

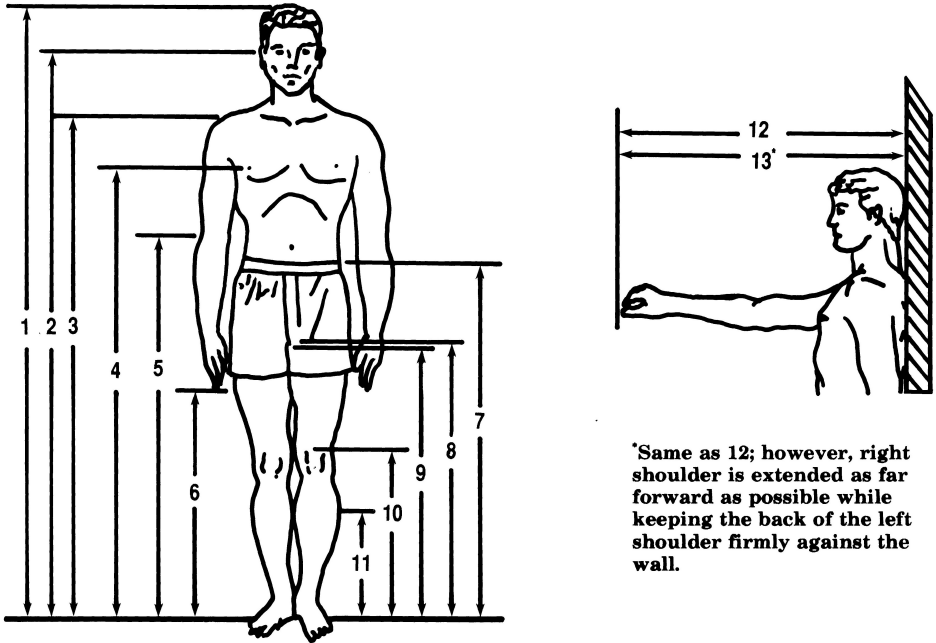
Appendix B

Ergonomics Data

TABLE B-1 Standing Body Dimensions (From MIL-STD-1472D)

	Percentile Values in Centimeters					
	5th Percentile			95th Percentile		
	Ground Troops	Aviators	Women	Ground Troops	Aviators	Women
Weight (kg)	55.5	60.4	46.4	91.6	96.0	74.5
Standing Body Dimensions						
1 Stature	162.8	164.2	152.4	185.6	187.7	174.1
2 Eye height (standing)	151.1	152.1	140.9	173.3	175.2	162.2
3 Shoulder (acromiale) height	133.6	133.3	123.0	154.2	154.8	143.7
4 Chest (nipple) height ^a	117.9	120.8	109.3	136.5	138.5	127.8
5 Elbow (radiale) height	101.0	104.8	94.9	117.8	120.0	110.7
6 Fingertip (dactylion) height		61.5			73.2	
7 Waist height	96.6	97.6	93.1	115.2	115.1	110.3
8 Crotch height	76.3	74.7	68.1	91.8	92.0	83.9
9 Gluteal furrow height	73.3	74.6	66.4	87.7	88.1	81.0
10 Kneecap height	47.5	46.8	43.8	58.6	57.8	52.5
11 Calf height	31.1	30.9	29.0	40.6	39.3	36.6
12 Functional reach	72.6	73.1	64.0	90.9	87.0	80.4
13 Functional reach, extended	84.2	82.3	73.5	101.2	97.3	92.7
	Percentile Values in Inches					
Weight (lb)	122.4	133.1	102.3	201.9	211.6	164.3
Standing Body Dimensions						
1 Stature	64.1	64.6	60.0	73.1	73.9	68.5
2 Eye height (standing)	59.5	59.9	55.5	68.2	69.0	63.9
3 Shoulder (acromiale) height	52.6	52.5	48.4	60.7	60.9	56.6
4 Chest (nipple) height ^a	46.4	47.5	43.0	53.7	54.5	50.3
5 Elbow (radiale) height	39.8	41.3	37.4	46.4	47.2	43.6
6 Fingertip (dactylion) height		24.2			28.8	
7 Waist height	38.0	38.4	36.6	45.3	45.3	43.4
8 Crotch height	30.0	29.4	26.8	36.1	36.2	33.0
9 Gluteal furrow height	28.8	29.4	26.2	34.5	34.7	31.9
10 Kneecap height	18.7	18.4	17.2	23.1	22.8	20.7
11 Calf height	12.2	12.2	11.4	16.0	15.5	14.4
12 Functional reach	28.6	28.8	25.2	35.8	34.3	31.7
13 Functional reach, extended	33.2	32.4	28.9	39.8	38.3	36.5

^aBustpoint height for women.



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

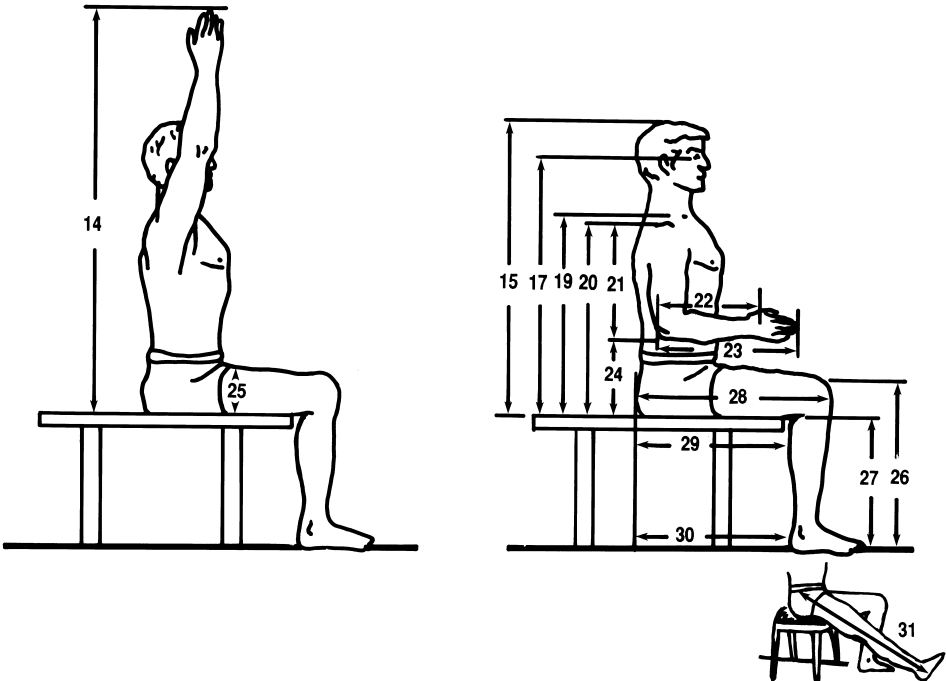


Figure B-2. Seated body dimensions. (From MIL-STD-1472D.)

TABLE B-2 Seated Body Dimensions (From MIL-STD-1472D)

	Percentile Values in Centimeters					
	5th Percentile			95th Percentile		
	Ground Troops	Aviators	Women	Ground Troops	Aviators	Women
Seated Body Dimensions						
14 Vertical arm reach, sitting	128.6	134.0	117.4	147.8	153.2	139.4
15 Sitting height, erect	83.5	85.7	79.0	96.9	98.6	90.9
16 Sitting height, relaxed	81.5	83.6	77.5	94.8	96.5	89.7
17 Eye height, sitting erect	72.0	73.6	67.7	84.6	86.1	79.1
18 Eye height, sitting relaxed	70.0	71.6	66.2	82.5	84.0	77.9
19 Mid-shoulder height	56.6	58.3	53.7	67.7	69.2	62.5
20 Shoulder height, sitting	54.2	54.6	49.9	65.4	65.9	60.3
21 Shoulder–elbow length	33.3	33.2	30.8	40.2	39.7	36.6
22 Elbow–grip length	31.7	32.6	29.6	38.3	37.9	35.4
23 Elbow–fingertip length	43.8	44.7	40.0	52.0	51.7	47.5
24 Elbow rest height	17.5	18.7	16.1	28.0	29.5	26.9
25 Thigh clearance height		12.4	10.4		18.8	17.5
26 Knee height, sitting	49.7	48.9	46.9	60.2	59.9	55.5
27 Popliteal height	39.7	38.4	38.0	50.0	47.7	45.7
28 Buttock–knee length	54.9	55.9	53.1	65.8	65.5	63.2
29 Buttock–popliteal length	45.8	44.9	43.4	54.5	54.6	52.6
30 Buttock–heel length		46.7			56.4	
31 Functional leg length	110.6	103.9	99.6	127.7	120.4	118.6
Percentile Values in Inches						
Seated Body Dimensions						
14 Vertical arm reach, sitting	50.6	52.8	46.2	58.2	60.3	54.9
15 Sitting height, erect	32.9	33.7	31.1	38.2	38.8	35.8
16 Sitting height, relaxed	32.1	32.9	30.5	37.3	38.0	35.3
17 Eye height, sitting erect	28.3	30.0	26.6	33.3	33.9	31.2
18 Eye height, sitting relaxed	27.6	28.2	26.1	32.5	33.1	30.7
19 Mid-shoulder height	22.3	23.0	21.2	26.7	27.3	24.6
20 Shoulder height, sitting	21.3	21.5	19.6	25.7	25.9	23.7
21 Shoulder–elbow length	13.1	13.1	12.1	15.8	15.6	14.4
22 Elbow–grip length	12.5	12.8	11.6	15.1	14.9	14.0
23 Elbow–fingertip length	17.3	17.6	15.7	20.5	20.4	18.7
24 Elbow rest height	6.9	7.4	6.4	11.0	11.6	10.6
25 Thigh clearance height		4.9	4.1		7.4	6.9
26 Knee height, sitting	19.6	19.3	18.5	23.7	23.6	21.8
27 Popliteal height	15.6	15.1	15.0	19.7	18.8	18.0
28 Buttock–knee length	21.6	22.0	20.9	25.9	25.8	24.9
29 Buttock–popliteal length	17.9	17.7	17.1	21.5	21.5	20.7
30 Buttock–heel length		18.4			22.2	
31 Functional leg length	43.5	40.9	39.2	50.3	47.4	46.7

TABLE B-3 Body Depth and Breadth Dimension (From MIL-STD-1472D)

Depth and Breadth Dimensions	Percentile Values in Centimeters					
	5th Percentile			95th Percentile		
	Ground Troops	Aviators	Women	Ground Troops	Aviators	Women
32 Chest depth ^a	18.9	20.4	19.6	26.7	27.8	27.2
33 Buttock depth		20.7	18.4		27.4	24.3
34 Chest breadth	27.3	29.5	25.1	34.4	38.5	31.4
35 Hip breadth, standing	30.2	31.7	31.5	36.7	38.8	39.5
36 Shoulder (bideltoid) breadth	41.5	43.2	38.2	49.8	52.6	45.8
37 Forearm–forearm breadth	39.8	43.2	33.0	53.6	60.7	44.9
38 Hip breadth, sitting	30.7	33.3	33.0	38.4	42.4	43.9
39 Knee-to-knee breadth		19.1			25.5	

Depth and Breadth Dimensions	Percentile Values in Inches					
	5th Percentile			95th Percentile		
	Ground Troops	Aviators	Women	Ground Troops	Aviators	Women
32 Chest depth ^a	7.5	8.0	7.7	10.5	11.0	10.7
33 Buttock depth		8.2	7.2		10.8	9.6
34 Chest breadth	10.8	11.6	9.9	13.5	15.1	12.4
35 Hip breadth, standing	11.9	12.5	12.4	14.5	15.3	15.6
36 Shoulder (bideltoid) breadth	16.3	17.0	15.0	19.6	20.7	18.0
37 Forearm–forearm breadth	15.7	17.0	13.0	21.1	23.9	17.7
38 Hip breadth, sitting	12.1	13.1	13.0	15.1	16.7	17.3
39 Knee-to-knee breadth		7.5			10.0	

^aBust depth for women.

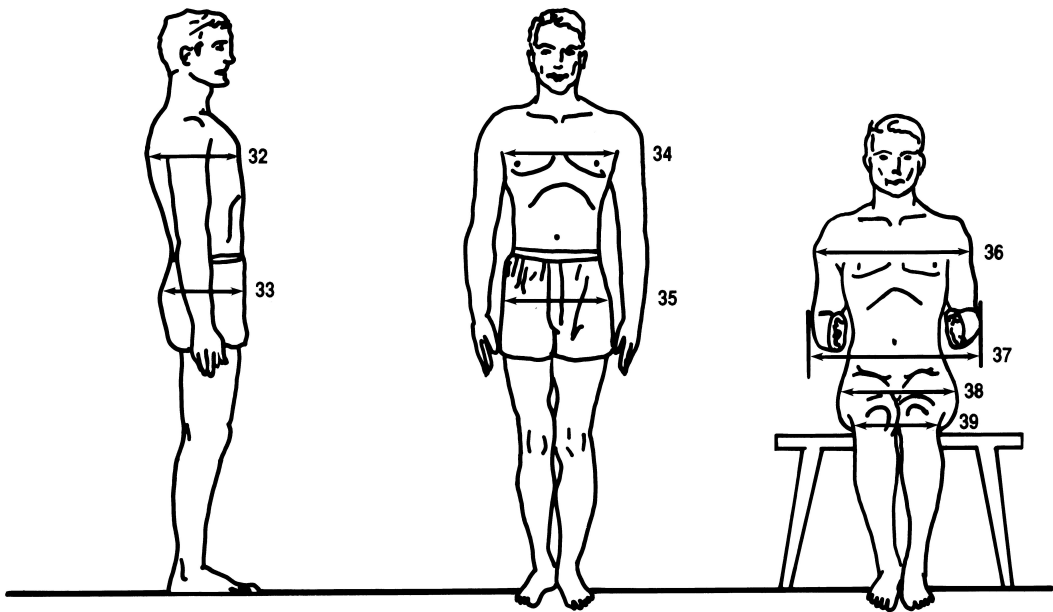


Figure B-3. Body depth and breadth dimensions. (From MIL-STD-1472D.)

TABLE B-4 Body Circumference and Surface Dimensions (From MIL-STD-1472D)

	Percentile Values in Centimeters					
	5th Percentile			95th Percentile		
	Ground Troops	Aviators	Women	Ground Troops	Aviators	Women
Circumferences						
40 Neck circumference	34.2	34.6	29.9	41.0	41.6	36.7
41 Chest circumference ^a	83.8	87.5	78.4	105.9	109.9	100.2
42 Waist circumference	68.4	73.5	59.5	95.9	101.7	83.5
43 Hip circumference	85.1	87.1	85.5	106.9	108.4	106.1
44 Hip circumference, sitting		97.0	87.7		119.3	110.8
45 Vertical trunk circumference, standing	150.6	156.3	142.2	178.6	181.9	168.3
46 Vertical trunk circumference, sitting		150.4	134.8		175.0	161.0
47 Arm scye circumference	39.6	39.9	33.6	50.3	53.0	41.7
48 Biceps circumference, flexed	27.0	27.8	23.2	37.0	36.9	30.8
49 Elbow circumference, flexed		28.5	23.5		34.2	30.0
50 Forearm circumference, flexed	26.1	26.3	22.2	33.1	33.1	27.5
51 Wrist circumference	15.7	15.3	13.6	18.6	19.2	16.2
52 Upper thigh circumference	48.1	49.6	48.7	63.9	66.9	64.5
53 Calf circumference	31.6	33.3	30.6	41.2	41.3	39.2
54 Ankle circumference	19.3	20.0	18.7	25.2	24.8	23.3
55 Waist back length	39.2	42.4	36.7	50.8	50.9	45.4
56 Waist front length	36.1	35.7	30.5	46.2	44.2	41.4
Percentile Values in Inches						
Circumferences						
40 Neck circumference	13.5	13.6	11.8	16.1	16.4	14.4
41 Chest circumference ^a	33.0	34.4	30.8	41.7	43.3	39.5
42 Waist circumference	26.9	28.9	23.4	37.8	40.0	32.9
43 Hip circumference	33.5	34.3	33.7	42.1	42.7	41.8
44 Hip circumference, sitting		38.2	34.5		47.0	43.6
45 Vertical trunk circumference, standing	59.3	61.6	56.0	70.3	71.6	65.5
46 Vertical trunk circumference, sitting		59.2	53.1		68.9	63.4
47 Arm scye circumference	15.6	15.7	13.2	19.8	20.9	16.4
48 Biceps circumference, flexed	10.6	11.0	9.1	14.6	14.5	12.1
49 Elbow circumference, flexed		11.2	9.2		13.5	11.8
50 Forearm circumference, flexed	10.3	10.4	8.7	13.0	13.0	10.8
51 Wrist circumference	6.2	6.0	5.4	7.3	7.6	6.4
52 Upper thigh circumference	18.9	19.5	19.2	25.1	26.3	25.4
53 Calf circumference	12.4	13.1	12.0	16.2	16.3	15.4
54 Ankle circumference	7.6	7.9	7.4	9.9	9.7	9.2
55 Waist back length	15.4	16.7	14.4	20.0	20.0	17.9
56 Waist front length	14.2	14.1	12.0	18.2	17.4	16.3

^aBust circumference for women.

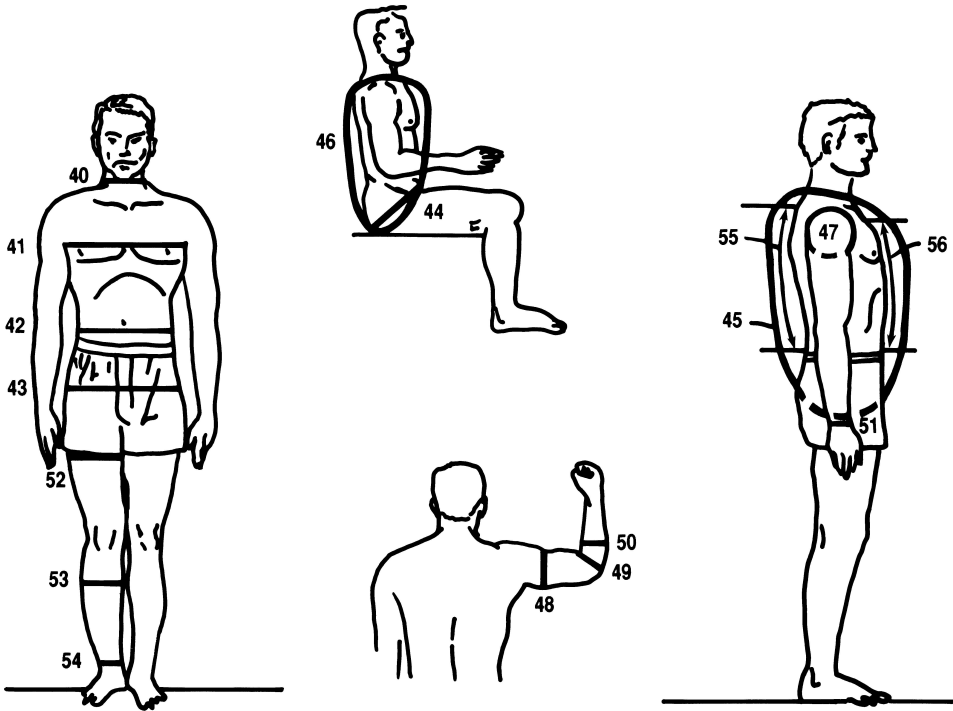


Figure B-4. Body circumferences and surface dimensions. (From MIL-STD-1472D.)

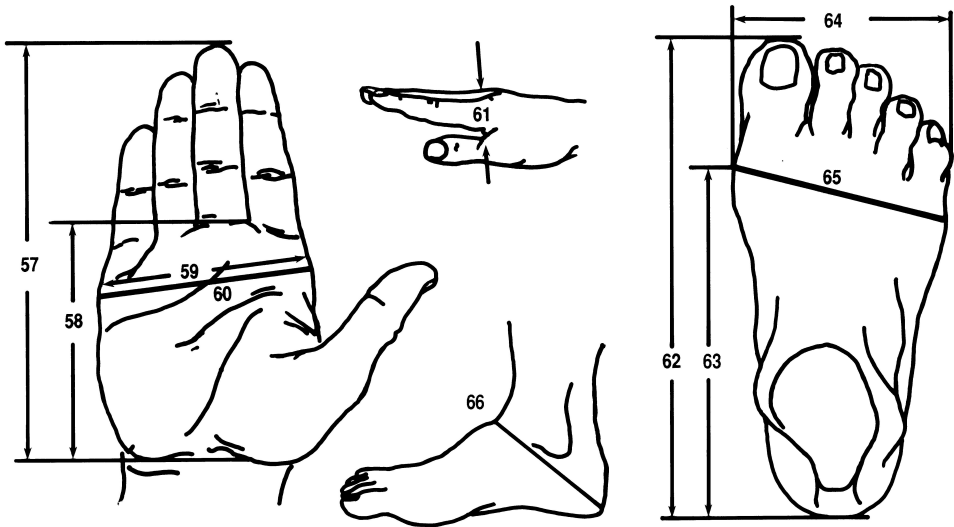


Figure B-5. Hand and foot dimensions. (From MIL-STD-1472D.)

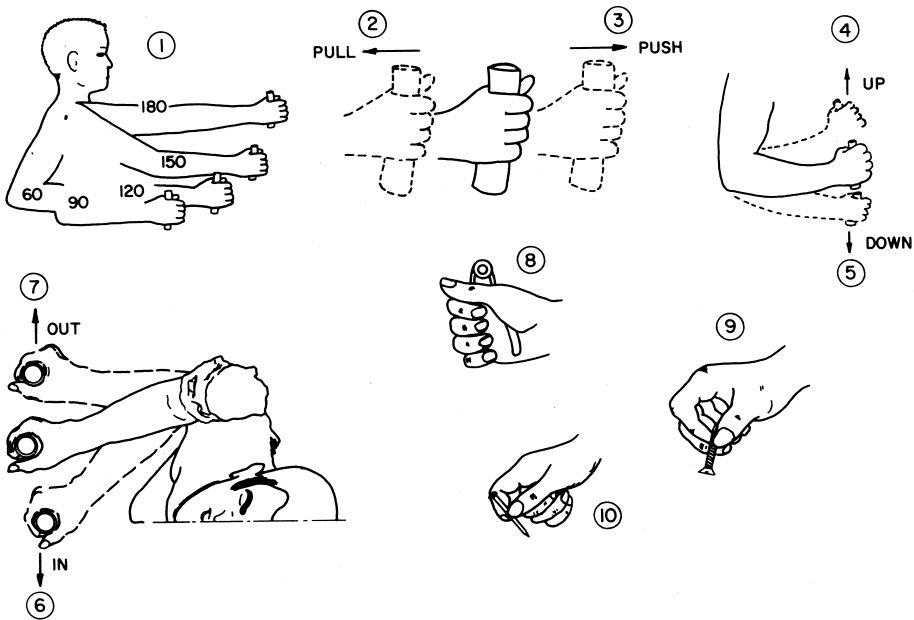
TABLE B-5 Hand and Foot Dimensions (From MIL-STD-1472D)

	Percentile Values in Centimeters					
	5th Percentile			95th Percentile		
	Ground Troops	Aviators	Women	Ground Troops	Aviators	Women
Hand Dimensions						
57 Hand length	17.4	17.7	16.1	20.7	20.7	20.0
58 Palm length	9.6	10.0	9.0	11.7	11.9	10.8
59 Hand breadth	8.1	8.2	6.9	9.7	9.7	8.5
60 Hand circumference	19.5	19.6	16.8	23.6	23.1	19.9
61 Hand thickness		2.4			3.5	
Foot Dimensions						
62 Foot length	24.5	24.4	22.2	29.0	29.0	26.5
63 Instep length	17.7	17.5	16.3	21.7	21.4	19.6
64 Foot breadth	9.0	9.0	8.0	10.9	11.6	9.8
65 Foot circumference	22.5	22.6	20.8	27.4	27.0	24.5
66 Heel-ankle circumference	31.3	30.7	28.5	37.0	36.3	33.3
Percentile Values in Inches						
Hand Dimensions						
57 Hand length	6.85	6.98	6.32	8.13	8.14	7.89
58 Palm length	3.77	3.92	3.56	4.61	4.69	4.24
59 Hand breadth	3.20	3.22	2.72	3.83	3.80	3.33
60 Hand circumference	7.68	7.71	6.62	9.28	9.11	7.82
61 Hand thickness		0.95			1.37	
Foot Dimensions						
62 Foot length	9.65	9.62	8.74	11.41	11.42	10.42
63 Instep length	6.97	6.88	6.41	8.54	8.42	7.70
64 Foot breadth	3.53	3.54	3.16	4.29	4.58	3.84
65 Foot circumference	8.86	8.91	8.17	10.79	10.62	9.65
66 Heel-ankle circumference	12.32	12.08	11.21	14.57	14.30	13.11

TABLE B-6 Static Muscle Strength Data (From MIL-STD-1472D)

	Percentile Values in Pounds			
	5th Percentile		95th Percentile	
	Men	Women	Men	Women
Strength Measurements				
A Standing two-handed pull:				
15 in level				
Mean force	166	74	304	184
Peak force	190	89	323	200
B Standing two-handed pull:				
20 in level				
Mean force	170	73	302	189
Peak force	187	84	324	203
C Standing two-handed pull:				
39 in level				
Mean force	100	42	209	100
Peak force	113	49	222	111
D Standing two-handed push:				
59 in level				
Mean force	92	34	229	85
Peak force	106	42	246	97
E Standing one-handed pull:				
39 in level				
Mean force	48	23	141	64
Peak force	58	30	163	72
F Standing one-handed pull:				
Centerline, 18 in level				
Mean force	51	24	152	88
Peak force	61	29	170	101
G Seated one-handed pull:				
Side, 18 in level				
Mean force	54	25	136	76
Peak force	61	30	148	89
H Seated two-handed pull:				
Centerline, 15 in level				
Mean force	134	54	274	173
Peak force	157	64	298	189
I Seated two-handed pull:				
Centerline, 20 in level				
Mean force	118	46	237	142
Peak force	134	53	267	157

TABLE B-7 Arm, Hand and Thumb-Finger Strength (5th Percentile Male Data)



(1) Degree of Elbow Flexion (deg)	Arm Strength (lb)											
	(2) Pull		(3) Push		(4) Up		(5) Down		(6) In		(7) Out	
	L ^a	R ^a	L	R	L	R	L	R	L	R	L	R
180	50	52	42	50	9	14	13	17	13	20	8	14
150	42	56	30	42	15	18	18	20	15	20	8	15
120	34	42	26	36	17	24	21	26	20	22	10	15
90	32	37	22	36	17	20	21	26	16	18	10	16
60	26	24	22	34	15	20	18	20	17	20	12	17

	Hand and Thumb—Finger Strength (N)					
	(8) Hand Grip		(9) Thumb—Finger Grip (Palmer)		(10) Thumb—Finger Grip (Tips)	
	L	R				
Momentary hold	56	59			13	13
Sustained hold	33	35			8	8

^aL = left; R = right.

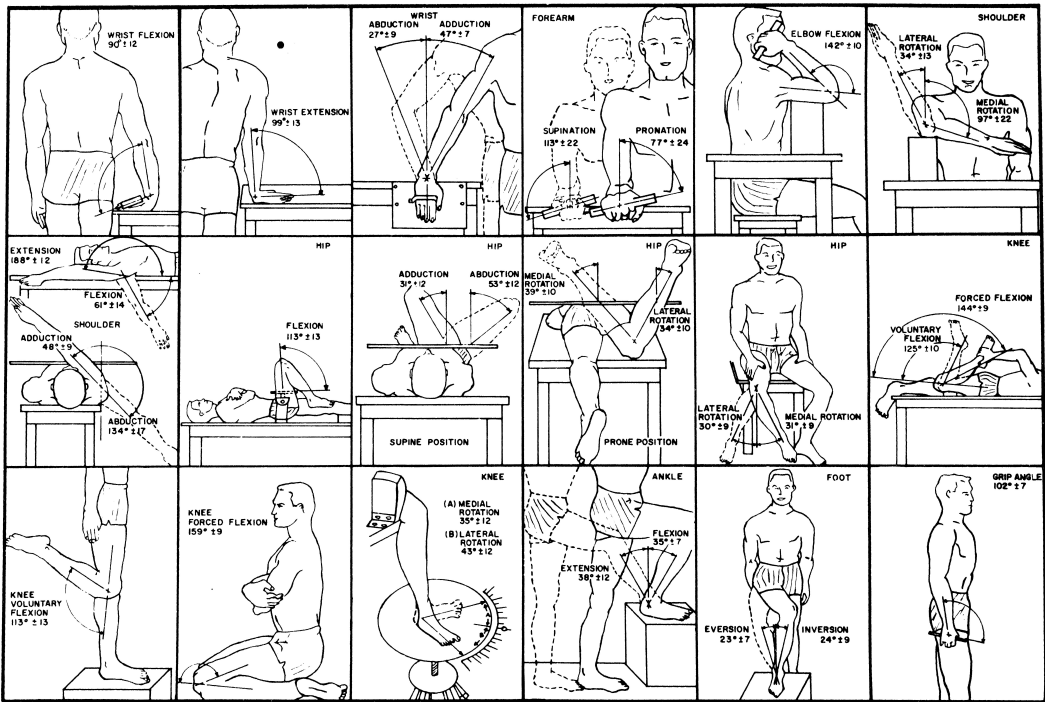
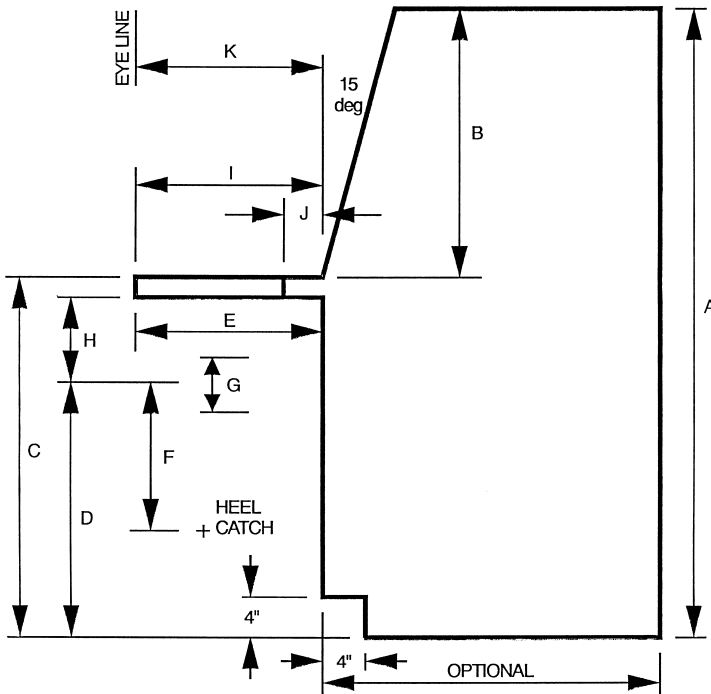


Figure B-6. Body movements. (From Webb, P., *Bioastronautics Data Book*, NASA SP3006, 1964.)

TABLE B-8 Dimensions for Various Types of Consoles (From MIL-STD-1472D)

Type of Console	Maximum Total Console Height From Standing Surface		Suggested Panel Vertical Dimension (Including Sills)		Writing Surface: Shelf Height From Standing Surface		Seat Height From Standing Surface At Midpoint of G		Maximum Console Width (Not Shown)	
	A		B		C		D			
KEY	m	in	mm	in	mm	in	mm	in	m	in
1. SIT (with vision over top)	1.170	46.0	520	20.5	650	25.5	435	17	1.120	44
	1.335	52.5	520	20.5	810	32.0	595	23.5	1.120	44
	1.435	56.5	520	20.5	910	36.0	695	27.5	1.120	44
2. SIT (without vision over top)	1.310	51.5	660	26.0	650	25.5	435	17.0	910	36.0
	1.470	58.0	660	26.0	810	32.0	595	23.5	910	36.0
3. SIT-STAND (with standing vision over top)	1.570	62.0	660	26.0	910	36.0	695	27.5	910	36.0
	1.535	60.5	620	24.5	910	36.0	695	27.5	910	36.0
4. STAND (with vision over top)	1.535	60.5	620	24.5	910	36.0	NA	NA	1.120	44.0
5. STAND (without vision over top)	1.830	72.0	910	36.0	910	36.0	NA	NA	910	36.0

^aThe range in "A" is provided to allow latitude in the volume of the lower part of the console. Note the relationship to "C" and "D".



Key	Dimensions	mm	in
A	Maximum total console height from standing surface		
B	Suggested vertical dimension of panel		See Table B-8
C	Writing surface: shelf height from standing surface		See Table B-8
D	Seat height from standing surface at midpoint of "G"		
E ¹	Minimum knee clearance	460	18.0
F ¹	Foot support to sitting surface ²	460	18.0
G ¹	Seat adjustability	150	6.0
H ¹	Minimum thigh clearance at midpoint of "G"	190	7.5
I	Writing surface depth including shelf	400	16.0
J	Minimum shelf depth	100	4.0
K	Eye line-to-console front distance	400	16.0

¹Not applicable to console Types 4 and 5 of Table B-8.

²Since this dimension must not be exceeded, a heel catch must be added to the chair if "D" exceeds 460 mm (18.0). Note: A shelf thickness of 25 mm (1 in) is assumed. For other shelf thicknesses, suitable adjustments should be made.

Figure B-7. Standard console dimensions. (From MIL-STD-1472D.)

