

## **Ergonomic Evaluation of the Spring Assisted Hook**

Spring Assisted Hook was designed and manufactured by Jerome Bauman (Patent Pending).

Evaluation completed 11/13/06 at Kemps Dairy. Force measurements were taken using the heaviest available full stack of crates, ½ gallon milk products in cardboard containers. Flooring was a wet diamond plated surface.

### **Measurements:**

- Forces to initiate movement of the stack of crates:
  - Standard tool required 70# of force.
  - Spring assisted tool required 58# of force.
- Length: The spring assisted tool is currently offered in 3 different lengths—30", 31", and 32". Based on the average male height of 5'9" with 30" between his knuckles and the floor, these tool lengths will satisfy 90% of males. Some accommodations may need to be made for females and those males that differ greatly from this average. Refer to attached documents from Human Engineering Guide to Equipment Design for average heights and knuckle to floor distances for males.
- Grip diameter: The tool is currently offered with 2 different size grips—1" and 1 ¼". Based on the attached information from PubMed and the fact that all employees wear gloves due to the cool environment, the above grip diameters are appropriate for this device.
- Wrist position: The tool utilizes a neutral wrist and forearm position, which will decrease the stress placed on the wrist and forearm tendons. Refer to attached document from the U.S. Department of Labor.

### **Benefits:**

- The spring assisted tool reduced the initial manual forces for crate movement by 17%.
- Based on the above forces, use of this spring assisted tool may increase the percentage of the male population that could complete that specific task safely by 17-18%. These figures were determined by utilizing a Push/Pull Analysis and The Liberty Mutual Manual Materials Handling Guidelines. Both documents are attached. Full documents can be found on their websites at
  - [http://hsc.usf.edu/~tbernard/HollowHills/PushPull\\_21.xls](http://hsc.usf.edu/~tbernard/HollowHills/PushPull_21.xls)
  - [http://libertymmhtables.libertymutual.com/CM\\_LMTablesWeb/pdf/LibertyMutualTables.pdf](http://libertymmhtables.libertymutual.com/CM_LMTablesWeb/pdf/LibertyMutualTables.pdf)

  
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STRUCTURAL BODY DIMENSIONS

TABLE 11-12. STATURE: NUDE U.S. FEMALE MILITARY PERSONNEL

Population	Percentiles (in.)					S.D.
	1st	5th	50th	95th	99th	
Air Force personnel:						
WAF basic trainees*	59.3	60.3	64.0	68.2	69.9	2.34
Pilots†	60.8	61.7	64.9	68.3	70.0	----
Flight nurses‡	59.0	60.2	63.5	67.7	69.3	----
Army personnel‡	58.4	59.9	63.9	68.0	69.7	2.42
WAC enlisted women§	58.3	60.0	63.9	68.0	69.6	2.40
WAC officers§	59.2	61.0	64.5	68.9	70.6	2.40
Nurses§	58.7	60.4	64.1	68.3	70.0	2.40

\* Daniels et al. (1953a).

† Randall et al. (1946).

‡ Randall and Munro (1949).

§ Randall (1947).

TABLE 11-13. STATURE: NUDE MALE CIVILIAN SAMPLES (U.S., CANADA)

Population	Percentiles (in.)					S.D.
	1st	5th	50th	95th	99th	
Railroad travelers†	*62.5	*64.5	*69.0	*73.8	*75.6	----
Truck and bus drivers†	63.0	64.6	68.4	72.5	74.1	----
Airline pilots§	64.4	66.0	70.0	73.9	75.6	2.40
Industrial workers¶	*64.4	*66.1	*70.3	*74.4	*76.2	2.46
College students:**	62.5	64.4	68.7	73.1	74.9	2.68
Eastern 18 years old††	64.5	66.1	69.9	73.8	75.4	2.38
Eastern 19 years old†††	65.0	66.5	70.2	74.0	75.5	2.30
Midwest, 18 years old§§	63.2	65.0	69.1	73.3	75.0	2.60
Midwest, 18-22 years old¶¶	64.2	65.9	70.0	74.1	75.8	2.49
Draft registrants***						
18-19 years old	62.0	63.8	68.0	72.3	74.1	2.61
20-24 years old	62.1	63.9	68.2	72.4	74.2	2.60
25-29 years old	61.9	63.7	68.1	72.4	74.2	2.63
30-34 years old	61.7	63.5	67.8	72.1	73.9	2.66
35-37 years old	61.3	63.2	67.6	72.0	73.8	2.64
Civilian men†††	61.7	63.6	68.3	72.8	74.6	----
Canadians†††						
18-19 years old	62.4	64.1	68.2	72.1	73.7	----
20-24 years old	62.0	63.8	68.3	72.5	74.3	----
25-29 years old	60.6	62.9	68.3	74.0	76.2	----
30-34 years old	61.5	63.4	68.1	72.8	74.8	----
35-44 years old	60.5	62.7	67.6	72.6	74.7	----
45-54 years old	59.7	61.8	66.8	72.0	74.1	----
55-64 years old	58.4	60.6	66.0	71.3	73.6	----
More than 64 years old	58.6	60.6	65.1	69.8	71.8	----

\*Including shoes (subtract 1 in. for nude height).

†Hooton (1945).

‡McFarland et al. (1958).

§McCormick (1947).

¶Tyroler (1958).

\*\*Diehl (1933a).

††Bowles (1932).

††Heath (1945).

§§Damon (1955).

¶¶Elbel (1954).

\*\*\*Karpinos (1958).

†††Stoudt et al. (1965).

†††Pett and Ogilvie (1957).

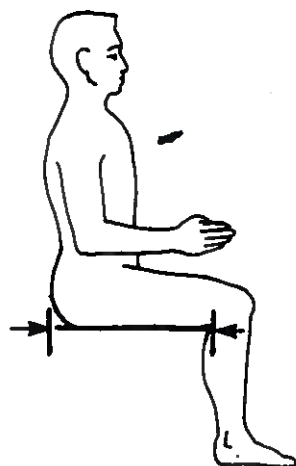


FIGURE 11-28. Buttock-popliteal length.

**11.4.28 Buttock Depth**

This is the horizontal distance between the buttocks and the abdomen at the level of the maximum protrusion of the buttocks. The subject stands erect. (See Figure 11-29.) The data are given in Table 11-55.

**11.4.29 Thigh Clearance Height, Sitting**

This is the vertical distance from the sitting surface to the top of the thigh at its intersection with the abdomen. The subject sits erect with his knees at right angles. (See Figure 11-30.) The data are given in Table 11-55.

For women, use the same values given for males. Add 0.1 to 0.2 in. for light clothing and 1.4 in. or more for heavy clothing.

**11.4.30 Knuckle Height**

This is the vertical distance from the floor to the point where the middle finger of the right hand meets the palm. The subject stands erect with his arm and hand extended straight,

TABLE 11-54. BUTTOCK-POPLITEAL LENGTH OF U.S. CIVILIAN SAMPLES

Sex	Percentiles (in.)				
	1st	5th	50th	95th	99th
Male <sup>1</sup> .....	16.6	17.4	18.9	20.8	21.5
Female <sup>1</sup> .....	16.0	16.8	18.2	20.0	20.6
Male <sup>2</sup> .....	16.5	17.3	19.5	21.6	22.7
Female <sup>2</sup> .....	16.1	17.0	18.9	21.0	22.0

<sup>1</sup> Hooton (1945).  
<sup>2</sup> Stoudt et al. (1965).

and his palm flat against the thigh. (See Figure 11-31.) The data are given in Table 11-55.

For clothing, add 1.0 in. for shoes and 1.3 in. for military boots.

**11.4.31 Hand Thickness**

This dimension is the maximum distance between the dorsal and palmar surfaces of the knuckle of the middle finger where it joins the

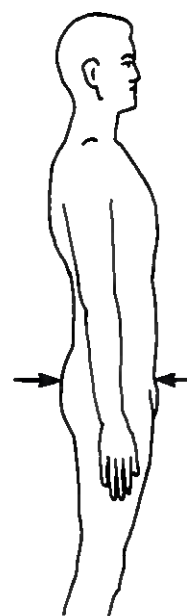


FIGURE 11-29. Buttock depth.

TABLE 11-55. BUTTOCK DEPTH, THIGH CLEARANCE HEIGHT, SITTING, AND KNUCKLE HEIGHT OF MALE USAF PERSONNEL

Dimension	Percentiles (in.)					S.D.
	1st	5th	50th	95th	99th	
Buttock depth.....	7.2	7.6	8.8	10.2	10.9	0.82
Thigh clearance height, sitting.....	4.5	4.8	5.6	6.5	6.8	.52
Knuckle height.....	26.7	27.7	30.0	32.4	33.5	1.45

Hertzberg et al. (1954).

## Optimum tool handle diameter for a cylinder grip.

- Sancho-Bru JL,
- Giurintano DJ,
- Perez-Gonzalez A,
- Vergara M.

Departament de Tecnologia, Universitat Jaume I  
Campus de Riu Sec 12071, Castello, Spain.

The ideal diameter for a tool handle for males and females has been determined using an existing biomechanical model of the hand validated in previous works. \*The model estimates a 33-mm optimum diameter tool handle for the general population (males and females). When the optimum diameter for a tool handle is selected, the muscles exert the minimum force needed to hold the tool and perform gripping activities. Optimal handle design reduces the force required for gripping a tool, protects the underlying joint structures, and reduces the risk of developing cumulative trauma associated with repetitive task requiring high grip forces and awkward postures. This article provides a design parameter for optimal tool diameter to aid the therapist in the selection of assistive devices, built-up handles, or for the fabrication of a tool handle.

PMID: 14605652 [PubMed - indexed for MEDLINE]

33 mm is equal to 1.3"





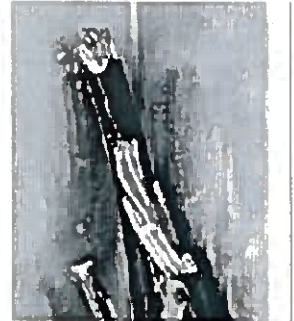
## Ergonomics eTool: Solutions for Electrical Contractors

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  - [Hazard Index](#)
  - [Ergonomic Principles](#)
  - [Ergonomic Solutions](#)

### Supplemental Information: Hazard Index

Electricians may be exposed to the hazards listed below. These are common hazards that occur in the construction trades.

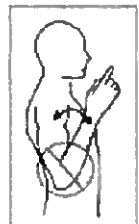


#### Awkward postures

Awkward postures means working with various parts of the body in bent, extended or flexed positions rather than in a straight or neutral position. Working in awkward postures increases the exertion and muscle force that workers must apply to complete a task and compresses tendons, nerves and blood vessels. In general, the more extreme the posture the more force is needed to complete the task. Examples of awkward postures include performing overhead work, bending or twisting to lift an object, typing with bent wrists, and squatting.

#### Bending the elbow

Repetitive elbow bending can irritate nerves and tendons in the forearms, and even lead to epicondylitis, or "tennis elbow".



#### Bent wrist

Working with wrists in a bent rather than straight position can result in ergonomic injuries, especially where the task also involves high hand force. Working with bent wrists puts stress on the tendons and tendon sheaths in the hands and wrists. When the wrists are bent the tendons and sheaths rub against hard bones and ligaments. If this happens repeatedly, the tendons and sheaths can become irritated and inflamed, resulting in injuries such as tendonitis. The inflamed tendons and sheaths can also press against the nerves that run through the wrist to the hand, resulting in carpal tunnel syndrome.



General controls to reduce awkward wrist postures:

- Bent handles that allow work to be done with straight wrists

**TABLE 9 (CONTINUED) - POPULATION PERCENTAGES FOR PULLING TASKS  
INITIAL FORCES**

			MALE					FEMALE							
			FREQUENCY ONE PULL EVERY			30s	1m	5m	30m	8h	30s	1m	5m	30m	8h
<b>INITIAL PULLING FORCE (POUNDS)</b>	76	57	-	-	15	16	43	<b>HAND HEIGHT (INCHES) - MALES</b>	<b>HAND HEIGHT (INCHES) - FEMALES</b>	53	-	-	12	17	25
		37	42	57	66	67	85			35	-	-	17	23	32
		25	60	73	79	80	+			22	-	-	24	31	41
	73	57	-	13	20	21	50			53	-	-	17	23	32
		37	48	63	71	72	88			35	-	-	22	30	40
		25	66	77	83	83	+			22	-	11	31	38	49
	70	57	-	17	26	27	56			53	-	-	23	30	40
		37	55	69	76	77	+			35	-	-	29	37	47
		25	71	81	86	86	+			22	-	15	38	46	56
	67	57	12	24	33	34	63			53	-	-	30	38	48
		37	62	74	80	81	+			35	-	15	37	45	55
		25	76	85	88	89	+			22	13	22	46	54	63
	64	57	17	31	40	42	69			53	-	15	38	46	56
		37	68	79	84	84	+			35	13	21	46	53	63
		25	81	88	+	+	+			25	19	29	54	62	70
	61	57	23	39	48	50	75			53	14	22	47	55	64
		37	74	83	87	88	+			35	19	29	54	62	70
		25	84	+	+	+	+			22	27	38	63	69	76
	58	57	31	47	56	58	80			53	21	31	56	63	71
		37	79	86	+	+	+			35	27	38	63	69	76
25		88	+	+	+	+	22	36	47	70	76	82			
55	57	40	56	64	66	84	53	29	40	65	71	78			
	37	83	89	+	+	+	35	37	48	71	76	82			
	25	+	+	+	+	+	22	46	57	77	81	86			
52	57	49	64	72	73	88	53	40	51	73	78	83			
	37	87	+	+	+	+	35	47	58	78	82	87			
	25	+	+	+	+	+	22	56	66	82	86	+			
49	57	59	72	78	79	+	53	50	61	80	84	88			
	37	+	+	+	+	+	35	58	67	83	87	+			
	25	+	+	+	+	+	22	65	74	87	+	+			
46	57	68	78	83	84	+	53	61	70	85	88	+			
	37	+	+	+	+	+	35	68	76	88	+	+			
	25	+	+	+	+	+	22	74	81	+	+	+			
43	57	76	84	88	88	+	53	71	79	+	+	+			
	37	+	+	+	+	+	35	76	83	+	+	+			
	25	+	+	+	+	+	22	82	87	+	+	+			
40	57	82	89	+	+	+	53	80	85	+	+	+			
	37	+	+	+	+	+	35	84	88	+	+	+			
	25	+	+	+	+	+	22	87	+	+	+	+			
37	57	88	+	+	+	+	53	87	+	+	+	+			
	37	+	+	+	+	+	35	89	+	+	+	+			
	25	+	+	+	+	+	22	+	+	+	+	+			
34	57	+	+	+	+	+	53	+	+	+	+	+			
	37	+	+	+	+	+	35	+	+	+	+	+			
	25	+	+	+	+	+	22	+	+	+	+	+			
31	57	+	+	+	+	+	53	+	+	+	+	+			
	37	+	+	+	+	+	35	+	+	+	+	+			
	25	+	+	+	+	+	22	+	+	+	+	+			
28	57	+	+	+	+	+	53	+	+	+	+	+			
	37	+	+	+	+	+	35	+	+	+	+	+			
	25	+	+	+	+	+	22	+	+	+	+	+			
25	57	+	+	+	+	+	53	+	+	+	+	+			
	37	+	+	+	+	+	35	+	+	+	+	+			
	25	+	+	+	+	+	22	+	+	+	+	+			

+ = GREATER THAN 90%      - = LESS THAN 10%

# Push/Pull Analysis -- Adapted from Liberty Mutual Tables

Job

11/14/2006

Notes

Directions  Units  Rate Representation

Effort Type  Vertical Zone  Distance of Travel  Frequency

		Design Goal	Limits in Pounds	Actual Value [lb]	% Accept. for Men	% Accept. for Women	
Initial		47		Initial	70.0	70	12
Sustained		28		Sustained			

		Percent Acceptable				
		10	25	50	75	90
Initial	Men	104	93	80	67	56
	Women	71	63	55	47	39
Sustained	Men	79	68	57	46	36
	Women	50	44	36	28	21

Note: All forces are reported to nearest whole number.

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		Design Goal	Limits in Pounds	Actual Value [lb]	% Accept. for Men	% Accept. for Women	
Initial		47		Initial	58.0	88	41
Sustained		28		Sustained			

			Percent Acceptable				
			10	25	50	75	90
Initial	Men		104	93	80	67	56
	Women		71	63	55	47	39
Sustained	Men		79	68	57	46	36
	Women		50	44	36	28	21

Note: All forces are reported to nearest whole number.