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The following corrections to Technical Report No. AMRL-TR-68-24,
Clearance and Performance Values for the Bare-Handed and the Pressure-
Gloved Operator:

Page 1, paragraph 3, lines 5 and 6: Streiner should be changed to Streimer.

Page 18, figure legend, line 2: palm up should be changed to palm down.

AEROSPACE MEDICAL RESEARCH LABORATORY
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AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

AMRL-TR-68-24

**CLEARANCE AND PERFORMANCE VALUES
FOR THE BARE-HANDED AND THE
PRESSURE-GLOVED OPERATOR**

JOHN W. GARRETT

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Foreword

This report was prepared by the Anthropology Branch, Behavioral Sciences Laboratory, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio. This research was performed in support of Project 7184, "Human Performance in Advanced Systems," Task 718408, "Anthropology for Design."

The author is grateful to the officers and men of the 4756th Physiological Training Flight, Tyndall Air Force Base, Florida, for their generous cooperation during the data collection phase of this study.

Deep appreciation is due the author's colleague, Milton Alexander, who conducted a concurrent anthropometric study of pressure-suited airmen at the 4756th Physiological Training Flight. The resultant interchange of ideas has undoubtedly increased the potential values of this research.

Special thanks are due to Charles E. Clauser, Chief, Anthropology Branch, for his sustained encouragement and guidance throughout this study.

Thanks are also due to M. J. Warrick for his technical evaluation and critical review during the preparation of this report.

The author's sincerest gratitude is extended to Mrs. Joan Robinette for her careful and cheerful editing of this report.

This technical report has been reviewed and is approved.

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Abstract

This report summarizes hand and arm dimensional, clearance, and strength data of 27 adult males wearing the A/P22S-2 full-pressure suit. Thirty-six measures were obtained under each of three conditions: bare-handed; gloved and unpressurized; and gloved and pressurized. The data are both summarized for all subjects and reported independently by glove size worn. Uses of the data are suggested and specific design values recommended.

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CLEARANCE AND PERFORMANCE VALUES FOR THE BARE-HANDED AND THE PRESSURE-GLOVED OPERATOR

Section I.

INTRODUCTION

This report quantifies spatial dimensions and performance decrements for 36 hand and arm positions and actions while wearing a full-pressure suit, both uninflated and inflated, and presents design criteria to help overcome the handicap.

One of the major problems in flying space vehicles or certain aircraft when the mission requires prolonged flight above 50,000 feet is restricted mobility caused by the full-pressure suit. In general, any hand covering lowers a man's maximum potential for performing certain manual operations; but, the full-pressure suits create severe decrements in hand mobility and an increase in the area occupied by the hand through the bulk of the glove. More than a decade of development has improved, but has not eliminated, the problem; nor, to my knowledge is there anything presently in the design stage that will permit full hand flexibility and dexterity, and significantly decrease the volume of the hand covering.

Previous studies on the manual work capability of pressure-suited operators have been directed into two avenues of research. The first of these is largely concerned with the combined effects of pressure suits and reduced gravity environments upon an operator. This research has dealt primarily with the problems of extravehicular activity required of astronauts during space missions. Streifer reviewed these studies in his paper, *The Effect of Reduced Gravity and Pressure Suits Upon Operator Capability* (Streiner, 1965).

The other type of research concerns the evaluation of various Air Force and National Aeronautics and Space Administration operational and developmental pressure suits and pressure gloves, including the A/P22S-2, A/P22S-2A, A/P22S-4, X-20, the XACS series, G4C, AX5H, the MD series, and the MOL series.¹ The research includes anthropometric measures of suit and glove ballooning, (i.e., the increase in size and changing configuration of the garment when inflated to various pressures) and simple manual dexterity tests like the Purdue Pegboard, which have been used to compare hand dexterity of pressure-suited subjects wearing inflated and uninflated gloves. Laboratory tests of this type have little practical systems design value for they are restricted to a few subjects in static positions or doing basically "unreal" tasks. Thus, the test results from a single subject on the Purdue Pegboard Test, where a man is required to pick up and manipulate very small pegs (1 by 0.125 inches), washers (0.369-inch od by 0.150-inch id), and collars (0.250-inch by 0.150-inch id), have little value to a human factors engineer designing for a task that requires operators of varied sizes and skills to manipulate certain items. The designer learns that a subject cannot handle the very small items with much speed or accuracy, but he does not learn what range of sizes the entire potential using population can handle effectively.

This study was initiated to study the effects of wearing pressure gloves on selected manipulative skills and the spaces required to accommodate the pressure gloved hand. The questions to be answered were:

¹For published data see Gillespie 1961, 1965; Pierce 1962; Rock 1964; and Walk 1964. Unpublished data have been compiled by Messrs. M. Alexander, J. Garrett, and K. Kennedy of the Anthropology Branch, Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio 45433.

1) What are the spatial requirements of a pilot's hand in a bare-handed condition, while wearing an uninflated full-pressure glove, and while wearing an inflated (3.5 psig) full-pressure glove?

2) What are the performance decrements for certain types of manual capability; that is, in torque potential, gripping power, and ability to rotate the hand, wrist and arm under the same three conditions as above?

3) What criteria can be established for the design of controls, handles, and apertures that a pressure-suited man is expected to operate or penetrate with his suit either uninflated or inflated?

Thirty-six anthropometric and biomechanical dimensions were selected. Each dimension was selected to provide specific data for a clearance problem, control design, or control placement. Many of those selected are basic to standard design criteria for barehanded operation as presented in Chapters 6 and 8 of the *Human Engineering Guide to Equipment Design* (HEGED) (Morgan et al, 1963). Each of the 36 dimensions is described in this report on separate pages, verbally and pictorially. Included are technical definitions for anthropologists and more general definitions for the design engineer. Also given are summary statistical data, percentage of value change (both as a function of the individual differences and of the differences of the means) between wearing uninflated and inflated gloves and the barehanded condition, and the complete range of values for wearers of each size glove. In addition, human engineering applications and specific design recommendations are presented.

As only a few of these dimensions had been taken during conventional anthropometric surveys, it was necessary to produce several new measuring instruments. These were constructed of common materials and equipment so that they may be duplicated with minimal effort if desired and are described in the appendix.

Three standard anthropometric dimensions of the hand (Hand Length, Hand Breadth and Hand Circumference), plus Weight and Stature were measured to compare the 27 subjects used in this study to 2420 Air Force rated personnel measured during a 1967 anthropometric survey of Air Force personnel. This comparison is shown in table I.

TABLE I.
COMPARATIVE DATA

	N=27		N=2420	
	Mean	SD	Mean	SD
Stature	174.52 cm; 68.61 in	8.11 cm; 3.19 in	177.34 cm; 69.82 in	6.20 cm; 2.44 in
Weight	74.20 kg; 163.25 lbs	11.76 kg; 25.88 lbs	78.90 kg; 173.60 lbs	9.75 kg; 21.44 lbs
Hand Length	19.38 cm; 7.63 in	1.16 cm; 0.45 in	19.11 cm; 7.52 in*	0.82 cm; 0.32 in
Hand Breadth	8.84 cm; 3.48 in	0.55 cm; 0.22 in	8.90 cm; 3.50 in	0.42 cm; 0.16 in
Hand Circumference	21.24 cm; 8.36 in	1.36 cm; 0.54 in	21.55 cm; 8.49 in	0.94 cm; 0.37 in

*On this sample, Hand Length was measured as Stylium landmark to Dactylion.

Measurements were taken of each of the 36 dimensions under three conditions on each subject: 1) barehanded and suited; 2) wearing an A/P22S-2 full pressure suit and gloves but no helmet; and 3) wearing the entire A/P22S-2 full pressure ensemble inflated to 3.5 psig. All measurements were taken on the subjects' right hand. A recent article (Laubach and McConville, 1967) has demonstrated the impracticability of considering right versus left hand anthropometric differences. This article reports right versus left hand mean differences of 0.01 cm (0.004 in) in Hand Length and 0.03 cm (0.012 in) in Hand Breadth. From a design viewpoint, I would suggest these represent no significant practical difference.

Each dimension was taken in the same position for all subjects during each of the three conditions. The subject was seated in a B-47 downward ejection seat with seat block and back support. Restraint was provided by a shoulder harness and lap belt. There is no special significance in the B-47 seat, it merely was available and provided a standard seat for all tests. A 30-inch high table was used when required. The rotation and torque indicators were always placed on the table just above the subject's right knee. Data collection was accomplished at the 4756th Physiological Training Flight, Tyndall AFB, Florida, during the spring and summer of 1967. Because of the great difficulty in obtaining access to a complete size range of A/P22S-2 suits and gloves and of the time involved in donning, adjusting and doffing a full-pressure suit, it was expedient to test only two subjects in each glove size. An additional subject was tested in a small glove (Size B), another in a medium glove (Size E), and another in the largest glove (Size L). This constitutes a total sample of 27. The A/P22S-2 full-pressure gloves (figure 1) were fitted according to the operational sizing chart, table II.

TABLE II.
A/P22S-2 FITTING CHART (GLOVES)
Inches - (Centimeters)

<i>If Hand Circumference is</i>	<i>and Hand Length is</i>	<i>Then Glove Size is</i>
7½ (19.77) - or below	6¾ (16.83) to 7* (17.78)	A
	7½ (18.10) to 7½ (19.05)	B
	7¾ (19.37) to 8 (20.32)	C
8 (20.32) to 8¾ (21.27)	6¾ (17.15) to 7½ (18.10)	D
	7¼ (18.42) to 7¾ (19.69)	E
	7¾ (20.00) to 8¼ (20.96)	F
8½ (21.59) to 8¾ (22.54)	7 (17.78) to 7¾ (18.73)	G
	7½ (19.05) to 7¾ (20.00)	H
	8 (20.32) to 8¾ (21.27)	I
9 (22.86) - and above	7½ (18.10) to 7½ (19.05)	J
	7¾ (19.37) to 8¾ (20.64)	K
	8¼ (20.96) and above	L

*In operational fitting, the measurements are taken to the nearest ¼ inch.

Each subject wore his correct suit size fitted according to the operational sizing chart, table III following.

TABLE III.
A/P22S-2 FITTING CHART

<i>If Weight is lb</i>	<i>and Height is inches—(centimeters)</i>	<i>then Suit size is</i>
125 - 149	63 (160.02) - 67½ (171.45)	Small Regular
125 - 149	67½ (171.45) - 72 (182.88)	Small Long
150 - 174	64½ (163.83) - 69 (175.26)	Medium Regular
150 - 174	69 (175.26) - 73½ (186.69)	Medium Long
175 - 199	66 (167.64) - 70½ (179.07)	Large Regular
175 - 199	70½ (179.07) - 75 (190.50)	Large Long
200 - 224	67½ (171.45) - 72 (182.88)	X-Large Regular
200 - 224	72 (182.88) - 76½ (194.31)	X-Large Long

Each suit size was worn by at least one subject.

The A/P22S-2 is the current USAF operational full-pressure suit (figure 2). It is described in detail in the Air Force Technical Order 14P3-6-81, dated 1 June 1964. The suit is constructed to Military Specification MIL-F-27628 (USAF) and the gloves to MIL-G-27650A (USAF). It is hoped that the engineering anthropometry data presented here may, with suitable alteration to reflect changed design features such as seam patterns or restraint configurations, be useful when the A/P22S-2 assembly is replaced in the Air Force inventory.

A listing of the 27 subjects and their pertinent anthropometric data are presented in table IV. All subjects were nonrated airmen stationed at Tyndall AFB, Florida.

The correlation coefficients for certain basic anthropometric dimensions are as follows: (all barehanded)

	N=27
Height and Hand Length	0.793
Weight and Hand Length	0.587
Height and Hand Circumference	0.517
Weight and Hand Circumference	0.733
Hand Length and Hand Circumference	0.571

The relationship between the size of a man's hand and the size of his body is not great enough for an accurate prediction of an individual's glove size from his height and weight. Therefore, the entire range of performance values for wearers of each glove size for each dimension is given graphically in the data section to provide data for any special design problem that may arise. The change in the data range is not necessarily consistent as one goes up or down the glove sizing range. A designer must take special care what values he incorporates into special design solutions. Values for glove size D are not necessarily greater than those for glove size B, nor are they necessarily less than values for glove size K.

Various explanations account for certain of these apparent inconsistencies. The primary reason running through the entire series of dimensions lies in the system which serves as sizing and fitting criteria for the gloves. Because the relationship between hand length and hand circumference is not great (correlation coefficient 0.571), the glove sizing program is based on an overlapping series of pairings with three hand lengths paired to each of four hand circumferences. This produces 12 alphabetized sizes predicated on anthropometric data. See table II. Thus, the four sizes C, F, I, and L are actually the longest gloves in the series. As there are only 12 sizes, the actual fitting of a population constitutes a spectrum of hand sizes within each glove size; some men barely fitting into the particular size range, some near the middle, and others near the upper limits. Each man will fit differently, but still satisfactorily within the conditions of the 12-size system. With different fit, various levels of motivation, and basically different manual manipulative skills for each man, it is not unreasonable that most performances will vary somewhat even when two or more men wear the same size gloves.



Figure 1
Close up of
A/P22S-2 Gloves



Figure 2
A/P22S-2 Full Pressure
Assembly

TABLE IV.
ANTHROPOMETRIC DATA OF THE 27 SUBJECTS
(Pounds and Centimeters)

Subject Number	Age	Height	Weight	Hand Length	Hand Circ.	Pressure Glove Size	Pressure Suit Size
1	24	155.2	110	16.2	18.9	A	Sm. Reg.
2	20	165.9	128	17.9	19.5	A	Sm. Reg.
3	23	167.5	139	19.0	20.3	B	Sm. Reg.
4	22	177.0	188	18.3	19.8	B	Lg. Reg.
5	31	174.5	183	19.0	20.3	B	Lg. Reg.
6	23	175.1	145	19.4	18.5	C	Sm. Long
7	22	174.2	147	19.5	19.6	C	Sm. Long
8	23	173.9	127	18.0	20.6	D	Sm. Long
9	21	168.2	152	18.2	21.2	D	Med. Reg.
10	22	174.6	157	19.2	20.4	E	Med. Reg.
11	20	164.6	127	19.4	20.5	E	Sm. Reg.
12	22	172.0	155	19.4	20.7	E	Med. Reg.
13	20	179.8	150	20.0	20.4	F	Med. Long
14	45	177.8	178	21.1	21.5	F	Lg. Reg.
15	24	164.8	161	18.9	21.6	G	Med. Reg.
16	20	164.1	144	18.7	21.6	G	Sm. Reg.
17	25	178.3	168	19.0	21.6	H	Med. Long
18	21	174.4	149	19.4	21.6	H	Sm. Long
19	20	183.1	165	21.0	21.8	I	Med. Long
20	29	184.0	191	20.2	21.7	I	Lg. Long
21	39	170.0	212	18.5	23.2	J	X-Lg. Reg.
22	21	181.4	177	19.2	23.1	J	Lg. Long
23	21	183.6	198	20.3	22.8	K	Lg. Long
24	27	170.2	182	19.7	22.8	K	Lg. Reg.
25	29	184.2	193	21.2	22.9	L	Lg. Long
26	19	193.0	205	21.3	23.4	L	X-Lg. Long
27	34	182.5	186	21.1	23.3	L	Lg. Long

The design criteria recommendations are 5th or 95th percentile values rounded to the nearest 0.25 inch, for the largest/highest or smallest/lowest measurement. A classic example will suffice to illustrate the principle involved. A cockpit canopy must be high enough to allow most, if not all (here arbitrarily 95%), of the pilots to sit comfortably without striking their heads. Panel controls must be located close enough to the seat to allow most, if not all, (again here arbitrarily 95%) of the operators to reach them. The canopy height is thus fixed at a distance above the seat at least equal to the sitting height of 95% of the pilots, a 95th percentile value for sitting height; and the control is placed within the distance from the seat back that is equal to the arm reach of 5% of the pilots, a 5th percentile value for arm reach. In this way, 95% of the using population can both sit comfortably in the closed cockpit and at the same time reach the controls.

The range of values for each glove size must be looked at for those specific problems where the 5th-95th percentile figures are not applicable, as interpolation between percentiles can provide erroneous information.

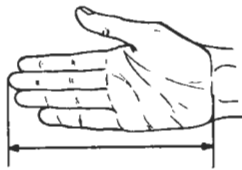
The design recommendations contained in this report provide data on the limits beyond which a man cannot perform, not at what point he performs best. Optimal design criteria can be established only through additional psychomotor and psychological testing procedures.

Contrails

Section II.

DIMENSIONS AND DATA

HAND LENGTH



Subject's right hand is extended, palm up. With the bar of the sliding caliper lying along his palm, measure the distance from the wrist crease to the tip of the longest finger.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

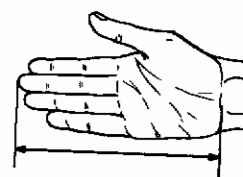
Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	19.38 cm; 7.63 in.	19.84 cm; 7.81 in.	19.70 cm; 7.76 in.
SD:	1.16 cm; 0.45 in.	1.22 cm; 0.48 in.	1.39 cm; 0.55 in.
V%: ²	5.96	6.14	7.07

²The coefficient of variation expresses the standard deviation as a percentage of the mean.

HAND LENGTH



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES³

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

³The percentile values for a particular set of data are treated as though plotted on normal-probability graph paper, and a smooth curve fitted to the points by conventional curve-fitting procedures (Hertzberg et al, 1963, p. 33).

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
21.27	95 TH	8.37	21.72	95 TH	8.55	22.03	95 TH	8.67
21.00	90 TH	8.27	21.53	90 TH	8.48	21.69	90 TH	8.54
20.69	85 TH	8.15	21.30	85 TH	8.39	21.30	85 TH	8.39
20.42	80 TH	8.04	21.08	80 TH	8.30	20.96	80 TH	8.25
20.17	75 TH	7.94	20.86	75 TH	8.21	20.65	75 TH	8.13
19.95	70 TH	7.86	20.65	70 TH	8.13	20.38	70 TH	8.02
19.75	65 TH	7.78	20.44	65 TH	8.05	20.13	65 TH	7.93
19.58	60 TH	7.71	20.24	60 TH	7.97	19.92	60 TH	7.84
19.41	55 TH	7.64	20.04	55 TH	7.89	19.72	55 TH	7.76
19.26	50 TH	7.58	19.84	50 TH	7.81	19.54	50 TH	7.69
19.12	45 TH	7.53	19.65	45 TH	7.73	19.37	45 TH	7.63
18.99	40 TH	7.48	19.45	40 TH	7.66	19.22	40 TH	7.57
18.87	35 TH	7.43	19.26	35 TH	7.58	19.08	35 TH	7.51
18.75	30 TH	7.38	19.06	30 TH	7.50	18.94	30 TH	7.45
18.63	25 TH	7.34	18.87	25 TH	7.43	18.79	25 TH	7.40
18.51	20 TH	7.29	18.68	20 TH	7.35	18.63	20 TH	7.34
18.37	15 TH	7.23	18.49	15 TH	7.28	18.43	15 TH	7.26
18.16	10 TH	7.15	18.33	10 TH	7.22	18.12	10 TH	7.14
17.73	5 TH	6.98	18.29	5 TH	7.20	17.42	5 TH	6.86

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 2.43%

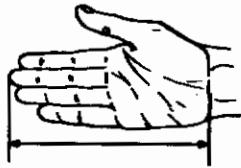
Condition 3: 1.71%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 2.37%

Condition 3: 1.65%



Hand Length

A standard anthropometric measurement of the maximally stretched hand, from the wrist to the tip of the longest finger

HUMAN ENGINEERING APPLICATIONS

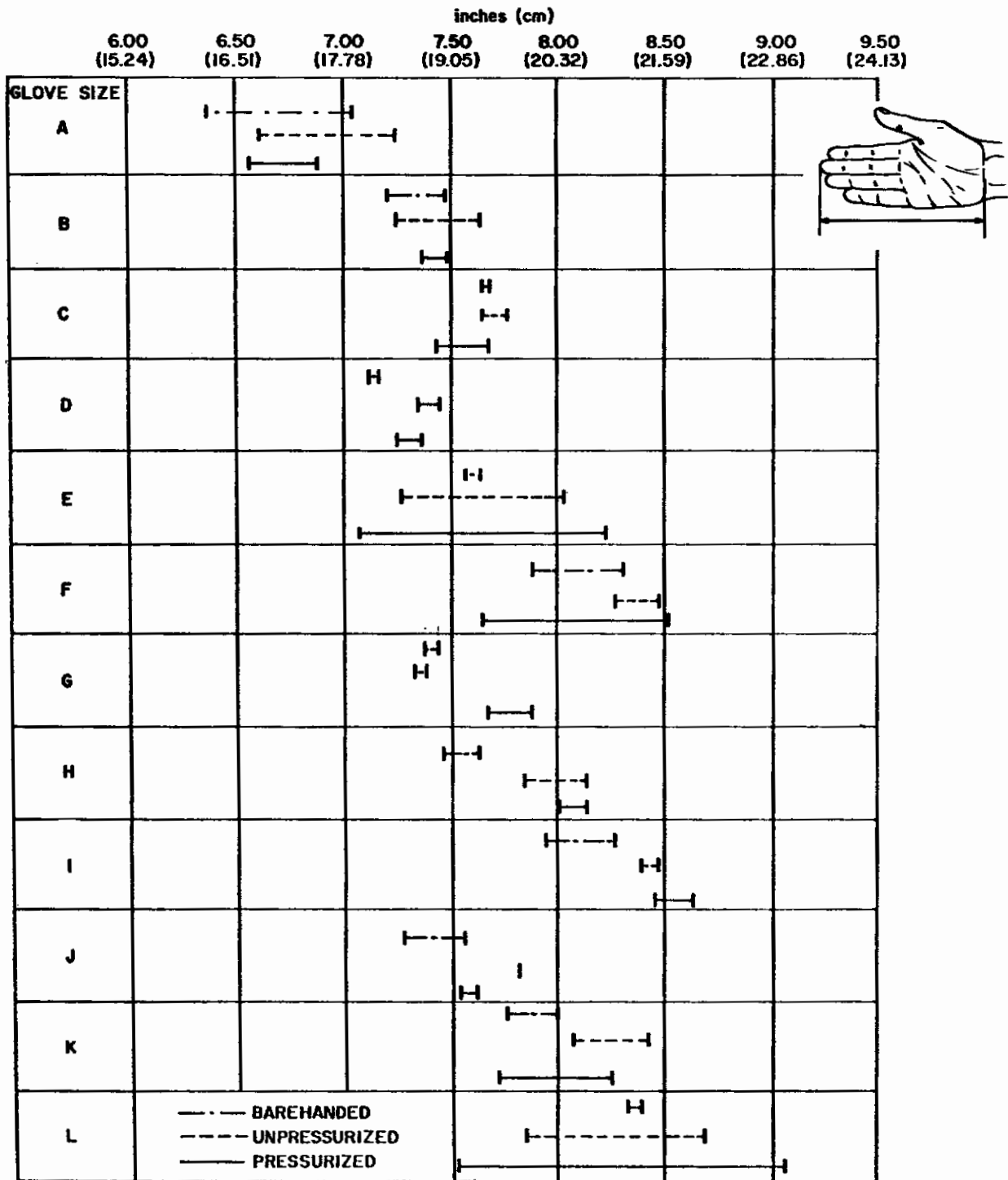
- For — 1) Comparison with published large anthropometric survey data or data from a pertinent specialized population
- 2) Access of the entire hand into a receptacle
 - 3) Location of finger tip controls in depth of receptacle

DESIGN CRITERIA

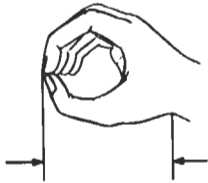
Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For applications 1 and 2	8½ in.	8¾ in.	8¾ in.
For applications 1 and 3	6¾ in.	7 in.	6¾ in.

Range of Values for Hand Length per Glove Size



HAND LENGTH; THUMB - FOREFINGER



Subject's right hand is extended, the tips of the thumb and forefinger lightly touching. Holding the bar of the sliding caliper parallel to the long axis of the thumb, measure from the wrist crease to the farthest point of digit 2.



ANTHROPOMETRIC DATA (N=27)

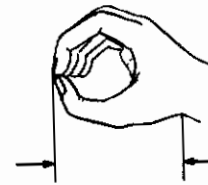
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	11.88 cm; 4.68 in.	13.27 cm; 5.22 in.	13.50 cm; 5.31 in.
SD:	1.02 cm; 0.40 in.	1.19 cm; 0.47 in.	1.18 cm; 0.46 in.
V%:	8.62	9.00	8.74

HAND LENGTH; THUMB - FOREFINGER



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
13.70	95 TH	5.39	15.56	95 TH	6.12	15.64	95 TH	6.16
13.26	90 TH	5.22	15.00	90 TH	5.91	14.98	90 TH	5.90
12.92	85 TH	5.09	14.57	85 TH	5.74	14.62	85 TH	5.75
12.65	80 TH	4.98	14.23	80 TH	5.60	14.37	80 TH	5.66
12.43	75 TH	4.89	13.94	75 TH	5.49	14.17	75 TH	5.58
12.25	70 TH	4.82	13.70	70 TH	5.40	14.01	70 TH	5.52
12.09	65 TH	4.76	13.50	65 TH	5.31	13.87	65 TH	5.46
11.96	60 TH	4.71	13.32	60 TH	5.24	13.74	60 TH	5.41
11.84	55 TH	4.66	13.16	55 TH	5.18	13.61	55 TH	5.36
11.74	50 TH	4.62	13.02	50 TH	5.13	13.49	50 TH	5.31
11.65	45 TH	4.59	12.89	45 TH	5.08	13.36	45 TH	5.26
11.57	40 TH	4.55	12.78	40 TH	5.03	13.23	40 TH	5.21
11.49	35 TH	4.52	12.67	35 TH	4.99	13.10	35 TH	5.16
11.41	30 TH	4.49	12.56	30 TH	4.94	12.95	30 TH	5.10
11.32	25 TH	4.46	12.45	25 TH	4.90	12.78	25 TH	5.03
11.21	20 TH	4.41	12.32	20 TH	4.85	12.57	20 TH	4.95
11.06	15 TH	4.35	12.16	15 TH	4.79	12.32	15 TH	4.85
10.78	10 TH	4.24	11.89	10 TH	4.68	11.97	10 TH	4.71
10.09	5 TH	3.97	11.27	5 TH	4.44	11.38	5 TH	4.48

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 12.09%

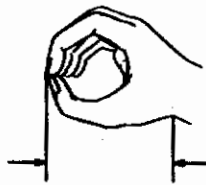
Condition 3: 13.99%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 12.96%

Condition 3: 13.72%



Hand Length; Thumb-Forefinger

A measurement of the length of the hand from the wrist to the farthest point of the index finger when it is in contact with the tip of the thumb; the so-called tip position (HEGED, op. cit., p. 568)

HUMAN ENGINEERING APPLICATIONS

For – 1) Effective length of the hand for grasping operations

2) Determination of length of hand support for those controls which require precise positioning (HEGED, op. cit., p. 283)

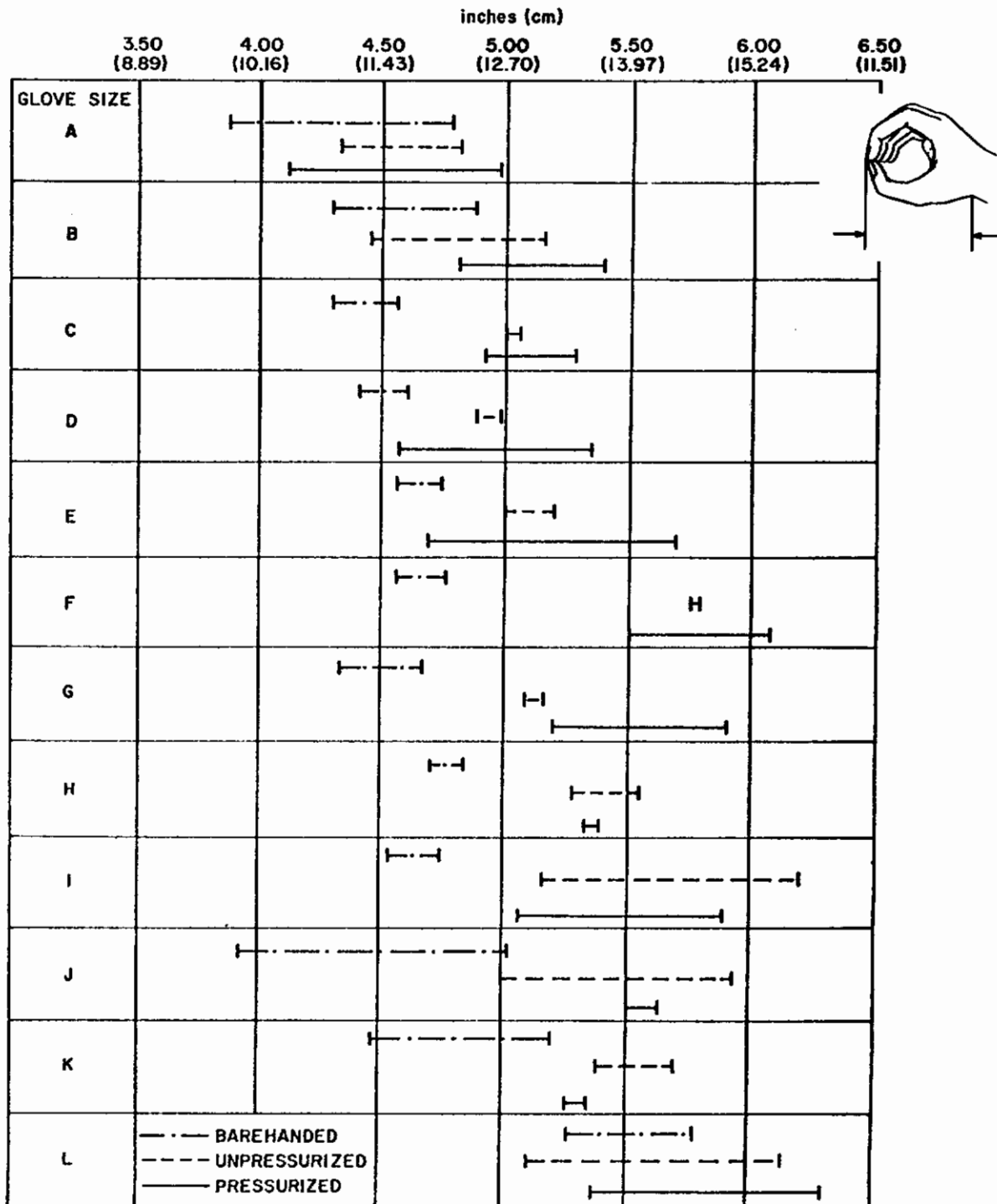
3) Location of controls within an aperture

DESIGN CRITERIA

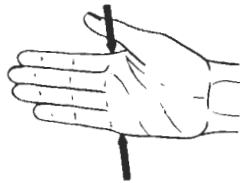
Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For applications 1 and 2	5½ in.	6¼ in.	6¼ in.
For application 3	3¾ in.	4¼ in.	4¼ in.

Range of Values for Hand Length; Thumb-Forefinger per Glove Size



HAND BREADTH; METACARPALE



Subject's right hand is extended, palm ^{down} up. With the bar of the sliding caliper lying across the back of his hand, measure the maximum breadth across the distal ends of the metacarpals (knuckles).



ANTHROPOMETRIC DATA (N=27)

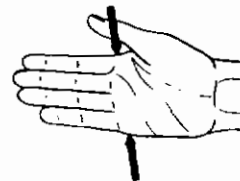
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	8.84 cm; 3.48 in.	9.59 cm; 3.77 in.	9.52 cm; 3.75 in.
SD:	0.55 cm; 0.22 in.	0.60 cm; 0.23 in.	0.66 cm; 0.26 in.
V%:	6.21	6.21	6.96

HAND BREADTH; METACARPALE



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
9.69	95 TH	3.82	10.58	95 TH	4.16	10.55	95 TH	4.16
9.63	90 TH	3.79	10.47	90 TH	4.12	10.48	90 TH	4.12
9.51	85 TH	3.74	10.32	85 TH	4.06	10.35	85 TH	4.08
9.38	80 TH	3.69	10.18	80 TH	4.01	10.23	80 TH	4.03
9.27	75 TH	3.65	10.05	75 TH	3.96	10.11	75 TH	3.98
9.16	70 TH	3.61	9.93	70 TH	3.91	9.99	70 TH	3.93
9.06	65 TH	3.57	9.82	65 TH	3.87	9.87	65 TH	3.89
8.97	60 TH	3.53	9.72	60 TH	3.83	9.76	60 TH	3.84
8.89	55 TH	3.50	9.63	55 TH	3.79	9.64	55 TH	3.80
8.81	50 TH	3.47	9.54	50 TH	3.76	9.53	50 TH	3.75
8.74	45 TH	3.44	9.46	45 TH	3.73	9.42	45 TH	3.71
8.67	40 TH	3.41	9.39	40 TH	3.69	9.31	40 TH	3.67
8.61	35 TH	3.39	9.31	35 TH	3.67	9.20	35 TH	3.62
8.54	30 TH	3.36	9.23	30 TH	3.64	9.09	30 TH	3.58
8.48	25 TH	3.34	9.16	25 TH	3.61	8.98	25 TH	3.53
8.42	20 TH	3.31	9.07	20 TH	3.57	8.86	20 TH	3.49
8.34	15 TH	3.28	8.97	15 TH	3.53	8.74	15 TH	3.44
8.22	10 TH	3.24	8.82	10 TH	3.47	8.61	10 TH	3.39
7.97	5 TH	3.14	8.50	5 TH	3.35	8.50	5 TH	3.35

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 8.63%

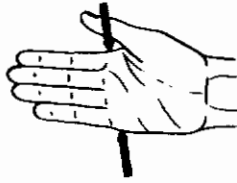
Condition 3: 7.81%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 8.48%

Condition 3: 7.69%



Hand Breadth; Metacarpale

A standard anthropometric measurement across the widest bony part of the flat, stretched hand; not including the thumb

HUMAN ENGINEERING APPLICATIONS

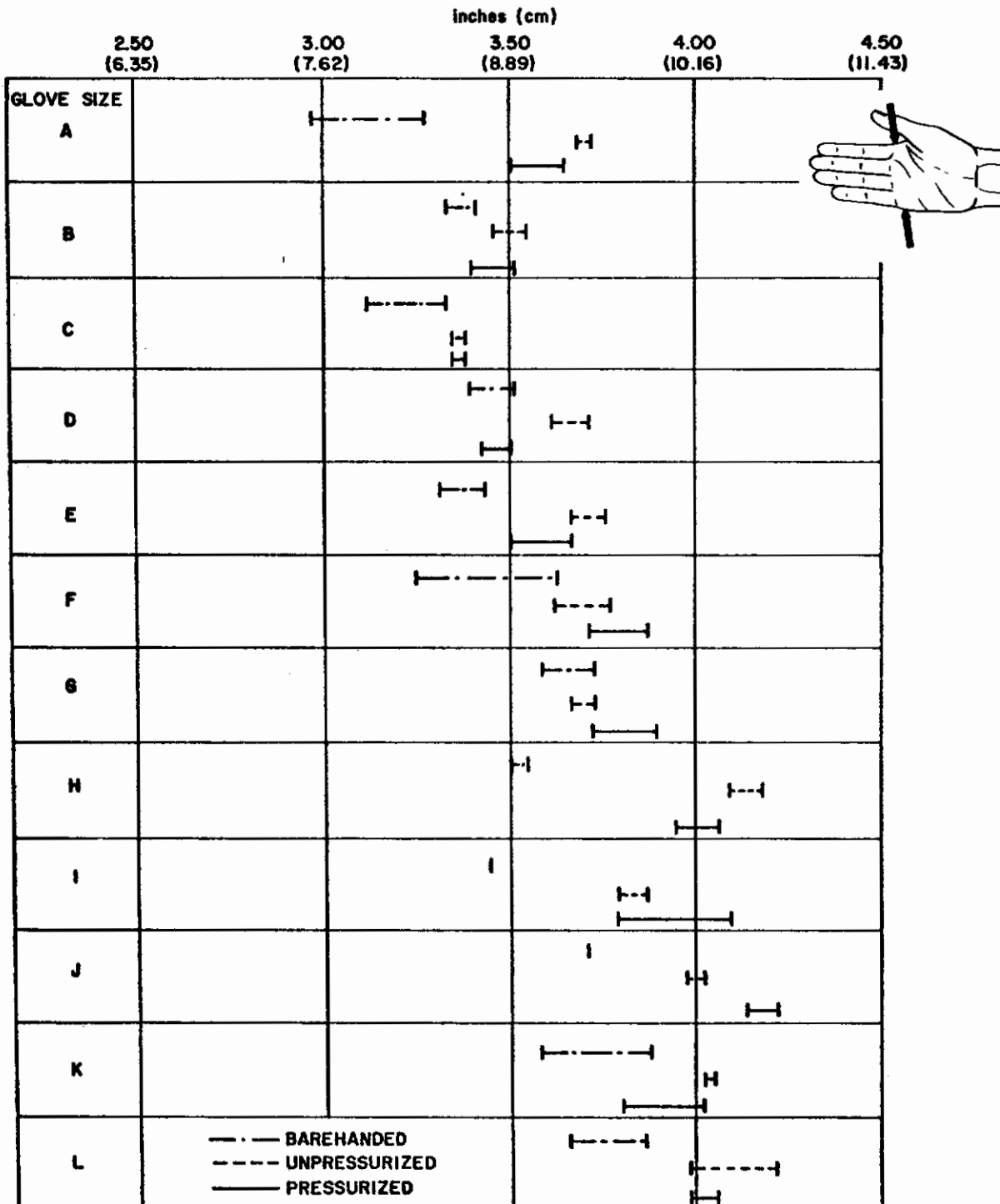
- For – 1) Comparison with published large anthropometric survey data or data from a pertinent, specialized population
- 2) Access of the flattened hand through an aperture
 - 3) Minimum length of handgrips and/or handles

DESIGN CRITERIA

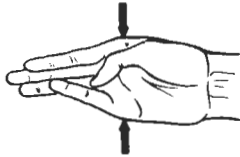
Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For applications 1, 2, 3	4 in.	4$\frac{1}{4}$ in.	4$\frac{1}{4}$ in.
For application 1	3 in.	3$\frac{1}{4}$ in.	3$\frac{1}{4}$ in.

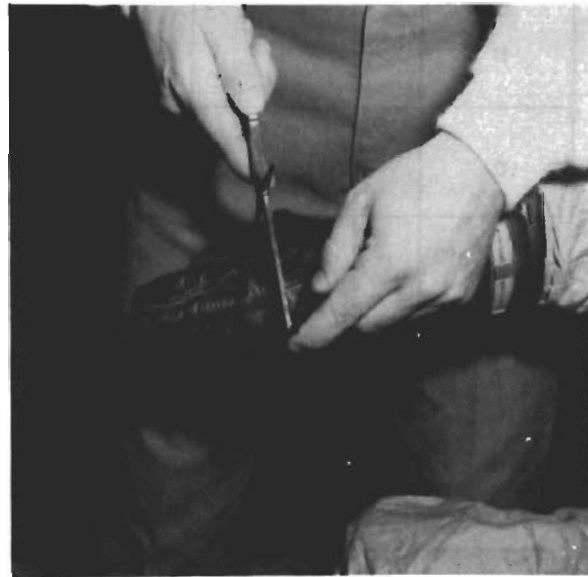
Range of Values for Hand Breadth; Metacarpale per Glove Size



HAND BREADTH; METACARPALE, MINIMUM



Subject extends and narrows his right hand as small as possible. Measure the maximum distance across the distal ends of the metacarpals (knuckles) of digits 2-5.



ANTHROPOMETRIC DATA (N=27)

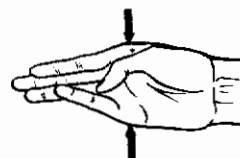
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	8.38 cm; 3.30 in.	9.31 cm; 3.66 in.	9.53 cm; 3.75 in.
SD:	0.51 cm; 0.20 in.	0.52 cm; 0.20 in.	0.65 cm; 0.26 in.
V%:	6.07	5.56	6.85

HAND BREADTH; METACARPALE, MINIMUM



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
9.24	95 TH	3.64	10.13	95 TH	3.99	10.61	95 TH	4.18
9.02	90 TH	3.55	10.11	90 TH	3.98	10.57	90 TH	4.16
8.91	85 TH	3.51	9.98	85 TH	3.93	10.44	85 TH	4.11
8.82	80 TH	3.47	9.85	80 TH	3.88	10.29	80 TH	4.05
8.75	75 TH	3.45	9.72	75 TH	3.83	10.15	75 TH	4.00
8.69	70 TH	3.42	9.60	70 TH	3.78	10.01	70 TH	3.94
8.63	65 TH	3.40	9.49	65 TH	3.74	9.88	65 TH	3.89
8.57	60 TH	3.37	9.39	60 TH	3.70	9.75	60 TH	3.84
8.51	55 TH	3.35	9.30	55 TH	3.66	9.63	55 TH	3.79
8.44	50 TH	3.32	9.21	50 TH	3.63	9.51	50 TH	3.74
8.37	45 TH	3.30	9.13	45 TH	3.60	9.39	45 TH	3.70
8.30	40 TH	3.27	9.06	40 TH	3.57	9.28	40 TH	3.65
8.22	35 TH	3.24	8.99	35 TH	3.54	9.17	35 TH	3.61
8.13	30 TH	3.20	8.93	30 TH	3.51	9.05	30 TH	3.56
8.03	25 TH	3.16	8.86	25 TH	3.49	8.94	25 TH	3.52
7.91	20 TH	3.12	8.80	20 TH	3.46	8.83	20 TH	3.48
7.78	15 TH	3.06	8.73	15 TH	3.44	8.72	15 TH	3.43
7.61	10 TH	3.00	8.63	10 TH	3.40	8.59	10 TH	3.38
7.40	5 TH	2.91	8.41	5 TH	3.31	8.43	5 TH	3.32

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 11.29%

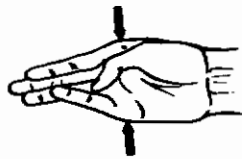
Condition 3: 13.92%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 11.10%

Condition 3: 13.72%



Hand Breadth; Metacarpale Minimum

A measure of the smallest possible breadth (width) to which a man can narrow his hand

HUMAN ENGINEERING APPLICATIONS

- For – 1) Determination of minimum dimensions, here widths, for ingress and egress of the hand into an aperture
2) The smallest width for placement of the hand anywhere

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

Unpressurized

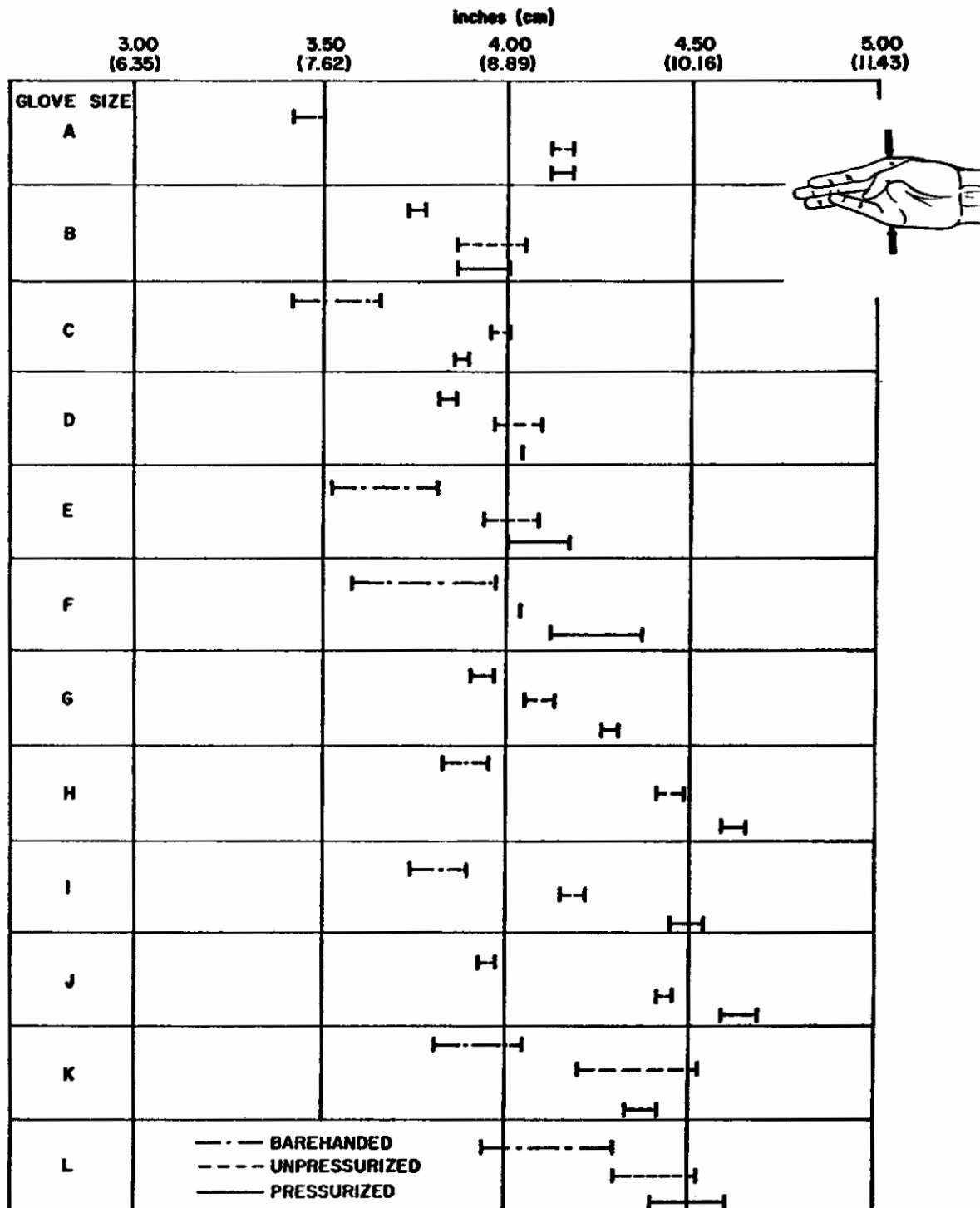
Pressurized

3¾ in.

4 in.

4¼ in.

Range of Values for Hand Breadth; Metacarpale, Minimum per Glove Size



HAND CIRCUMFERENCE; METACARPALE



Subject's right hand is extended, palm down, thumb held away from the fingers. With the tape, measure the circumference around the distal ends of the metacarpals (knuckles) of digits 2 and 5.



ANTHROPOMETRIC DATA (N=27)

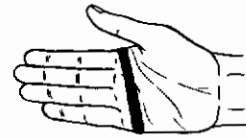
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	21.24 cm; 8.36 in.	22.99 cm; 9.05 in.	24.55 cm; 9.67 in.
SD:	1.36 cm; 0.54 in.	1.45 cm; 0.57 in.	1.54 cm; 0.61 in.
V%:	6.41	6.29	6.29

HAND CIRCUMFERENCE; METACARPALE



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
23.38	95 TH	9.20	25.54	95 TH	10.06	27.01	95 TH	10.63
23.35	90 TH	9.19	24.99	90 TH	9.84	26.80	90 TH	10.55
23.04	85 TH	9.07	24.63	85 TH	9.70	26.49	85 TH	10.43
22.71	80 TH	8.94	24.34	80 TH	9.58	26.18	80 TH	10.31
22.39	75 TH	8.82	24.08	75 TH	9.48	25.87	75 TH	10.19
22.10	70 TH	8.70	23.84	70 TH	9.38	25.57	70 TH	10.07
21.82	65 TH	8.59	23.61	65 TH	9.29	25.28	65 TH	9.95
21.57	60 TH	8.49	23.38	60 TH	9.20	25.00	60 TH	9.84
21.34	55 TH	8.40	23.16	55 TH	9.12	24.72	55 TH	9.73
21.13	50 TH	8.32	22.94	50 TH	9.03	24.44	50 TH	9.62
20.94	45 TH	8.24	22.71	45 TH	8.94	24.17	45 TH	9.52
20.76	40 TH	8.17	22.48	40 TH	8.85	23.90	40 TH	9.41
20.59	35 TH	8.10	22.25	35 TH	8.76	23.64	35 TH	9.31
20.42	30 TH	8.04	22.01	30 TH	8.67	23.37	30 TH	9.20
20.26	25 TH	7.98	21.77	25 TH	8.57	23.11	25 TH	9.10
20.09	20 TH	7.91	21.52	20 TH	8.47	22.85	20 TH	9.00
19.89	15 TH	7.83	21.28	15 TH	8.38	22.60	15 TH	8.90
19.58	10 TH	7.71	21.07	10 TH	8.30	22.39	10 TH	8.82
18.86	5 TH	7.43	21.05	5 TH	8.29	22.32	5 TH	8.79

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 8.28%

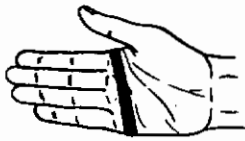
Condition 3: 15.64%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 8.24%

Condition 3: 15.58%



Hand Circumference; Metacarpale

A standard anthropometric measurement of the circumference around the knuckles of the flattened hand

HUMAN ENGINEERING APPLICATIONS

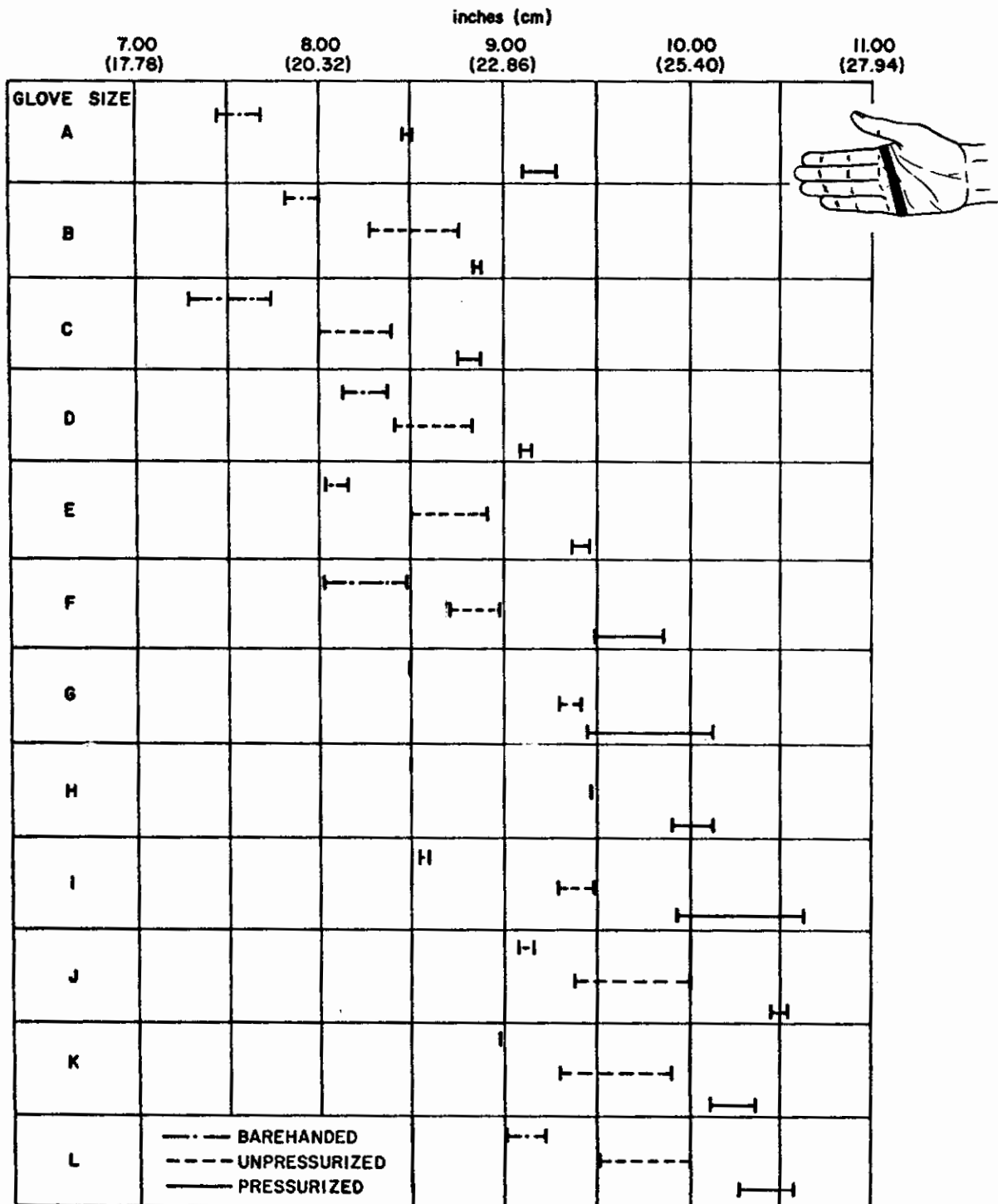
- For – 1) Comparison with published large anthropometric survey data or data from a pertinent specialized population
- 2) Access of the hand from fingertips to thumb crotch into an aperture or receptacle

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For application 1	7$\frac{1}{4}$ in.	8$\frac{1}{4}$ in.	8$\frac{3}{4}$ in.
For applications 1 and 2	9$\frac{1}{4}$ in.	10$\frac{1}{4}$ in.	10$\frac{3}{4}$ in.

Range of Values for Hand Circumference, Metacarpale per Glove Size



HAND CIRCUMFERENCE; THUMB - FOREFINGER



Subject's right hand is extended with the tips of the thumb and forefinger lightly touching. With the tape passing over the distal ends of the metacarpals (knuckles) of all five digits, measure the circumference of the hand.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	27.36 cm; 10.77 in.	28.87 cm; 11.37 in.	31.27 cm; 12.31 in.
SD:	1.77 cm; 0.70 in.	1.65 cm; 0.65 in.	1.53 cm; 0.60 in.
V%:	6.48	5.71	4.91

HAND CIRCUMFERENCE; THUMB - FOREFINGER



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
30.97	95 TH	12.19	31.15	95 TH	12.26	33.25	95 TH	13.09
29.92	90 TH	11.78	30.88	90 TH	12.16	33.03	90 TH	13.01
29.27	85 TH	11.52	30.62	85 TH	12.05	32.90	85 TH	12.95
28.80	80 TH	11.34	30.36	80 TH	11.95	32.77	80 TH	12.90
28.42	75 TH	11.19	30.11	75 TH	11.85	32.62	75 TH	12.84
28.11	70 TH	11.07	29.86	70 TH	11.75	32.46	70 TH	12.78
27.84	65 TH	10.96	29.61	65 TH	11.66	32.29	65 TH	12.71
27.60	60 TH	10.87	29.35	60 TH	11.56	32.09	60 TH	12.64
27.38	55 TH	10.78	29.10	55 TH	11.46	31.88	55 TH	12.55
27.17	50 TH	10.70	28.84	50 TH	11.35	31.65	50 TH	12.46
26.97	45 TH	10.62	28.58	45 TH	11.25	31.39	45 TH	12.36
26.78	40 TH	10.54	28.31	40 TH	11.15	31.12	40 TH	12.25
26.58	35 TH	10.46	28.03	35 TH	11.04	30.81	35 TH	12.13
26.37	30 TH	10.38	27.75	30 TH	10.92	30.48	30 TH	12.00
26.15	25 TH	10.29	27.45	25 TH	10.81	30.11	25 TH	11.85
25.88	20 TH	10.19	27.14	20 TH	10.69	29.70	20 TH	11.69
25.55	15 TH	10.06	26.84	15 TH	10.57	29.24	15 TH	11.51
25.07	10 TH	9.87	26.55	10 TH	10.45	28.74	10 TH	11.32
24.17	5 TH	9.51	26.41	5 TH	10.40	28.30	5 TH	11.14

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 5.65%

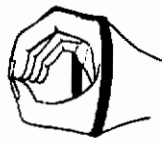
Condition 3: 14.60%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 5.52%

Condition 3: 14.29%



Hand Circumference; Thumb-Forefinger

A measurement of the circumference of the hand around the knuckles when the tip of the index finger is in contact with the tip of the thumb; this is the so-called tip position

HUMAN ENGINEERING APPLICATIONS

- For – 1) Determination of the dimensions of apertures and workspace areas designed for occupation by a man's hand in the tip position
- 2) Location of certain types of controls (toggles, rotary switches, etc.) in depth of receptacle

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For application 1	12$\frac{1}{4}$ in.	12$\frac{1}{2}$ in.	13$\frac{1}{4}$ in.
For application 2	9$\frac{1}{2}$ in.	10$\frac{1}{4}$ in.	11 in.

Range of Values for Hand Circumference; Thumb-Forefinger per Glove Size

		inches (cm)					
		9.00 (22.86)	10.00 (25.40)	11.00 (27.94)	12.00 (30.48)	13.00 (33.02)	14.00 (35.56)
GLOVE SIZE							
A							
B			 				
C			 				
D			 				
E							
F			 				
G							
H							
I							
J							
K							
L		 		 			



HAND CIRCUMFERENCE; METACARPALE, MINIMUM



Subject extends and narrows his right hand as small as possible. With the tape, measure the circumference around the distal ends of the metacarpals (knuckles) of digits 2 and 5.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	23.77 cm; 9.36 in.	26.19 cm; 10.31 in.	28.03 cm; 11.04 in.
SD:	2.30 cm; 0.91 in.	2.62 cm; 1.03 in.	2.79 cm; 1.10 in.
V%:	9.69	10.00	9.96



HAND CIRCUMFERENCE;

METACARPALE, MINIMUM

ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
26.87	95 TH	10.58	29.69	95 TH	11.69	31.94	95 TH	12.57
26.85	90 TH	10.57	29.47	90 TH	11.60	31.71	90 TH	12.48
26.54	85 TH	10.45	29.24	85 TH	11.51	31.35	85 TH	12.34
26.16	80 TH	10.30	29.02	80 TH	11.42	30.96	80 TH	12.19
25.77	75 TH	10.14	28.79	75 TH	11.34	30.53	75 TH	12.02
25.37	70 TH	9.99	28.20	70 TH	11.10	30.10	70 TH	11.85
24.98	65 TH	9.83	27.53	65 TH	10.84	29.66	65 TH	11.68
24.59	60 TH	9.68	27.05	60 TH	10.65	29.21	60 TH	11.50
24.21	55 TH	9.53	26.71	55 TH	10.52	28.74	55 TH	11.32
23.82	50 TH	9.38	26.38	50 TH	10.38	28.27	50 TH	11.13
23.44	45 TH	9.23	25.83	45 TH	10.17	27.77	45 TH	10.93
23.06	40 TH	9.08	25.10	40 TH	9.88	27.27	40 TH	10.74
22.67	35 TH	8.93	24.93	35 TH	9.82	26.74	35 TH	10.53
22.28	30 TH	8.77	24.76	30 TH	9.75	26.20	30 TH	10.31
21.87	25 TH	8.61	23.71	25 TH	9.33	25.63	25 TH	10.09
21.45	20 TH	8.45	23.48	20 TH	9.25	25.03	20 TH	9.86
21.02	15 TH	8.28	23.26	15 TH	9.16	24.43	15 TH	9.62
20.56	10 TH	8.09	22.60	10 TH	8.90	23.85	10 TH	9.39
20.06	5 TH	7.90	21.92	5 TH	8.63	23.55	5 TH	9.27

*Percentage Increase of the
Individual Differences (Averaged)*

Condition 1 as Base

Condition 2: 10.24%

Condition 3: 18.10%

*Percentage Increase of the
Means*

Condition 1 as Base

Condition 2: 10.18%

Condition 3: 17.92%



Hand Circumference; Metacarpale, Minimum

A measure of the smallest circumference when the hand is narrowed as much as possible

HUMAN ENGINEERING APPLICATIONS

- For – 1) Determination of minimum dimensions for ingress and egress of the hand into an aperture
2) The smallest spatial envelope for placement of the hand anywhere

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

10³/₄ in.

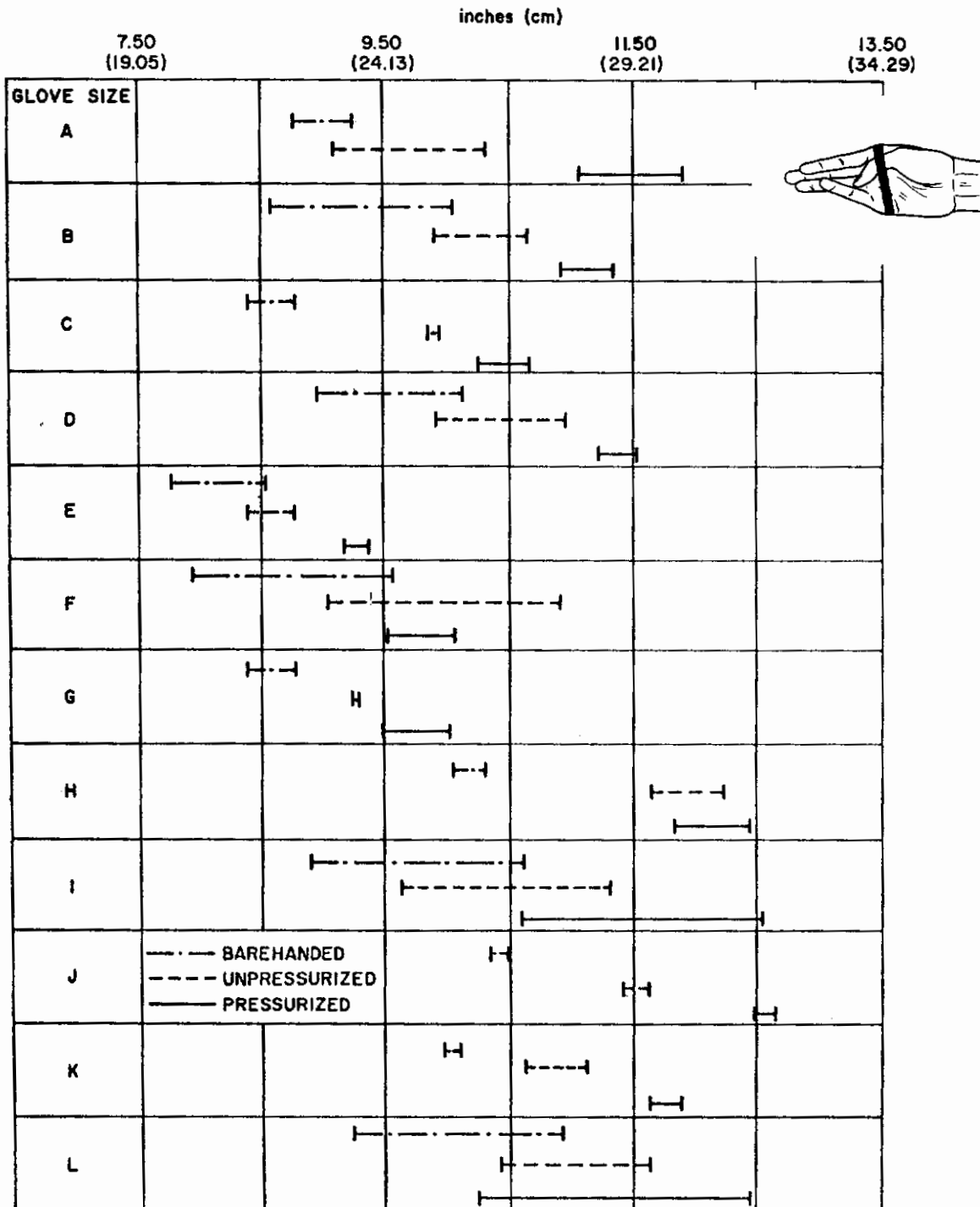
Unpressurized

11³/₄ in.

Pressurized

12³/₄ in.

Range of Values for Hand Circumference; Metacarpale, Minimum per Glove Size



FIST CIRCUMFERENCE



Subject makes a tight fist with his right hand. With the tape passing over the distal ends of the metacarpals (knuckles) of all five digits, measure the circumference of the fist.



ANTHROPOMETRIC DATA (N = 27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	29.02 cm; 11.42 in.	30.77 cm; 12.11 in.	31.91 cm; 12.56 in.
SD:	1.99 cm; 0.79 in.	1.42 cm; 0.56 in.	1.60 cm; 0.63 in.
V%:	6.87	4.61	5.01



FIST CIRCUMFERENCE

ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
32.11	95 TH	12.64	32.87	95 TH	12.94	34.09	95 TH	13.42
31.83	90 TH	12.53	32.72	90 TH	12.88	33.91	90 TH	13.35
31.44	85 TH	12.38	32.47	85 TH	12.78	33.72	85 TH	13.27
31.05	80 TH	12.22	32.21	80 TH	12.68	33.51	80 TH	13.19
30.67	75 TH	12.08	31.96	75 TH	12.58	33.30	75 TH	13.11
30.32	70 TH	11.94	31.72	70 TH	12.49	33.07	70 TH	13.02
29.97	65 TH	11.80	31.50	65 TH	12.40	32.83	65 TH	12.93
29.64	60 TH	11.67	31.28	60 TH	12.32	32.58	60 TH	12.83
29.32	55 TH	11.54	31.07	55 TH	12.23	32.33	55 TH	12.73
29.00	50 TH	11.42	30.87	50 TH	12.15	32.06	50 TH	12.62
28.69	45 TH	11.29	30.67	45 TH	12.08	31.77	45 TH	12.51
28.38	40 TH	11.17	30.48	40 TH	12.00	31.48	40 TH	12.39
28.08	35 TH	11.05	30.28	35 TH	11.92	31.17	35 TH	12.27
27.77	30 TH	10.93	30.08	30 TH	11.84	30.84	30 TH	12.14
27.45	25 TH	10.81	29.87	25 TH	11.76	30.50	25 TH	12.01
27.13	20 TH	10.68	29.64	20 TH	11.67	30.15	20 TH	11.87
26.79	15 TH	10.55	29.37	15 TH	11.56	29.80	15 TH	11.73
26.43	10 TH	10.40	29.01	10 TH	11.42	29.49	10 TH	11.61
26.02	5 TH	10.25	28.39	5 TH	11.18	29.44	5 TH	11.59

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 6.26%

Condition 3: 10.22%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 6.03%

Condition 3: 9.96%



Fist Circumference

A measure of the circumference of the tight fist taken over the knuckles

HUMAN ENGINEERING APPLICATIONS

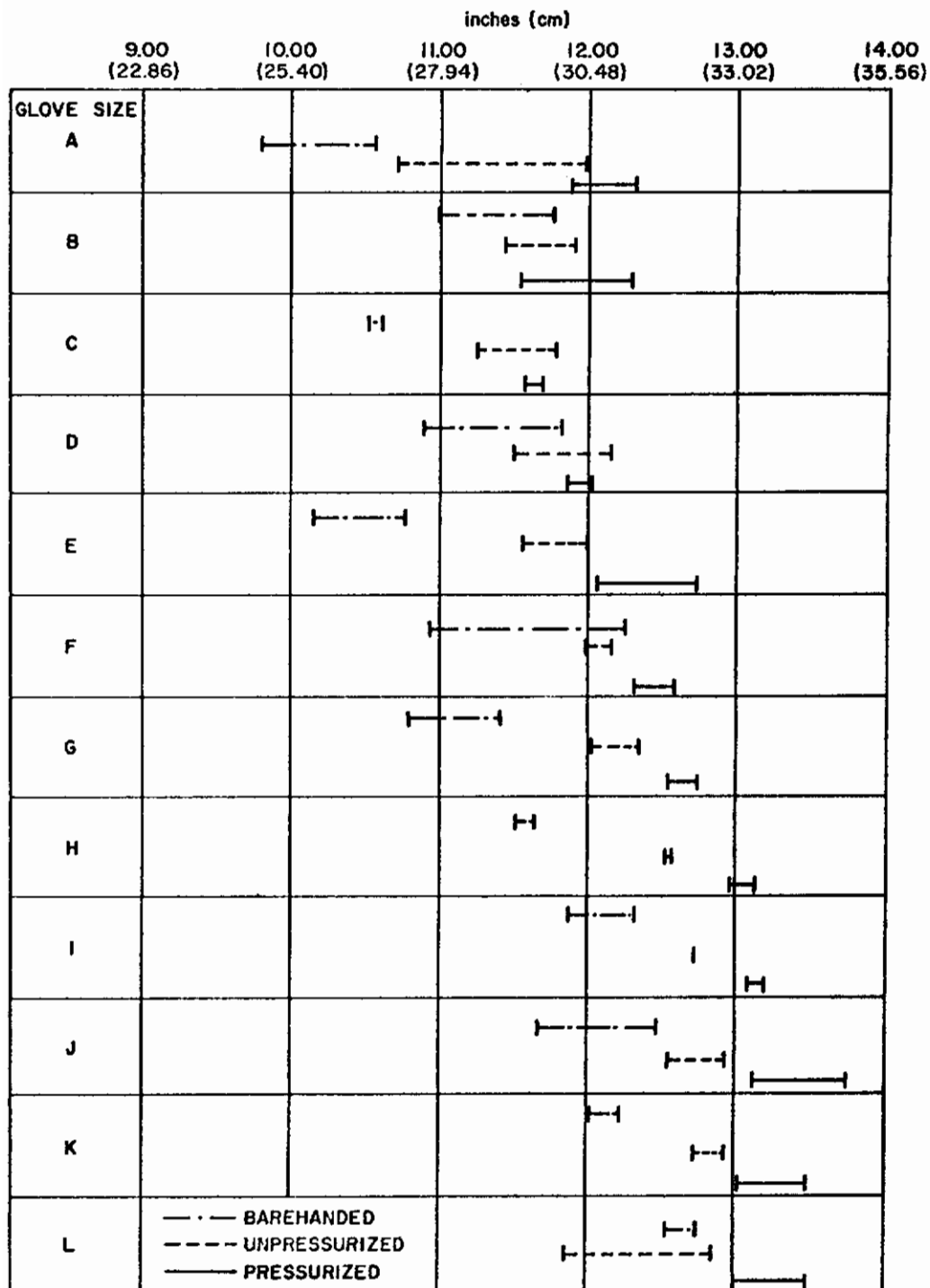
For – 1) Determination of the minimum dimensions of apertures and workspaces designed to accept a man's fist

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
12³/₄ in.	13 in.	13¹/₂ in.

Range of Values for Fist Circumference per Glove Size



FINGER BREADTH;

DIGIT 2



Subject's right index finger is inserted into a series of graduated holes. Record the diameter of the hole which most closely approximates the maximum breadth of the finger.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	2.04 cm; 0.80 in.	2.37 cm; 0.93 in.	2.57 cm; 1.01 in.
SD:	0.12 cm; 0.05 in.	0.11 cm; 0.05 in.	0.17 cm; 0.07 in.
V%:	5.87	4.84	6.46

FINGER BREADTH;

DIGIT 2



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
2.25	95 TH	0.88	2.55	95 TH	1.00	2.82	95 TH	1.11
2.23	90 TH	0.88	2.53	90 TH	1.00	2.73	90 TH	1.08
2.21	85 TH	0.87	2.51	85 TH	0.99	2.70	85 TH	1.06
2.10	80 TH	0.83	2.48	80 TH	0.98	2.68	80 TH	1.05
2.09	75 TH	0.82	2.46	75 TH	0.97	2.66	75 TH	1.05
2.09	70 TH	0.82	2.45	70 TH	0.96	2.64	70 TH	1.04
2.08	65 TH	0.82	2.43	65 TH	0.96	2.63	65 TH	1.03
2.08	60 TH	0.82	2.41	60 TH	0.95	2.61	60 TH	1.03
2.07	55 TH	0.82	2.40	55 TH	0.94	2.60	55 TH	1.02
2.07	50 TH	0.81	2.38	50 TH	0.94	2.58	50 TH	1.01
2.06	45 TH	0.81	2.37	45 TH	0.93	2.56	45 TH	1.01
2.06	40 TH	0.81	2.35	40 TH	0.93	2.54	40 TH	1.00
2.05	35 TH	0.81	2.34	35 TH	0.92	2.51	35 TH	0.99
1.94	30 TH	0.77	2.32	30 TH	0.91	2.48	30 TH	0.98
1.94	25 TH	0.76	2.30	25 TH	0.91	2.46	25 TH	0.97
1.93	20 TH	0.76	2.29	20 TH	0.90	2.42	20 TH	0.95
1.92	15 TH	0.76	2.27	15 TH	0.89	2.39	15 TH	0.94
1.91	10 TH	0.75	2.24	10 TH	0.88	2.36	10 TH	0.93
1.91	5 TH	0.75	2.19	5 TH	0.86	2.36	5 TH	0.93

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 16.53%

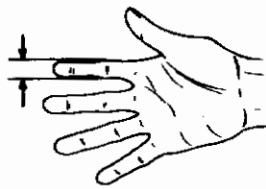
Condition 3: 26.41%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 16.18%

Condition 3: 25.98%



Finger Breadth; Digit 2

The maximum breadth of the index finger

HUMAN ENGINEERING APPLICATIONS

- For – 1) Sizing of apertures to permit entry of the index finger
2) Determination of minimum distance between control buttons

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

1 in.

Unpressurized

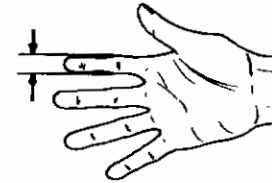
1 in.

Pressurized

1¼ in.

Range of Values for Finger Breadth; Digit 2 per Glove Size

	inches (cm)				
	0.70 (1.78)	0.80 (2.03)	0.90 (2.29)	1.00 (2.54)	1.10 (2.79)
GLOVE SIZE					
A	I		I	I	
B	I	I	I	I	
C	I	I	I		
D		I	I	I	
E	I		I	I	
F		I	I	I	
G	I			I	
H		I	I	I	
I		I	I	I	
J		I		I	
K		I	I	I	
L		I	I	I	



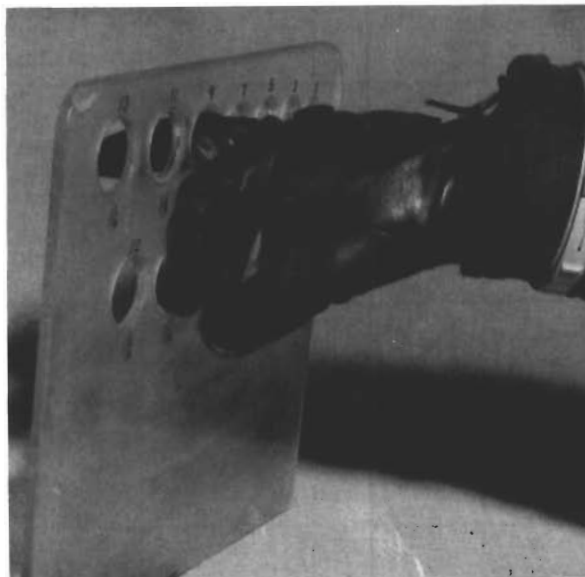
— BAREHANDED
 - - - UNPRESSURIZED
 — PRESSURIZED

FINGER BREADTH;

DIGIT 3



Subject's right middle finger is inserted into a series of graduated holes. Record the diameter of the hole which most closely approximates the maximum breadth of the finger.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	2.09 cm; 0.82 in.	2.42 cm; 0.95 in.	2.62 cm; 1.03 in.
SD:	0.13 cm; 0.05 in.	0.12 cm; 0.05 in.	0.16 cm; 0.06 in.
V%:	6.06	4.95	6.04

FINGER BREADTH;

DIGIT 3



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
2.25	95 TH	0.89	2.54	95 TH	1.00	2.84	95 TH	1.12
2.24	90 TH	0.88	2.54	90 TH	1.00	2.77	90 TH	1.09
2.23	85 TH	0.88	2.53	85 TH	1.00	2.73	85 TH	1.08
2.23	80 TH	0.88	2.53	80 TH	1.00	2.71	80 TH	1.07
2.22	75 TH	0.87	2.52	75 TH	0.99	2.70	75 TH	1.06
2.21	70 TH	0.87	2.52	70 TH	0.99	2.69	70 TH	1.06
2.21	65 TH	0.87	2.51	65 TH	0.99	2.67	65 TH	1.05
2.20	60 TH	0.87	2.50	60 TH	0.99	2.66	60 TH	1.05
2.09	55 TH	0.82	2.40	55 TH	0.94	2.65	55 TH	1.04
2.09	50 TH	0.82	2.39	50 TH	0.94	2.63	50 TH	1.04
2.08	45 TH	0.82	2.39	45 TH	0.94	2.61	45 TH	1.03
2.07	40 TH	0.82	2.38	40 TH	0.94	2.60	40 TH	1.02
2.07	35 TH	0.81	2.37	35 TH	0.93	2.58	35 TH	1.01
2.06	30 TH	0.81	2.37	30 TH	0.93	2.55	30 TH	1.00
2.05	25 TH	0.81	2.36	25 TH	0.93	2.52	25 TH	0.99
1.94	20 TH	0.77	2.36	20 TH	0.93	2.49	20 TH	0.98
1.93	15 TH	0.76	2.35	15 TH	0.93	2.46	15 TH	0.97
1.92	10 TH	0.76	2.23	10 TH	0.88	2.41	10 TH	0.95
1.91	5 TH	0.75	2.22	5 TH	0.87	2.35	5 TH	0.93

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 15.84%

Condition 3: 25.67%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 15.79%

Condition 3: 25.36%



Finger Breadth; Digit 3

The maximum breadth of the middle finger

HUMAN ENGINEERING APPLICATIONS

- For – 1) Sizing of apertures to permit entry of the middle finger
2) Determination of minimum distance between control buttons

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

1 in.

Unpressurized

1 in.

Pressurized

1¼ in.

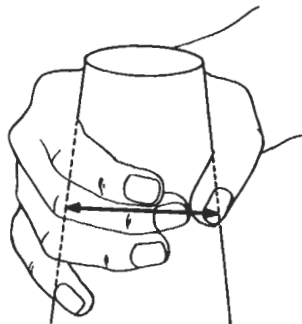
Range of Values for Finger Breadth; Digit 3 per Glove Size

	inches (cm)					
	0.70 (1.78)	0.80 (2.03)	0.90 (2.29)	1.00 (2.54)	1.10 (2.79)	1.20 (3.05)
GLOVE SIZE						
A	I		I			
B		I	I			
C	I		I			
D		I	I			
E	I		I			
F		I	I			
G	I					
H		I	I			
I		I				
J		I				
K		I				
L		I				



— BAREHANDED
 - - - UNPRESSURIZED
 — PRESSURIZED

GRIP BREADTH; INSIDE



Subject holds a cone at the largest circumference that he can grasp with his thumb and middle fingers just touching. Record the diameter of the cone corresponding to this maximum circumference.



ANTHROPOMETRIC DATA (N=27)

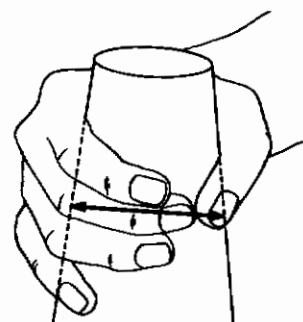
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	4.87 cm; 1.92 in.	4.37 cm; 1.72 in.	4.03 cm; 1.59 in.
SD:	0.41 cm; 0.16 in.	0.40 cm; 0.16 in.	0.47 cm; 0.19 in.
V%:	8.33	9.12	11.70

GRIP BREADTH; INSIDE



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
5.55	95 TH	2.19	5.16	95 TH	2.03	4.83	95 TH	1.90
5.48	90 TH	2.16	5.03	90 TH	1.98	4.74	90 TH	1.86
5.39	85 TH	2.12	4.90	85 TH	1.93	4.63	85 TH	1.82
5.30	80 TH	2.09	4.79	80 TH	1.88	4.53	80 TH	1.78
5.22	75 TH	2.06	4.68	75 TH	1.84	4.43	75 TH	1.74
5.14	70 TH	2.02	4.60	70 TH	1.81	4.34	70 TH	1.71
5.07	65 TH	1.99	4.52	65 TH	1.78	4.26	65 TH	1.68
4.99	60 TH	1.97	4.44	60 TH	1.75	4.18	60 TH	1.65
4.92	55 TH	1.94	4.38	55 TH	1.72	4.10	55 TH	1.62
4.86	50 TH	1.91	4.32	50 TH	1.70	4.03	50 TH	1.59
4.79	45 TH	1.89	4.26	45 TH	1.68	3.96	45 TH	1.56
4.72	40 TH	1.86	4.21	40 TH	1.66	3.89	40 TH	1.53
4.66	35 TH	1.83	4.17	35 TH	1.64	3.82	35 TH	1.50
4.60	30 TH	1.81	4.12	30 TH	1.62	3.75	30 TH	1.48
4.53	25 TH	1.79	4.08	25 TH	1.60	3.68	25 TH	1.45
4.47	20 TH	1.76	4.03	20 TH	1.59	3.60	20 TH	1.42
4.41	15 TH	1.74	3.98	15 TH	1.57	3.51	15 TH	1.38
4.36	10 TH	1.72	3.91	10 TH	1.54	3.40	10 TH	1.34
4.32	5 TH	1.70	3.75	5 TH	1.48	3.23	5 TH	1.27

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 10.06%

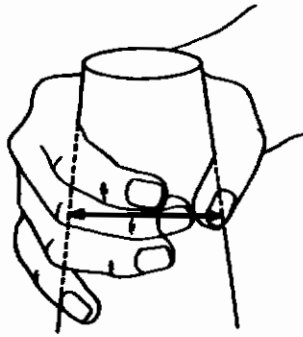
Condition 3: 17.24%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 10.27%

Condition 3: 17.86%



Grip Breadth; Inside

The diameter of the largest cylinder that a man can completely enclose with the tips of his thumb and middle finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum diameter of rod shaped or cylindrical objects which a man can completely enclose with the fingers of one hand; for instance, handles, struts, building materials

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

1½ in.

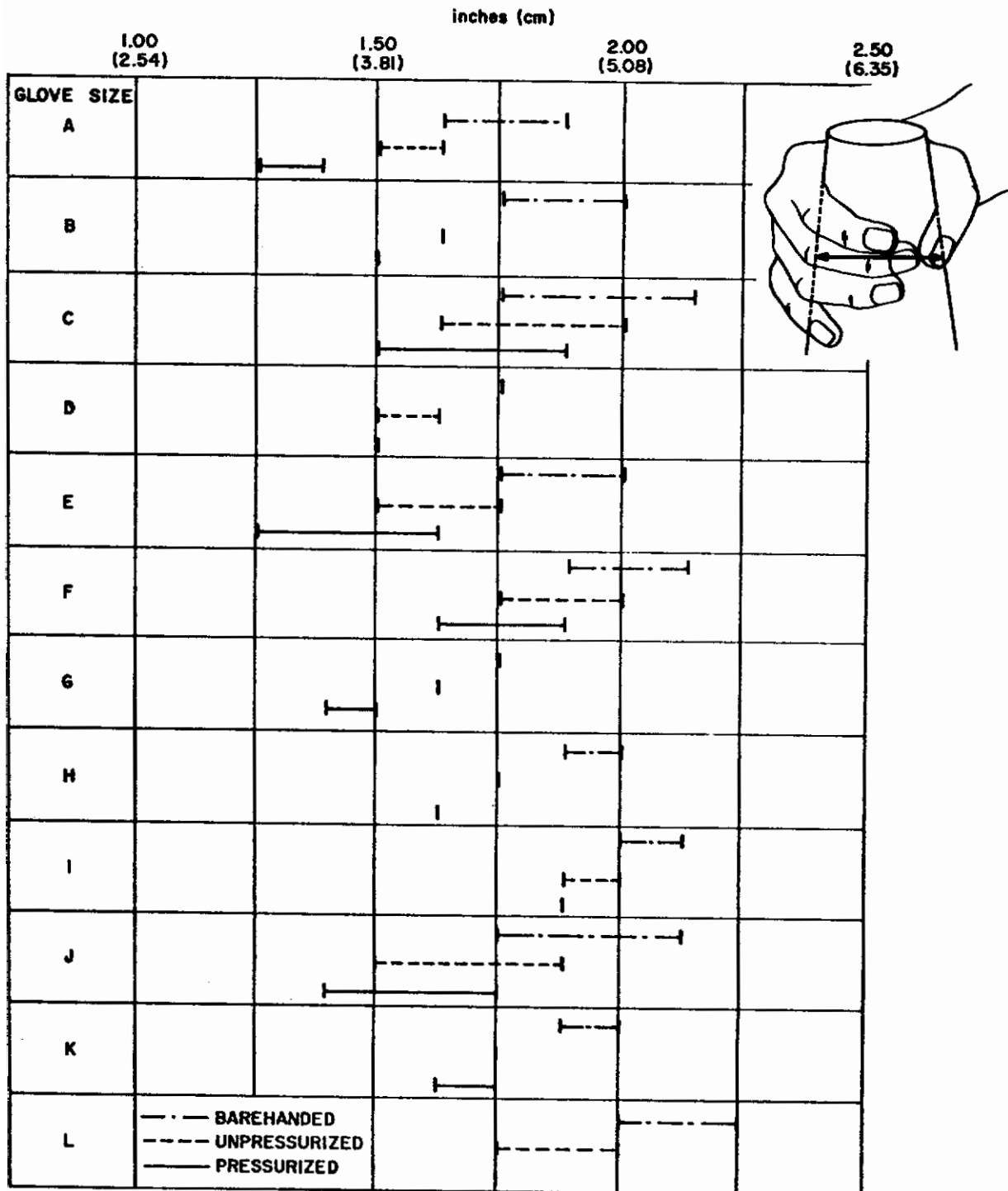
Unpressurized

1¼ in.

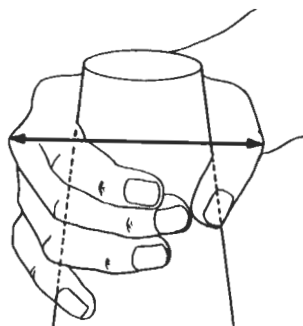
Pressurized

1¼ in.

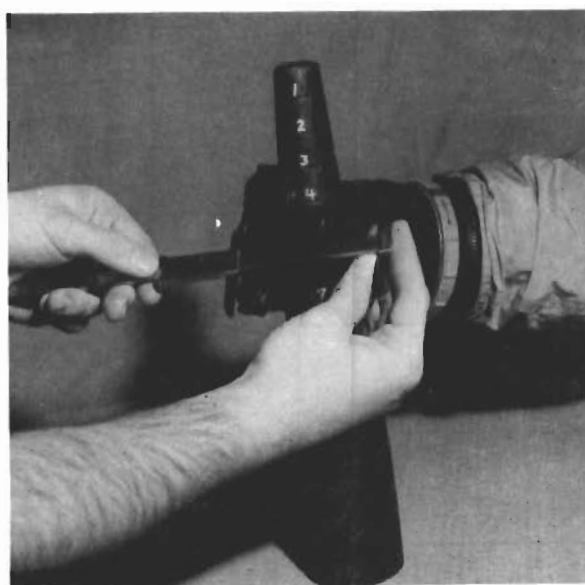
Range of Values for Grip Breadth; Inside per Glove Size



GRIP BREADTH; OUTSIDE



Subject holds a cone at the largest circumference that he can grasp with his thumb and middle finger just touching. Using the sliding caliper, measure from the interphalangeal joint of the thumb to the knuckle of the middle finger.



ANTHROPOMETRIC DATA (N=27)

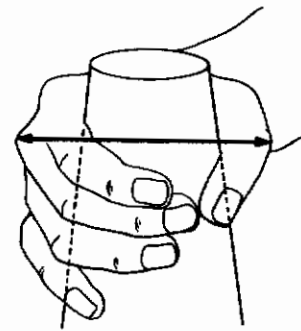
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	10.57 cm; 4.16 in.	10.69 cm; 4.21 in.	11.80 cm; 4.64 in.
SD:	0.76 cm; 0.30 in.	0.73 cm; 0.29 in.	1.11 cm; 0.44 in.
V%:	7.23	6.81	9.39

GRIP BREADTH; OUTSIDE



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
11.75	95 TH	4.62	11.70	95 TH	4.61	13.71	95 TH	5.40
11.42	90 TH	4.50	11.55	90 TH	4.55	13.30	90 TH	5.24
11.28	85 TH	4.43	11.47	85 TH	4.52	13.03	85 TH	5.13
11.16	80 TH	4.39	11.40	80 TH	4.49	12.81	80 TH	5.04
11.07	75 TH	4.36	11.33	75 TH	4.46	12.61	75 TH	4.97
10.99	70 TH	4.33	11.25	70 TH	4.43	12.43	70 TH	4.89
10.92	65 TH	4.30	11.16	65 TH	4.39	12.28	65 TH	4.83
10.84	60 TH	4.27	11.07	60 TH	4.36	12.10	60 TH	4.76
10.76	55 TH	4.24	10.96	55 TH	4.32	11.94	55 TH	4.70
10.68	50 TH	4.20	10.85	50 TH	4.27	11.78	50 TH	4.64
10.59	45 TH	4.17	10.73	45 TH	4.22	11.62	45 TH	4.58
10.49	40 TH	4.13	10.60	40 TH	4.17	11.46	40 TH	4.51
10.38	35 TH	4.09	10.45	35 TH	4.12	11.30	35 TH	4.45
10.26	30 TH	4.04	10.30	30 TH	4.05	11.13	30 TH	4.38
10.13	25 TH	3.99	10.13	25 TH	3.99	10.95	25 TH	4.31
9.98	20 TH	3.93	9.95	20 TH	3.92	10.77	20 TH	4.24
9.80	15 TH	3.86	9.76	15 TH	3.84	10.59	15 TH	4.17
9.58	10 TH	3.77	9.58	10 TH	3.77	10.41	10 TH	4.10
9.33	5 TH	3.67	9.52	5 TH	3.75	10.31	5 TH	4.06

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 1.30%

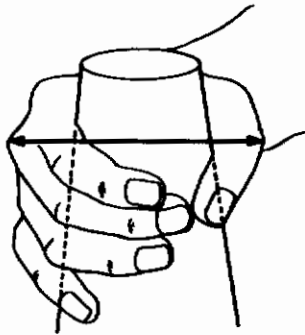
Condition 3: 11.63%

Percentage Increase of the Means

Condition 1 as Base

Condition 2: 1.23%

Condition 3: 11.64%



Grip Breadth; Outside

The maximum distance across the most protruding joint of the thumb and middle fingers with the hand grasping and completely enclosing a cone at the largest diameter possible

HUMAN ENGINEERING APPLICATIONS

- For — 1) Determination of the minimum size of apertures to be entered by the hand while grasping a cylindrical object
- 2) Minimum clearance required beyond the range of movable handles to accommodate the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

4 $\frac{3}{4}$ in.

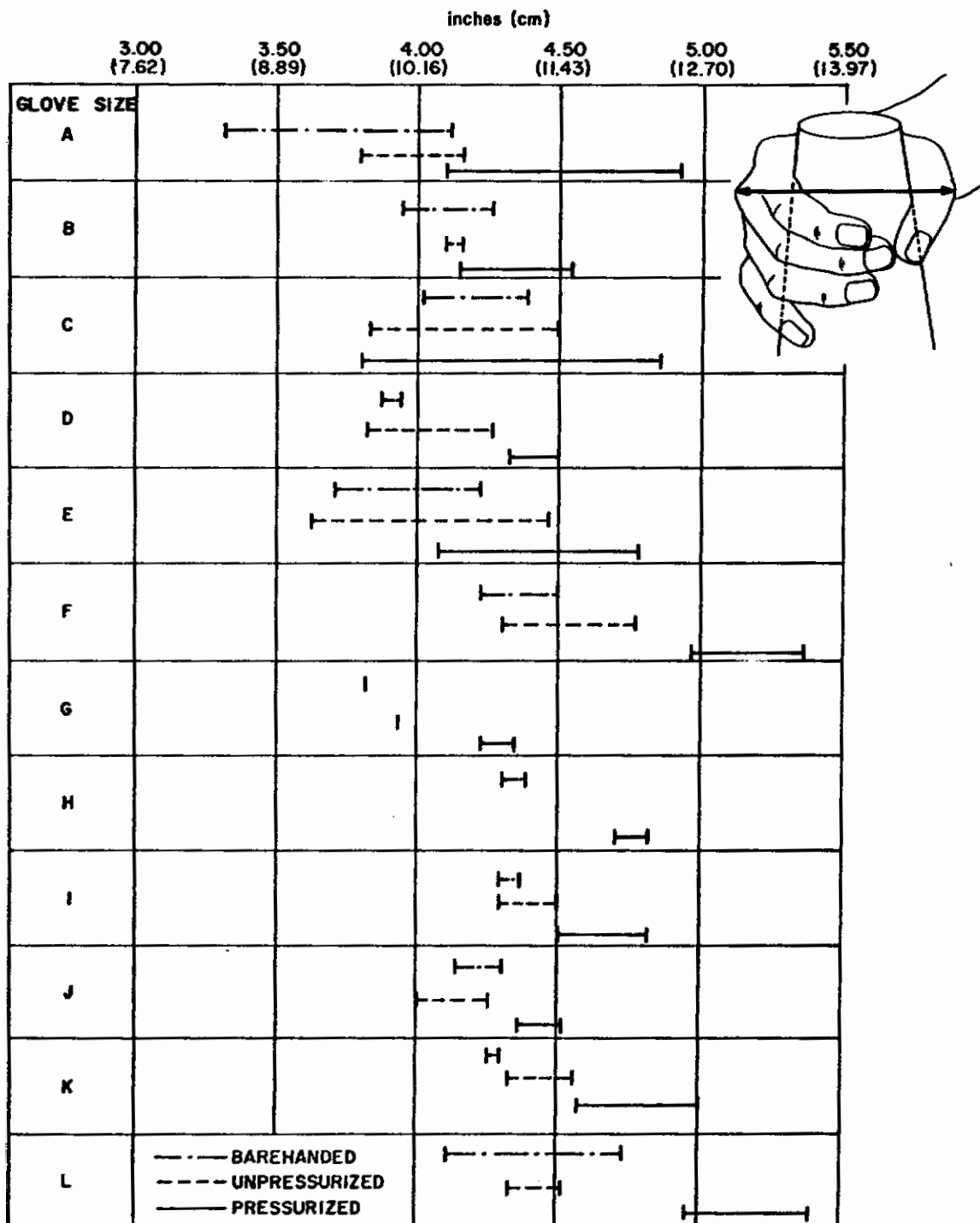
Unpressurized

4 $\frac{3}{4}$ in.

Pressurized

5 $\frac{1}{2}$ in.

Range of Values for Grip Breadth; Outside per Glove Size



FINGER TIP SPREAD;

DIGITS 2 - 3



Subject's right hand is extended, palm down. Subject maximally spreads digits 2 and 3. With sliding caliper, measure the distance in the region of the fingernail from the thenar side of digit 2 to the hypothenar side of digit 3.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	9.27 cm; 3.65 in.	8.53 cm; 3.36 in.	7.51 cm; 2.96 in.
SD:	1.57 cm; 0.62 in.	0.99 cm; 0.39 in.	1.05 cm; 0.41 in.
V%:	16.89	11.59	13.99

FINGER TIP SPREAD; DIGITS 2 - 3



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
11.95	95 TH	4.70	9.72	95 TH	3.83	9.03	95 TH	3.56
11.52	90 TH	4.54	9.64	90 TH	3.80	8.73	90 TH	3.44
11.12	85 TH	4.38	9.54	85 TH	3.76	8.52	85 TH	3.36
10.77	80 TH	4.24	9.43	80 TH	3.71	8.35	80 TH	3.29
10.46	75 TH	4.12	9.32	75 TH	3.67	8.19	75 TH	3.23
10.17	70 TH	4.00	9.19	70 TH	3.62	8.05	70 TH	3.17
9.90	65 TH	3.90	9.07	65 TH	3.57	7.91	65 TH	3.11
9.65	60 TH	3.80	8.94	60 TH	3.52	7.77	60 TH	3.06
9.41	55 TH	3.71	8.80	55 TH	3.46	7.63	55 TH	3.00
9.18	50 TH	3.62	8.66	50 TH	3.41	7.49	50 TH	2.95
8.96	45 TH	3.53	8.51	45 TH	3.35	7.35	45 TH	2.89
8.75	40 TH	3.44	8.35	40 TH	3.29	7.21	40 TH	2.84
8.53	35 TH	3.36	8.18	35 TH	3.22	7.06	35 TH	2.78
8.32	30 TH	3.28	8.01	30 TH	3.15	6.90	30 TH	2.72
8.10	25 TH	3.19	7.81	25 TH	3.08	6.75	25 TH	2.66
7.86	20 TH	3.10	7.60	20 TH	2.99	6.58	20 TH	2.59
7.61	15 TH	3.00	7.37	15 TH	2.90	6.41	15 TH	2.52
7.29	10 TH	2.87	7.12	10 TH	2.80	6.24	10 TH	2.46
6.81	5 TH	2.68	6.85	5 TH	2.70	6.13	5 TH	2.42

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 6.39%

Condition 3: 17.60%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 7.98%

Condition 3: 18.99%



Finger Tip Spread; Digits 2-3

The greatest distance which a man can spread his index and middle fingers; the measured distance includes the two finger tips

HUMAN ENGINEERING APPLICATIONS

- For — 1) Maximum distance between two push buttons designed for simultaneous operation by digits 2 and 3
- 2) Maximum distance between two toggle switches designed for simultaneous operation by digits 2 and 3
- 3) Maximum distance between two finger rings or hooks designed for simultaneous operation by digits 2 and 3

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

2½ in.

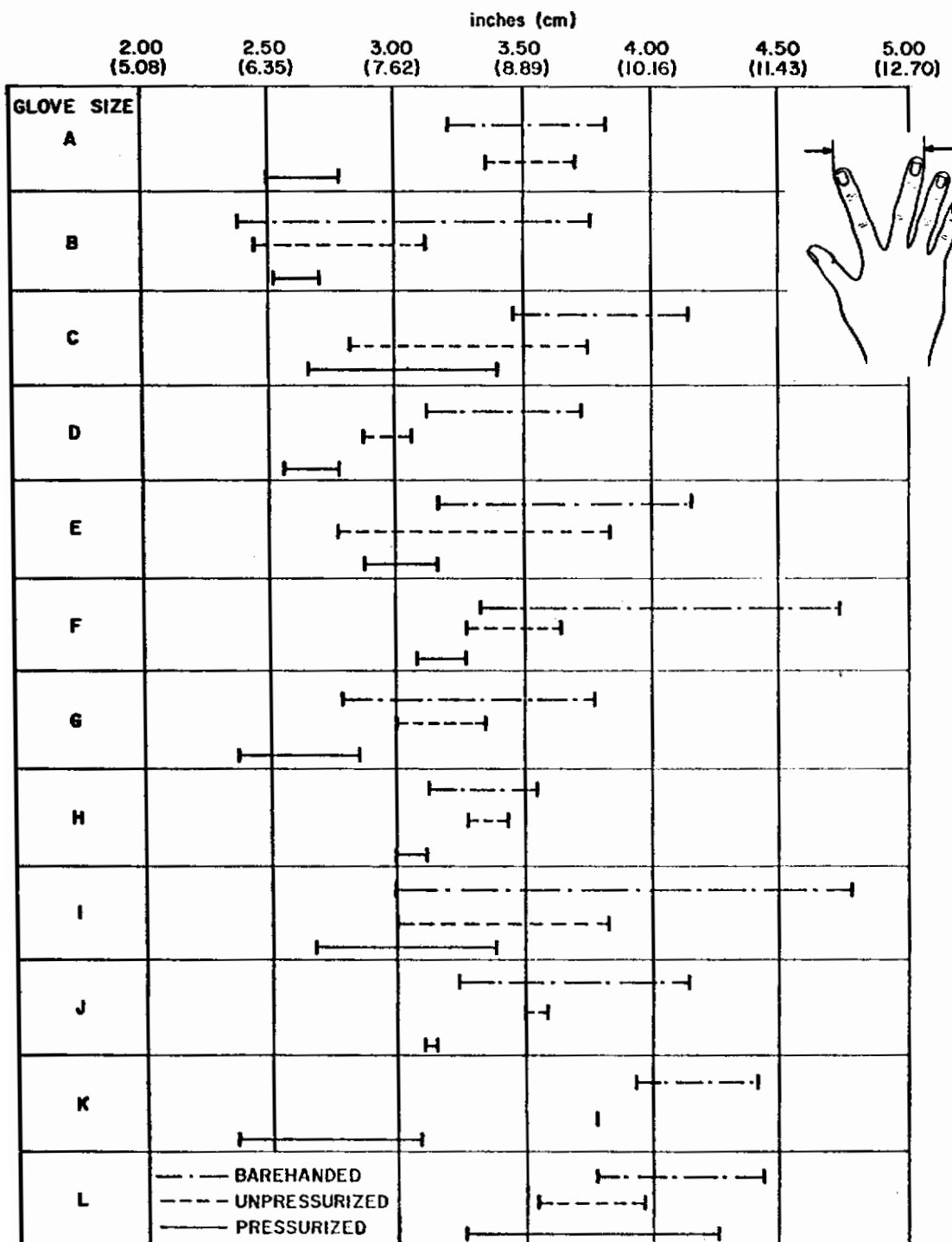
Unpressurized

2½ in.

Pressurized

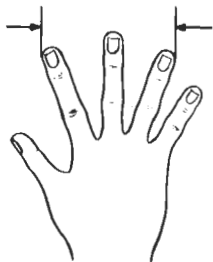
2¼ in.

Range of Values for Finger Tip Spread; Digits 2-3 per Glove Size



FINGER TIP SPREAD;

DIGITS 2 - 4



Subject's right hand is extended, palm down. Subject maximally spreads digits 2 and 4. With sliding caliper, measure the distance in the region of the fingernail from the thenar side of digit 2 to the hypothenar side of digit 4.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

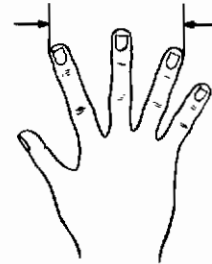
Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	12.33 cm; 4.86 in.	11.76 cm; 4.63 in.	10.47 cm; 4.12 in.
SD:	1.63 cm; 0.64 in.	1.27 cm; 0.50 in.	1.08 cm; 0.42 in.
V%:	13.21	10.81	10.29

FINGER TIP SPREAD;

DIGITS 2 - 4



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
14.65	95 TH	5.77	13.64	95 TH	5.37	12.57	95 TH	4.95
14.60	90 TH	5.75	13.37	90 TH	5.26	11.88	90 TH	4.68
14.25	85 TH	5.61	13.10	85 TH	5.16	11.57	85 TH	4.56
13.89	80 TH	5.47	12.86	80 TH	5.06	11.38	80 TH	4.48
13.56	75 TH	5.34	12.64	75 TH	4.98	11.23	75 TH	4.42
13.26	70 TH	5.22	12.45	70 TH	4.90	11.09	70 TH	4.37
12.99	65 TH	5.11	12.28	65 TH	4.84	10.96	65 TH	4.31
12.75	60 TH	5.02	12.12	60 TH	4.77	10.82	60 TH	4.26
12.54	55 TH	4.94	11.98	55 TH	4.71	10.68	55 TH	4.21
12.35	50 TH	4.86	11.83	50 TH	4.66	10.53	50 TH	4.15
12.18	45 TH	4.80	11.69	45 TH	4.60	10.37	45 TH	4.08
12.03	40 TH	4.73	11.55	40 TH	4.55	10.20	40 TH	4.02
11.88	35 TH	4.68	11.41	35 TH	4.49	10.02	35 TH	3.94
11.73	30 TH	4.62	11.25	30 TH	4.43	9.81	30 TH	3.86
11.56	25 TH	4.55	11.06	25 TH	4.36	9.59	25 TH	3.78
11.35	20 TH	4.47	10.83	20 TH	4.27	9.36	20 TH	3.68
11.04	15 TH	4.35	10.52	15 TH	4.14	9.11	15 TH	3.59
10.46	10 TH	4.12	10.02	10 TH	3.95	8.87	10 TH	3.49
8.96	5 TH	3.53	8.95	5 TH	3.53	8.83	5 TH	3.48

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 4.06%

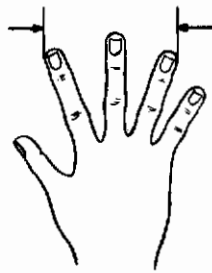
Condition 3: 13.85%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 4.62%

Condition 3: 15.09%



Finger Tip Spread; Digits 2-4

The greatest distance which a man can spread his index and ring fingers; the measured distance includes the two finger tips

HUMAN ENGINEERING APPLICATIONS

- For – 1) Maximum distance between two push buttons designed for simultaneous operation by digits 2 and 4
- 2) Maximum distance between two toggle switches designed for simultaneous operation by digits 2 and 4
- 3) Maximum distance between two finger rings or hooks designed for simultaneous operation by digits 2 and 4

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

3½ in.

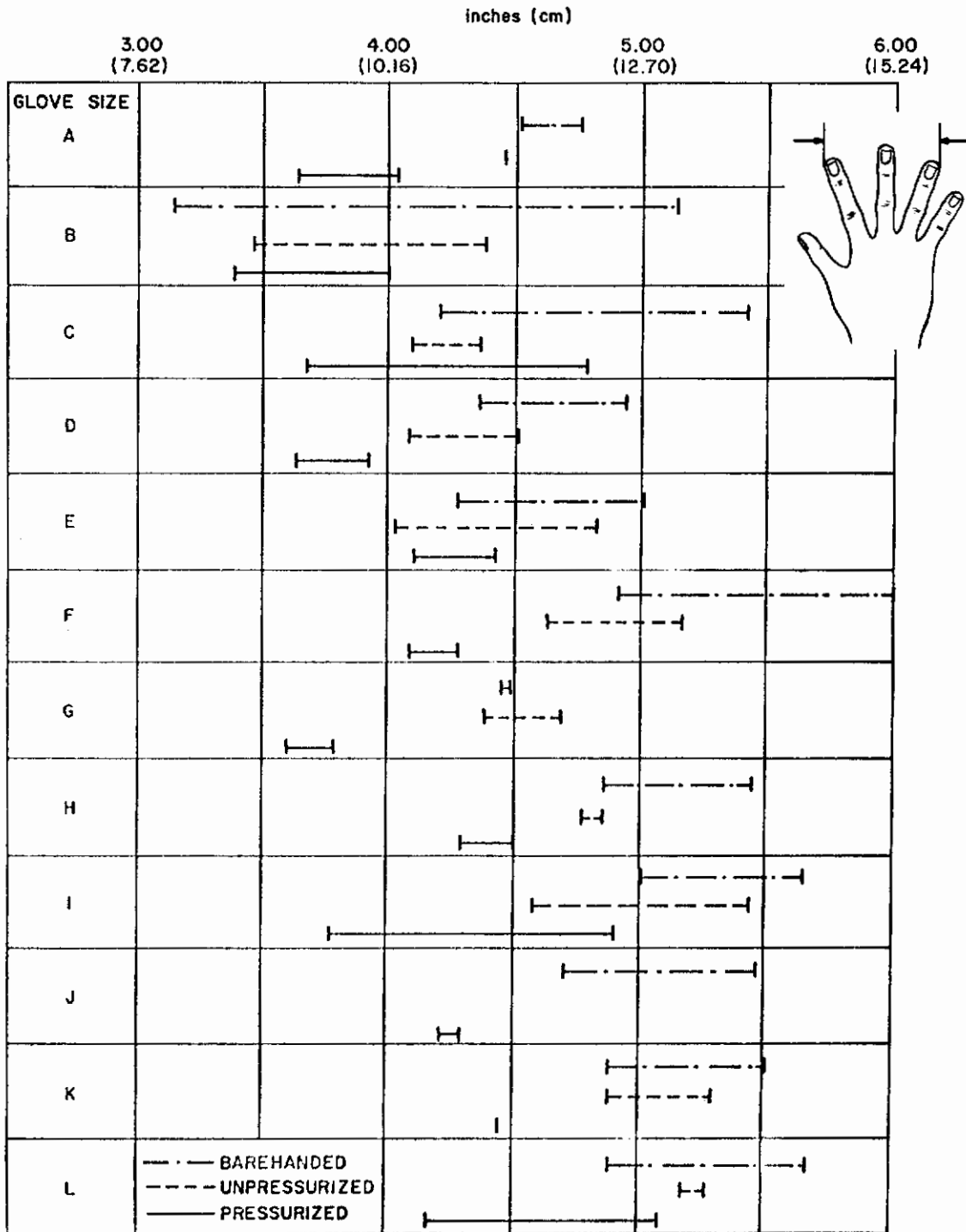
Unpressurized

3½ in.

Pressurized

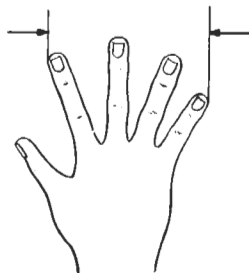
3¼ in.

Range of Values for Finger Tip Spread; Digits 2-4 per Glove Size



FINGER TIP SPREAD;

DIGITS 2 - 5



Subject's right hand is extended, palm down. Subject maximally spreads digits 2 and 5. With sliding caliper, measure the distance in the region of the fingernail from the thenar side of digit 2 to the hypothenar side of digit 5.



ANTHROPOMETRIC DATA (N = 27)

Condition 1: Subject wearing unpressurized suit but barehanded.

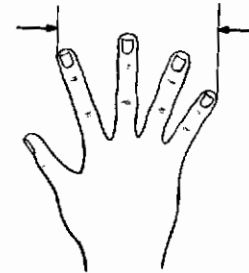
Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	16.13 cm; 6.35 in.	15.19 cm; 5.98 in.	13.04 cm; 5.13 in.
SD:	1.50 cm; 0.59 in.	1.49 cm; 0.59 in.	1.36 cm; 0.54 in.
V%:	9.32	9.83	10.43

FINGER TIP SPREAD;

DIGITS 2 - 5



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
18.20	95 TH	7.16	17.07	95 TH	6.72	15.46	95 TH	6.09
17.80	90 TH	7.01	17.00	90 TH	6.69	14.67	90 TH	5.78
17.52	85 TH	6.90	16.71	85 TH	6.58	14.35	85 TH	5.65
17.30	80 TH	6.81	16.41	80 TH	6.46	14.16	80 TH	5.57
17.11	75 TH	6.74	16.14	75 TH	6.36	14.00	75 TH	5.51
16.94	70 TH	6.67	15.91	70 TH	6.27	13.86	70 TH	5.46
16.78	65 TH	6.61	15.71	65 TH	6.19	13.72	65 TH	5.40
16.62	60 TH	6.55	15.55	60 TH	6.12	13.57	60 TH	5.34
16.47	55 TH	6.49	15.40	55 TH	6.06	13.41	55 TH	5.28
16.32	50 TH	6.42	15.27	50 TH	6.01	13.23	50 TH	5.21
16.15	45 TH	6.36	15.16	45 TH	5.97	13.03	45 TH	5.13
15.98	40 TH	6.29	15.06	40 TH	5.93	12.81	40 TH	5.04
15.80	35 TH	6.22	14.96	35 TH	5.89	12.57	35 TH	4.95
15.58	30 TH	6.14	14.84	30 TH	5.84	12.29	30 TH	4.84
15.33	25 TH	6.04	14.70	25 TH	5.79	11.99	25 TH	4.72
15.02	20 TH	5.91	14.49	20 TH	5.71	11.64	20 TH	4.58
14.62	15 TH	5.75	14.14	15 TH	5.57	11.27	15 TH	4.44
14.00	10 TH	5.51	13.42	10 TH	5.29	10.87	10 TH	4.28
12.85	5 TH	5.06	11.52	5 TH	4.53	10.60	5 TH	4.17

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 5.62%

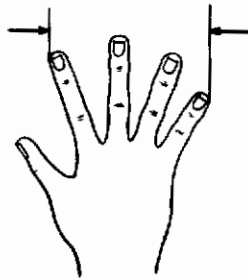
Condition 3: 18.88%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 5.83%

Condition 3: 19.16%



Finger Tip Spread; Digits 2-5

The greatest distance which a man can spread his index and little fingers; the measured distance includes the two finger tips

HUMAN ENGINEERING APPLICATIONS

- For – 1) Maximum distance between two push buttons designed for simultaneous operation by digits 2 and 5
- 2) Maximum distance between two toggle switches designed for simultaneous operation by digits 2 and 5
- 3) Maximum distance between two finger rings or hooks designed for simultaneous operation by digits 2 and 5

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

5 in.

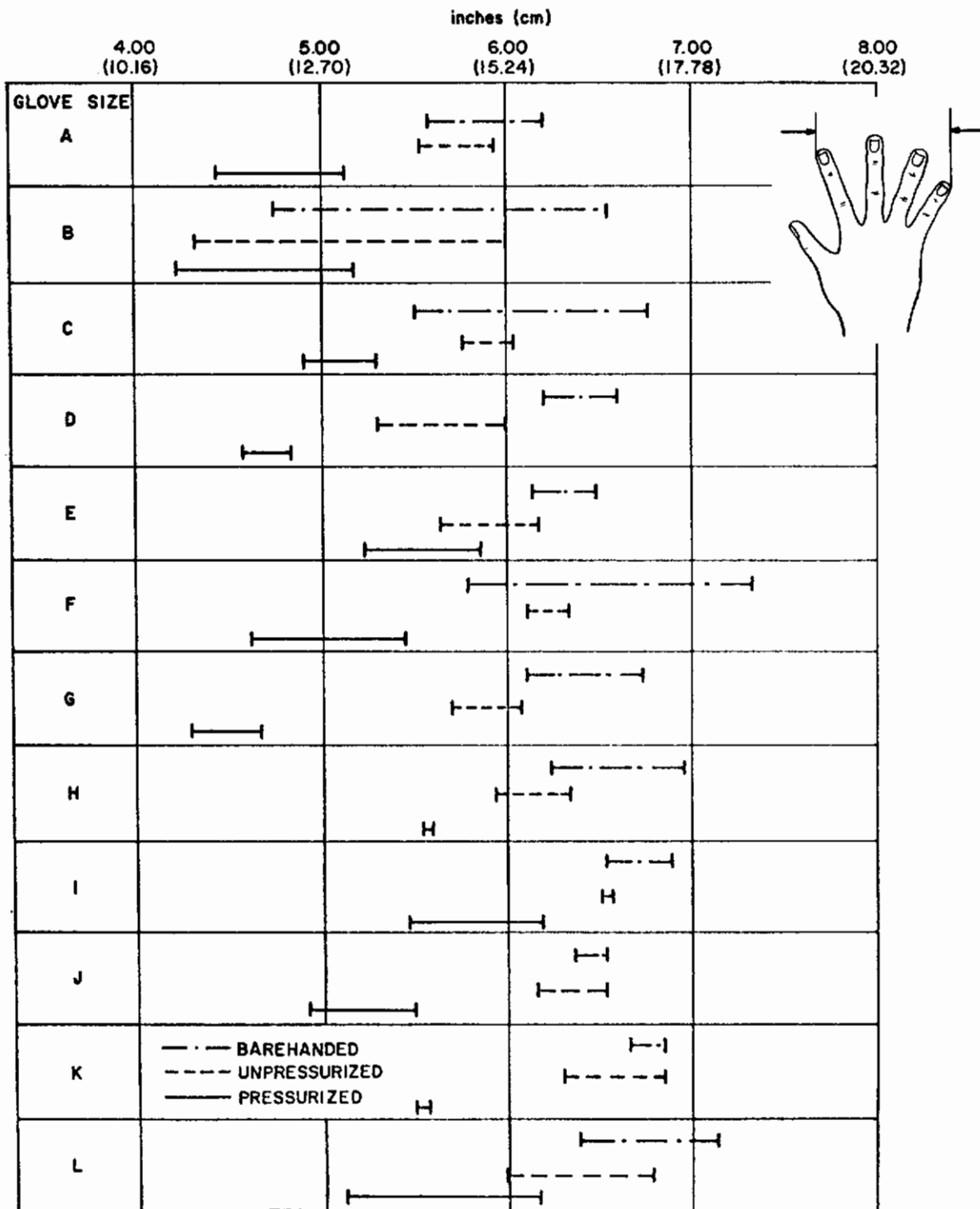
Unpressurized

4½ in.

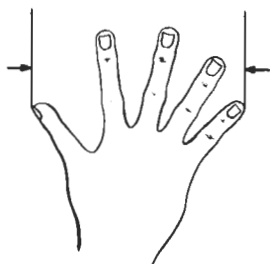
Pressurized

4 in.

Range of Values for Finger Tip Spread; Digits 2-5 per Glove Size



HAND SPREAD; MAXIMUM



Subject extends his right hand and spreads all five digits as far apart as possible. With a sliding or beam caliper, measure the maximum spread from the thumb tip to the edge of the fifth digit.



ANTHROPOMETRIC DATA (N = 27)

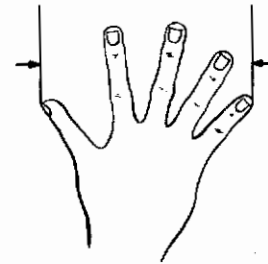
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	21.53 cm; 8.47 in.	19.46 cm; 7.66 in.	17.02 cm; 6.70 in.
SD:	1.54 cm; 0.61 in.	1.49 cm; 0.59 in.	1.58 cm; 0.62 in.
V%:	7.16	7.66	9.30

HAND SPREAD; MAXIMUM



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
24.04	95 TH	9.46	21.69	95 TH	8.54	19.48	95 TH	7.67
23.67	90 TH	9.32	21.27	90 TH	8.37	19.22	90 TH	7.57
23.32	85 TH	9.18	21.03	85 TH	8.28	18.90	85 TH	7.44
23.00	80 TH	9.06	20.84	80 TH	8.20	18.58	80 TH	7.31
22.71	75 TH	8.94	20.66	75 TH	8.13	18.27	75 TH	7.19
22.44	70 TH	8.84	20.49	70 TH	8.07	17.98	70 TH	7.08
22.19	65 TH	8.74	20.32	65 TH	8.00	17.70	65 TH	6.97
21.95	60 TH	8.64	20.14	60 TH	7.93	17.43	60 TH	6.86
21.72	55 TH	8.55	19.95	55 TH	7.85	17.17	55 TH	6.76
21.49	50 TH	8.46	19.74	50 TH	7.77	16.91	50 TH	6.66
21.27	45 TH	8.37	19.52	45 TH	7.69	16.66	45 TH	6.56
21.05	40 TH	8.29	19.29	40 TH	7.59	16.41	40 TH	6.46
20.83	35 TH	8.20	19.03	35 TH	7.49	16.16	35 TH	6.36
20.60	30 TH	8.11	18.74	30 TH	7.38	15.91	30 TH	6.27
20.36	25 TH	8.02	18.43	25 TH	7.25	15.66	25 TH	6.17
20.10	20 TH	7.91	18.06	20 TH	7.11	15.40	20 TH	6.06
19.81	15 TH	7.80	17.64	15 TH	6.95	15.13	15 TH	5.96
19.45	10 TH	7.66	17.15	10 TH	6.75	14.83	10 TH	5.84
18.91	5 TH	7.55	16.56	5 TH	6.52	14.50	5 TH	5.71

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 9.41%

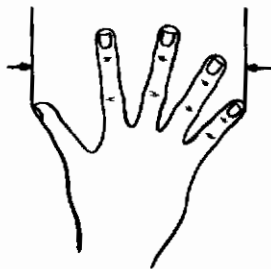
Condition 3: 20.84%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 9.61%

Condition 3: 20.95%



Hand Spread; Maximum

The maximum distance (width) from thumb to little finger of the completely spread hand

HUMAN ENGINEERING APPLICATIONS

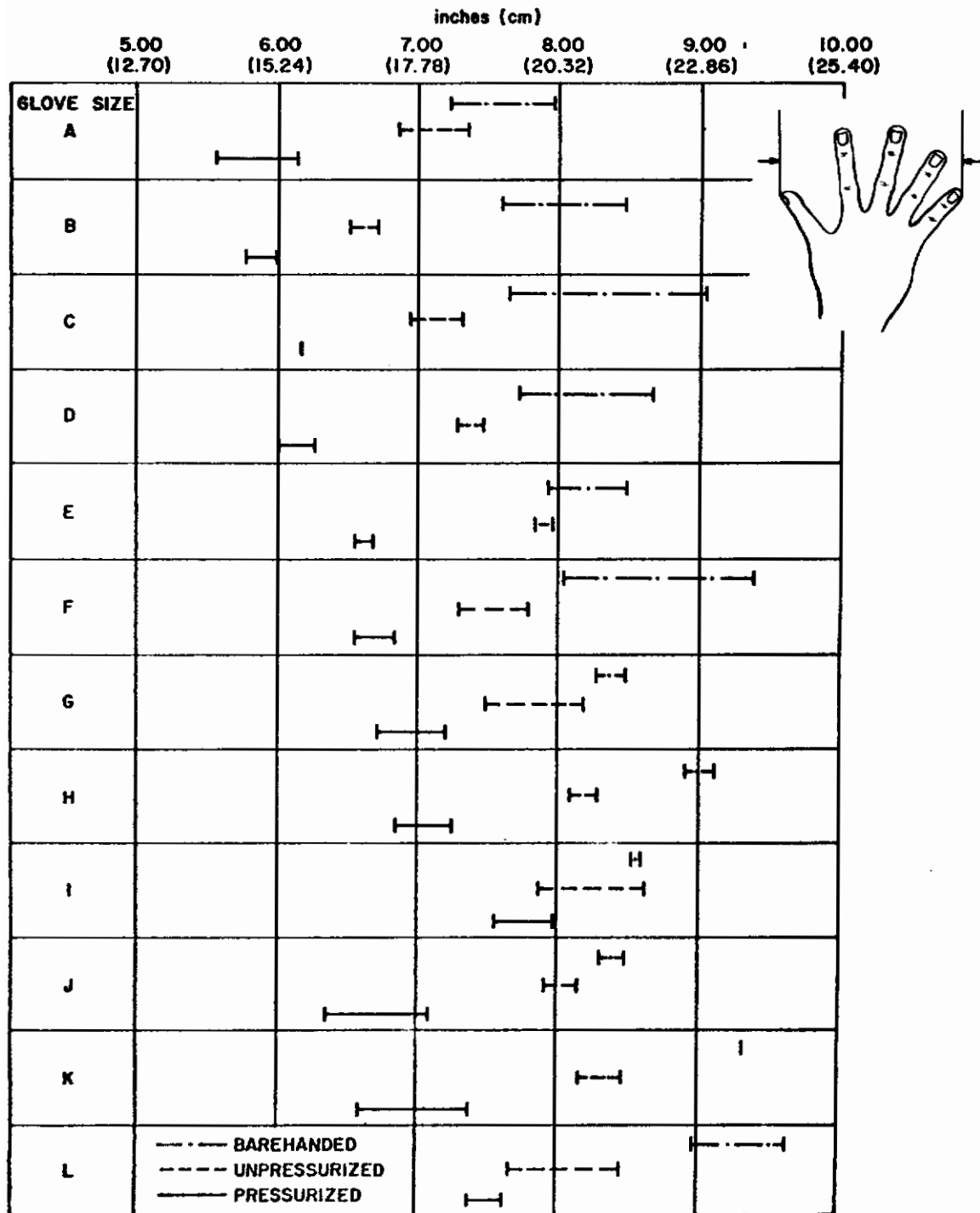
- For — 1) Determination of the maximum distance between buttons or controls designed to be activated simultaneously by the thumb and little finger
- 2) Determination of general workspace clearance where the hand will operate at various degrees of spread including maximum

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For application 1	7$\frac{1}{4}$ in.	6$\frac{1}{2}$ in.	5$\frac{1}{2}$ in.
For application 2	9$\frac{1}{2}$ in.	8$\frac{3}{4}$ in.	7$\frac{3}{4}$ in.

Range of Values for Hand Spread; Maximum per Glove Size



MAXIMUM ROTATION; SUPINATION



Subject extends his right hand and grasps the knob on the measuring instrument between his thumb and forefinger. Subject then rotates the knob to his right, using only his hand, wrist, and arm, until he achieves maximum supination of his right hand.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	221.67°	188.52°	120.19°
SD:	33.03°	35.03°	27.30°
V%:	14.90	18.58	22.63

MAXIMUM ROTATION; SUPINATION



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

<i>Condition 1</i>		<i>Condition 2</i>		<i>Condition 3</i>	
<i>Degrees</i>	<i>Percentiles</i>	<i>Degrees</i>	<i>Percentiles</i>	<i>Degrees</i>	<i>Percentiles</i>
280.64	95 TH	239.07	95 TH	151.27	95 TH
264.10	90 TH	237.50	90 TH	151.12	90 TH
255.97	85 TH	230.44	85 TH	147.89	85 TH
250.34	80 TH	222.86	80 TH	144.16	80 TH
245.60	75 TH	215.46	75 TH	140.35	75 TH
241.28	70 TH	208.56	70 TH	136.64	70 TH
237.06	65 TH	202.11	65 TH	133.00	65 TH
232.82	60 TH	196.13	60 TH	129.46	60 TH
228.48	55 TH	190.57	55 TH	126.00	55 TH
223.89	50 TH	185.34	50 TH	122.53	50 TH
219.05	45 TH	180.44	45 TH	119.05	45 TH
213.94	40 TH	175.87	40 TH	115.54	40 TH
208.43	35 TH	171.53	35 TH	111.87	35 TH
202.49	30 TH	167.38	30 TH	107.96	20 TH
196.08	25 TH	163.35	25 TH	103.67	25 TH
189.11	20 TH	159.27	20 TH	98.69	20 TH
181.76	15 TH	154.86	15 TH	92.54	15 TH
174.44	10 TH	149.08	10 TH	83.79	10 TH
170.82	5 TH	137.87	5 TH	67.68	5 TH

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 14.81%

Condition 3: 45.54%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 14.96%

Condition 3: 45.78%



Maximum Rotation; Supination

A measure of the maximum number of degrees a dial or object may be turned clockwise with a single turn, without conscious shoulder movement

HUMAN ENGINEERING APPLICATIONS

- For – 1) Determination of the maximum number of degrees a rotary switch may be turned clockwise with one movement
- 2) Determination of the number of discrete motions by the operator to complete a task involving repetitive rotary motion, i.e., tightening a bolt or screw

DESIGN CRITERIA

Number of degrees necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

170°

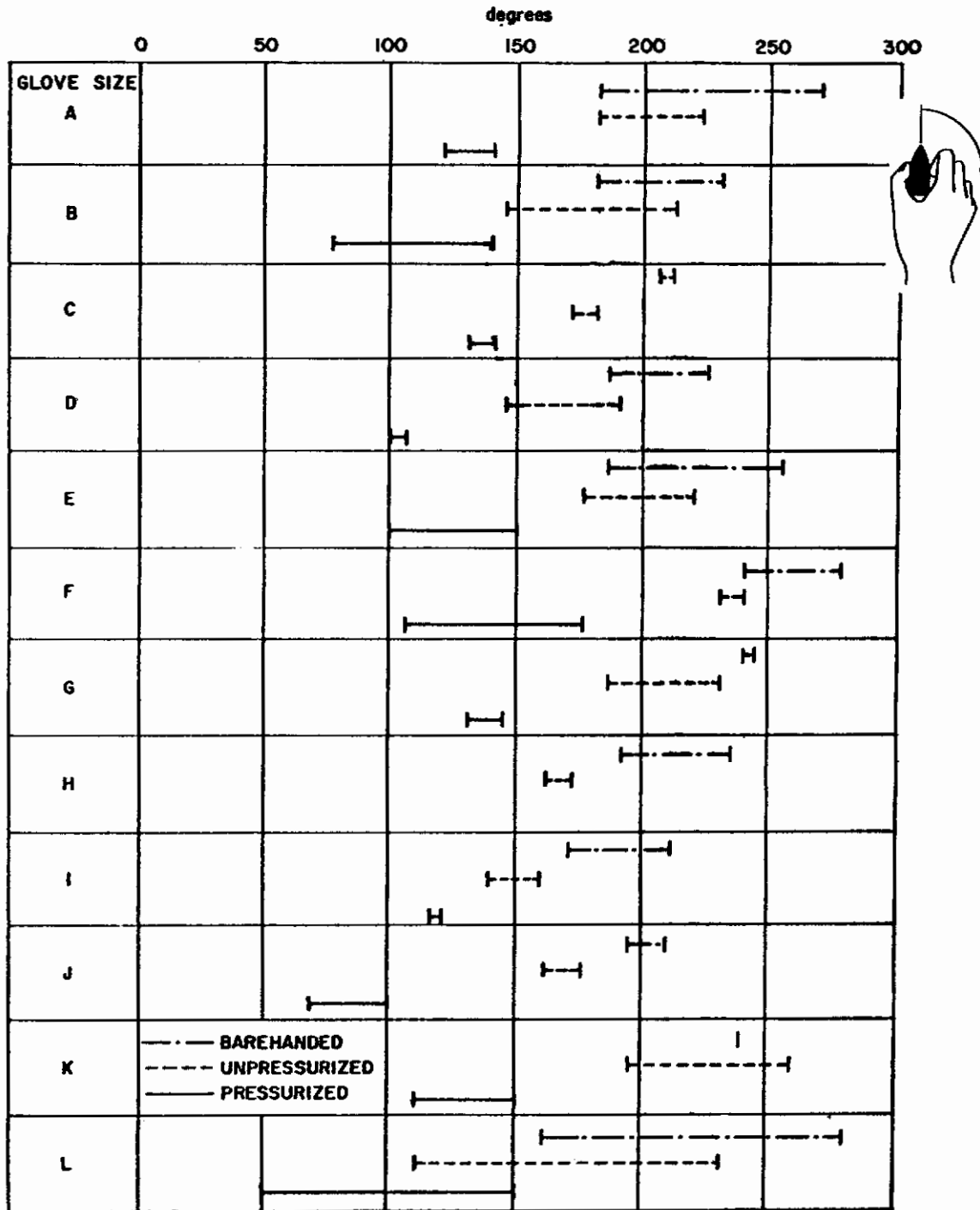
Unpressurized

137°

Pressurized

67°

Range of Values for Maximum Rotation; Supination per Glove Size



MAXIMUM ROTATION; PRONATION



Subject extends his right hand and grasps the knob on the measuring instrument between his thumb and forefinger. Subject then rotates the knob to his left, using his hand, wrist, and arm, until he achieves maximum pronation of his right hand.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	157.78°	128.52°	78.33°
SD:	28.75°	28.18°	20.37°
V%:	18.22	21.93	26.00

MAXIMUM ROTATION; PRONATION



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1		Condition 2		Condition 3	
Degrees	Percentiles	Degrees	Percentiles	Degrees	Percentiles
195.98	95 TH	173.50	95 TH	110.43	95 TH
189.05	90 TH	163.62	90 TH	108.43	90 TH
183.75	85 TH	157.17	85 TH	103.12	85 TH
179.24	80 TH	152.05	80 TH	97.72	80 TH
175.12	75 TH	147.50	75 TH	92.64	75 TH
171.29	70 TH	143.32	70 TH	88.04	70 TH
167.62	65 TH	139.32	65 TH	83.87	65 TH
164.07	60 TH	135.45	60 TH	80.11	60 TH
160.59	55 TH	131.63	55 TH	76.76	55 TH
157.10	50 TH	127.76	50 TH	73.71	50 TH
153.59	45 TH	123.85	45 TH	71.00	45 TH
150.07	40 TH	119.88	40 TH	68.60	40 TH
146.44	35 TH	115.76	35 TH	66.49	35 TH
142.69	30 TH	111.45	30 TH	64.63	30 TH
138.77	25 TH	106.93	25 TH	63.01	25 TH
134.60	20 TH	102.12	20 TH	61.55	20 TH
130.18	15 TH	97.06	15 TH	60.11	15 TH
125.37	10 TH	91.76	10 TH	58.07	10 TH
120.52	5 TH	87.38	5 TH	52.69	5 TH

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 18.24%

Condition 3: 49.84%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 18.54%

Condition 3: 50.35%



Maximum Rotation; Pronation

A measure of the maximum number of degrees a dial or object may be turned counter-clockwise with a single turn, without conscious shoulder movement

HUMAN ENGINEERING APPLICATIONS

- For – 1) Determination of the maximum number of degrees a rotary switch may be turned counter-clockwise with one movement
- 2) Determination of the number of discrete motions by the operator to complete a task involving rotary motion, i.e., tightening a bolt or screw

DESIGN CRITERIA

Number of degrees necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

120°

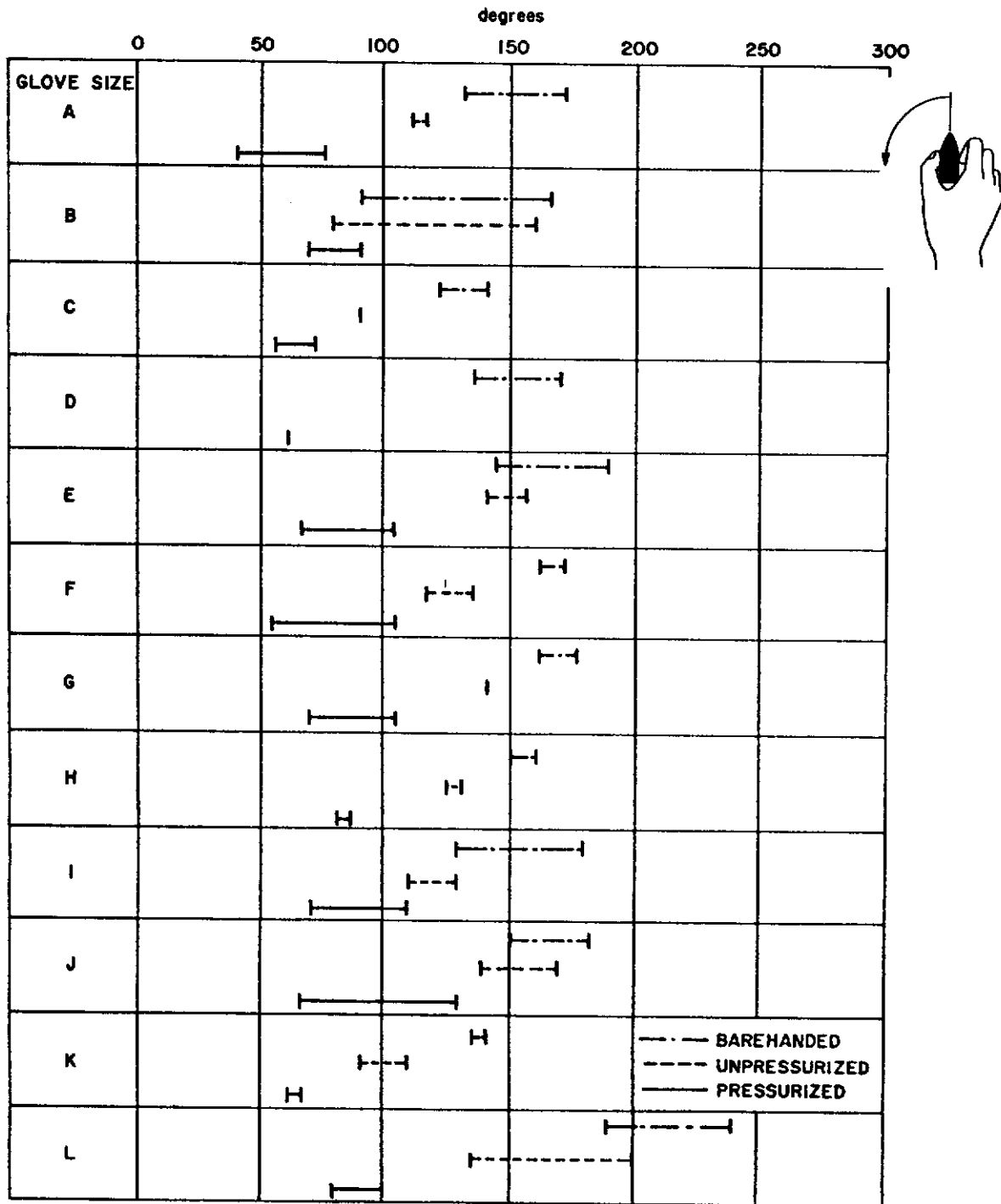
Unpressurized

87°

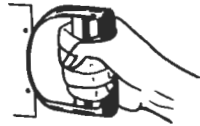
Pressurized

52°

Range of Values for Maximum Rotation; Pronation per Glove Size



GRIP STRENGTH



Subject grasps the Smedley Hand Dynamometer, fully extends his right arm, and squeezes the instrument. Recording is taken from the instrument.



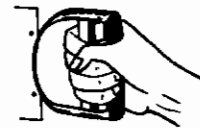
FORCE DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	48.11 kg; 105.84 lb.	35.89 kg; 78.96 lb.	30.22 kg; 66.49 lb.
SD:	8.60 kg; 18.91 lb.	6.40 kg; 14.08 lb.	4.77 kg; 10.50 lb.
V%:	17.87	17.84	15.79



GRIP STRENGTH

FORCE DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Kilograms	Percentiles	Pounds	Kilograms	Percentiles	Pounds	Kilograms	Percentiles	Pounds
58.31	95 TH	128.28	48.32	95 TH	106.30	36.74	95 TH	80.82
57.73	90 TH	127.00	44.42	90 TH	97.72	35.73	90 TH	78.60
55.99	85 TH	123.19	42.33	85 TH	93.13	34.82	85 TH	76.60
54.29	80 TH	119.45	40.90	80 TH	89.97	34.06	80 TH	74.92
52.75	75 TH	116.06	39.75	75 TH	87.45	33.40	75 TH	73.47
51.41	70 TH	113.11	38.77	70 TH	85.30	32.82	70 TH	72.21
50.24	65 TH	110.54	37.89	65 TH	83.37	32.31	65 TH	71.07
49.23	60 TH	108.31	37.07	60 TH	81.56	31.83	60 TH	70.03
48.36	55 TH	106.38	36.29	55 TH	79.84	31.39	55 TH	69.06
47.58	50 TH	104.68	35.52	50 TH	78.14	30.96	50 TH	68.10
46.90	45 TH	103.18	34.74	45 TH	76.43	30.52	45 TH	67.14
46.29	40 TH	101.83	33.96	40 TH	74.72	30.07	40 TH	66.16
45.70	35 TH	100.54	33.16	35 TH	72.95	29.58	35 TH	65.08
45.09	30 TH	99.20	32.32	30 TH	71.11	29.02	30 TH	63.84
44.38	25 TH	97.65	31.45	25 TH	69.18	28.33	25 TH	62.32
43.41	20 TH	95.51	30.51	20 TH	67.13	27.42	20 TH	60.32
41.86	15 TH	92.08	29.54	15 TH	64.98	26.11	15 TH	57.44
38.77	10 TH	85.29	28.54	10 TH	62.79	23.90	10 TH	52.58
30.50	5 TH	67.10	27.85	5 TH	61.27	19.05	5 TH	41.90

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 24.66%

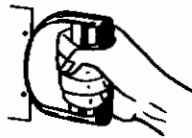
Condition 3: 36.46%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 25.40%

Condition 3: 37.19%



Grip Strength

A measure of a man's one-handed grip strength, while seated and with arm outstretched, taken on a commercially available hand dynamometer

HUMAN ENGINEERING APPLICATIONS

- For — 1) Determination of the amount of force loading on double-handled squeeze controls
2) Limits of a man's hand to hold onto something against a force
3) Can be used with the coefficient of friction at the grasped surface

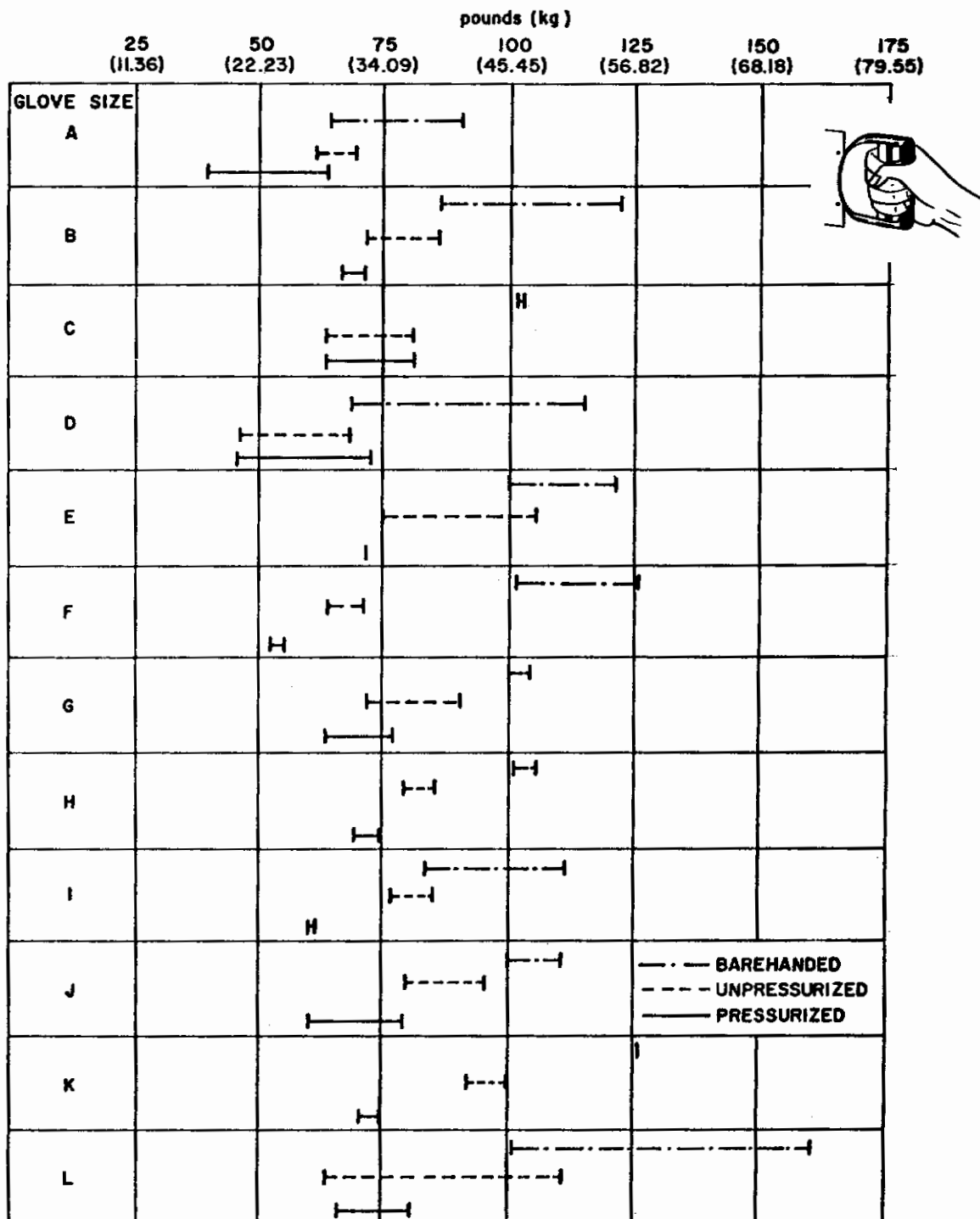
Note: The impedance of the pressurized gloves in fitting the hand into the handle of the dynamometer affected performance

DESIGN CRITERIA

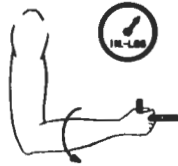
Number of pounds necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For applications 1, 2, 3	67 lb.	61 lb.	41 lb.
For application 3	129 lb.	107 lb.	81 lb.

Range of Values for Grip Strength per Glove Size



MAXIMUM TORQUE; SUPINATION



Subject grasps the metal handle with the shank between digits 2 and 3. His thumb touches the finger tips. On signal, the subject exerts his maximum effort in turning the handle to his right. Reading is taken from memory device on the torque wrench.



TORQUE DATA (N = 27)

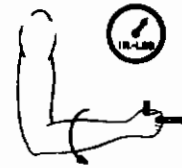
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	121.48 in.-lb.	119.44 in.-lb.	95.93 in.-lb.
SD:	30.12 in.-lb.	25.14 in.-lb.	28.96 in.-lb.
V%:	24.79	21.05	30.19

MAXIMUM TORQUE; SUPINATION



TORQUE DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

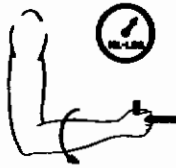
Condition 1		Condition 2		Condition 3	
Inch-Pounds	Percentiles	Inch-Pounds	Percentiles	Inch-Pounds	Percentiles
178.95	95 TH	151.38	95 TH	142.06	95 TH
159.34	90 TH	147.21	90 TH	140.38	90 TH
149.26	85 TH	143.59	85 TH	138.69	85 TH
142.49	80 TH	140.26	80 TH	130.50	80 TH
137.17	75 TH	137.04	75 TH	118.75	75 TH
132.69	70 TH	133.90	70 TH	109.75	70 TH
128.67	65 TH	130.78	65 TH	101.75	65 TH
124.92	60 TH	127.65	60 TH	99.50	60 TH
121.33	55 TH	124.49	55 TH	92.13	55 TH
117.76	50 TH	121.23	50 TH	88.75	50 TH
114.18	45 TH	117.87	45 TH	81.97	45 TH
110.56	40 TH	114.40	40 TH	81.13	40 TH
106.82	35 TH	110.73	35 TH	80.28	35 TH
102.90	30 TH	106.83	30 TH	79.44	30 TH
98.79	25 TH	102.63	25 TH	78.59	25 TH
94.44	20 TH	98.00	20 TH	77.75	20 TH
89.94	15 TH	92.86	15 TH	67.75	15 TH
85.52	10 TH	86.88	10 TH	60.33	10 TH
83.30	5 TH	79.85	5 TH	58.08	5 TH

*Percentage Increase/Decrease of the
Individual Differences (Averaged)*

Condition 2: 0.27% increase
Condition 3: 19.54% decrease

*Percentage Decrease of the
Means*

Condition 2: 1.68%
Condition 3: 21.03%



Maximum Torque; Supination

The number of inch-pounds a man can record on a torque wrench by grasping and turning to his right (palms up) an attached T-bar rod handle

HUMAN ENGINEERING APPLICATIONS

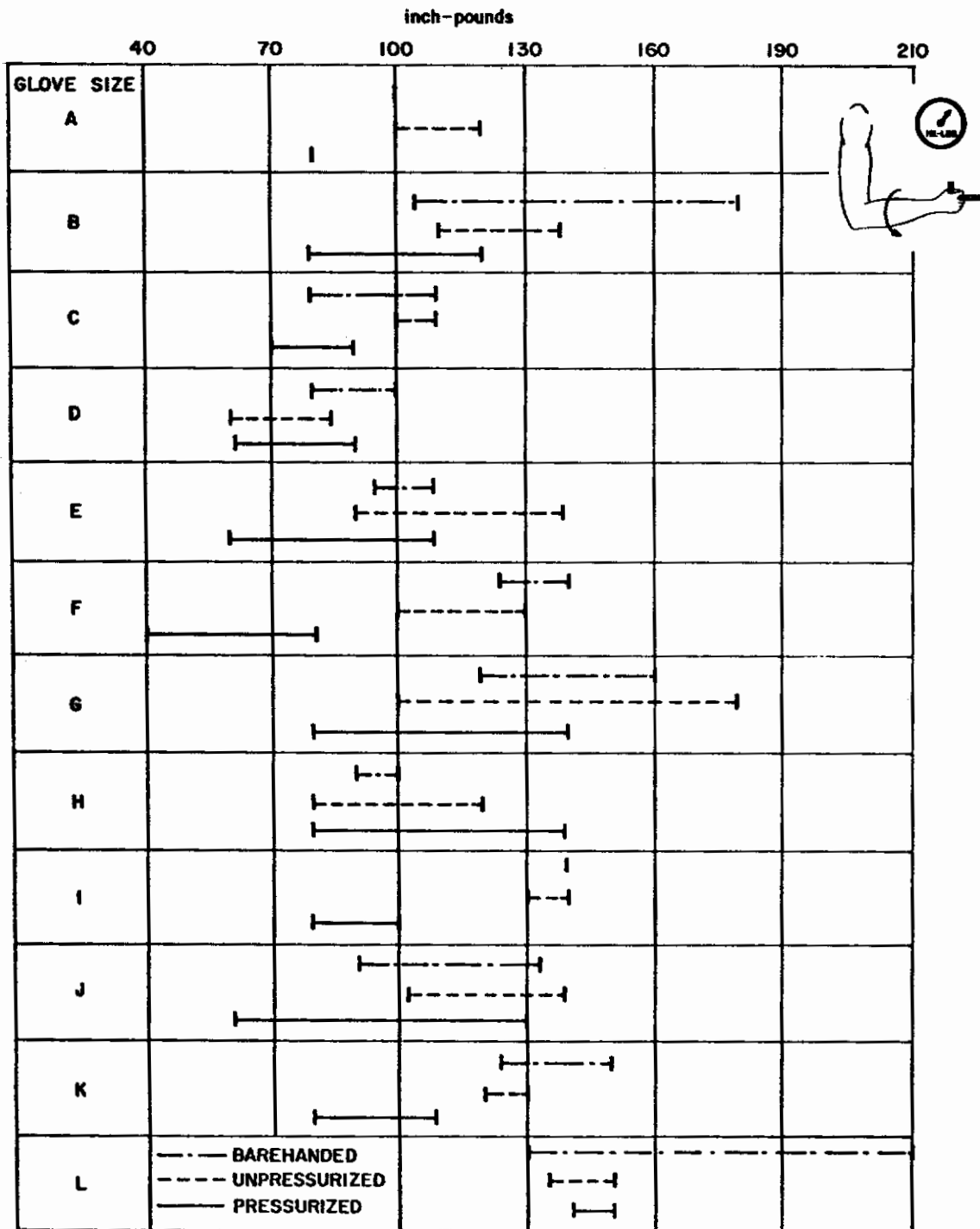
- For – 1) Determination of the maximum resistance allowable on a rotary switch
2) Determination of the maximum torque for bolts, fasteners, etc.
3) Limitation of man's capacity for torque around an axis in or near his forearm

DESIGN CRITERIA

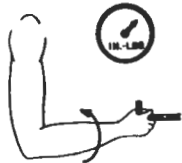
Number of inch-pounds torque necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For applications 1, 2, 3	83¼ in.-lb.	79¾ in.-lb.	58 in.-lb.
For application 3	179 in.-lb.	151½ in.-lb.	142½ in.-lb.

Range of Values for Maximum Torque; Supination per Glove Size



MAXIMUM TORQUE; PRONATION



Subject grasps the metal handle with the shank between digits 2 and 3. His thumb touches the finger tips. On signal, subject exerts his maximum effort in turning the handle to his left. Reading is taken from memory device on torque wrench.



TORQUE DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	153.89 in.-lb.	161.48 in.-lb.	151.30 in.-lb.
SD:	45.02 in.-lb.	47.59 in.-lb.	49.94 in.-lb.
V%:	29.25	29.47	33.01

MAXIMUM TORQUE; PRONATION



TORQUE DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

<i>Condition 1</i>		<i>Condition 2</i>		<i>Condition 3</i>	
<i>Inch-Pounds</i>	<i>Percentiles</i>	<i>Inch-Pounds</i>	<i>Percentiles</i>	<i>Inch-Pounds</i>	<i>Percentiles</i>
222.90	95 TH	252.60	95 TH	244.88	95 TH
203.80	90 TH	213.01	90 TH	205.27	90 TH
193.19	85 TH	195.49	85 TH	185.30	85 TH
185.48	80 TH	185.38	80 TH	173.05	80 TH
178.99	75 TH	178.49	75 TH	164.64	75 TH
173.19	70 TH	173.38	70 TH	158.64	70 TH
167.73	65 TH	169.19	65 TH	154.17	65 TH
162.45	60 TH	165.54	60 TH	150.76	60 TH
157.26	55 TH	162.14	55 TH	148.10	55 TH
151.99	50 TH	158.75	50 TH	145.89	50 TH
146.62	45 TH	155.24	45 TH	143.99	45 TH
141.14	40 TH	151.50	40 TH	142.23	40 TH
135.44	35 TH	147.33	35 TH	140.38	35 TH
129.46	30 TH	142.54	30 TH	138.17	30 TH
123.19	25 TH	136.92	25 TH	135.25	25 TH
116.58	20 TH	130.06	20 TH	130.91	20 TH
109.82	15 TH	121.46	15 TH	123.90	15 TH
103.32	10 TH	109.79	10 TH	110.74	10 TH
100.44	5 TH	92.49	5 TH	79.32	5 TH

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 6.33%

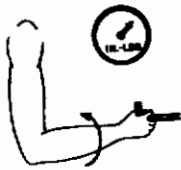
Condition 3: 0.53%

Percentage Increase/Decrease of the Means

Condition 1 as Base

Condition 2: 4.93% increase

Condition 3: 1.68% decrease



Maximum Torque; Pronation

The number of inch-pounds a man can record on a torque wrench by grasping and turning an attached vertical rod to his left (palm down)

HUMAN ENGINEERING APPLICATIONS

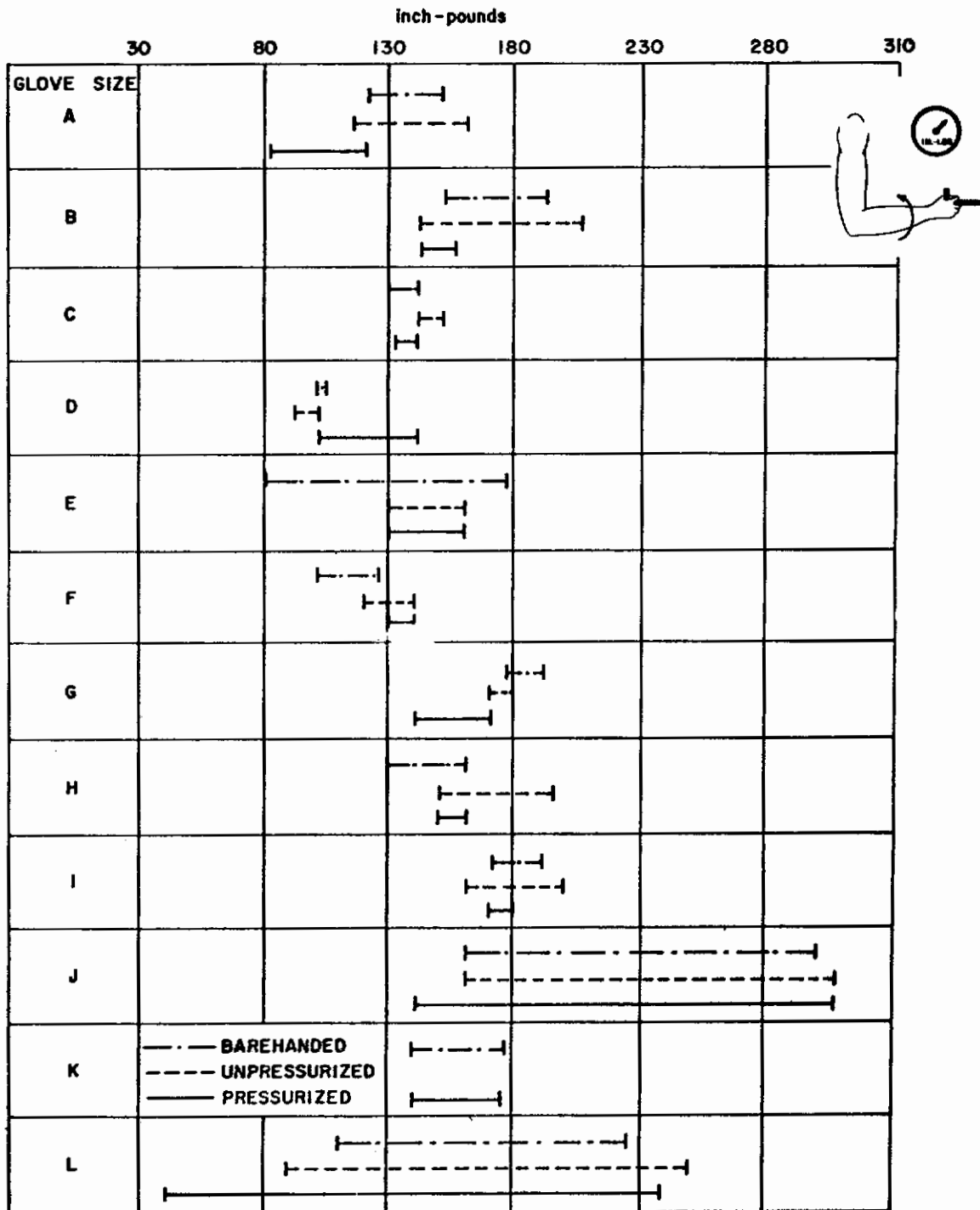
- For – 1) Determination of the maximum resistance allowable on a rotary switch
- 2) Determination of the maximum torque for hand tightened bolts, fasteners, etc.
- 3) Limitation of man's capacity for torque around an axis in or near his forearm

DESIGN CRITERIA

Number of inch-pounds torque necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
For applications 1, 2, 3	100 in.-lb.	92 in.-lb.	79 in.-lb.
For application 3	223 in.-lb.	253 in.-lb.	245 in.-lb.

Range of Values for Maximum Torque; Pronation per Glove Size



HAND CLEARANCE AROUND KNOB; HYPOTHENAR



Subject extends his right hand and grasps the knob on the measuring instrument between his thumb and forefinger. The knob indicator points up to zero. Using a vertical wooden block, measure from the knob center to the most protrusive point on the hypothenar surface of the hand.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	6.73 cm; 2.65 in.	8.26 cm; 3.25 in.	9.47 cm; 3.73 in.
SD:	1.03 cm; 0.41 in.	0.83 cm; 0.33 in.	1.01 cm; 0.40 in.
V%:	15.38	10.03	10.69

HAND CLEARANCE AROUND KNOB; HYPOTHENAR



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
8.62	95 TH	3.39	9.48	95 TH	3.73	10.98	95 TH	4.32
8.09	90 TH	3.19	8.23	90 TH	3.63	10.69	90 TH	4.21
7.76	85 TH	3.05	9.09	85 TH	3.58	10.51	85 TH	4.14
7.52	80 TH	2.96	8.97	80 TH	3.53	10.37	80 TH	4.08
7.33	75 TH	2.89	8.87	75 TH	3.49	10.25	75 TH	4.03
7.18	70 TH	2.83	8.76	70 TH	3.45	10.13	70 TH	3.99
7.06	65 TH	2.78	8.66	65 TH	3.41	10.01	65 TH	3.94
6.95	60 TH	2.74	8.56	60 TH	3.37	9.89	60 TH	3.89
6.85	55 TH	2.70	8.45	55 TH	3.33	9.77	55 TH	3.85
6.76	50 TH	2.66	8.34	50 TH	3.28	9.65	50 TH	3.80
6.67	45 TH	2.63	8.23	45 TH	3.24	9.52	45 TH	3.75
6.59	40 TH	2.59	8.10	40 TH	3.19	9.38	40 TH	3.69
6.49	35 TH	2.56	7.97	35 TH	3.14	9.22	35 TH	3.63
6.38	30 TH	2.51	7.83	30 TH	3.08	9.06	30 TH	3.57
6.25	25 TH	2.46	7.68	25 TH	3.02	8.87	25 TH	3.49
6.08	20 TH	2.39	7.51	20 TH	2.96	8.65	20 TH	3.41
5.82	15 TH	2.29	7.34	15 TH	2.89	8.40	15 TH	3.31
5.37	10 TH	2.11	7.15	10 TH	2.81	8.07	10 TH	3.18
4.36	5 TH	1.72	7.01	5 TH	2.76	7.62	5 TH	3.00

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 24.70%

Condition 3: 44.33%

Percentage Increase of the Means

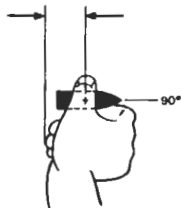
Condition 1 as Base

Condition 2: 22.73%

Condition 3: 40.71%

(HUMAN ENGINEERING APPLICATIONS AND DESIGN CRITERIA ON P. 100)

HAND CLEARANCE AROUND KNOB; PALMAR



Subject extends his right hand and grasps the knob on the measuring instrument between his thumb and forefinger. The knob is rotated 90 degrees from zero to the subject's right. Using a vertical wooden block, measure from the knob center to the most protrusive point on the palmar side of the hand.



ANTHROPOMETRIC DATA (N=27)

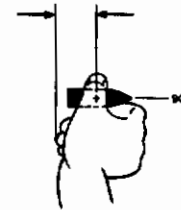
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	4.05 cm; 1.60 in.	4.41 cm; 1.74 in.	4.51 cm; 1.78 in.
SD:	0.74 cm; 0.29 in.	0.81 cm; 0.32 in.	0.94 cm; 0.37 in.
V%:	18.19	18.30	20.79

HAND CLEARANCE AROUND KNOB; PALMAR



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
5.34	95 TH	2.10	5.70	95 TH	2.24	6.32	95 TH	2.49
5.19	90 TH	2.04	5.40	90 TH	2.13	5.90	90 TH	2.32
4.95	85 TH	1.95	5.15	85 TH	2.03	5.60	85 TH	2.20
4.73	80 TH	1.86	4.94	80 TH	1.95	5.36	80 TH	2.11
4.53	75 TH	1.78	4.77	75 TH	1.88	5.15	75 TH	2.03
4.36	70 TH	1.72	4.63	70 TH	1.82	4.96	70 TH	1.95
4.20	65 TH	1.65	4.51	65 TH	1.77	4.79	65 TH	1.89
4.06	60 TH	1.60	4.41	60 TH	1.74	4.64	60 TH	1.82
3.94	55 TH	1.55	4.32	55 TH	1.70	4.49	55 TH	1.77
3.83	50 TH	1.51	4.25	50 TH	1.67	4.35	50 TH	1.71
3.74	45 TH	1.47	4.19	45 TH	1.65	4.22	45 TH	1.66
3.66	40 TH	1.44	4.13	40 TH	1.63	4.09	40 TH	1.61
3.59	35 TH	1.41	4.09	35 TH	1.61	3.96	35 TH	1.56
3.53	30 TH	1.39	4.05	30 TH	1.59	3.84	30 TH	1.51
3.48	25 TH	1.37	4.01	25 TH	1.58	3.73	25 TH	1.47
3.44	20 TH	1.35	3.96	20 TH	1.56	3.62	20 TH	1.42
3.39	15 TH	1.34	3.89	15 TH	1.53	3.51	15 TH	1.38
3.33	10 TH	1.31	3.75	10 TH	1.48	3.43	10 TH	1.35
3.13	5 TH	1.23	3.35	5 TH	1.32	3.41	5 TH	1.34

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 10.32%

Condition 3: 15.04%

Percentage Increase of the Means

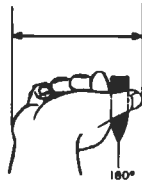
Condition 1 as Base

Condition 2: 8.89%

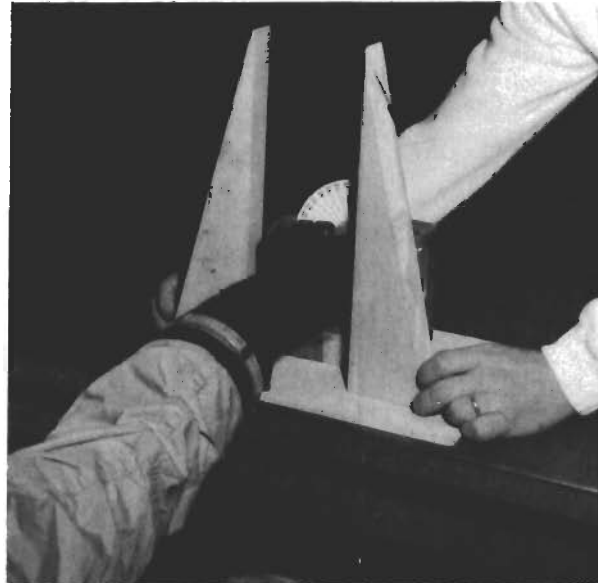
Condition 3: 11.36%

(HUMAN ENGINEERING APPLICATIONS AND DESIGN CRITERIA ON P. 100)

HAND CLEARANCE AROUND KNOB; SUPINATED HAND



Subject extends his right hand and grasps the knob on the measuring instrument between his thumb and forefinger. The knob is rotated 180 degrees from zero to the subject's right. Using vertical wooden blocks, measure from the most protrusive point on the hypothenar side to the most protrusive point on the thenar side of the supinated hand.



ANTHROPOMETRIC DATA (N = 27)

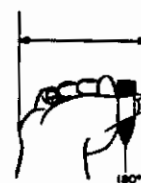
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	10.20 cm; 4.01 in.	11.26 cm; 4.43 in.	11.63 cm; 4.58 in.
SD:	0.80 cm; 0.31 in.	0.63 cm; 0.25 in.	0.80 cm; 0.31 in.
V%:	7.84	5.61	6.92

HAND CLEARANCE AROUND KNOB; SUPINATED HAND



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
11.12	95 TH	4.38	12.33	95 TH	4.86	13.05	95 TH	5.14
11.06	90 TH	4.35	12.19	90 TH	4.80	12.80	90 TH	5.04
11.00	85 TH	4.33	12.03	85 TH	4.73	12.57	85 TH	4.95
10.95	80 TH	4.31	11.88	80 TH	4.68	12.37	80 TH	4.87
10.89	75 TH	4.29	11.75	75 TH	4.63	12.18	75 TH	4.80
10.79	70 TH	4.25	11.63	70 TH	4.58	12.02	70 TH	4.73
10.68	65 TH	4.20	11.52	65 TH	4.54	11.87	65 TH	4.67
10.53	60 TH	4.15	11.43	60 TH	4.50	11.74	60 TH	4.62
10.37	55 TH	4.08	11.33	55 TH	4.46	11.61	55 TH	4.57
10.25	50 TH	4.04	11.25	50 TH	4.43	11.49	50 TH	4.52
10.14	45 TH	3.99	11.17	45 TH	4.40	11.38	45 TH	4.48
10.05	40 TH	3.96	11.09	40 TH	4.37	11.27	40 TH	4.44
9.97	35 TH	3.93	11.02	35 TH	4.34	11.17	35 TH	4.40
9.89	30 TH	3.89	10.95	30 TH	4.31	11.08	30 TH	4.36
9.58	25 TH	3.77	10.88	25 TH	4.28	10.99	25 TH	4.33
9.52	20 TH	3.75	10.80	20 TH	4.25	10.91	20 TH	4.30
9.47	15 TH	3.73	10.72	15 TH	4.22	10.84	15 TH	4.27
9.41	10 TH	3.70	10.61	10 TH	4.18	10.78	10 TH	4.24
8.47	5 TH	3.33	10.42	5 TH	4.10	10.74	5 TH	4.23

Percentage Increase of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 10.91%

Condition 3: 15.46%

Percentage Increase of the Means

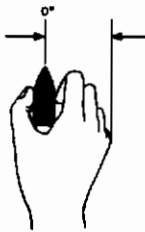
Condition 1 as Base

Condition 2: 10.39%

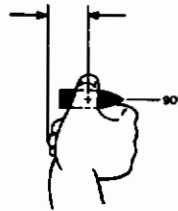
Condition 3: 14.02%

(HUMAN ENGINEERING APPLICATIONS AND DESIGN CRITERIA ON P. 100)

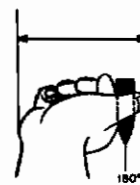
A



B



C



Hand Clearance Around Knob

Three dimensions taken to measure the spatial requirements of the hand while grasping a rotary knob turned to various positions

HUMAN ENGINEERING APPLICATIONS

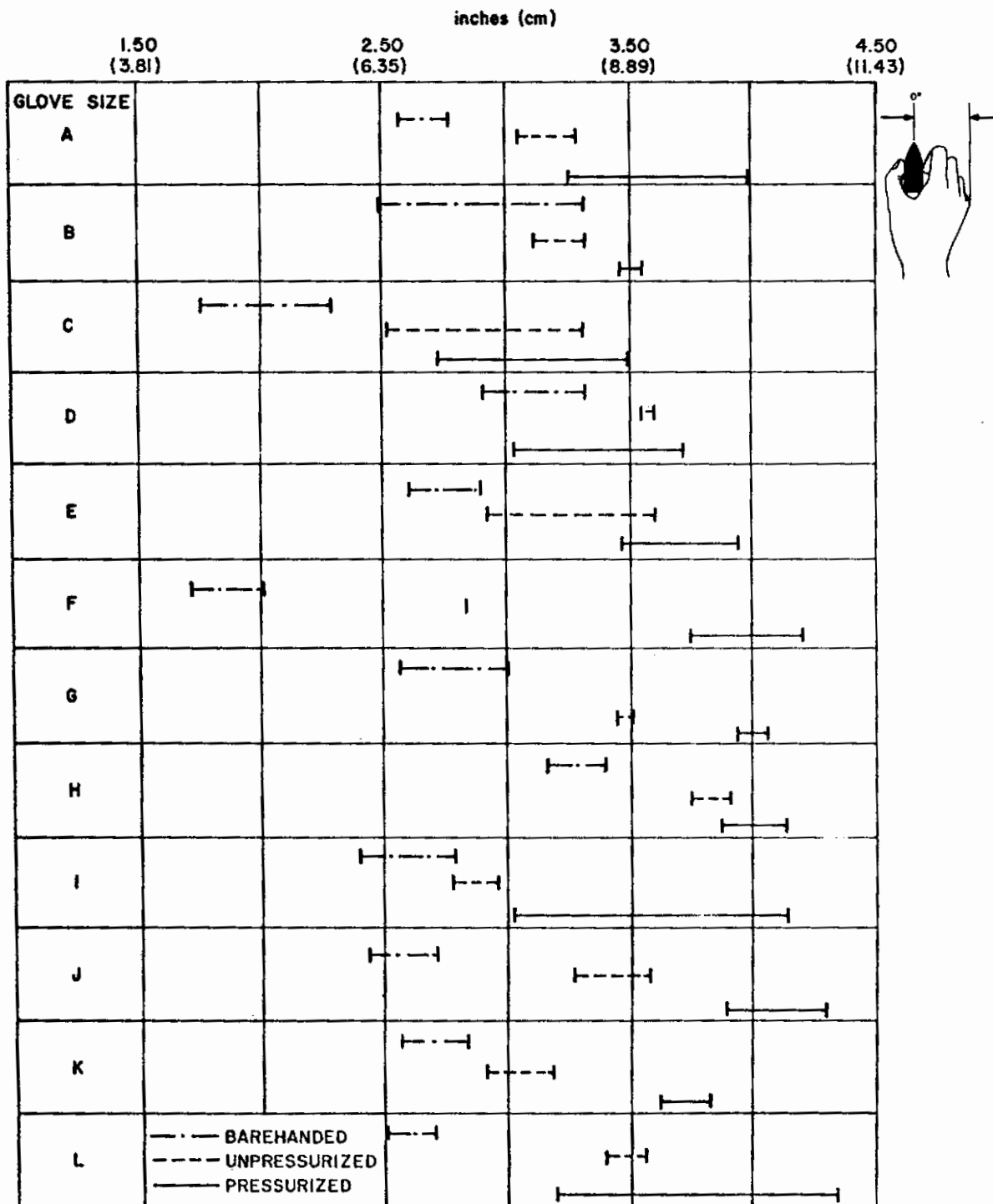
- For — 1) Use A to determine the minimum clearance to the user's right for a rotary knob
- 2) Use A and B to determine the minimum clearance on both sides or the radius of minimum clearance around a rotary knob designed to turn 90 degrees
- 3) Use A and C to determine the minimum clearance on both sides or the diameter of minimum clearance around a rotary knob designed to turn 180 degrees

DESIGN CRITERIA

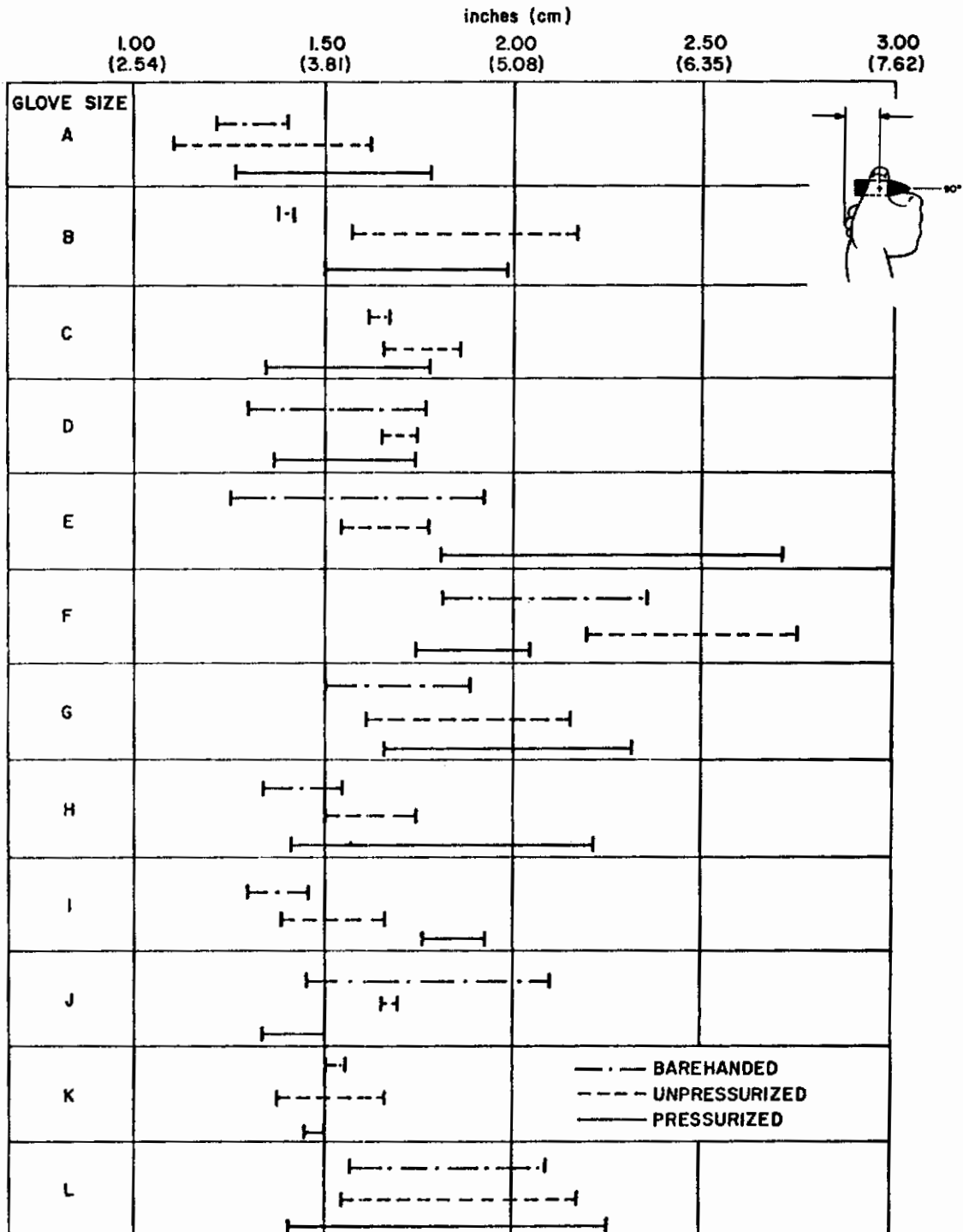
Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

	<i>Barehanded</i>	<i>Unpressurized</i>	<i>Pressurized</i>
A	3½ in.	3¾ in.	4½ in.
B	2¼ in.	2¼ in.	2½ in.
C	4½ in.	5 in.	5¼ in.

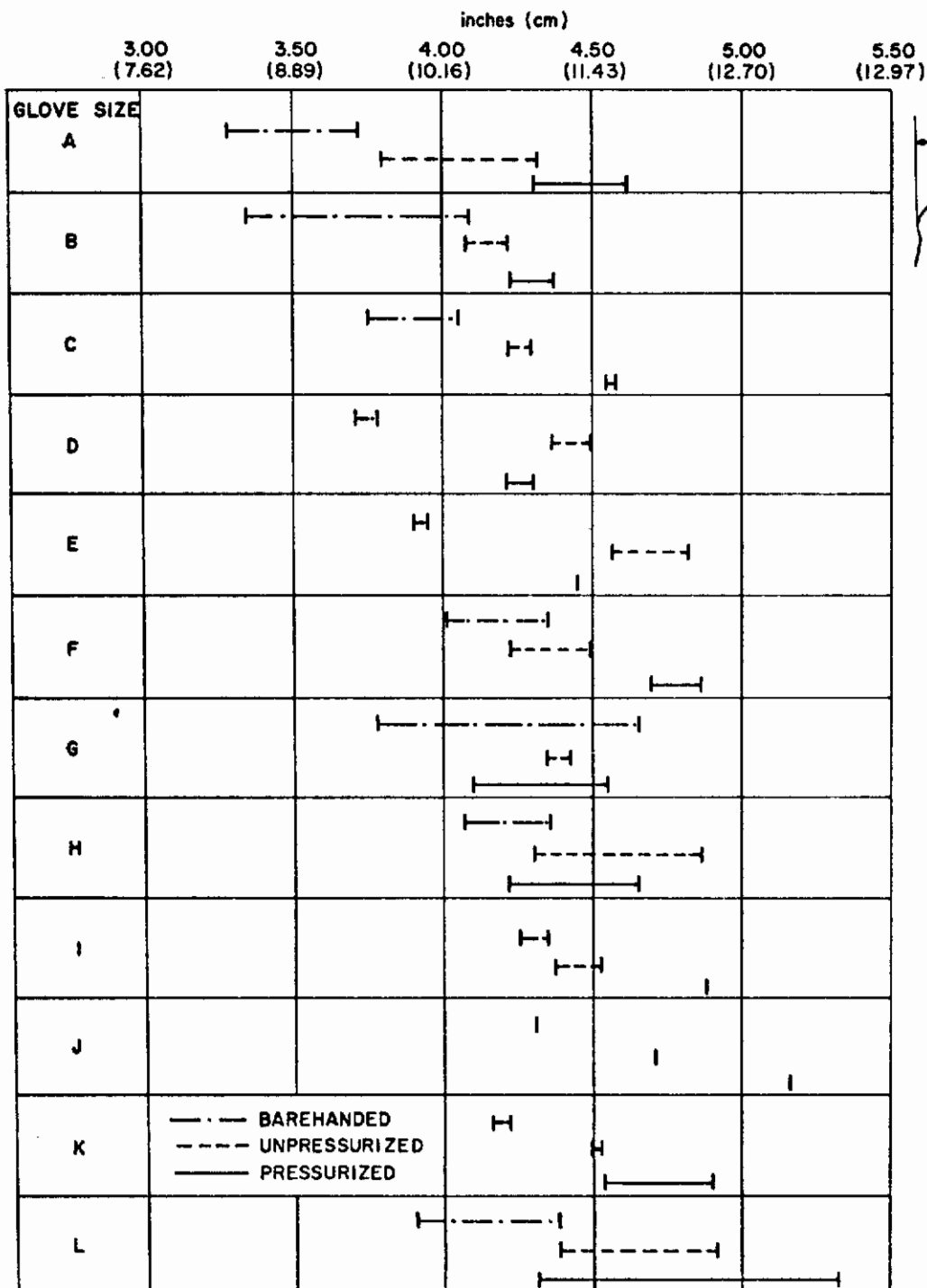
Range of Values for Hand Clearance Around Knob; Hypothenar per Glove Size

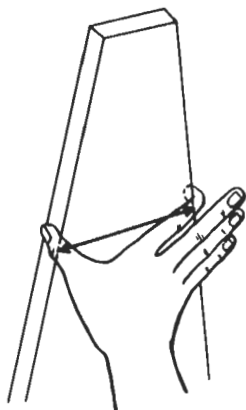


Range of Values for Hand Clearance Around Knob; Palmar, per Glove Size



Range of Values for Hand Clearance Around Knob; Supinated Hand per Glove Size





HAND SPREAD ACROSS WEDGE-1;

DISTAL JOINT OF DIGIT 1 TO DISTAL
JOINT OF DIGIT 2

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the distal joint of digit 2 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

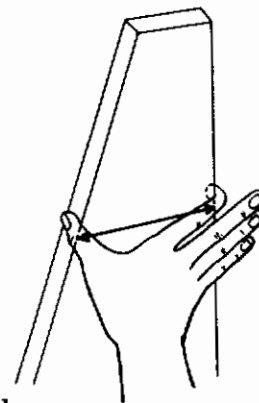
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	12.42 cm; 4.89 in.	10.37 cm; 4.08 in.	8.89 cm; 3.50 in.
SD:	1.41 cm; 0.55 in.	1.27 cm; 0.50 in.	1.27 cm; 0.50 in.
V%:	11.34	12.24	14.29

HAND SPREAD ACROSS WEDGE-1



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
14.65	95 TH	5.77	12.40	95 TH	4.88	11.28	95 TH	4.44
14.39	90 TH	5.67	12.24	90 TH	4.82	10.44	90 TH	4.11
14.02	85 TH	5.52	11.95	85 TH	4.70	10.10	85 TH	3.97
13.68	80 TH	5.38	11.65	80 TH	4.59	9.89	80 TH	3.89
13.36	75 TH	5.26	11.38	75 TH	4.48	9.73	75 TH	3.83
13.08	70 TH	5.15	11.12	70 TH	4.38	9.59	70 TH	3.78
12.83	65 TH	5.05	10.88	65 TH	4.28	9.45	65 TH	3.72
12.61	60 TH	4.96	10.65	60 TH	4.19	9.31	60 TH	3.67
12.40	55 TH	4.88	10.44	55 TH	4.11	9.16	55 TH	3.61
12.22	50 TH	4.81	10.24	50 TH	4.03	9.00	50 TH	3.54
12.05	45 TH	4.74	10.05	45 TH	3.96	8.82	45 TH	3.47
11.89	40 TH	4.68	9.87	40 TH	3.88	8.63	40 TH	3.40
11.74	35 TH	4.62	9.69	35 TH	3.82	8.41	35 TH	3.31
11.59	30 TH	4.56	9.53	30 TH	3.75	8.18	30 TH	3.22
11.44	25 TH	4.50	9.37	25 TH	3.69	7.92	25 TH	3.12
11.26	20 TH	4.43	9.21	20 TH	3.62	7.63	20 TH	3.00
11.04	15 TH	4.35	9.04	15 TH	3.56	7.33	15 TH	2.89
10.68	10 TH	4.20	8.85	10 TH	3.49	7.05	10 TH	2.78
9.83	5 TH	3.87	8.57	5 TH	3.37	7.01	5 TH	2.76

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 16.24%

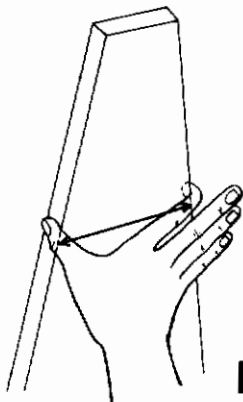
Condition 3: 28.09%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 16.51%

Condition 3: 28.42%



Hand Spread Across Wedge-1

Distal joint of digit 1 to distal joint of digit 2 – A measure of the gripping spread between the last or outer segments of the thumb and index finger

HUMAN ENGINEERING APPLICATIONS

For – 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

3 $\frac{3}{4}$ in.

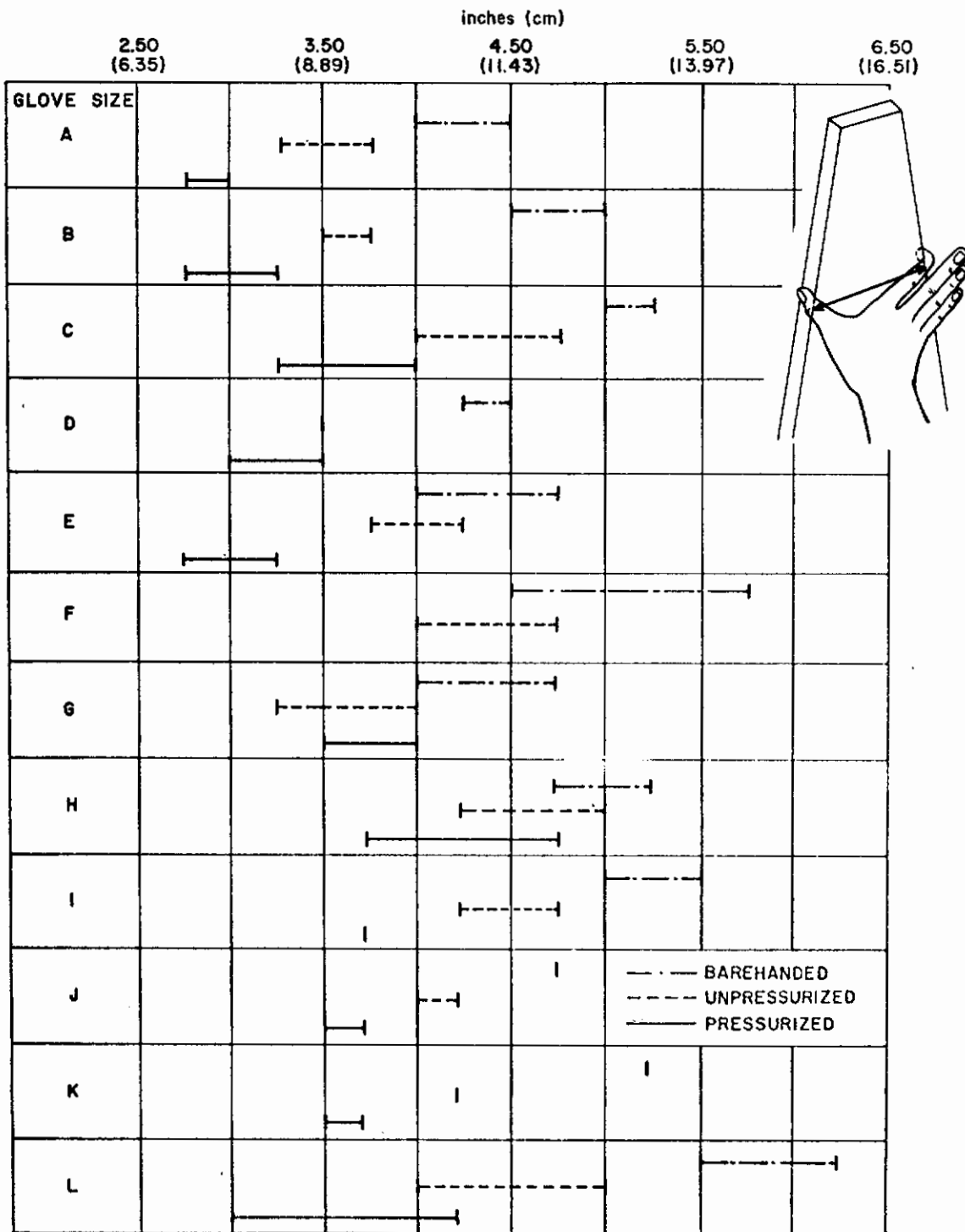
Unpressurized

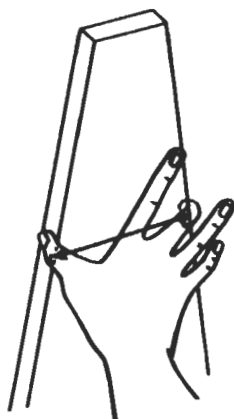
3 $\frac{1}{4}$ in.

Pressurized

2 $\frac{3}{4}$ in.

Range of Values for Hand Spread Across Wedge-1 per Glove Size





HAND SPREAD ACROSS WEDGE-2;

DISTAL JOINT OF DIGIT 1 TO DISTAL
JOINT OF DIGIT 3

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the distal joint of digit 3 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	14.58 cm; 5.74 in.	12.23 cm; 4.81 in.	10.02 cm; 3.94 in.
SD:	1.48 cm; 0.58 in.	1.30 cm; 0.51 in.	1.46 cm; 0.57 in.
V%:	10.16	10.63	14.57

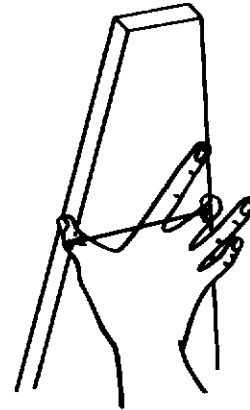
HAND SPREAD ACROSS WEDGE-2

ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.



<i>Condition 1</i>			<i>Condition 2</i>			<i>Condition 3</i>		
<i>Centimeters</i>	<i>Percentiles</i>	<i>Inches</i>	<i>Centimeters</i>	<i>Percentiles</i>	<i>Inches</i>	<i>Centimeters</i>	<i>Percentiles</i>	<i>Inches</i>
18.10	95 TH	7.13	14.22	95 TH	5.60	12.19	95 TH	4.80
16.82	90 TH	6.62	14.13	90 TH	5.56	11.97	90 TH	4.71
16.07	85 TH	6.33	13.80	85 TH	5.43	11.74	85 TH	4.62
15.56	80 TH	6.13	13.47	80 TH	5.31	11.52	80 TH	4.53
15.18	75 TH	5.98	13.17	75 TH	5.18	11.29	75 TH	4.45
14.88	70 TH	5.86	12.89	70 TH	5.07	10.98	70 TH	4.32
14.64	65 TH	5.76	12.64	65 TH	4.98	10.19	65 TH	4.01
14.44	60 TH	5.68	12.42	60 TH	4.89	10.02	60 TH	3.95
14.27	55 TH	5.62	12.21	55 TH	4.81	9.86	55 TH	3.88
14.13	50 TH	5.56	12.03	50 TH	4.74	9.71	50 TH	3.82
14.01	45 TH	5.51	11.87	45 TH	4.67	9.62	45 TH	3.79
13.90	40 TH	5.47	11.72	40 TH	4.61	9.52	40 TH	3.75
13.81	35 TH	5.44	11.58	35 TH	4.56	9.42	35 TH	3.71
13.72	30 TH	5.40	11.45	30 TH	4.51	9.33	30 TH	3.67
13.63	25 TH	5.37	11.32	25 TH	4.46	9.21	25 TH	3.63
13.54	20 TH	5.33	11.17	20 TH	4.40	8.98	20 TH	3.54
13.40	15 TH	5.28	10.98	15 TH	4.32	8.76	15 TH	3.45
13.18	10 TH	5.19	10.65	10 TH	4.19	8.42	10 TH	3.32
12.63	5 TH	4.97	9.81	5 TH	3.86	7.43	5 TH	2.92

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 15.90%

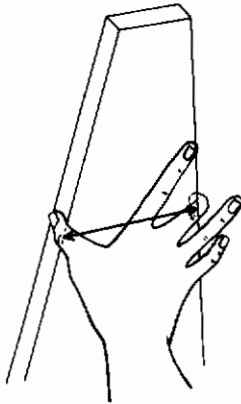
Condition 3: 31.06%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 16.12%

Condition 3: 31.28%



Hand Spread Across Wedge-2

Distal joint of digit 1 to distal joint of digit 3 — A measure of the gripping spread between the last or outer segments of the thumb and middle fingers

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

4³/₄ in.

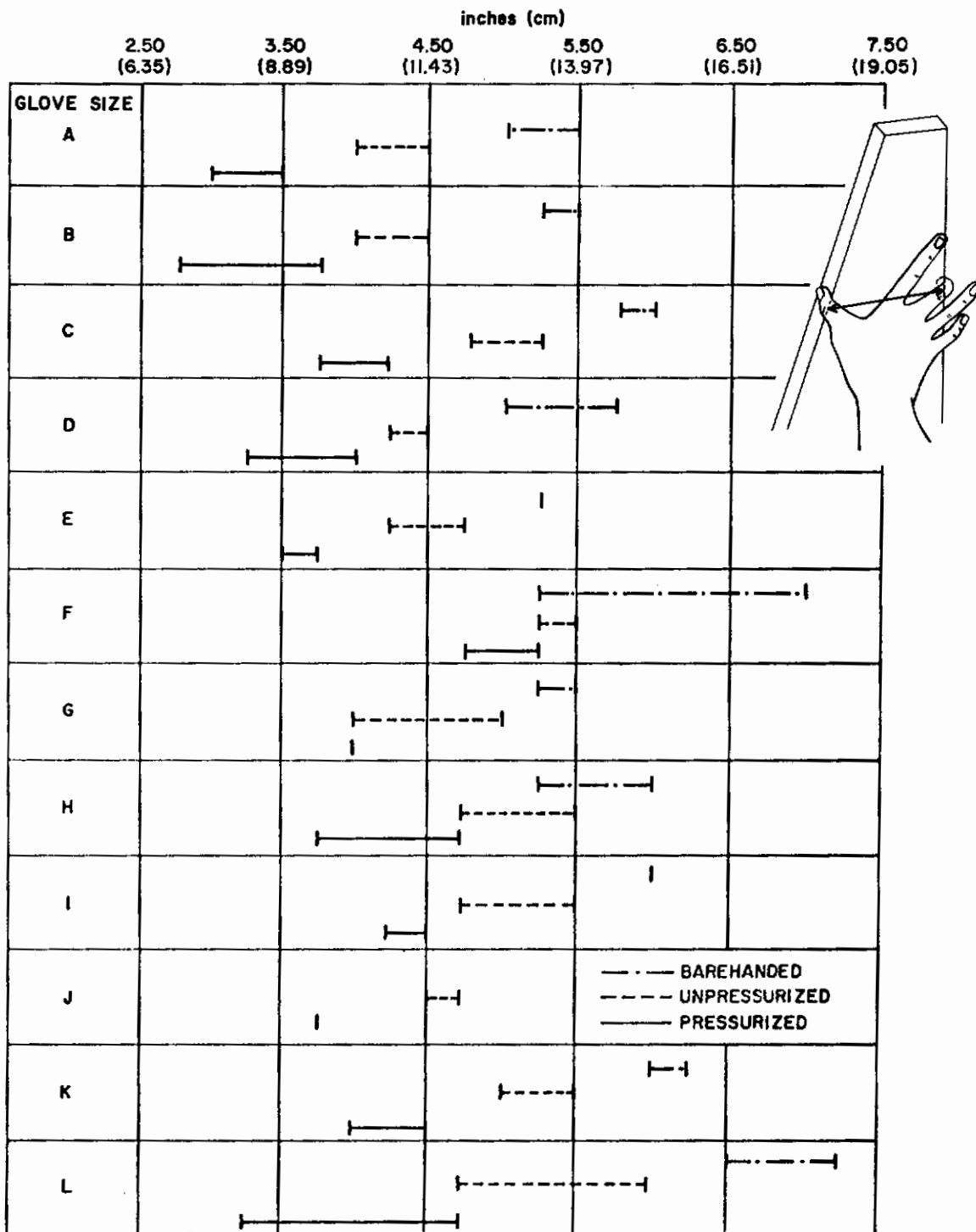
Unpressurized

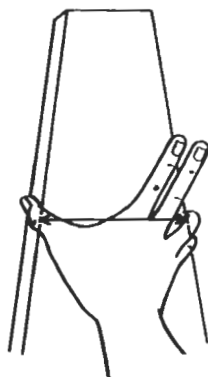
3³/₄ in.

Pressurized

2³/₄ in.

Range of Values for Hand Spread Across Wedge-2 per Glove Size





HAND SPREAD ACROSS WEDGE-3;

**DISTAL JOINT OF DIGIT 1 TO DISTAL
JOINT OF DIGIT 4**

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the distal joint of digit 4 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last ¼ inch line completely cleared.



ANTHROPOMETRIC DATA (N = 27)

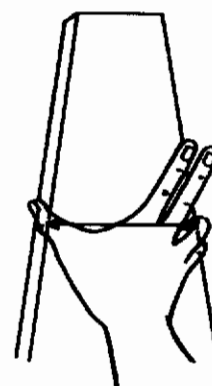
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	15.43 cm; 6.07 in.	12.61 cm; 4.96 in.	10.32 cm; 4.06 in.
SD:	1.52 cm; 0.60 in.	1.29 cm; 0.51 in.	1.53 cm; 0.60 in.
V%:	9.88	10.23	14.84

HAND SPREAD ACROSS WEDGE-3



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
18.62	95 TH	7.33	14.65	95 TH	5.77	12.59	95 TH	4.96
17.79	90 TH	7.01	14.45	90 TH	5.69	12.45	90 TH	4.90
17.12	85 TH	6.74	14.08	85 TH	5.54	12.09	85 TH	4.76
16.59	80 TH	6.53	13.73	80 TH	5.41	11.73	80 TH	4.62
16.15	75 TH	6.36	13.42	75 TH	5.28	11.39	75 TH	4.49
15.79	70 TH	6.22	13.14	70 TH	5.17	11.09	70 TH	4.37
15.48	65 TH	6.10	12.90	65 TH	5.08	10.82	65 TH	4.26
15.23	60 TH	6.00	12.69	60 TH	5.00	10.57	60 TH	4.16
15.02	55 TH	5.91	12.51	55 TH	4.93	10.34	55 TH	4.07
14.84	50 TH	5.84	12.35	50 TH	4.86	10.14	50 TH	3.99
14.69	45 TH	5.78	12.21	45 TH	4.81	9.95	45 TH	3.92
14.57	40 TH	5.74	12.08	40 TH	4.76	9.78	40 TH	3.85
14.47	35 TH	5.70	11.97	35 TH	4.71	9.62	35 TH	3.79
14.40	30 TH	5.67	11.87	30 TH	4.67	9.46	30 TH	3.72
14.34	25 TH	5.64	11.76	25 TH	4.63	9.30	25 TH	3.66
14.28	20 TH	5.62	11.63	20 TH	4.58	9.13	20 TH	3.59
14.19	15 TH	5.59	11.44	15 TH	4.50	8.90	15 TH	3.50
14.00	10 TH	5.51	11.08	10 TH	4.36	8.53	10 TH	3.36
13.36	5 TH	5.26	10.07	5 TH	3.97	7.63	5 TH	3.00

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 18.02%

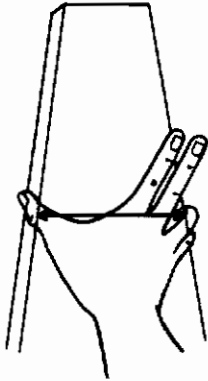
Condition 3: 32.91%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 18.28%

Condition 3: 33.12%



Hand Spread Across Wedge-3

Distal joint of digit 1 to distal joint of digit 4 — A measure of the gripping spread between the last or outer segments of the thumb and ring fingers

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

5 $\frac{1}{4}$ in.

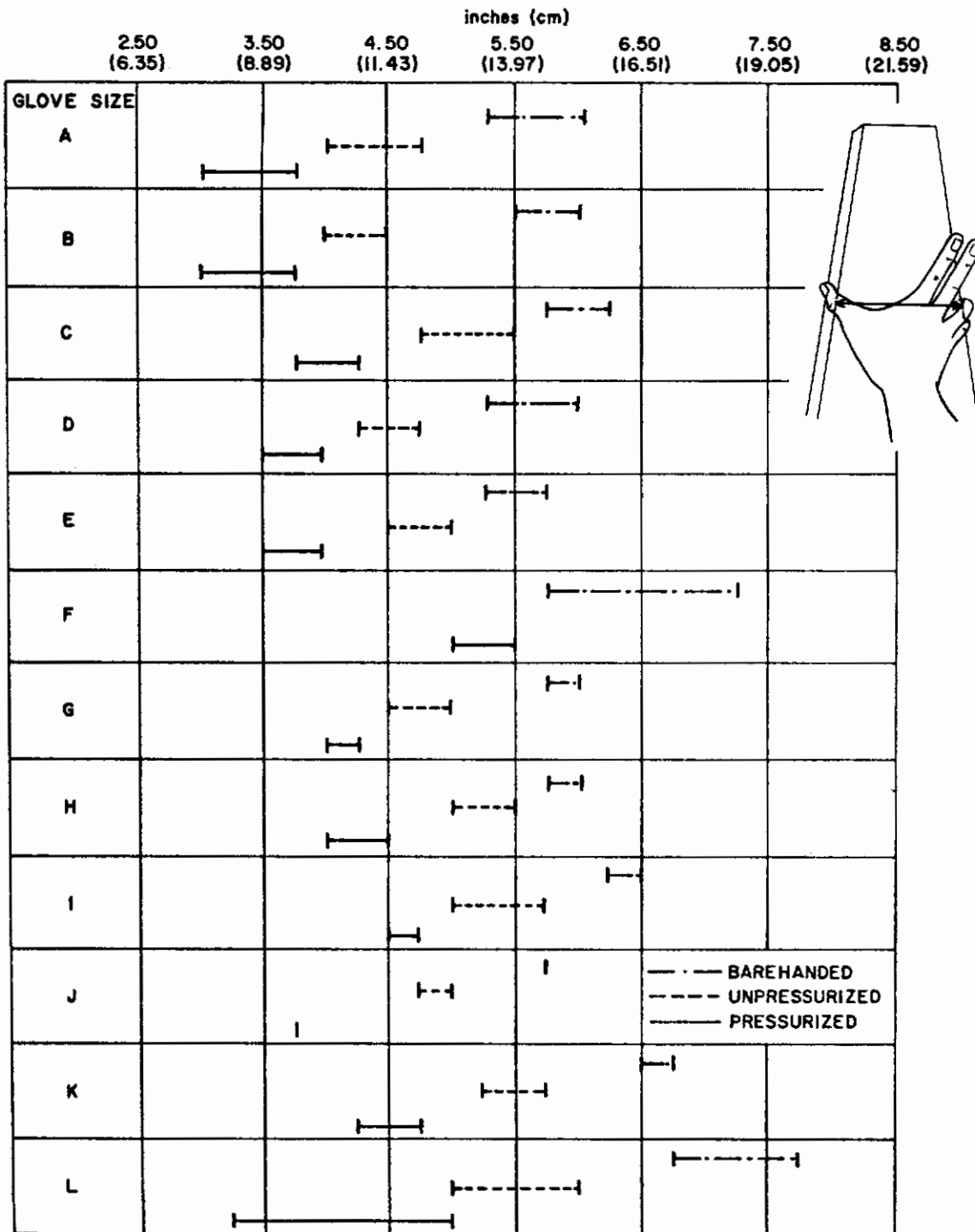
Unpressurized

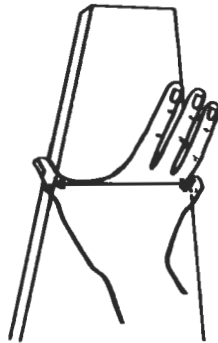
3 $\frac{3}{4}$ in.

Pressurized

3 in.

Range of Values for Hand Spread Across Wedge-3 per Glove Size





HAND SPREAD ACROSS WEDGE-4;

DISTAL JOINT OF DIGIT 1 TO DISTAL
JOINT OF DIGIT 5

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the distal joint of digit 5 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N = 27)

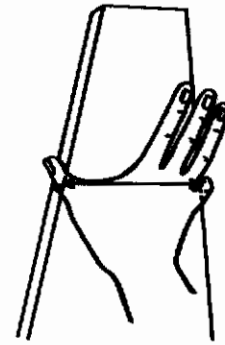
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	15.36 cm; 6.05 in.	12.84 cm; 5.06 in.	9.83 cm; 3.87 in.
SD:	1.37 cm; 0.54 in.	1.43 cm; 0.56 in.	1.58 cm; 0.62 in.
V%:	8.93	11.13	16.05

HAND SPREAD ACROSS WEDGE-4



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
18.05	95 TH	7.11	15.02	95 TH	5.92	12.16	95 TH	4.79
17.70	90 TH	6.97	14.80	90 TH	5.83	12.12	90 TH	4.77
17.22	85 TH	6.78	14.49	85 TH	5.70	11.77	85 TH	4.63
16.77	80 TH	6.60	14.20	80 TH	5.59	11.39	80 TH	4.49
16.37	75 TH	6.44	14.03	75 TH	5.52	11.04	75 TH	4.35
16.01	70 TH	6.30	13.86	70 TH	5.46	10.72	70 TH	4.22
15.69	65 TH	6.18	13.64	65 TH	5.37	10.43	65 TH	4.10
15.41	60 TH	6.07	13.30	60 TH	5.24	10.16	60 TH	4.00
15.16	55 TH	5.97	12.56	55 TH	4.94	9.93	55 TH	3.91
14.94	50 TH	5.88	12.33	50 TH	4.86	9.72	50 TH	3.83
14.74	45 TH	5.80	12.20	45 TH	4.80	9.53	45 TH	3.75
14.57	40 TH	5.74	12.11	40 TH	4.77	9.35	40 TH	3.68
14.42	35 TH	5.68	12.03	35 TH	4.74	9.19	35 TH	3.62
14.30	30 TH	5.63	11.94	30 TH	4.70	9.04	30 TH	3.56
14.20	25 TH	5.59	11.86	25 TH	4.67	8.88	25 TH	3.49
14.12	20 TH	5.56	11.77	20 TH	4.64	8.69	20 TH	3.42
14.05	15 TH	5.53	11.59	15 TH	4.56	8.43	15 TH	3.32
13.97	10 TH	5.50	11.37	10 TH	4.48	7.98	10 TH	3.14
13.74	5 TH	5.41	10.92	5 TH	4.30	6.80	5 TH	2.68

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 16.31%

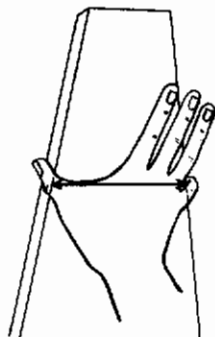
Condition 3: 35.94%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 16.41%

Condition 3: 36.00%



Hand Spread Across Wedge-4

Distal joint of digit 1 to distal joint of digit 5 — A measure of the gripping spread between the last or outer segments of the thumb and little finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

5 $\frac{1}{4}$ in.

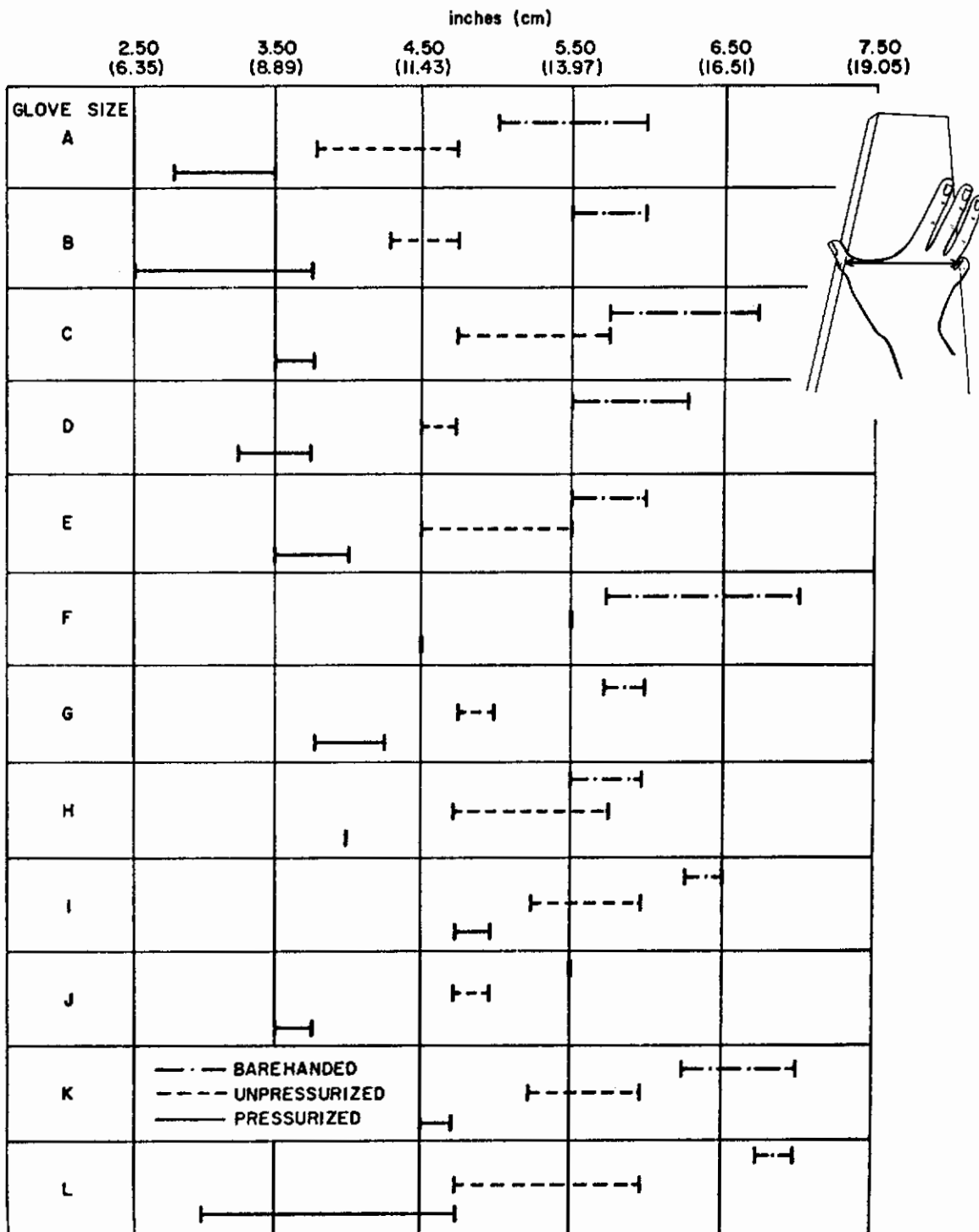
Unpressurized

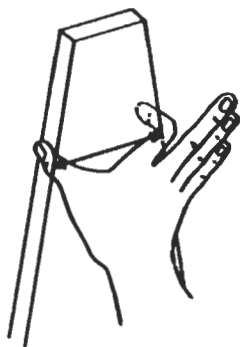
4 $\frac{1}{4}$ in.

Pressurized

2 $\frac{1}{2}$ in.

Range of Values for Hand Spread Across Wedge-4 per Glove Size





HAND SPREAD ACROSS WEDGE-5;

DISTAL JOINT OF DIGIT 1 TO MIDDLE
JOINT OF DIGIT 2

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the middle joint of digit 2 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N = 27)

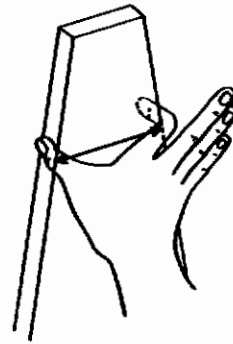
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	10.49 cm; 4.13 in.	9.17 cm; 3.61 in.	8.04 cm; 3.17 in.
SD:	0.98 cm; 0.39 in.	0.92 cm; 0.36 in.	0.99 cm; 0.39 in.
V%:	9.37	10.03	12.34

HAND SPREAD ACROSS WEDGE-5



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
11.97	95 TH	4.71	10.99	95 TH	4.33	9.66	95 TH	3.80
11.90	90 TH	4.68	10.42	90 TH	4.10	9.33	90 TH	3.67
11.68	85 TH	4.60	10.10	85 TH	3.98	9.15	85 TH	3.60
11.46	80 TH	4.51	9.88	80 TH	3.89	9.02	80 TH	3.55
11.24	75 TH	4.43	9.70	75 TH	3.82	8.90	75 TH	3.50
11.04	70 TH	4.35	9.56	70 TH	3.76	8.78	70 TH	3.46
10.86	65 TH	4.28	9.43	65 TH	3.71	8.65	65 TH	3.41
10.69	60 TH	4.21	9.31	60 TH	3.67	8.52	60 TH	3.36
10.53	55 TH	4.15	9.20	55 TH	3.62	8.39	55 TH	3.30
10.38	50 TH	4.09	9.10	50 TH	3.58	8.24	50 TH	3.24
10.25	45 TH	4.03	9.01	45 TH	3.55	8.08	45 TH	3.18
10.12	40 TH	3.98	8.92	40 TH	3.51	7.92	40 TH	3.12
9.99	35 TH	3.93	8.82	35 TH	3.47	7.74	35 TH	3.05
9.87	30 TH	3.89	8.73	30 TH	3.44	7.54	30 TH	2.97
9.75	25 TH	3.84	8.64	25 TH	3.40	7.32	25 TH	2.88
9.63	20 TH	3.79	8.55	20 TH	3.37	7.09	20 TH	2.79
9.48	15 TH	3.73	8.46	15 TH	3.33	6.84	15 TH	2.69
9.27	10 TH	3.65	8.36	10 TH	3.29	6.58	10 TH	2.59
8.83	5 TH	3.48	8.29	5 TH	3.26	6.43	5 TH	2.53

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 12.38%

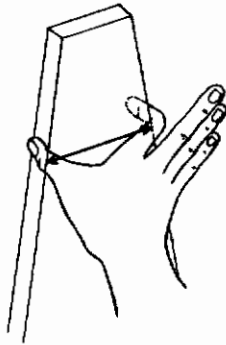
Condition 3: 23.02%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 12.58%

Condition 3: 23.36%



Hand Spread Across Wedge-5

Distal joint of digit 1 to middle joint of digit 2 — A measure of the gripping spread between the last or outer segment of the thumb and the middle segment of the index finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

Unpressurized

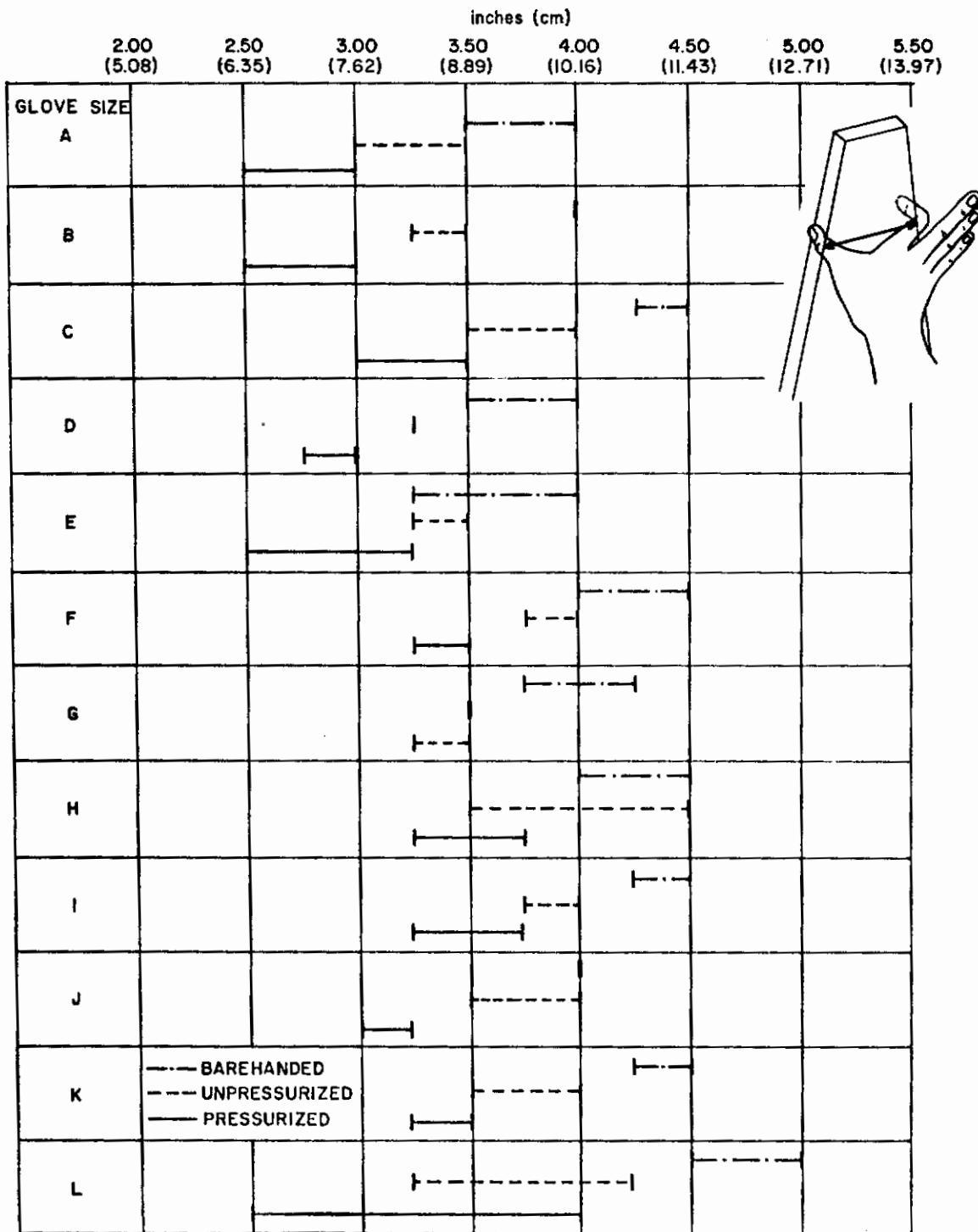
Pressurized

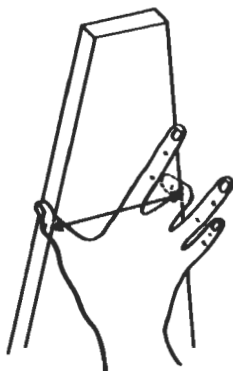
3½ in.

3¼ in.

2½ in.

Range of Values for Hand Spread Across Wedge-5 per Glove Size





HAND SPREAD ACROSS WEDGE-6;

DISTAL JOINT OF DIGIT 1 TO MIDDLE
JOINT OF DIGIT 3

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the middle joint of digit 3 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

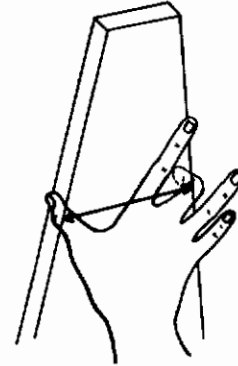
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	12.28 cm; 4.83 in.	10.49 cm; 4.13 in.	8.96 cm; 3.53 in.
SD:	1.21 cm; 0.48 in.	1.08 cm; 0.43 in.	1.29 cm; 0.51 in.
V%:	9.85	10.34	14.35

HAND SPREAD ACROSS WEDGE-6



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
14.65	95 TH	5.77	12.21	95 TH	4.81	11.55	95 TH	4.55
14.00	90 TH	5.51	12.04	90 TH	4.74	10.72	90 TH	4.22
13.56	85 TH	5.34	11.87	85 TH	4.67	10.29	85 TH	4.05
13.22	80 TH	5.20	11.68	80 TH	4.60	9.99	80 TH	3.93
12.94	75 TH	5.09	11.46	75 TH	4.51	9.77	75 TH	3.85
12.71	70 TH	5.00	11.23	70 TH	4.42	9.58	70 TH	3.77
12.51	65 TH	4.92	10.89	65 TH	4.29	9.42	65 TH	3.71
12.33	60 TH	4.85	10.21	60 TH	4.02	9.28	60 TH	3.65
12.17	55 TH	4.79	10.15	55 TH	4.00	9.14	55 TH	3.60
12.03	50 TH	4.74	10.09	50 TH	3.97	9.01	50 TH	3.55
11.90	45 TH	4.69	10.03	45 TH	3.95	8.88	45 TH	3.50
11.78	40 TH	4.64	9.97	40 TH	3.92	8.74	40 TH	3.44
11.67	35 TH	4.59	9.91	35 TH	3.90	8.60	35 TH	3.38
11.56	30 TH	4.55	9.85	30 TH	3.88	8.44	30 TH	3.32
11.46	25 TH	4.51	9.78	25 TH	3.85	8.28	25 TH	3.25
11.35	20 TH	4.47	9.65	20 TH	3.80	8.04	20 TH	3.17
11.22	15 TH	4.42	9.42	15 TH	3.71	7.77	15 TH	3.08
11.05	10 TH	4.35	9.17	10 TH	3.61	7.38	10 TH	2.91
10.72	5 TH	4.22	8.84	5 TH	3.48	6.72	5 TH	2.65

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 14.25%

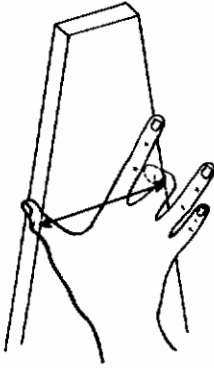
Condition 3: 26.77%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 14.58%

Condition 3: 27.04%



Hand Spread Across Wedge-6

Distal joint of digit 1 to middle joint of digit 3 — A measure of the gripping spread between the last or outer segment of the thumb and the middle segment of the middle finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

4 in.

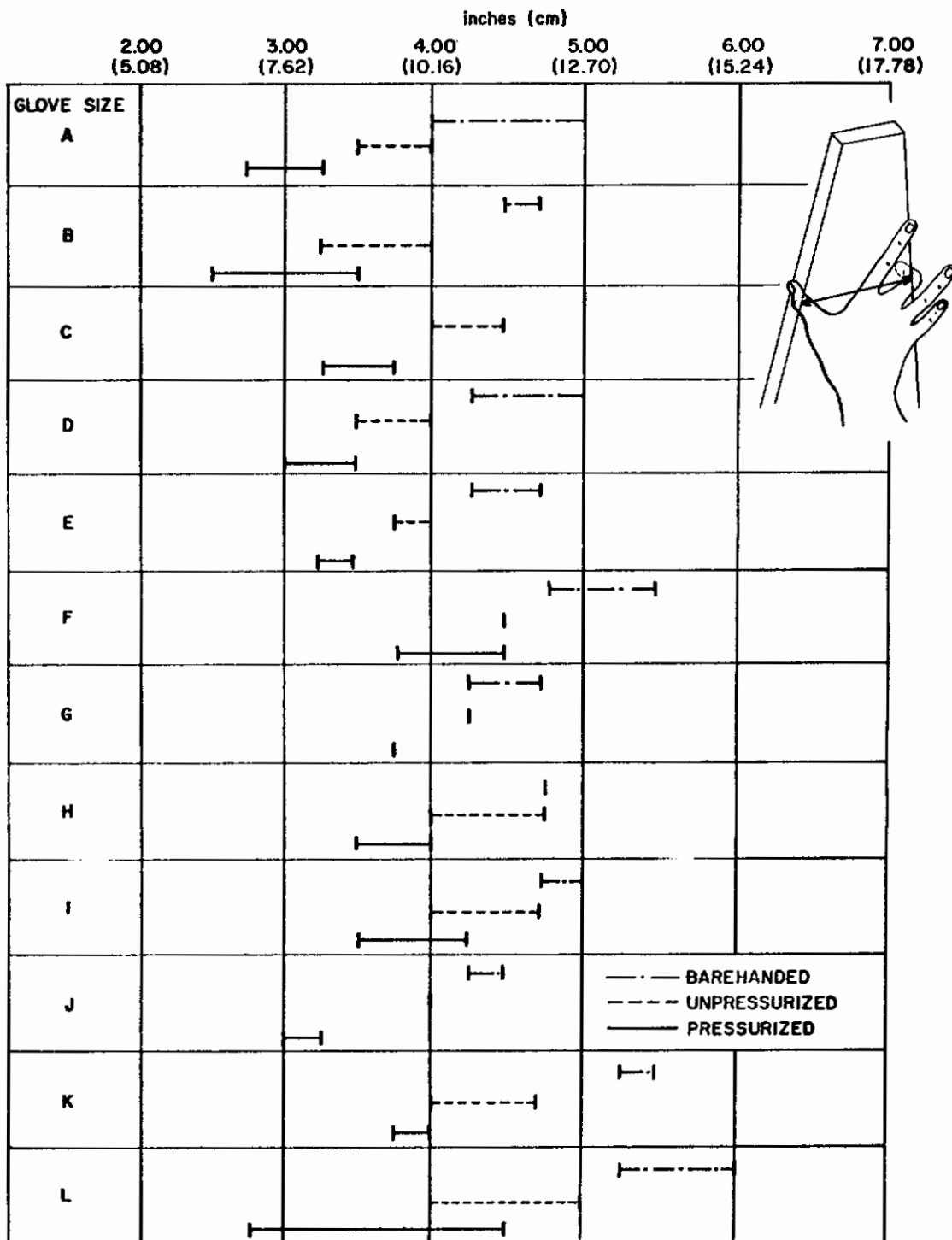
Unpressurized

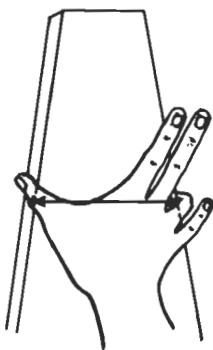
3¼ in.

Pressurized

2½ in.

Range of Values for Hand Spread Across Wedge-6 per Glove Size





HAND SPREAD ACROSS WEDGE-7;

DISTAL JOINT OF DIGIT 1 TO MIDDLE
JOINT OF DIGIT 4

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the middle joint of digit 4 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

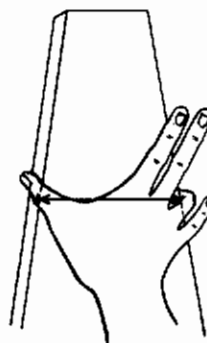
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	13.10 cm; 5.16 in.	11.08 cm; 4.36 in.	9.24 cm; 3.64 in.
SD:	1.20 cm; 0.47 in.	1.21 cm; 0.48 in.	1.44 cm; 0.57 in.
V%:	9.15	10.96	15.57

HAND SPREAD ACROSS WEDGE-7



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
15.00	95 TH	5.91	12.74	95 TH	5.02	12.19	95 TH	4.80
14.69	90 TH	5.79	12.53	90 TH	4.93	11.40	90 TH	4.49
14.37	85 TH	5.66	12.30	85 TH	4.84	10.85	85 TH	4.27
14.09	80 TH	5.55	12.10	80 TH	4.76	10.45	80 TH	4.11
13.83	75 TH	5.44	11.90	75 TH	4.69	10.13	75 TH	3.99
13.59	70 TH	5.35	11.73	70 TH	4.62	9.86	70 TH	3.88
13.37	65 TH	5.27	11.56	65 TH	4.55	9.64	65 TH	3.79
13.18	60 TH	5.19	11.39	60 TH	4.49	9.44	60 TH	3.72
12.99	55 TH	5.11	11.24	55 TH	4.42	9.27	55 TH	3.65
12.82	50 TH	5.05	11.08	50 TH	4.36	9.12	50 TH	3.59
12.65	45 TH	4.98	10.93	45 TH	4.30	8.97	45 TH	3.53
12.50	40 TH	4.92	10.78	40 TH	4.24	8.84	40 TH	3.48
12.36	35 TH	4.86	10.63	35 TH	4.18	8.72	35 TH	3.43
12.22	30 TH	4.81	10.47	30 TH	4.12	8.59	30 TH	3.38
12.08	25 TH	4.76	10.31	25 TH	4.06	8.45	25 TH	3.33
11.95	20 TH	4.71	10.13	20 TH	3.99	8.28	20 TH	3.26
11.83	15 TH	4.66	9.93	15 TH	3.91	8.05	15 TH	3.17
11.69	10 TH	4.60	9.68	10 TH	3.81	7.67	10 TH	3.02
11.50	5 TH	4.53	9.30	5 TH	3.66	6.81	5 TH	2.68

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 15.22%

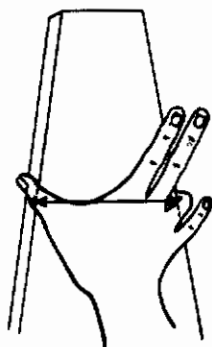
Condition 3: 29.26%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 15.42%

Condition 3: 29.47%



Hand Spread Across Wedge-7

Distal joint of digit 1 to middle joint of digit 4 — A measure of the gripping spread between the last or outer segment of the thumb and the middle segment of the ring finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

Unpressurized

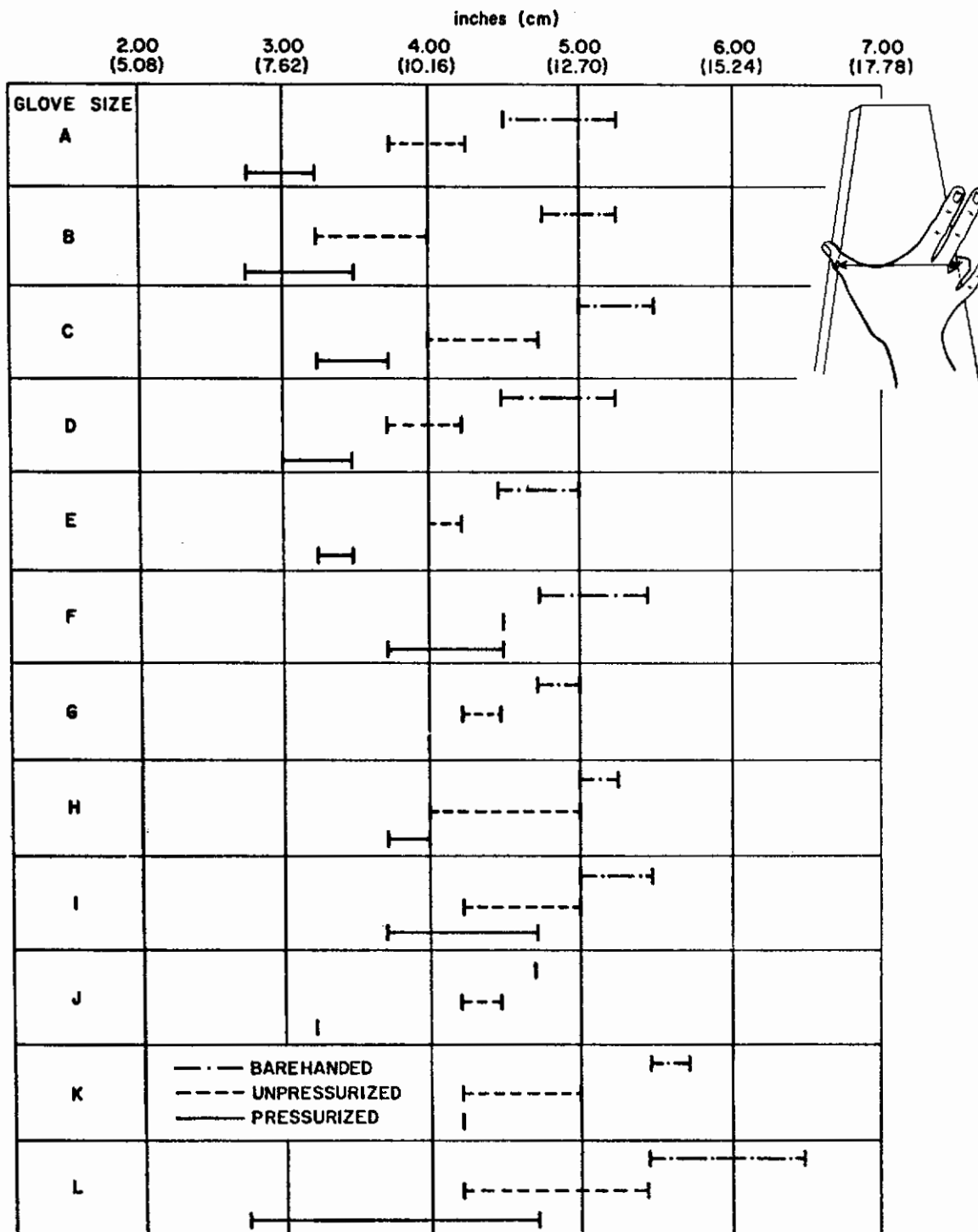
Pressurized

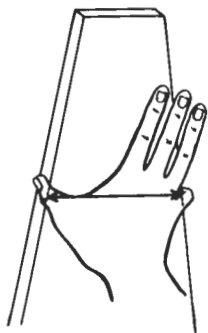
4½ in.

3½ in.

2½ in.

Range of Values for Hand Spread Across Wedge-7 per Glove Size





HAND SPREAD ACROSS WEDGE-8;

DISTAL JOINT OF DIGIT 1 TO MIDDLE
JOINT OF DIGIT 5

Subject places his right hand on the measuring wedge so that the distal joint of his thumb is on the right edge of the wedge and the middle joint of digit 5 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

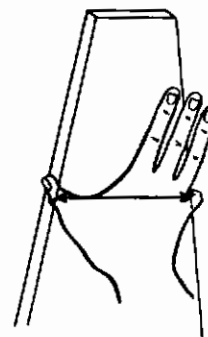
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	13.41 cm; 5.28 in.	11.41 cm; 4.49 in.	8.96 cm; 3.53 in.
SD:	1.16 cm; 0.46 in.	1.32 cm; 0.52 in.	1.48 cm; 0.58 in.
V%:	8.68	11.59	16.52

HAND SPREAD ACROSS WEDGE-8



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
15.91	95 TH	6.26	13.67	95 TH	5.38	11.69	95 TH	4.60
14.90	90 TH	5.87	13.45	90 TH	5.30	10.98	90 TH	4.32
14.58	85 TH	5.74	13.08	85 TH	5.15	10.57	85 TH	4.16
14.35	80 TH	5.65	12.73	80 TH	5.01	10.28	80 TH	4.05
14.17	75 TH	5.58	12.41	75 TH	4.89	10.03	75 TH	3.95
14.04	70 TH	5.53	12.14	70 TH	4.78	9.81	70 TH	3.86
13.90	65 TH	5.47	11.90	65 TH	4.68	9.61	65 TH	3.78
13.77	60 TH	5.42	11.69	60 TH	4.60	9.41	60 TH	3.70
13.56	55 TH	5.34	11.51	55 TH	4.53	9.22	55 TH	3.63
13.33	50 TH	5.25	11.35	50 TH	4.47	9.02	50 TH	3.55
12.70	45 TH	5.00	11.20	45 TH	4.41	8.82	45 TH	3.47
12.61	40 TH	4.97	11.08	40 TH	4.36	8.61	40 TH	3.39
12.53	35 TH	4.93	10.97	35 TH	4.32	8.39	35 TH	3.20
12.44	30 TH	4.90	10.86	30 TH	4.27	8.16	30 TH	3.21
12.36	25 TH	4.87	10.74	25 TH	4.23	7.91	25 TH	3.11
12.27	20 TH	4.83	10.60	20 TH	4.17	7.63	20 TH	3.00
12.13	15 TH	4.78	10.38	15 TH	4.09	7.31	15 TH	2.88
11.96	10 TH	4.71	9.97	10 TH	3.92	6.95	10 TH	2.74
11.79	5 TH	4.64	8.84	5 TH	3.48	6.54	5 TH	2.57

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 14.78%

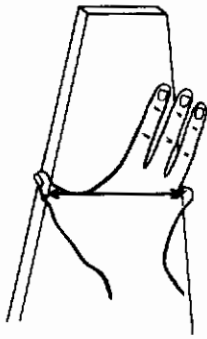
Condition 3: 32.94%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 14.91%

Condition 3: 33.18%



Hand Spread Across Wedge-8

Distal joint of digit 1 to middle joint of digit 5 — A measure of the gripping spread between the last or outer segment of the thumb and the middle segment of the little finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two segments of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

4½ in.

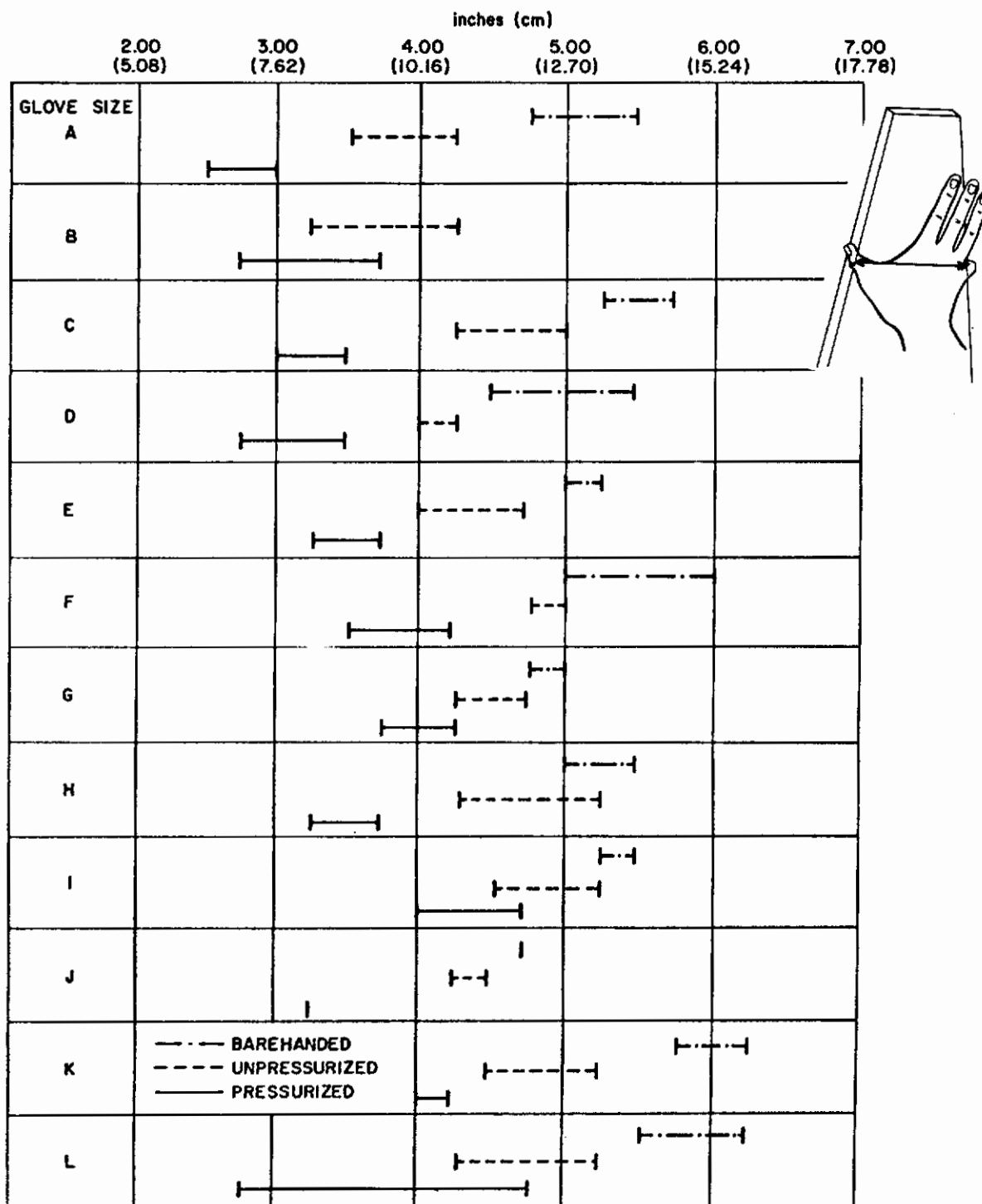
Unpressurized

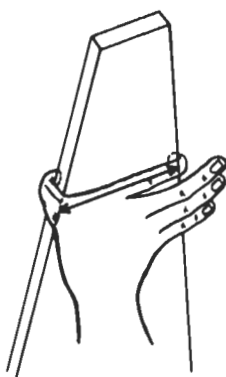
3¼ in.

Pressurized

2½ in.

Range of Values for Hand Spread Across Wedge-8 per Glove Size





HAND SPREAD ACROSS WEDGE-9;

CROTCH 1 OF HAND TO DISTAL JOINT
OF DIGIT 2

Subject places his right hand on the measuring wedge so that crotch 1 is on the right edge of the wedge and the distal joint of digit 2 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N = 27)

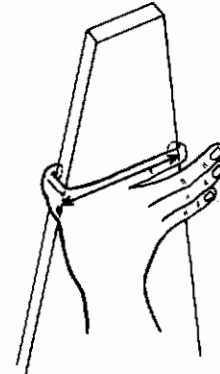
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	10.75 cm; 4.23 in.	9.29 cm; 3.66 in.	7.97 cm; 3.14 in.
SD:	1.09 cm; 0.43 in.	1.14 cm; 0.45 in.	0.94 cm; 0.37 in.
V%:	10.16	12.22	11.74

HAND SPREAD ACROSS WEDGE-9



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
12.29	95 TH	4.84	11.49	95 TH	4.52	9.60	95 TH	3.78
11.98	90 TH	4.72	10.64	90 TH	4.19	9.45	90 TH	3.72
11.83	85 TH	4.66	10.31	85 TH	4.06	9.20	85 TH	3.62
11.70	80 TH	4.61	10.13	80 TH	3.99	8.96	80 TH	3.53
11.59	75 TH	4.56	10.00	75 TH	3.94	8.73	75 TH	3.44
11.47	70 TH	4.52	9.89	70 TH	3.89	8.52	70 TH	3.35
11.35	65 TH	4.47	9.78	65 TH	3.85	8.33	65 TH	3.28
11.23	60 TH	4.42	9.67	60 TH	3.81	8.15	60 TH	3.21
11.09	55 TH	4.37	9.55	55 TH	3.76	7.99	55 TH	3.14
10.94	50 TH	4.31	9.42	50 TH	3.71	7.84	50 TH	3.09
10.79	45 TH	4.25	9.27	45 TH	3.65	7.70	45 TH	3.03
10.62	40 TH	4.18	9.11	40 TH	3.59	7.57	40 TH	2.98
10.43	35 TH	4.11	8.92	35 TH	3.51	7.44	35 TH	2.93
10.23	30 TH	4.03	8.70	30 TH	3.43	7.33	30 TH	2.89
10.00	25 TH	3.94	8.46	25 TH	3.33	7.22	25 TH	2.84
9.75	20 TH	3.84	8.19	20 TH	3.22	7.11	20 TH	2.80
9.48	15 TH	3.73	7.88	15 TH	3.10	7.00	15 TH	2.76
9.18	10 TH	3.62	7.55	10 TH	2.97	6.86	10 TH	2.70
8.94	5 TH	3.52	7.34	5 TH	2.89	6.59	5 TH	2.60

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 13.57%

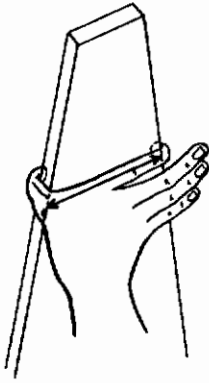
Condition 3: 25.65%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 13.58%

Condition 3: 25.86%



Hand Spread Across Wedge-9

Crotch 1 of hand to distal joint of digit 2 — A measure of the gripping spread between the crotch formed at the juncture of the thumb and forefinger and the last segment of the forefinger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two areas of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

3½ in.

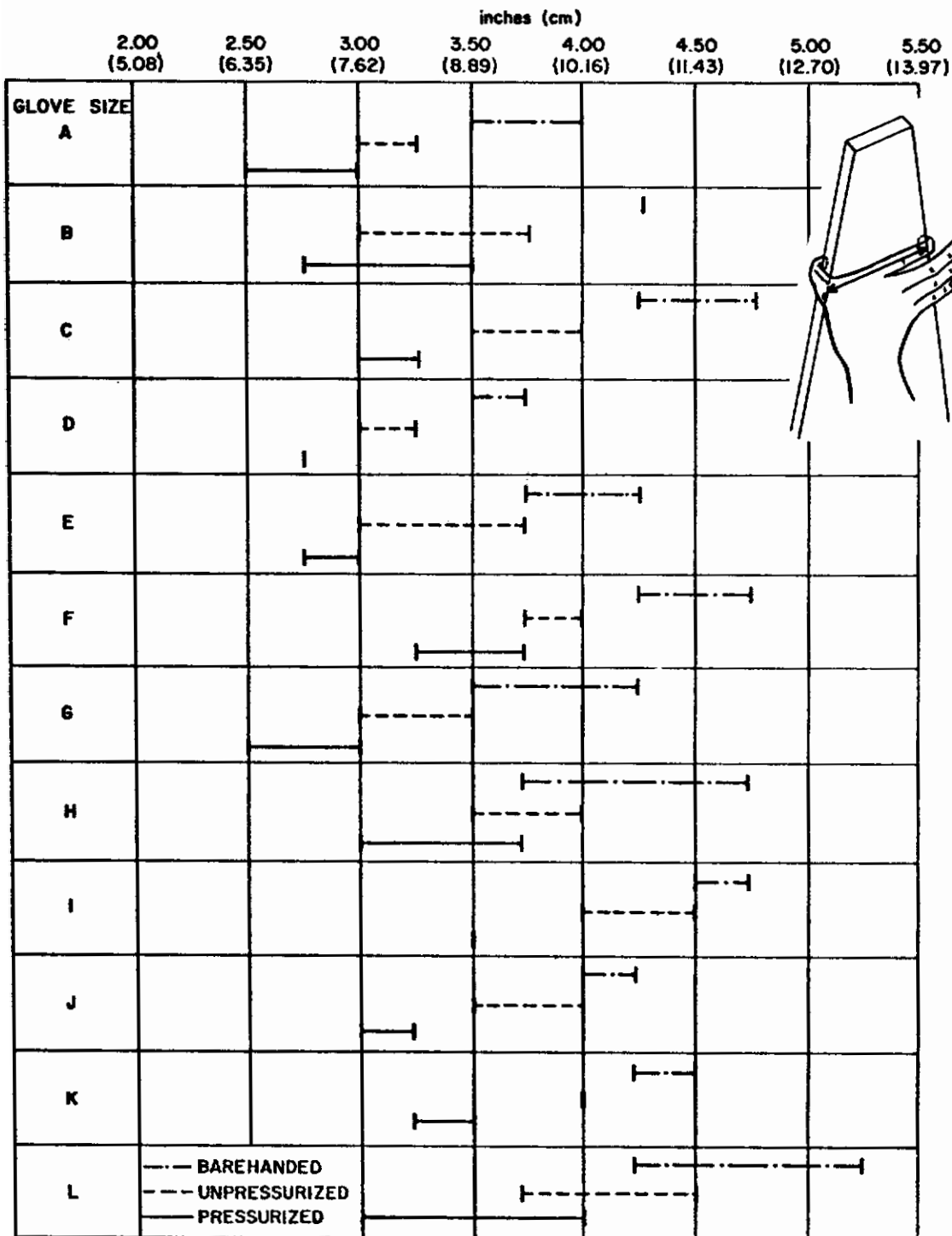
Unpressurized

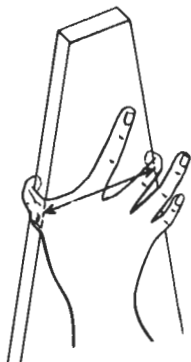
2¾ in.

Pressurized

2½ in.

Range of Values for Hand Spread Across Wedge-9 per Glove Size





HAND SPREAD ACROSS WEDGE-10;

CROTCH 1 OF HAND TO DISTAL JOINT
OF DIGIT 3

Subject places his right hand on the measuring wedge so that crotch 1 is on the right edge of the wedge and the distal joint of digit 3 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

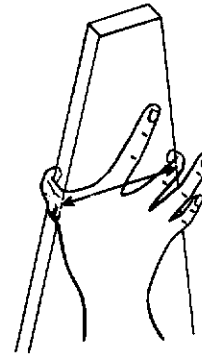
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	Condition 1	Condition 2	Condition 3
\bar{X} :	12.58 cm; 4.95 in.	10.58 cm; 4.17 in.	8.65 cm; 3.41 in.
SD:	1.15 cm; 0.45 in.	1.16 cm; 0.46 in.	1.02 cm; 0.40 in.
V%:	9.11	10.95	11.84

HAND SPREAD ACROSS WEDGE-10



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
14.52	95 TH	5.72	12.41	95 TH	4.89	10.90	95 TH	4.29
14.33	90 TH	5.64	12.01	90 TH	4.73	9.95	90 TH	3.92
14.01	85 TH	5.52	11.81	85 TH	4.65	9.59	85 TH	3.77
13.70	80 TH	5.39	11.66	80 TH	4.59	9.39	80 TH	3.70
13.42	75 TH	5.28	11.52	75 TH	4.53	9.27	75 TH	3.65
13.16	70 TH	5.18	11.38	70 TH	4.48	9.17	70 TH	3.61
12.93	65 TH	5.09	11.24	65 TH	4.42	9.09	65 TH	3.58
12.73	60 TH	5.01	11.09	60 TH	4.37	9.01	60 TH	3.55
12.54	55 TH	4.94	10.93	55 TH	4.30	8.92	55 TH	3.51
12.37	50 TH	4.87	10.76	50 TH	4.23	8.83	50 TH	3.48
12.21	45 TH	4.81	10.57	45 TH	4.16	8.72	45 TH	3.43
12.08	40 TH	4.75	10.37	40 TH	4.08	8.60	40 TH	3.39
11.95	35 TH	4.70	10.16	35 TH	4.00	8.46	35 TH	3.33
11.83	30 TH	4.66	9.93	30 TH	3.91	8.30	30 TH	3.27
11.72	25 TH	4.62	9.69	25 TH	3.81	8.10	25 TH	3.19
11.61	20 TH	4.57	9.42	20 TH	3.71	7.87	20 TH	3.10
11.50	15 TH	4.53	9.15	15 TH	3.60	7.60	15 TH	2.99
11.32	10 TH	4.46	8.91	10 TH	3.51	7.27	10 TH	2.86
10.91	5 TH	4.30	8.88	5 TH	3.49	6.92	5 TH	2.73

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 15.87%

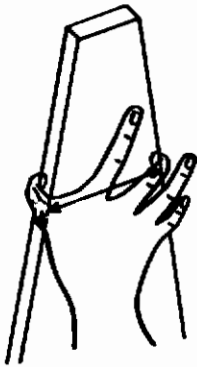
Condition 3: 31.06%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 15.90%

Condition 3: 31.24%



Hand Spread Across Wedge-10

Crotch 1 of hand to distal joint of digit 3 — A measure of the gripping spread between the crotch formed at the juncture of the thumb and forefinger and the last segment of the middle finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two areas of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

4 $\frac{1}{4}$ in.

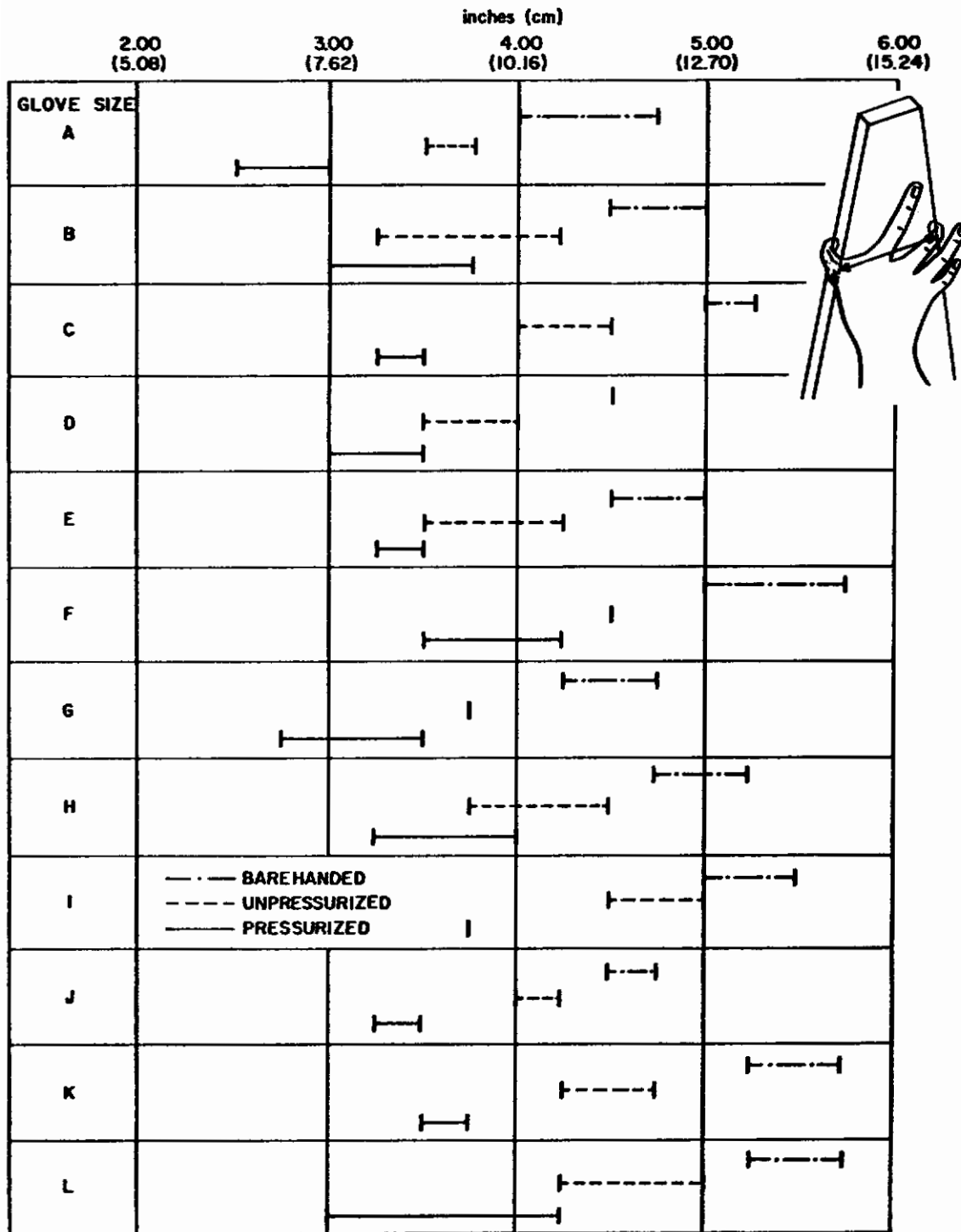
Unpressurized

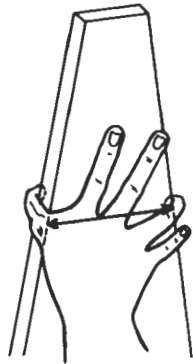
3 $\frac{1}{4}$ in.

Pressurized

2 $\frac{1}{2}$ in.

Range of Values for Hand Spread Across Wedge-10 per Glove Size





HAND SPREAD ACROSS WEDGE-11;

CROTCH 1 OF HAND TO DISTAL JOINT
OF DIGIT 4

Subject places his right hand on the measuring wedge so that crotch 1 is on the right edge of the wedge and the distal joint of digit 4 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

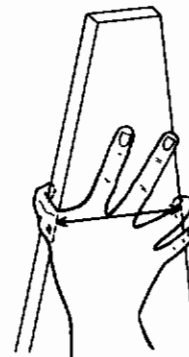
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	<i>Condition 1</i>	<i>Condition 2</i>	<i>Condition 3</i>
\bar{X} :	13.01 cm; 5.12 in.	10.94 cm; 4.31 in.	8.75 cm; 3.44 in.
SD:	1.40 cm; 0.55 in.	1.31 cm; 0.52 in.	1.03 cm; 0.40 in.
V%:	10.74	11.97	11.74

HAND SPREAD ACROSS WEDGE-11



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

<i>Condition 1</i>			<i>Condition 2</i>			<i>Condition 3</i>		
<i>Centimeters</i>	<i>Percentiles</i>	<i>Inches</i>	<i>Centimeters</i>	<i>Percentiles</i>	<i>Inches</i>	<i>Centimeters</i>	<i>Percentiles</i>	<i>Inches</i>
15.11	95 TH	5.95	13.68	95 TH	5.38	10.19	95 TH	4.01
14.79	90 TH	5.82	12.80	90 TH	5.04	9.95	90 TH	3.92
14.48	85 TH	5.70	12.39	85 TH	4.88	9.79	85 TH	3.86
14.21	80 TH	5.59	12.13	80 TH	4.77	9.66	80 TH	3.80
13.96	75 TH	5.49	11.92	75 TH	4.69	9.54	75 TH	3.76
13.72	70 TH	5.40	11.74	70 TH	4.62	9.42	70 TH	3.71
13.51	65 TH	5.32	11.56	65 TH	4.55	9.29	65 TH	3.66
13.31	60 TH	5.24	11.39	60 TH	4.49	9.16	60 TH	3.61
13.11	55 TH	5.16	11.22	55 TH	4.42	9.03	55 TH	3.56
12.93	50 TH	5.09	11.04	50 TH	4.35	8.89	50 TH	3.50
12.74	45 TH	5.02	10.85	45 TH	4.27	8.74	45 TH	3.44
12.57	40 TH	4.95	10.65	40 TH	4.19	8.59	40 TH	3.38
12.39	35 TH	4.88	10.44	35 TH	4.11	8.42	35 TH	3.32
12.21	30 TH	4.81	10.20	30 TH	4.02	8.25	30 TH	3.25
12.03	25 TH	4.74	9.95	25 TH	3.92	8.06	25 TH	3.17
11.84	20 TH	4.66	9.68	20 TH	3.81	7.85	20 TH	3.09
11.63	15 TH	4.58	9.39	15 TH	3.70	7.64	15 TH	3.01
11.37	10 TH	4.48	9.10	10 TH	3.58	7.41	10 TH	2.92
10.99	5 TH	4.33	8.98	5 TH	3.54	7.27	5 TH	2.86

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 15.83%

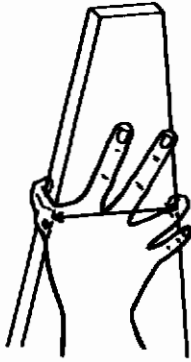
Condition 3: 32.61%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 15.91%

Condition 3: 32.74%



Hand Spread Across Wedge-11

Crotch 1 of hand to distal joint of digit 4 — A measure of the gripping spread between the crotch formed at the juncture of the thumb and forefinger and the last segment of the ring finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two areas of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

4 $\frac{1}{4}$ in.

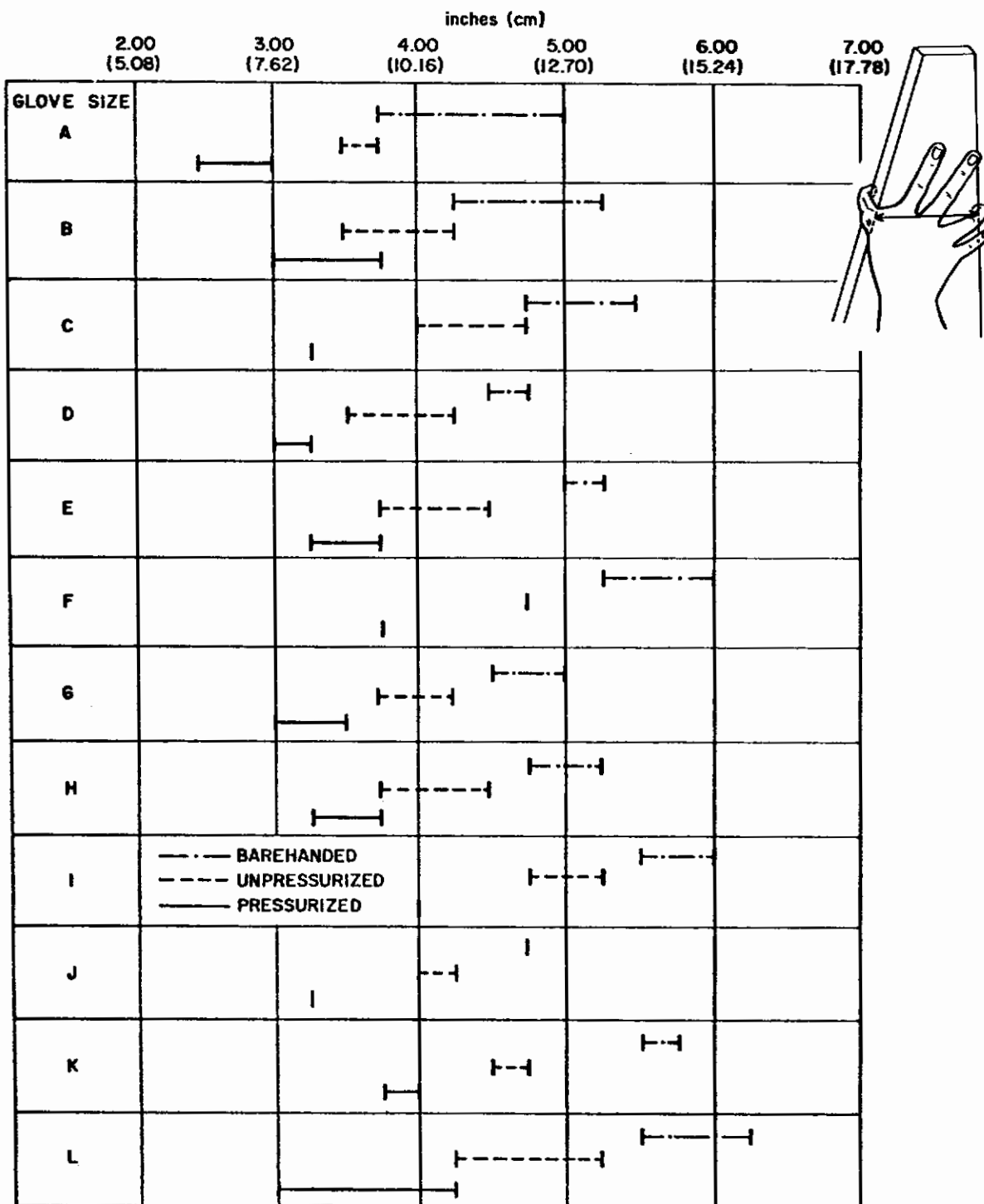
Unpressurized

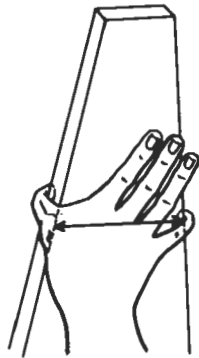
3 $\frac{1}{2}$ in.

Pressurized

2 $\frac{3}{4}$ in.

Range of Values for Hand Spread Across Wedge-11 per Glove Size





HAND SPREAD ACROSS WEDGE-12;

CROTCH 1 OF HAND TO DISTAL JOINT
OF DIGIT 5

Subject places his right hand on the measuring wedge so that crotch 1 is on the right edge of the wedge and the distal joint of digit 5 is on the left edge of the wedge. Subject slides his hand down the sides of the wedge to the maximal spread while maintaining joint contact on the edges. Reading is taken at the last $\frac{1}{4}$ inch line completely cleared.



ANTHROPOMETRIC DATA (N=27)

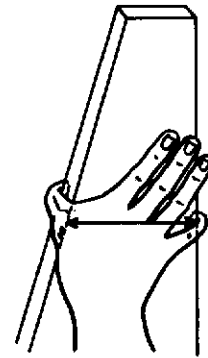
Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

	Condition 1	Condition 2	Condition 3
\bar{X} :	12.72 cm; 5.01 in.	10.72 cm; 4.22 in.	8.25 cm; 3.25 in.
SD:	1.51 cm; 0.60 in.	1.45 cm; 0.57 in.	1.21 cm; 0.48 in.
V%:	11.88	13.51	14.63

HAND SPREAD ACROSS WEDGE-12



ANTHROPOMETRIC DATA EXPRESSED AS PERCENTILES

Condition 1: Subject wearing unpressurized suit but barehanded.

Condition 2: Subject wearing unpressurized suit and gloves.

Condition 3: Subject wearing suit and gloves pressurized to 3.5 psig.

Condition 1			Condition 2			Condition 3		
Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches	Centimeters	Percentiles	Inches
14.65	95 TH	5.77	13.33	95 TH	5.25	11.15	95 TH	4.39
14.56	90 TH	5.73	12.83	90 TH	5.05	10.25	90 TH	4.04
14.46	85 TH	5.69	12.45	85 TH	4.90	9.73	85 TH	3.83
14.36	80 TH	5.66	12.13	80 TH	4.78	9.37	80 TH	3.69
14.27	75 TH	5.62	11.84	75 TH	4.66	9.08	75 TH	3.57
13.73	70 TH	5.40	11.57	70 TH	4.55	8.84	70 TH	3.48
13.39	65 TH	5.27	11.32	65 TH	4.45	8.63	65 TH	3.40
12.68	60 TH	4.99	11.07	60 TH	4.36	8.44	60 TH	3.32
12.57	55 TH	4.95	10.84	55 TH	4.27	8.27	55 TH	3.28
12.46	50 TH	4.90	10.62	50 TH	4.18	8.11	50 TH	3.19
12.35	45 TH	4.86	10.39	45 TH	4.09	7.95	45 TH	3.13
12.23	40 TH	4.81	10.17	40 TH	4.01	7.80	40 TH	3.07
12.09	35 TH	4.76	9.95	35 TH	3.92	7.66	35 TH	3.01
11.96	30 TH	4.71	9.74	30 TH	3.83	7.51	30 TH	2.96
11.82	25 TH	4.66	9.52	25 TH	3.75	7.36	25 TH	2.90
11.65	20 TH	4.59	9.30	20 TH	3.66	7.20	20 TH	2.83
11.42	15 TH	4.50	9.09	15 TH	3.58	7.02	15 TH	2.77
11.17	10 TH	4.40	8.91	10 TH	3.51	6.83	10 TH	2.69
10.84	5 TH	4.27	8.84	5 TH	3.48	6.60	5 TH	2.60

Percentage Decrease of the Individual Differences (Averaged)

Condition 1 as Base

Condition 2: 15.55%

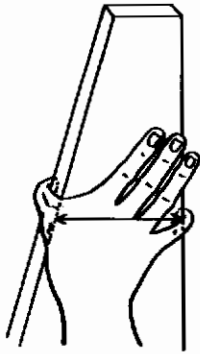
Condition 3: 34.72%

Percentage Decrease of the Means

Condition 1 as Base

Condition 2: 15.72%

Condition 3: 35.14%



Hand Spread Across Wedge-12

Crotch 1 of hand to distal joint of digit 5 — A measure of the gripping spread between the crotch formed at the juncture of the thumb and forefinger and the last segment of the little finger

HUMAN ENGINEERING APPLICATIONS

For — 1) Determination of the maximum size of wheels to be grasped and/or turned by these two areas of the hand

DESIGN CRITERIA

Number of inches necessary to include or accommodate approximately 95% of USAF rated personnel:

Barehanded

Unpressurized

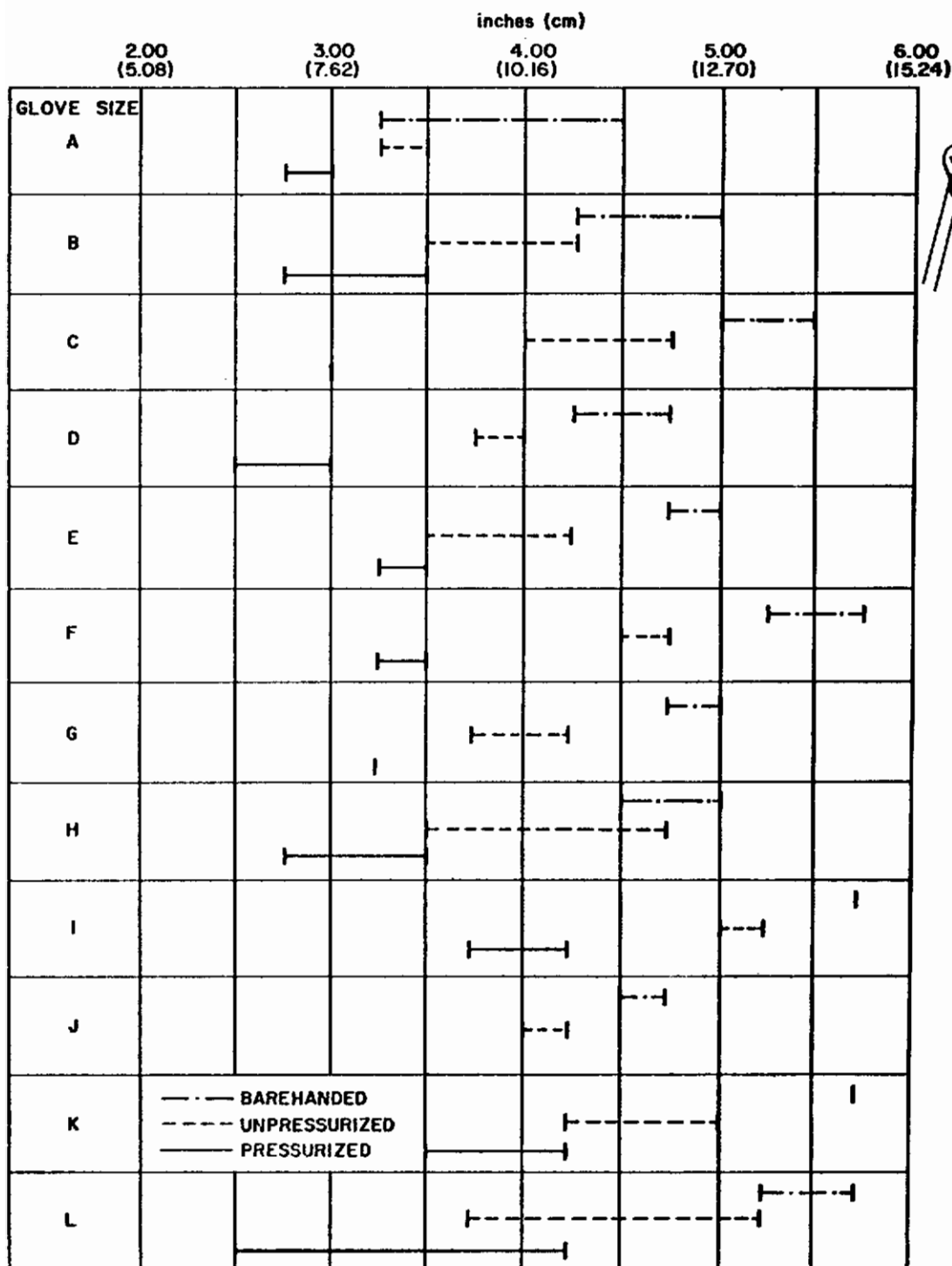
Pressurized

4½ in.

3¼ in.

2½ in.

Range of Values for Hand Spread Across Wedge-12 per Glove Size



Section III.

MEASURING INSTRUMENTS

Sliding Caliper (dimensions 1-4, 13-16): a standard anthropometric instrument

Flexible Steel Tape (5-8): a standard anthropometric instrument

Beam Caliper (16): a standard anthropometric instrument consisting of the upper half of a standard anthropometer

Finger Board (9-10): a $\frac{1}{4}$ -inch thick, rigid plastic sheet, with a drilled series of graduated holes ranging from $\frac{1}{2}$ -inch to $1\frac{1}{4}$ -inch in diameter

Hand Cone (11-12): a hardwood cone, graduated into 24 equal sections ranging from 2 to 8 inches in circumference

Rotation Box (17-18; 22-24): a 5-inch diameter protractor, marked in 10-degree intervals, fastened on a 6 x 6 x $1\frac{1}{4}$ -inch cardboard box; weights are inserted to provide balance. A class C (basically a C-1 knob illustrated in HEGED, op. cit., p. 273) rotary knob mounted on a metallic shaft penetrates the center of the protractor. (See figure 3.)

Dynamometer (19): a Smedley Hand Dynamometer calibrated in kilograms and manufactured by C. H. Stoelting Co., Chicago, Ill.

Torque Wrench Assembly (20-21): a standard inch-pound torque wrench mounted freely as shown in plate 3 on a plywood A-frame, used with a steel T-bar handle, $\frac{3}{4}$ -inch in diameter, welded to a $\frac{5}{8}$ -inch diameter shank and $\frac{3}{8}$ -inch socket

Wedge (25-36): a 24-inch long, 1-inch thick hardwood measuring block, 8-inches wide at the bottom and 2-inches wide at the top. (This slope provides a $\frac{1}{4}$ -inch change in width for every 1-inch of length. The face of the wedge is marked with both actual width dimensions and a numerical code. The code was used to facilitate vocalizing and recording measurements.)

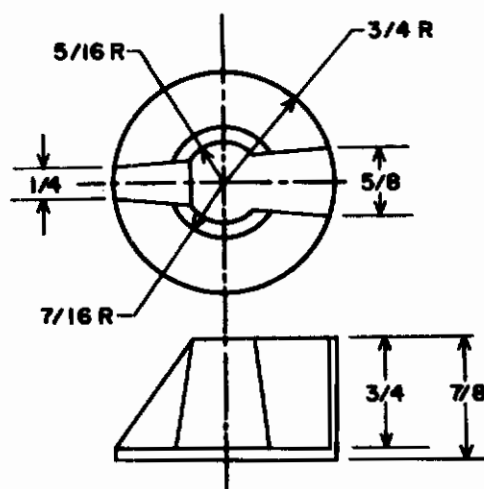


Figure 3. Knob used on rotation box

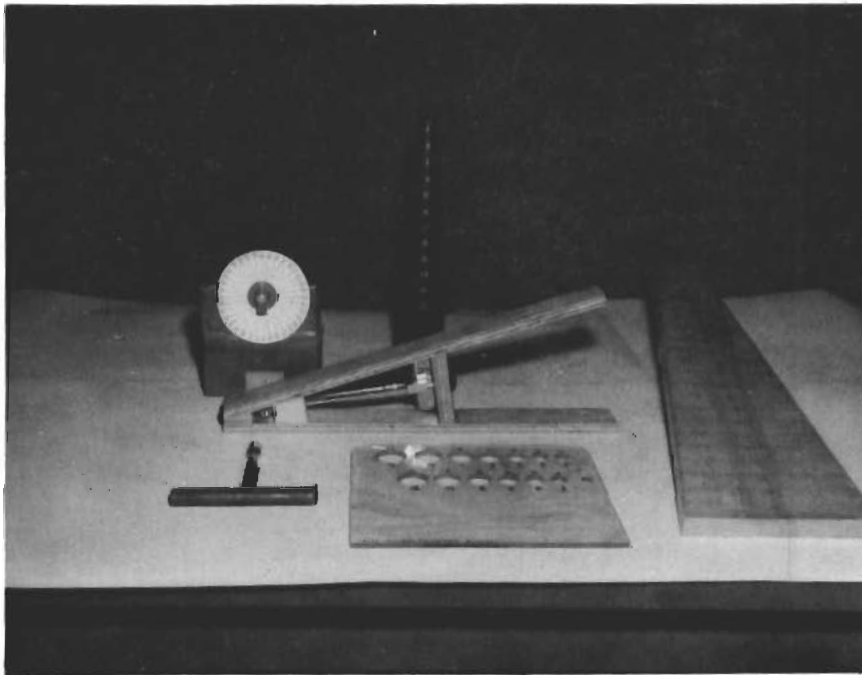
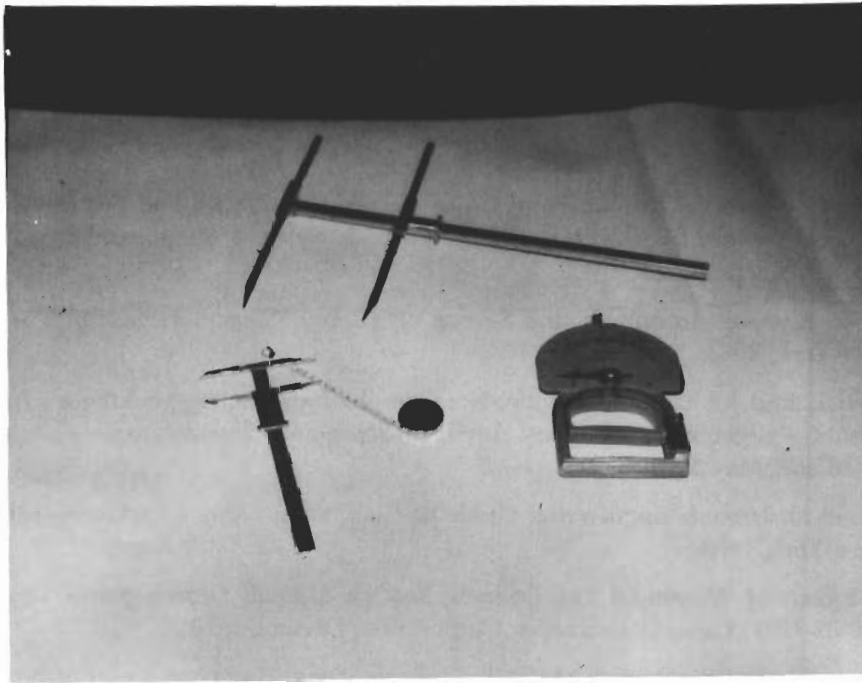


Figure 4. Measuring instruments

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13. ABSTRACT This report summarizes hand and arm dimensional, clearance, and strength data of 27 adult males wearing the A/P22S-2 full-pressure suit. Thirty-six measures were obtained under each of three conditions: bare-handed; gloved and unpressurized; and gloved and pressurized. The data are both summarized for all subjects and reported independently by glove size worn. Uses of the data are suggested and specific design values recommended.			

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Anthropology Hand dimensions Arm dimensions Bare-handed measurements Gloved, unpressurized measurements Gloved, pressurized measurements Clearance and performance values Strength						

Security Classification