation that would normally be confirmed by a comparatively high coefficient of correlation (0.7 and higher). If this slope is absent, and the distribution is oval in shape, that means the correlation coefficient is low, and that the two variables are not changing in a similar fashion. See Table 17 for a bivariate frequency table for waist circumference and crotch height.

5.6.2.4 Regression analysis. The coefficient of correlation is a measure of the relationship between variables. Given values of one variable, it is possible to predict the value of another variable. The predictive relationship between two variables can be shown in terms of a "line of best fit," or in terms of the mathematical definition of this line, called a "regression line." The application of regression analysis is useful for predicting measurements and relationships between measurements when an actual sample is not available.

5.6.3 Use of data.

5.6.3.1 Interrelationships. The anthropometric data represent values for individual body measurements. These are values for each independent measurement and, as such, give no indication of the interrelationships or correlations among the various body measurements.

5.6.3.2 Multiple dimensions. Extreme caution should be used when two or more dimensions are simultaneously used as criteria for design. Percentile values are not additive between different dimensions (see "An Alternative to Percentile Model," Society of Automotive Engineers (SAE) Technical Paper No. 810217). For example, it is incorrect to assume that the combination of the 5th percentile values will describe the dimensions of a "5th percentile man." In practice, the 5th to 95th percentile values

TABLE 17. A bivariate frequency table.

		CROTCH HEIGHT (cm)																								
		65.50	67.00	68.50	70.00	71.50	73.00	74.50	76.00	77.50	79.00	80.50	82.00	83.50	85.00	86.50	88.00	89.50	91.00	92.50	94.00	95.50	97.00	98.50	100.00	101.50	TOTALS
	127.50						1																				1
	125.00																										0
	122.50																										0
	120.00						1			1																	2
	117.50												1		1					1							3
WAIST CIRCUMFERENCE cm	115.00											1	1				1	1									4
	112.50										1	1	1	2		2	1	1									9
	110.00	1					1		1	1	2			2	4		3	2		1							18
	107.50							1	1	4	2		3	1	2	1		1	1								17
	105.00			1	1		1		3	3	3	3	4	3	4	1	2	4	1				2				36
	102.50							2	4	2	3	5	7	7	11	3	3	2	1	4	2						66
	100.00					1		2	4	5	5	4	11	8	7	4	10	4	4	1	2			1			73
	97.50						1	2	4	6	8	11	14	7	13	7	8	3	5		4						93
	95.00			1		2	3	3	3	7	13	9	21	19	19	19	11	14	5	4	2	1	1				158
	92.50				1	3	4	3	11	11	12	12	32	24	23	23	25	6	8	2	5	1	1				206
	90.00		1				6	5	4	11	20	29	44	33	33	28	27	15	11	7	5	1	2	1	1		284
	87.50		1		2		1	9	12	27	21	37	45	55	40	39	42	27	19	11	7		1	1			397
	85.00				2	2	5	9	13	20	39	49	65	63	60	55	41	32	29	14	4	2		1			503
	82.50					3	6	16	10	32	37	73	70	97	74	84	49	41	24	16	7	4	1	2		1	647
	80.00			2	1	2	5	13	20	38	62	90	119	107	110	94	86	72	36	27	10	8	4		2		908
	77.50				2	1	6	6	19	43	50	122	100	119	141	91	87	57	43	23	15	9	1	1	1		937
	75.00				1	2	2	13	22	40	82	72	131	139	114	102	89	57	43	23	19	8	4	1			964
	72.50			1	2	2	6	5	18	38	50	62	84	96	104	80	54	48	18	12	12	4	3				699
	70.00			1		1	6	12	12	36	40	41	56	58	63	45	33	17	19	3	1	2	1		1		448
	67.50				1		3	7	9	5	10	18	17	27	15	20	13	6	5	4							160
	65.00					2	6	2	3	3	.7	5	6	1	4	2	2	2	5	1							46
	62.50						1				.1		1	3		2											8
	60.00											1	1	1													3
	Totals	1	2	6	13	21	64	110	174	333	468	645	834	872	842	702	587	411	272	164	95	40	21	8	5	1	6682

SUMMARY STATISTICS

	MEAN	STD DEV	REGRESSION EQUATIONS	SE-EST	R
WAIST CIRCUMFERENCE	80.30	8.18	.005*X + 79.877	8.18	.003
CROTCH HEIGHT	83.94	4.67	.002*Y + 83.782	4.67	

of some dimensions will have to be exceeded in order to accommodate the same range in another key dimension. Therefore, percentile values are inadequate for designs where two or more dimensions are used simultaneously as design parameters. Instead, appropriate multivariate data and techniques should be used (see: "Computerized Accommodated Percentage Evaluation (CAPE) Model for Cockpit Analysis and Other Exclusion Studies," Pacific Missile Test Center (PMTC), TP 75-49; and "A Family of Manikins for Workstation Design," Naval Air Engineering Center (NAEC) TR 2100-07B).

5.6.3.3 Variability of relationships. The relationships or correlations between body measurements are highly variable. Certain dimensions may not always have the same influence on other dimensions.

5.6.3.4 Clothing. Examples of the changes in anthropometric values imposed by different clothing ensembles and more specific may be found in "Anthropometry of the Clothed U.S. Army Ground Troop and Combat Vehicle Crewmen," Natick Research, Development and Engineering Center (NRDEC) TR 84-034.

5.6.3.5 Posture. Different cockpits and crewstations often require their operators to assume different postures, which may change as the operator fatigues. Because anthropometric data are derived from measurements taken in standard anthropometric postures, suitable allowances should be made for postural variation. Further information may be obtained from the appropriate service agency responsible for anthropometry.

5.6.3.6 Slump factor. Seated eye-height measurements may be reduced as much as 65 mm when personnel sit in a relaxed or slumped position. This slump factor should be considered when selecting the range of movement for adjustable seats, as well as in locating displays, optics, and vision ports. The slump factor is not a valid reason for lowering ceilings to save space.

5.6.3.7 Human subjects. Once the equipment or workspace design has progressed from the drawing board to a full scale mockup, the use of persons closely resembling various percentiles in conjunction with the mockup is a valuable design practice.

5.6.3.8 Information sources. Data on arm and leg reach, center-of-mass and joint centers for body segments and the inertial properties of the human body are sometimes of interest to equipment and workspace designers. Data are available in various publications. An example of a convenient and informative source of data is NASA-STD-3000, "Man-Systems Integration Standards."

5.6.4 Special populations. Reserved.

5.6.5 Body movement.

5.6.5.1 Range of motion. Table 18 gives the ranges, in angular degrees, for all voluntary movements the joints of the body can make, as illustrated in Figure 26. The designer should remember that these are maximum values; since they were measured with nude personnel, they do not reflect the restrictions clothing would impose. The lower limit should be used when personnel must operate or maintain a component; the upper limit should be used in designing for freedom of movement.

5.6.5.2 Whole body. All operating positions should allow enough space to move the trunk of the body. When large forces (more than 13.6 kg) or large control displacements (more than 380 mm in a fore-aft direction) are required, the operator should have enough space to move his entire body.

5.6.6 Human strength and handling capacity.

5.6.6.1 Exerted forces. The maximum amount of force or resistance designed into a control should be determined by the greatest amount of force that can be exerted by the weakest person likely to operate the control. The maximum force that can be applied will depend on such factors as the type of control, the body member used to operate it, the position of this body member during control operations, the general position of the body, and whether or not support is provided by backrests.

5.6.6.2 Lifting.

5.6.6.2.1 Comparative strength. Much research, currently investigating the maximum lifting characteristics of males and females, has produced little insight into the relative strength of women to men. The U.S. Army Research Institute of Environmental Medicine (ARIEM) has been collecting data in this area. ARIEM suggests the following strength relationship:

a. For upper extremities, women's strength is 56.5% of men.

b. For lower extremities, women's strength is 64.2% of men.

c. For trunk extremities, women's strength is 66.0% of men.

These numbers (based on sample size N = 1500) may serve as a preliminary design guideline until more up-to-date information may be available.

5.6.6.2.2 One person lift. Whenever possible, equipment should be designed so one person can lift it. Some lifting tasks may require two persons, but this is not normally desirable.

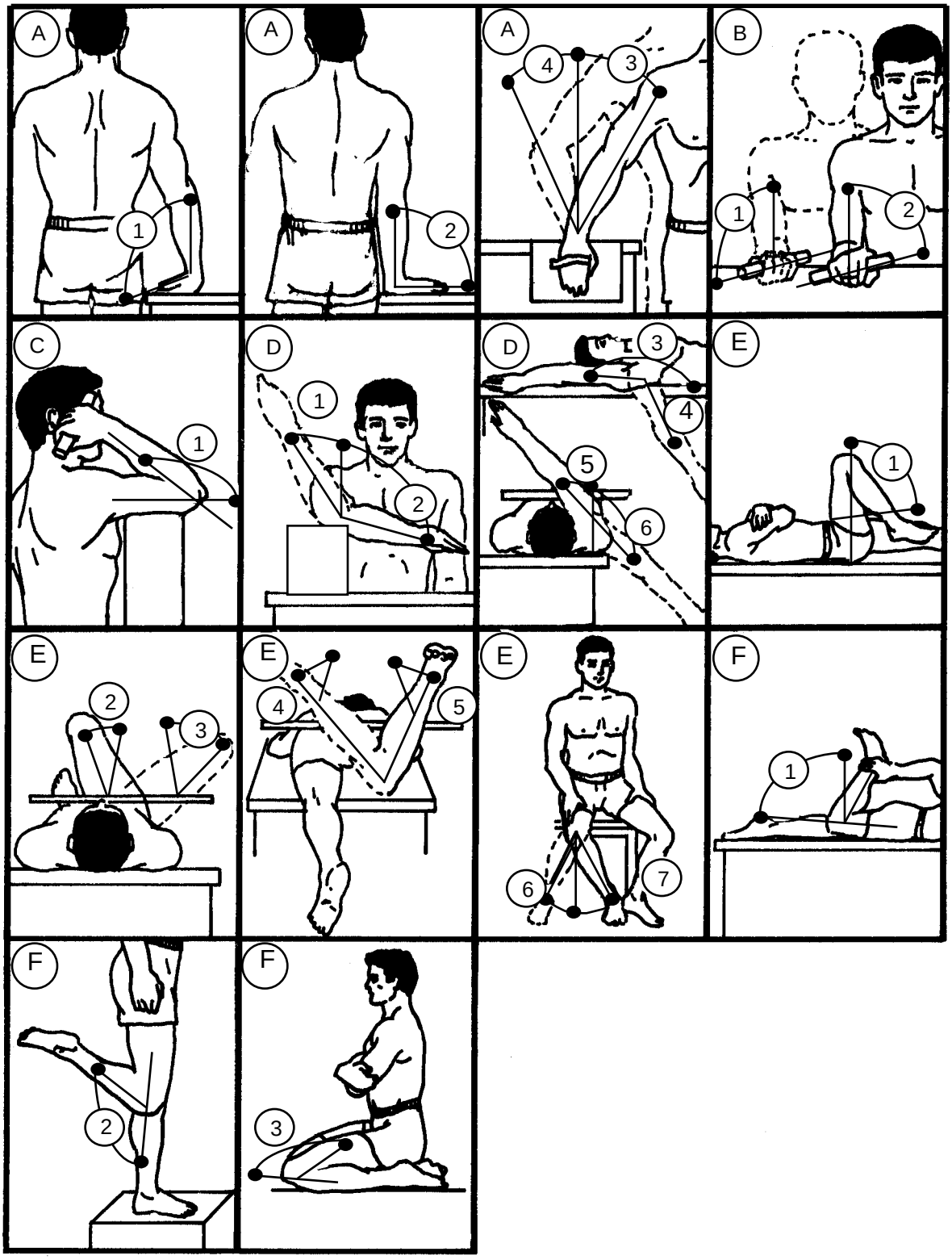


FIGURE 26. Range of human motion.

TABLE 18. Range of human motion.[1]

Body Member	Movement	Lower Limit (degrees)	Average (degrees)	Upper Limit (degrees)
A. Wrist	1. Flexion	78	90	102
	2. Extension	86	99	112
	3. Adduction	18	27	36
	4. Abduction	40	47	54
B. Forearm	1. Supination	91	113	135
	2. Pronation	53	77	101
C. Elbow	1. Flexion	132	142	152
D. Shoulder	1. Lateral Rotation	21	34	47
	2. Medial Rotation	75	97	119
	3. Extension	47	61	75
	4. Flexion	176	188	190
	5. Adduction	39	48	57
	6. Abduction	117	134	151
E. Hip	1. Flexion	100	113	126
	2. Adduction	19	31	43
	3. Abduction	41	53	65
	4. Medial Rotation (prone)	29	39	49
	5. Lateral Rotation (prone)	24	34	44
	6. Lateral Rotation (sitting)	21	30	39
	7. Medial Rotation (sitting)	22	31	40
F. Knee Flexion	1. Prone	115	125	135
	2. Standing	100	113	126
	3. Kneeling	150	159	168

[1]These values are based on the nude body. The ranges are larger than they would be for clothed personnel.

SUPERSEDES PAGE 141 OF MIL-HDBK-759C

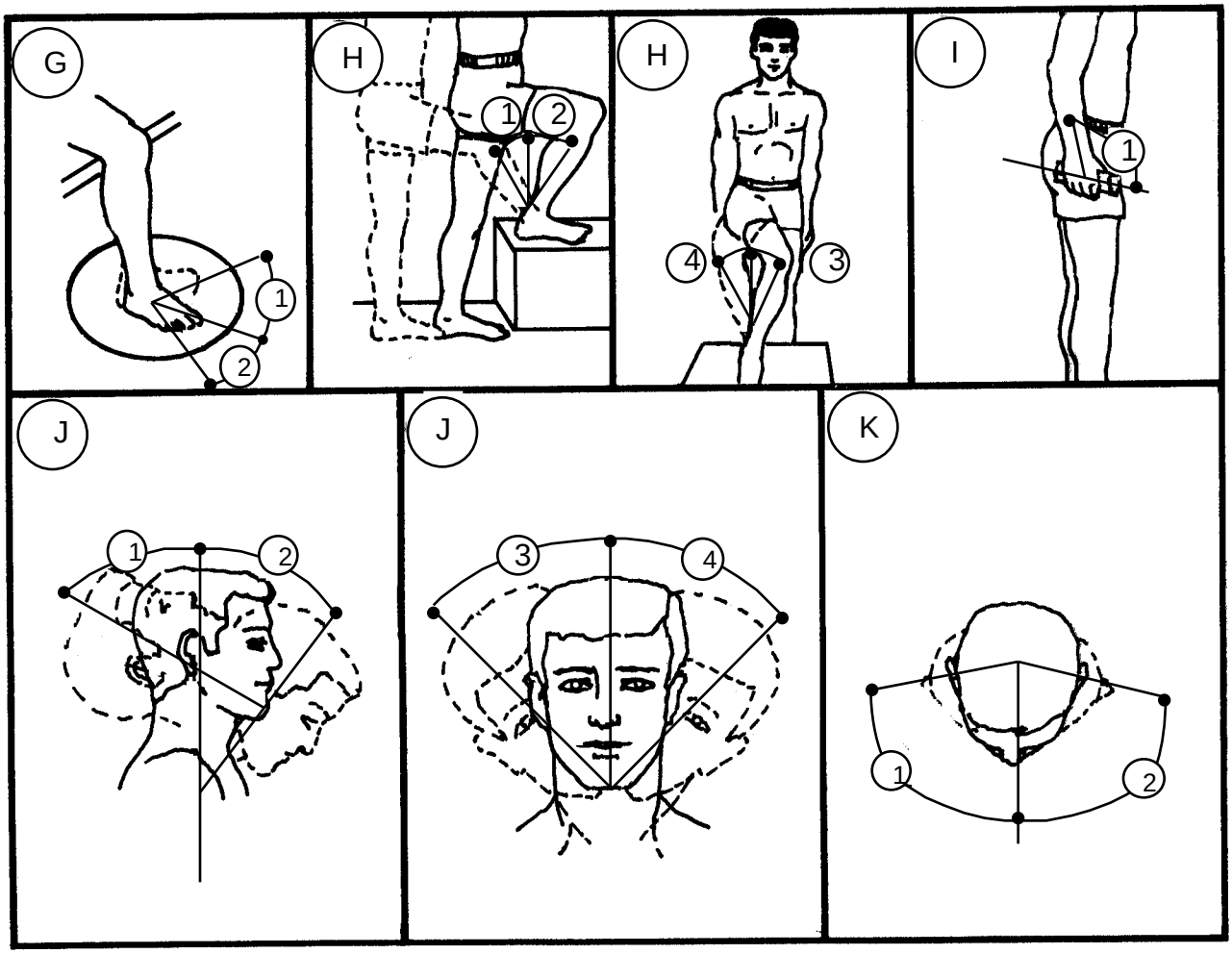


FIGURE 26. Range of human motion - continued.

TABLE 18. Range of human motion - continued.[1]

Body Member	Movement	Lower Limit (degrees)	Average (degrees)	Upper Limit (degrees)
G. Foot Rotation	1. Medial	23	35	47
	2. Lateral	31	43	55
H. Ankle	1. Extension	26	38	50
	2. Flexion	28	35	42
	3. Adduction	15	24	33
	4. Abduction	16	23	30
I. Grip Angle		95	102	109
J. Neck Flexion	1. Dorsal (back)	44	61	88
	2. Ventral (forward)	48	60	72
	3. Right	34	41	48
	4. Left	34	41	48
K. Neck Rotation	1. Right	65	79	93
	2. Left	65	79	93

[1]These values are based on the nude body. The ranges are larger than they would be for clothed personnel.

Flexion: Bending or decreasing the angle between parts of the body.
Extension: Straightening or increasing the angle between parts of the body.
Adduction: Moving toward the midline of the body.
Abduction: Moving away from the midline of the body.
Medial Rotation: Turning toward the midplane of the body.
Lateral Rotation: Turning away from the midplane of the body.
Pronation: Rotation of the palm of the hand downward.
Supination: Rotation of the palm of the hand upward.

5.6.6.2.3 Other application limits. Design should also take into consideration conditions when the object might be very difficult to handle (slippery), workspace might be less than optimal, or the object must be positioned or handled delicately.