

Manual Handling Guidelines: Using Liberty Mutual Tables

Risk Control from Liberty Mutual Insurance



Tables for evaluating lifting, lowering, pushing, pulling, and carrying tasks.

Since the late 1970s, Liberty Mutual has been analyzing and evaluating lifting, lowering, pushing, pulling, and carrying tasks using “Psychophysical Tables.” These tables are research based using psychophysical methodology that includes measurements of oxygen consumption, heart rate, and anthropometric characteristics. Psychophysical tables provide important information about capability and limitations of workers and the design of manual handling tasks to reduce low back disability.

During these studies, research subjects could either control the weight or force variable, and the experimenter controlled all other task variables such as frequency, size, height, distance, etc. The subject monitored his or her own feelings of exertion or fatigue, and adjusted the weight or force of the object accordingly. Details of the experimental designs are found in the individual papers (Ciriello and Snook 1983, Ciriello et al. 1990, Ciriello et al. 1993).

Differentiator

The tables used by Liberty Mutual Risk Control are called Liberty Mutual Tables. They are much different from those used in published literature. Some have referred to those in the published literature as “Snook Tables” (Snook, 1978) or “Snook and Ciriello Tables” (Snook and Ciriello, 1991). Liberty Mutual Tables provide the male and female population percentages able to perform these tasks, while the published tables provided Maximum Acceptable Weights and Forces for 10, 25, 50, 75, 90 percent of the male and female population. CompuTask™ is an ergonomic software analysis program based, in part, on the Liberty Mutual Tables.

Liberty Mutual Tables

The goal of the Liberty Mutual Tables (hereafter called “Tables”) is to help control costs associated with manual handling operations. These costs can be attributed to high low-back disability costs and reduced productivity and quality due to poor job design. These Tables provide the user with an objective assessment of a problematic manual handling job and the foundation on which to build a solution in the following ways:

- By helping recognize risk factors associated with manual handling activity and,
- Helping make good business decisions on implementing cost effective ergonomic solutions that offer the highest degree of control.

Using these Tables effectively requires basic level training in ergonomics and manual handling task analysis and evaluation. Users should be knowledgeable of biomechanical, physiological, and psychophysical workload criteria (Waters, 1994) and evaluation methods. Training should include developing an analysis strategy and collection of basic measurements including weights, initial and sustained forces, distances (lifting, lowering, carrying, hand distance from body) and task frequency.

Using the Tables: Population Percentage Criteria

As a general rule of thumb, designing manual tasks for greater than 75 percent of the female work population will offer the best protection from manual handling injuries. Studies have shown that two-thirds of low back claims from low percentage tasks (tasks capable of being performed by a small percentage of the population) can be prevented if the tasks are designed to accommodate at least 75 percent of the female work population (Snook et al., 1978). Tasks having population percentages of less than 10 percent should be prioritized for task redesign.



With certain industries and jobs, however, it is very difficult to design jobs that can be performed by 75 percent of the female work population. The Tables can be used to perform what-if scenarios of various ergonomic interventions to help determine the most cost effective and practical solution that offers the highest degree of control.

The Tables are self-explanatory and easy to use. The following is an example.

Suppose you want to find the female population percentage for lifting tote pans. Your measurements show the following:

- Tote pan weight of 29 lbs.(Object Weight)
- Hand distance of 7 in. (Hand Distance Away from Body)
- An initial hand height of 30 in. (Hand Height at Start)
- A final hand height of 50 in. (Hand Height at End)
- Pans are lifted once every 5 min. (Task Frequency)

The first step is to find the correct table. Since this is a lifting task ending between knuckle and shoulder height ($\geq 28"$ and $\leq 53"$) and you are looking for female population percentage, go to Table 2F. Using the object weight of 29 lbs. to select the row, and hand distance of 7 in. to select the column, locate the data in the large cell as shown below.

Since lifting Distance is 20 in. and frequency is once every 5 minutes, this task is acceptable to 60% of the female work population.

Object Weight	35	20	–	14	22	32	66	–	–	–	16	50	–	–	–	–	16
		10	11	18	35	47	76	–	–	18	29	63	–	–	–	–	28
		30	–	–	20	30	64	–	–	–	15	48	–	–	–	–	14
	32	20	20	25	34	46	76	–	11	18	28	62	–	–	–	–	28
		10	20	30	49	60	83	–	14	31	42	73	–	–	–	11	42
	29	30	12	18	33	45	75	–	–	17	27	61	–	–	–	–	27
		20	34	39	49	60	83	18	22	31	43	74	–	–	–	11	42
	26	10	34	45	62	71	89	18	27	45	56	82	–	–	13	22	56
		30	25	33	50	60	84	11	17	32	43	74	–	–	–	11	43
	23	20	50	55	64	73	89	32	38	47	58	83	–	–	14	23	58
10		30	12	18	33	45	75	–	–	17	27	61	–	–	–	27	
20	20	34	39	49	60	83	18	22	31	43	74	–	–	–	11	42	
	10	34	45	62	71	89	18	27	45	56	82	–	–	13	22	56	
	10	80	85	+	+	+	69	76	85	89	+	37	47	64	72	89	

Since measurements seldom correspond exactly to the data points used in the tables, it will often be necessary to estimate the population percentage. For example, if the object weighed 30 lbs., it would fall between the 29 lb. cell as shown above and the 32 lb. cell. Interpolation gives a population percentage of 55.

Hand Distance

Determining hand distance is one dimension that can be confusing. Hand distance is the distance from the front of the body to the hands. Note: This is a different measurement from the one used for the NIOSH model. Hand distance will normally be half the width of the object that is being handled, unless the object is purposely held away from the body.

Pushing and Pulling Tasks

For pushing and pulling tasks, you will need to obtain a spring scale, a load cell, or other force measurement device and enter the initial force, in pounds, that is needed to start the object moving. Take several measurements and enter the highest value particularly when floor or wheel conditions are poor.

For pushing tasks, if you only have a spring scale device, you can measure the force by pulling. However, while the effect on the worker may be different between a push and pull, the measured force will be the same. Also, obtain the sustained force measurement to keep the object moving. Take all measurements at an acceleration representative of the task as performed in the actual operating environment.

Resources

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Ciriello, V. M., Snook, S. H., & Hughes, G. (1993). Further studies of psychophysically determined maximum acceptable weights and forces. *Human Factors*, 35:11, 175-186.

Ciriello, V. M., Snook, S. H., Blick, A. C., & Wilkinson, P. L. (1990). The effects of task duration on psychophysically-determined maximum acceptable weights and forces. *Ergonomics*, 33:2, 187-200.

Ciriello, V.M., McGorry, R.W., Martin, S., & Bezverkhny, I.B. (1999). Maximum acceptable forces of dynamic pushing: comparison of two techniques. *Ergonomics*, 42:1, 32-39.

Snook, S.H. (1978). The design of manual handling tasks. *Ergonomics*, 21:12-963-985.

Snook, S. H., & Ciriello, V. M. (1991). The design of manual handling tasks: revised tables of maximum acceptable weights and forces. *Ergonomics*, 34:9 1197-1213.

Waters, T.R., Putz-Anderson, V., & Garg, A.. (1994). *Applications Manual for the Revised NIOSH Lifting Equation*. U.S. Department of Health and Human Services, Centers for Disease Control, Cincinnati, OH, DHHS (NIOSH) Publication No. 94-110.

Frequency

We define frequency as the average time between handling individual objects. Frequency can be confusing when more than one task component is present. For example, lifting an object, carrying it a distance, and putting it back down. In our example, if objects are lifted, carried, and lowered within a job cycle time of 30 seconds, the frequency would be 30 seconds for the lift, 30 seconds for the carry, and 30 seconds for the lower.

Important Considerations

A word of caution about using the Tables. Do not evaluate tasks based solely on population percentages. Other important considerations include the following:

- Injuries: Any job that is producing injuries is a good candidate for redesign.
- Bending: Any task that begins or ends with the hands below knuckle height presents some degree of risk. The deeper the bending motion, the greater is the physical stress on the low back. Frequent bending, regardless of weight, is not recommended.
- Twisting: This motion puts uneven forces on the back, thereby, presenting additional physical stress. The greater the twist, the more physically stressful the task.
- Reaching: The distance away from the body that a load is held greatly affects the forces on the back, shoulders, and arms. The farther the reach, the more physically stressful the task
- One-Handed Lifts: The Tables cannot be used to evaluate one-handed tasks. By nature, these tasks place uneven loads on the back and present a greater physical stress than two-handed lifts
- Handholds: Inability to get a good grip on the load presents a greater physical stress.
- Catching or Throwing Items: The Tables cannot be used to evaluate these types of tasks. Any task involving catching or throwing items is physically stressful and, therefore, a good candidate for redesign.

Population Percentages

The population percentages in these Tables are based on weights selected by subjects in the laboratory working as hard as they could without straining themselves, or without becoming unusually tired, weakened, overheated, or out of breath. Jobs designed ergonomically should fit most workers. That is why 75 percent of the female work population is used as a design starting point.

- Do not use population percentages in the Tables to determine whether male or female workers can perform certain jobs and then place workers accordingly.
- Use the Tables to design manual handling jobs with physical requirements so that as many workers as possible can perform them without risk of injury.

Training

As previously mentioned, effectively using the Tables requires training in ergonomics and task evaluation methods. Users of the Tables should be trained in collecting hand distance, lifting distance, and task frequency measurements. Liberty Mutual Group workers compensation insured customers may contact their Risk Control Consultant or the Risk Control Consulting Center for more information.

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The illustrations, instructions, and principles contained in the material are general in scope and, to the best of our knowledge, current at the time of publication. Our risk control services are advisory only. We assume no responsibility for: managing or controlling customer safety activities, implementing any recommended corrective measures, or identifying all potential hazards.

No attempt has been made to interpret any referenced codes, standards, or regulations. Please refer to the appropriate government authority for interpretation or clarification.

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Liberty Mutual Tables

Contents

Table 1F	Female Population Percentages for Lifting Tasks Ending Below Knuckle Height (< 28")	2
Table 1M	Male Population Percentages for Lifting Tasks Ending Below Knuckle Height (< 31")	3
Table 2F	Female Population Percentages for Lifting Tasks Ending Between Knuckle and Shoulder Height ($\geq 28"$ & $\leq 53"$)	4
Table 2M	Male Population Percentages for Lifting Tasks Ending Between Knuckle and Shoulder Height ($\geq 31"$ & $\leq 57"$)	5
Table 3F	Female Population Percentages for Lifting Tasks Ending Above Shoulder Height (> 53")	6
Table 3M	Male Population Percentages for Lifting Tasks Ending Above Shoulder Height (> 57")	7
Table 4F	Female Population Percentages for Lowering Tasks Beginning Below Knuckle Height (< 28")	8
Table 4M	Male Population Percentages for Lowering Tasks Beginning Below Knuckle Height (< 31")	9
Table 5F	Female Population Percentages for Lowering Tasks Beginning Between Knuckle and Shoulder Heights ($\geq 28"$ & $\leq 53"$)	10
Table 7	Population Percentages for Pushing Tasks Initial Forces (<i>continued</i>)	11 12
Table 8F	Female Population Percentages for Pushing Tasks Sustained Force	13
Table 8M	Male Population Percentages for Pushing Tasks Sustained Force	14
Table 9	Population Percentages for Pulling Tasks Initial Forces (<i>Continued</i>)	15 16
Table 10F	Female Population Percentages for Pulling Tasks Sustained Force	17
Table 10M	Male Population Percentages for Pulling Tasks Sustained Force	18
Table 11F	Female Population Percentages for Carrying Tasks	19
Table 11M	Male Population Percentages for Carrying Tasks	20

Table 1F

Female Population Percentages for Lifting Tasks Ending Below Knuckle Height (< 28")

Hand Distance		7 inches					10 inches					15 inches					
		15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	
Object Weight (pounds)	59	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	56	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-
	53	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-
	50	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	29	-	-	-	-	14	-	-	-	-	-
	47	30	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	24	-	-	-	-	11	-	-	-	-	-
		10	-	-	-	-	38	-	-	-	-	21	-	-	-	-	-
	44	30	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	34	-	-	-	-	17	-	-	-	-	-
		10	-	-	-	15	48	-	-	-	-	30	-	-	-	-	-
	41	30	-	-	-	-	29	-	-	-	-	14	-	-	-	-	-
		20	-	-	-	12	44	-	-	-	-	26	-	-	-	-	-
		10	-	-	14	23	58	-	-	-	-	41	-	-	-	-	-
	38	30	-	-	-	-	40	-	-	-	-	22	-	-	-	-	-
		20	-	-	12	21	56	-	-	-	-	38	-	-	-	-	-
		10	-	-	23	34	68	-	-	-	18	52	-	-	-	-	17
	35	30	-	-	-	18	52	-	-	-	-	34	-	-	-	-	-
		20	-	14	22	32	66	-	-	-	16	50	-	-	-	-	16
		10	11	18	35	47	76	-	-	18	29	63	-	-	-	-	28
	32	30	-	-	20	30	64	-	-	-	15	48	-	-	-	-	14
		20	20	25	34	46	76	-	11	18	28	62	-	-	-	-	28
		10	20	30	49	60	83	-	14	31	42	73	-	-	-	11	42
29	30	12	18	33	45	75	-	-	17	27	61	-	-	-	-	27	
	20	34	39	49	60	83	18	22	31	43	74	-	-	-	11	42	
	10	34	45	62	71	89	18	27	45	56	82	-	-	13	22	56	
26	30	25	33	50	60	84	11	17	32	43	74	-	-	-	11	43	
	20	50	55	64	73	89	32	38	47	58	83	-	-	14	23	58	
	10	50	60	75	81	+	33	43	61	70	88	-	12	26	37	70	
23	30	43	52	66	74	+	25	34	50	61	84	-	-	16	26	60	
	20	66	70	77	83	+	51	56	64	73	89	17	21	30	41	73	
	10	67	74	84	88	+	51	61	75	81	+	18	26	44	55	81	
20	30	62	70	80	85	+	46	54	68	76	+	14	20	35	46	76	
	20	80	83	87	+	+	69	73	79	84	+	37	41	51	61	84	
	10	80	85	+	+	+	69	76	85	89	+	37	47	64	72	89	
17	30	79	84	+	+	+	68	74	83	88	+	35	44	59	68	87	
	20	+	+	+	+	+	83	86	89	+	+	60	64	71	79	+	
	10	+	+	+	+	+	84	88	+	+	+	61	69	80	85	+	
14	30	+	+	+	+	+	85	88	+	+	+	63	70	80	85	+	
	20	+	+	+	+	+	+	+	+	+	+	80	83	87	+	+	
	10	+	+	+	+	+	+	+	+	+	+	81	85	+	+	+	
11	30	+	+	+	+	+	+	+	+	+	+	85	88	+	+	+	
	20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
8	30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

+ = Greater than 90%
 - = Less than 10%

Table 1M

Male Population Percentages for Lifting Tasks Ending Below Knuckle Height (< 31")

		Hand Distance					7 inches					10 inches					15 inches				
		Frequency: One Lift Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h
Object Weight (pounds)	Lifting Distance (inches)	96	30	-	-	-	30	49	-	-	-	16	35	-	-	-	-	-	-	-	
			20	-	-	13	34	54	-	-	-	20	39	-	-	-	-	-	-	12	
			10	-	11	25	48	65	-	-	13	33	53	-	-	-	-	-	-	23	
		92	30	-	-	14	34	54	-	-	-	20	40	-	-	-	-	-	-	12	
			20	-	-	17	39	58	-	-	-	24	44	-	-	-	-	-	-	16	
			10	-	15	30	52	69	-	-	16	38	57	-	-	-	-	11	28		
		88	30	-	-	17	39	58	-	-	-	25	45	-	-	-	-	-	-	16	
			20	-	-	21	44	62	-	-	-	29	49	-	-	-	-	-	-	20	
			10	11	19	34	57	72	-	-	20	43	61	-	-	-	-	15	33		
		84	30	-	-	22	45	63	-	-	-	30	50	-	-	-	-	-	-	20	
			20	-	11	26	49	66	-	-	14	34	54	-	-	-	-	-	-	25	
			10	15	23	40	61	75	-	11	25	48	65	-	-	-	-	19	38		
		80	30	-	-	27	50	67	-	-	14	35	55	-	-	-	-	-	-	25	
			20	-	14	31	54	70	-	-	18	40	59	-	-	-	-	13	30		
			10	20	28	45	65	78	-	15	30	53	69	-	-	-	-	24	43		
		76	30	-	14	33	55	71	-	-	19	41	60	-	-	-	-	13	31		
			20	11	19	37	59	73	-	-	23	46	63	-	-	-	-	17	36		
			10	25	34	51	69	80	12	19	36	58	73	-	-	-	-	29	49		
		72	30	-	19	39	60	74	-	-	24	47	64	-	-	-	-	18	37		
			20	15	24	43	64	77	-	12	29	51	68	-	-	-	-	22	42		
			10	31	40	56	73	83	16	25	42	63	76	-	-	-	14	35	55		
		68	30	15	25	45	65	78	-	12	30	53	69	-	-	-	-	24	43		
			20	20	31	50	69	80	-	16	35	57	72	-	-	-	-	28	48		
			10	37	46	62	77	85	21	31	48	68	79	-	-	-	19	42	60		
		64	30	20	31	52	70	81	-	17	37	59	73	-	-	-	11	30	50		
			20	26	37	56	73	83	13	22	42	63	76	-	-	-	14	35	54		
			10	44	53	67	80	87	28	38	55	72	82	-	-	-	25	48	66		
		60	30	27	39	58	75	84	13	23	44	65	77	-	-	-	16	37	57		
			20	34	45	62	77	85	18	29	49	68	80	-	-	-	20	42	60		
			10	51	59	72	83	89	35	45	61	76	85	-	-	-	14	33	55	71	
56	30	35	46	64	79	86	19	31	52	70	81	-	-	-	22	45	63				
	20	41	52	68	81	88	25	37	56	73	83	-	-	-	27	50	66				
	10	58	65	76	86	+	42	52	67	80	87	12	21	40	62	75					
52	30	43	54	70	82	89	27	39	59	75	84	-	-	-	11	30	53	69			
	20	49	59	73	84	+	33	45	63	78	86	-	-	-	14	35	57	72			
	10	65	71	80	88	+	51	60	72	84	89	18	28	48	68	79					
48	30	52	62	76	85	+	36	48	66	80	87	-	-	-	17	39	61	75			
	20	58	66	78	87	+	42	53	69	82	88	11	22	44	64	77					
	10	71	76	84	+	+	59	66	77	87	+	26	37	57	74	83					
44	30	60	69	80	88	+	45	57	73	84	89	14	26	49	68	80					
	20	65	73	82	89	+	52	62	75	85	+	19	31	53	71	82					
	10	76	81	87	+	+	66	73	82	89	+	35	47	65	79	86					
40	30	68	76	85	+	+	56	66	78	87	+	23	37	59	75	84					
	20	73	79	86	+	+	61	70	81	88	+	29	42	62	77	85					
	10	81	85	+	+	+	73	79	86	+	+	46	57	72	83	89					
36	30	76	81	88	+	+	65	73	83	+	+	35	48	68	81	88					
	20	79	84	89	+	+	70	77	85	+	+	40	53	71	83	89					
	10	86	88	+	+	+	80	84	89	+	+	57	66	78	87	+					
32	30	82	86	+	+	+	74	80	88	+	+	48	60	76	86	+					
	20	84	88	+	+	+	77	83	89	+	+	53	64	78	87	+					
	10	89	+	+	+	+	85	88	+	+	+	67	75	84	+	+					
28	30	87	+	+	+	+	81	86	+	+	+	61	71	83	+	+					
	20	89	+	+	+	+	84	87	+	+	+	66	74	84	+	+					
	10	+	+	+	+	+	89	+	+	+	+	77	82	88	+	+					

+ = Greater than 90%
- = Less than 10%

Table 2F

Female Population Percentages for Lifting Tasks Ending Between Knuckle and Shoulder Height ($\geq 28''$ & $\leq 53''$)

		Hand Distance					7 inches					10 inches					15 inches				
		Frequency: One Lift Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h
Object Weight (pounds)	59	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	56	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-
	53	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-
	50	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-
		10	-	-	-	-	-	-	-	29	-	-	-	-	14	-	-	-	-	-	-
	47	30	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	24	-	-	-	-	11	-	-	-	-	-	-
		10	-	-	-	-	-	-	-	38	-	-	-	-	21	-	-	-	-	-	-
	44	30	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	-	-	-	34	-	-	-	-	17	-	-	-	-	-	-
		10	-	-	-	-	15	48	-	30	-	-	-	-	30	-	-	-	-	-	-
	41	30	-	-	-	-	-	-	-	29	-	-	-	-	14	-	-	-	-	-	-
		20	-	-	-	-	12	44	-	26	-	-	-	-	26	-	-	-	-	-	-
		10	-	-	14	23	58	-	41	-	41	-	-	-	41	-	-	-	-	-	-
	38	30	-	-	-	-	-	-	-	40	-	-	-	-	22	-	-	-	-	-	-
		20	-	-	12	21	56	-	38	-	38	-	-	-	38	-	-	-	-	-	-
		10	-	-	23	34	68	-	52	-	52	-	-	18	52	-	-	-	-	-	17
35	30	-	-	-	18	52	-	34	-	34	-	-	-	34	-	-	-	-	-	-	
	20	-	14	22	32	66	-	50	-	50	-	-	16	50	-	-	-	-	-	16	
	10	11	18	35	47	76	-	63	-	63	-	-	18	63	-	-	-	-	-	28	
32	30	-	-	20	30	64	-	48	-	48	-	-	15	48	-	-	-	-	-	14	
	20	20	25	34	46	76	-	62	-	62	-	11	62	-	-	-	-	-	-	28	
	10	20	30	49	60	83	-	73	-	73	-	14	73	-	-	-	11	42	-	42	
29	30	12	18	33	45	75	-	61	-	61	-	-	17	61	-	-	-	-	-	27	
	20	34	39	49	60	83	-	74	18	74	-	22	74	-	-	-	11	42	-	42	
	10	34	45	62	71	89	-	82	18	82	-	27	82	-	-	13	22	56	-	56	
26	30	25	33	50	60	84	-	74	11	74	-	17	74	-	-	-	11	43	-	43	
	20	50	55	64	73	89	-	83	32	83	-	38	83	-	-	14	23	58	-	58	
	10	50	60	75	81	+	-	88	33	88	-	43	88	-	12	26	37	70	-	70	
23	30	43	52	66	74	+	-	84	25	84	-	34	84	-	-	16	26	60	-	60	
	20	66	70	77	83	+	-	89	51	89	-	56	89	-	17	21	30	41	73	73	
	10	67	74	84	88	+	-	+	51	+	-	61	+	18	26	44	55	81	-	81	
20	30	62	70	80	85	+	-	+	46	+	-	54	+	14	20	35	46	76	-	76	
	20	80	83	87	+	+	-	+	69	+	-	73	+	37	41	51	61	84	-	84	
	10	80	85	+	+	+	-	+	69	+	-	76	+	37	47	64	72	89	-	89	
17	30	79	84	+	+	+	-	+	68	+	-	74	+	35	44	59	68	87	-	87	
	20	+	+	+	+	+	-	+	83	+	-	86	+	60	64	71	79	+	-	+	
	10	+	+	+	+	+	-	+	84	+	-	88	+	61	69	80	85	+	-	+	
14	30	+	+	+	+	+	-	+	85	+	-	88	+	63	70	80	85	+	-	+	
	20	+	+	+	+	+	-	+	+	+	-	+	+	80	83	87	+	+	-	+	
	10	+	+	+	+	+	-	+	+	+	-	+	+	81	85	+	+	+	-	+	
11	30	+	+	+	+	+	-	+	+	+	-	+	+	85	88	+	+	+	-	+	
	20	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	-	+	
	10	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	-	+	
8	30	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	-	+	
	20	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	-	+	
	10	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	-	+	

+ = Greater than 90%
 - = Less than 10%

Table 2M

Male Population Percentages for Lifting Tasks Ending Between Knuckle and Shoulder Height (≥ 31" & ≤ 57")

		Hand Distance					7 inches					10 inches					15 inches				
		Frequency: One Lift Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h
Object Weight (pounds)	Lifting Distance (inches)	96	30	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-
			20	-	-	-	-	25	-	-	-	-	-	12	-	-	-	-	-	-	-
			10	-	-	16	21	46	-	-	-	-	-	30	-	-	-	-	-	-	-
		92	30	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-
			20	-	-	-	-	30	-	-	-	-	-	16	-	-	-	-	-	-	-
			10	-	-	20	26	52	-	-	-	-	13	36	-	-	-	-	-	-	-
		88	30	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-
			20	-	-	-	13	36	-	-	-	-	-	21	-	-	-	-	-	-	-
			10	-	11	25	32	57	-	-	12	17	42	-	-	-	-	-	-	-	13
		84	30	-	-	-	-	27	-	-	-	-	-	13	-	-	-	-	-	-	-
			20	-	-	12	17	42	-	-	-	-	-	26	-	-	-	-	-	-	-
			10	-	15	31	38	63	-	-	17	22	48	-	-	-	-	-	-	-	17
		80	30	-	-	-	11	33	-	-	-	-	-	18	-	-	-	-	-	-	-
			20	-	-	17	23	49	-	-	-	-	11	32	-	-	-	-	-	-	-
			10	12	20	38	44	68	-	-	22	28	54	-	-	-	-	-	-	-	23
		76	30	-	-	11	16	40	-	-	-	-	-	24	-	-	-	-	-	-	-
			20	-	-	23	29	55	-	-	11	15	39	-	-	-	-	-	-	-	11
			10	17	26	45	51	72	-	13	29	35	60	-	-	-	-	-	-	-	29
		72	30	-	-	16	21	47	-	-	-	-	-	31	-	-	-	-	-	-	-
			20	-	14	30	36	61	-	-	16	21	47	-	-	-	-	-	-	-	16
			10	23	33	52	58	77	11	19	36	42	66	-	-	-	-	-	-	-	36
		68	30	-	11	22	28	54	-	-	-	15	39	-	-	-	-	-	-	-	11
			20	12	20	37	44	67	-	-	22	28	54	-	-	-	-	-	-	-	23
			10	30	41	59	64	81	16	25	43	50	72	-	-	14	19	44	-	-	44
64	30	12	17	30	36	61	-	-	16	21	47	-	-	-	-	-	-	-	16		
	20	18	27	45	52	73	-	14	29	36	61	-	-	-	-	-	-	-	30		
	10	38	49	65	70	84	23	33	51	57	77	-	-	20	26	52	-	-	52		
60	30	18	25	38	45	68	-	12	23	29	55	-	-	-	-	-	-	-	24		
	20	25	35	54	60	78	13	20	38	44	68	-	-	-	-	15	39	-	39		
	10	47	57	72	76	87	31	42	59	64	81	-	13	28	34	60	-	-	60		
56	30	26	33	48	54	74	13	19	32	38	63	-	-	-	-	-	-	-	32		
	20	34	45	62	67	83	20	29	47	53	74	-	-	17	22	48	-	-	48		
	10	56	65	77	81	+	41	51	67	71	85	13	20	37	44	67	-	-	67		
52	30	36	43	57	63	80	21	28	41	48	70	-	-	13	17	42	-	-	42		
	20	44	54	69	74	86	28	39	56	62	80	-	11	25	31	57	-	-	57		
	10	64	72	82	85	+	50	60	73	77	88	20	29	47	53	74	-	-	74		
48	30	46	54	66	71	85	31	38	52	58	77	-	11	21	27	53	-	-	53		
	20	54	63	76	80	+	39	49	65	70	84	12	19	36	42	66	-	-	66		
	10	72	78	86	88	+	60	68	80	83	+	30	40	57	63	80	-	-	80		
44	30	57	64	74	78	88	42	50	62	67	83	14	19	32	38	63	-	-	63		
	20	64	72	82	85	+	51	60	74	77	88	20	29	47	53	74	-	-	74		
	10	79	84	+	+	+	69	76	85	87	+	42	51	67	71	85	-	-	85		
40	30	68	73	81	84	+	55	61	72	76	87	24	31	44	51	72	-	-	72		
	20	73	79	87	89	+	62	70	81	84	+	32	42	59	64	81	-	-	81		
	10	85	88	+	+	+	77	82	89	+	+	54	63	75	79	89	-	-	89		
36	30	77	81	87	89	+	66	72	80	83	+	38	45	58	63	80	-	-	80		
	20	81	85	+	+	+	72	78	86	88	+	46	56	70	74	87	-	-	87		
	10	89	+	+	+	+	84	88	+	+	+	66	73	82	85	+	-	-	+		
32	30	84	87	+	+	+	77	81	86	88	+	53	60	70	74	87	-	-	87		
	20	87	+	+	+	+	81	85	+	+	+	61	69	79	83	+	-	-	+		
	10	+	+	+	+	+	89	+	+	+	+	76	82	88	+	+	-	-	+		
28	30	+	+	+	+	+	85	88	+	+	+	68	73	81	84	+	-	-	+		
	20	+	+	+	+	+	88	+	+	+	+	74	79	87	89	+	-	-	+		
	10	+	+	+	+	+	+	+	+	+	+	85	88	+	+	+	-	-	+		

+ = Greater than 90%
 - = Less than 10%

Table 3M

Male Population Percentages for Lifting Tasks Ending Above Shoulder Height (> 57")

		Hand Distance					7 inches					10 inches					15 inches				
		Frequency: One Lift Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h
77	30	-	-	-	-	28	-	-	-	-	14	-	-	-	-	-					
	20	-	-	14	18	44	-	-	-	-	28	-	-	-	-	-					
	10	-	16	33	39	64	-	-	18	24	49	-	-	-	-	19					
	74	30	-	-	-	11	33	-	-	-	-	18	-	-	-	-	-				
		20	-	-	17	23	49	-	-	-	11	33	-	-	-	-	-				
		10	12	20	38	45	68	-	-	22	29	54	-	-	-	-	23				
	71	30	-	-	-	15	39	-	-	-	-	23	-	-	-	-	-				
		20	-	-	22	28	54	-	-	-	14	38	-	-	-	-	11				
		10	16	25	44	50	72	-	12	28	34	59	-	-	-	-	28				
	68	30	-	-	14	19	45	-	-	-	-	29	-	-	-	-	-				
		20	-	12	27	34	59	-	-	14	19	44	-	-	-	-	14				
		10	21	31	49	55	75	-	17	33	40	64	-	-	-	11	34				
	65	30	-	-	19	25	50	-	-	-	12	35	-	-	-	-	-				
		20	-	16	33	40	64	-	-	18	24	50	-	-	-	-	19				
		10	27	37	55	61	79	13	22	39	46	69	-	-	11	16	40				
	62	30	-	13	24	31	56	-	-	12	16	41	-	-	-	-	12				
		20	13	22	40	46	69	-	-	24	30	56	-	-	-	-	25				
		10	33	43	60	66	82	18	27	46	52	73	-	-	16	21	46				
59	30	12	18	31	37	62	-	-	16	22	47	-	-	-	-	17					
	20	18	28	46	52	73	-	14	30	37	62	-	-	-	-	31					
	10	39	50	66	71	85	24	34	52	58	77	-	-	21	27	53					
56	30	17	24	38	44	68	-	11	22	28	54	-	-	-	-	23					
	20	24	34	53	59	78	12	20	37	44	67	-	-	-	14	38					
	10	46	56	71	75	87	30	41	58	64	81	-	12	27	33	59					
53	30	23	31	45	51	73	11	17	29	35	61	-	-	-	-	30					
	20	31	42	59	65	81	17	26	44	51	72	-	-	15	20	45					
	10	53	62	76	79	89	38	48	64	69	84	11	18	34	41	65					
50	30	31	38	52	58	77	17	23	37	43	67	-	-	-	14	37					
	20	39	50	66	77	85	24	34	52	58	77	-	-	21	27	53					
	10	60	68	80	83	+	46	55	70	74	87	16	25	42	49	71					
47	30	39	47	60	65	82	24	31	45	51	73	-	-	15	20	46					
	20	47	57	72	76	87	32	42	59	65	81	-	13	28	35	60					
	10	67	74	84	86	+	54	63	76	79	89	23	33	50	56	76					
44	30	48	55	67	72	85	32	40	53	59	78	-	12	22	28	54					
	20	56	65	77	81	+	41	51	67	71	85	13	20	37	44	67					
	10	73	79	87	89	+	61	69	80	83	+	31	41	58	64	81					
41	30	57	63	74	77	88	42	49	62	67	82	13	19	31	37	62					
	20	64	72	82	85	+	50	59	73	77	88	20	29	46	53	74					
	10	79	83	+	+	+	69	75	84	87	+	41	51	66	71	85					
38	30	65	71	79	82	+	51	58	70	74	86	21	28	41	48	70					
	20	71	78	86	88	+	59	67	79	82	+	29	39	56	62	79					
	10	83	87	+	+	+	75	81	88	+	+	51	60	73	77	88					
35	30	73	78	84	87	+	61	67	77	80	+	31	39	52	58	77					
	20	78	83	89	+	+	68	75	84	86	+	40	50	65	70	84					
	10	87	+	+	+	+	81	85	+	+	+	61	69	79	83	+					
32	30	80	83	88	+	+	70	75	83	85	+	43	50	62	68	83					
	20	84	87	+	+	+	76	81	88	+	+	52	61	74	78	88					
	10	+	+	+	+	+	86	89	+	+	+	70	76	85	87	+					
29	30	85	88	+	+	+	78	82	87	89	+	56	62	72	76	88					
	20	88	+	+	+	+	83	86	+	+	+	63	71	81	84	+					
	10	+	+	+	+	+	+	+	+	+	+	78	83	89	+	+					
26	30	+	+	+	+	+	85	88	+	+	+	68	73	81	83	+					
	20	+	+	+	+	+	88	+	+	+	+	74	79	87	89	+					
	10	+	+	+	+	+	+	+	+	+	+	85	88	+	+	+					

+ = Greater than 90%
 - = Less than 10%

Table 4F

Female Population Percentages for Lowering Tasks Beginning Below Knuckle Height (< 28")

		Hand Distance					7 inches					10 inches					15 inches				
		Frequency: One Lift Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h
Object Weight (pounds)	51	30	-	-	-	-	47	-	-	-	-	26	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	17	69	-	-	-	-	50	-	-	-	-	-	-	-	12
		10	-	-	-	-	22	73	-	-	-	-	56	-	-	-	-	-	-	-	16
	48	30	-	-	-	-	56	-	-	-	-	36	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	25	75	-	-	-	-	59	-	-	-	-	-	-	-	18
		10	-	-	11	31	79	-	-	-	14	64	-	-	-	-	-	-	-	-	24
	45	30	-	-	-	-	14	65	-	-	-	-	46	-	-	-	-	-	-	-	-
		20	-	-	14	35	81	-	-	-	16	68	-	-	-	-	-	-	-	-	27
		10	-	12	18	41	84	-	-	-	21	72	-	-	-	-	-	-	-	-	33
	43	30	-	-	-	-	20	71	-	-	-	-	53	-	-	-	-	-	-	-	14
		20	-	-	19	42	84	-	-	-	22	73	-	-	-	-	-	-	-	-	34
		10	14	17	24	49	87	-	-	-	28	77	-	-	-	-	-	-	-	-	41
	41	30	-	-	-	-	26	76	-	-	-	-	60	-	-	-	-	-	-	-	19
		20	-	12	25	50	87	-	-	-	29	78	-	-	-	-	-	-	-	-	42
		10	20	24	31	56	89	-	-	14	35	81	-	-	-	-	-	-	-	-	48
	39	30	-	-	13	34	80	-	-	-	15	67	-	-	-	-	-	-	-	-	26
		20	12	18	33	58	+	-	-	15	37	82	-	-	-	-	-	-	-	-	50
		10	27	31	39	63	+	-	12	20	43	85	-	-	-	-	-	-	-	-	56
	37	30	-	12	19	42	84	-	-	-	22	73	-	-	-	-	-	-	-	-	34
		20	18	25	41	65	+	-	-	21	45	86	-	-	-	-	-	-	-	-	58
		10	35	39	48	70	+	15	18	27	52	88	-	-	-	-	-	-	-	-	63
	35	30	15	19	26	51	88	-	-	-	30	78	-	-	-	-	-	-	-	-	43
		20	25	34	50	72	+	-	14	29	54	89	-	-	-	-	-	-	-	-	66
		10	44	48	56	76	+	22	26	35	60	+	-	-	-	-	-	-	-	-	70
33	30	23	27	36	60	+	-	-	17	40	83	-	-	-	-	-	-	-	-	52	
	20	34	43	59	78	+	14	22	39	63	+	-	-	-	-	-	-	-	-	73	
	10	53	57	64	81	+	30	35	45	68	+	-	-	-	-	-	-	-	-	77	
31	30	32	37	46	68	+	13	16	25	50	87	-	-	-	-	-	-	-	-	62	
	20	44	53	67	83	+	22	31	49	70	+	-	-	-	-	-	-	-	-	79	
	10	62	66	72	86	+	40	45	55	75	+	-	-	-	-	-	-	-	-	82	
29	30	43	47	56	76	+	21	25	35	60	+	-	-	-	-	-	-	-	-	70	
	20	55	63	75	87	+	32	41	59	77	+	-	-	-	-	-	-	-	-	84	
	10	71	74	79	89	+	51	55	64	81	+	-	-	-	-	-	-	-	-	87	
27	30	54	58	66	82	+	31	36	47	69	+	-	-	-	-	-	-	-	-	78	
	20	65	72	81	+	+	43	53	68	83	+	-	-	-	-	-	-	-	-	88	
	10	78	80	84	+	+	61	65	73	86	+	16	22	34	59	+	-	-	-	+	
25	30	65	69	75	87	+	43	49	58	77	+	-	-	-	-	-	-	-	-	84	
	20	74	79	87	+	+	55	64	77	88	+	11	20	40	64	+	-	-	-	+	
	10	84	86	89	+	+	71	74	80	+	+	26	33	46	69	+	-	-	-	+	
23	30	75	78	82	+	+	56	61	69	84	+	12	17	29	54	89	-	-	-	+	
	20	81	85	+	+	+	67	74	84	+	+	21	32	53	74	+	-	-	-	+	
	10	89	+	+	+	+	79	82	86	+	+	39	46	59	78	+	-	-	-	+	
21	30	83	85	88	+	+	69	72	79	89	+	23	30	44	67	+	-	-	-	+	
	20	88	+	+	+	+	77	82	89	+	+	34	46	66	82	+	-	-	-	+	
	10	+	+	+	+	+	86	88	+	+	+	53	60	71	85	+	-	-	-	+	
18	30	+	+	+	+	+	83	86	89	+	+	47	54	66	82	+	-	-	-	+	
	20	+	+	+	+	+	88	+	+	+	+	59	68	82	+	+	-	-	-	+	
	10	+	+	+	+	+	+	+	+	+	+	74	78	85	+	+	-	-	-	+	
15	30	+	+	+	+	+	+	+	+	+	+	72	77	84	+	+	-	-	-	+	
	20	+	+	+	+	+	+	+	+	+	+	80	85	+	+	+	-	-	-	+	
	10	+	+	+	+	+	+	+	+	+	+	88	+	+	+	+	-	-	-	+	
12	30	+	+	+	+	+	+	+	+	+	+	89	+	+	+	+	-	-	-	+	
	20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	
	10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	

+ = Greater than 90%
 - = Less than 10%

Table 4M

Male Population Percentages for Lowering Tasks Beginning Below Knuckle Height (< 31")

		Hand Distance					10 inches					15 inches					
		7 inches					10 inches					15 inches					
Frequency: One Lift Every		15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	
Object Weight (pounds)	87	30	-	-	23	47	73	-	-	11	31	62	-	-	-	-	33
		20	-	14	28	51	76	-	-	14	36	66	-	-	-	-	38
		10	21	28	42	64	83	-	14	26	50	75	-	-	-	20	52
	84	30	-	13	27	51	75	-	-	14	35	65	-	-	-	-	37
		20	-	17	32	55	78	-	-	17	40	69	-	-	-	12	42
		10	24	32	46	67	84	11	17	30	54	77	-	-	-	24	55
	81	30	-	16	31	55	78	-	-	17	40	69	-	-	-	12	41
		20	13	20	36	59	80	-	-	21	44	72	-	-	-	15	46
		10	29	36	50	70	86	14	20	35	58	80	-	-	-	28	59
	78	30	13	20	35	58	80	-	-	21	44	71	-	-	-	15	46
		20	16	24	40	62	82	-	11	25	49	74	-	-	-	19	50
		10	33	40	54	72	87	17	24	39	61	81	-	-	11	32	63
	75	30	16	24	40	62	82	-	11	25	49	74	-	-	-	19	50
		20	20	28	45	66	84	-	14	29	53	77	-	-	-	23	54
		10	37	45	58	75	88	21	29	44	65	83	-	-	15	36	66
	72	30	20	28	45	66	84	-	14	29	53	77	-	-	-	23	54
		20	24	33	49	69	85	11	18	34	57	79	-	-	-	27	59
		10	42	50	62	78	89	25	33	48	68	85	-	-	18	41	70
	69	30	24	33	50	69	85	11	18	34	57	79	-	-	-	27	59
		20	29	38	54	72	87	14	22	39	61	81	-	-	11	32	63
		10	47	54	66	80	+	30	38	53	72	87	-	-	23	46	73
	66	30	29	38	54	73	87	15	23	39	62	82	-	-	12	32	63
		20	34	43	59	76	88	18	27	44	66	84	-	-	15	37	67
		10	52	59	69	82	+	35	44	58	75	88	-	13	27	51	76
63	30	35	44	59	76	89	19	28	45	66	84	-	-	15	38	67	
	20	40	49	63	78	+	23	32	49	69	85	-	-	19	43	70	
	10	57	63	73	84	+	41	49	62	78	89	-	17	33	56	79	
60	30	40	49	64	79	+	24	33	50	70	86	-	-	20	43	71	
	20	45	54	67	81	+	28	38	55	73	87	-	-	24	48	74	
	10	62	67	76	86	+	46	54	66	80	+	14	21	38	61	81	
57	30	46	55	68	82	+	29	39	56	74	88	-	-	26	49	75	
	20	51	59	71	83	+	34	44	60	76	89	-	13	30	54	77	
	10	66	72	79	88	+	52	59	71	83	+	18	27	44	66	84	
54	30	52	60	72	84	+	36	45	61	77	89	-	14	32	55	78	
	20	57	64	75	86	+	40	50	65	80	+	-	18	36	59	80	
	10	71	75	82	+	+	58	64	74	85	+	24	33	50	70	86	
51	30	58	66	76	86	+	42	52	66	80	+	11	19	38	61	81	
	20	62	69	79	88	+	47	56	70	82	+	14	23	43	65	83	
	10	75	79	85	+	+	63	69	78	87	+	30	40	56	74	88	
48	30	64	71	80	88	+	49	58	71	83	+	16	26	45	66	84	
	20	68	74	82	89	+	54	62	74	85	+	20	30	50	70	86	
	10	78	82	87	+	+	68	74	81	89	+	37	47	62	78	+	
45	30	70	75	83	+	+	56	64	76	86	+	22	33	52	71	86	
	20	73	78	85	+	+	60	68	78	87	+	26	38	57	74	88	
	10	82	85	89	+	+	73	78	84	+	+	44	54	68	81	+	
42	30	75	79	86	+	+	63	70	80	88	+	30	41	60	76	89	
	20	77	81	87	+	+	67	73	82	89	+	34	46	63	79	+	
	10	85	87	+	+	+	78	82	87	+	+	52	61	73	85	+	
39	30	79	83	88	+	+	69	75	83	+	+	38	49	66	80	+	
	20	81	85	89	+	+	72	78	85	+	+	43	54	70	82	+	
	10	88	+	+	+	+	82	85	89	+	+	60	67	78	87	+	
36	30	83	+	+	+	+	75	80	87	+	+	47	58	73	84	+	
	20	85	+	+	+	+	78	82	88	+	+	52	62	75	86	+	
	10	+	+	+	+	+	85	88	+	+	+	67	74	82	+	+	

+ = Greater than 90%
- = Less than 10%

Table 5F

Female Population Percentages for Lowering Tasks Beginning Between Knuckle and Shoulder Heights ($\geq 28''$ & $\leq 53''$)

		Hand Distance					7 inches					10 inches					15 inches					
		Frequency: One Lift Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	
Object Weight (pounds)	Lowering Distance (inches)	51	30	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	
			20	-	-	-	-	43	-	-	-	-	-	23	-	-	-	-	-	-	-	-
		48	10	-	-	-	21	58	-	-	-	-	38	-	-	-	-	-	-	-	-	-
			30	-	-	-	-	35	-	-	-	-	17	-	-	-	-	-	-	-	-	-
		45	20	-	-	-	17	53	-	-	-	-	33	-	-	-	-	-	-	-	-	-
			10	-	-	-	30	67	-	-	-	14	49	-	-	-	-	-	-	-	-	12
		43	30	-	-	-	12	46	-	-	-	-	26	-	-	-	-	-	-	-	-	-
			20	-	-	-	26	63	-	-	-	-	44	-	-	-	-	-	-	-	-	-
		41	10	-	-	11	41	75	-	-	-	22	59	-	-	-	-	-	-	-	-	20
			30	-	-	-	17	54	-	-	-	-	33	-	-	-	-	-	-	-	-	-
		39	20	-	-	-	33	69	-	-	-	15	51	-	-	-	-	-	-	-	-	14
			10	-	-	15	49	79	-	-	-	29	65	-	-	-	-	-	-	-	-	27
		37	30	-	-	-	24	61	-	-	-	-	41	-	-	-	-	-	-	-	-	-
			20	-	-	-	41	75	-	-	-	22	59	-	-	-	-	-	-	-	-	20
		35	10	-	-	22	57	83	-	-	-	37	72	-	-	-	-	-	-	-	-	35
			30	-	-	-	32	68	-	-	-	14	50	-	-	-	-	-	-	-	-	13
		33	20	-	11	16	49	80	-	-	-	29	66	-	-	-	-	-	-	-	-	27
			10	-	14	29	64	87	-	-	-	13	45	77	-	-	-	-	-	-	-	43
		31	30	-	-	-	40	74	-	-	-	21	58	-	-	-	-	-	-	-	-	20
			20	14	16	23	58	84	-	-	-	38	72	-	-	-	-	-	-	-	-	36
		29	10	14	21	38	71	+	-	-	-	19	54	82	-	-	-	-	-	-	-	52
			30	-	-	16	50	80	-	-	-	30	66	-	-	-	-	-	-	-	-	28
		27	20	21	24	31	66	88	-	-	-	14	47	78	-	-	-	-	-	-	-	45
			10	21	30	47	77	+	-	-	-	13	27	62	86	-	-	-	-	-	-	61
25	30	-	13	24	59	85	-	-	-	39	74	-	-	-	-	-	-	-	-	37		
	20	29	33	41	73	+	13	16	22	57	83	-	-	-	-	-	-	-	-	55		
23	10	30	39	57	82	+	13	21	37	70	89	-	-	-	-	-	-	-	-	69		
	30	14	20	34	68	89	-	-	-	16	50	80	-	-	-	-	-	-	-	48		
21	20	40	44	52	80	+	21	24	31	66	88	-	-	-	-	-	-	-	-	64		
	10	40	50	66	87	+	21	30	47	77	+	-	-	-	-	-	-	-	-	76		
18	30	23	30	45	76	+	-	14	25	60	85	-	-	-	-	-	-	-	-	59		
	20	51	55	62	85	+	31	35	43	74	+	-	-	-	-	-	-	-	-	73		
15	10	51	60	74	+	+	32	41	58	83	+	-	-	-	-	-	-	-	-	82		
	30	34	42	57	82	+	16	23	37	70	89	-	-	-	-	-	-	-	-	69		
12	20	62	65	71	89	+	43	47	54	81	+	-	-	-	-	-	-	-	-	80		
	10	62	70	81	+	+	44	53	68	88	+	-	-	-	-	-	-	-	-	87		
10	30	47	55	68	88	+	27	35	50	79	+	-	-	-	-	-	-	-	-	77		
	20	72	75	80	+	+	56	59	66	87	+	18	21	27	62	86	-	-	-	86		
8	10	72	79	87	+	+	56	65	77	+	+	19	27	43	74	+	-	-	-	86		
	30	60	67	77	+	+	41	49	63	85	+	-	13	24	59	85	-	-	-	85		
6	20	81	83	86	+	+	68	71	76	+	+	31	34	41	73	+	-	-	-	85		
	10	81	85	+	+	+	68	75	84	+	+	31	40	57	82	+	-	-	-	85		
4	30	72	78	85	+	+	56	63	74	+	+	19	25	39	71	+	-	-	-	85		
	20	87	89	+	+	+	78	80	84	+	+	46	50	56	82	+	-	-	-	85		
2	10	88	+	+	+	+	78	83	+	+	+	46	55	70	89	+	-	-	-	85		
	30	86	89	+	+	+	76	81	87	+	+	43	50	63	86	+	-	-	-	85		
1	20	+	+	+	+	+	89	+	+	+	+	69	72	76	+	+	-	-	-	85		
	10	+	+	+	+	+	89	+	+	+	+	70	76	85	+	+	-	-	-	85		
0.5	30	+	+	+	+	+	+	+	+	+	+	70	76	83	+	+	-	-	-	85		
	20	+	+	+	+	+	+	+	+	+	+	86	88	+	+	+	-	-	-	85		
0.25	10	+	+	+	+	+	+	+	+	+	+	87	+	+	+	+	-	-	-	85		
	30	+	+	+	+	+	+	+	+	+	+	89	+	+	+	+	-	-	-	85		
0.125	20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	85		
	10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	85		

+ = Greater than 90%
- = Less than 10%

Table 7

Population Percentages for Pushing Tasks Initial Forces

		Male					Female				
		Frequency: One Push Every					Frequency: One Push Every				
Initial Pushing Force (pounds)		Hand Height (inches) — Males					Hand Height (inches) — Females				
		30s	1m	5m	30m	8h	30s	1m	5m	30m	8h
130	57	-	-	-	-	25	53	-	-	-	-
	37	-	-	13	14	36	35	-	-	-	-
	25	-	-	-	-	22	22	-	-	-	-
127	57	-	-	-	-	28	53	-	-	-	-
	37	-	-	15	16	39	35	-	-	-	-
	25	-	-	-	-	25	22	-	-	-	-
124	57	-	-	-	11	31	53	-	-	-	-
	37	-	12	18	19	42	35	-	-	-	-
	25	-	-	-	-	29	22	-	-	-	-
121	57	-	12	13		35	53	-	-	-	-
	37	-	14	20	21	46	35	-	-	-	-
	25	-	-	-	11	32	22	-	-	-	-
118	57	-	-	15	16	38	53	-	-	-	-
	37	-	17	23	25	49	35	-	-	-	-
	25	-	-	13	13	35	25	-	-	-	-
115	57	-	12	17	18	42	53	-	-	-	-
	37	11	19	27	28	52	35	-	-	-	-
	25	-	-	15	16	39	22	-	-	-	-
112	57	-	14	20	21	46	53	-	-	-	-
	37	13	23	30	31	56	35	-	-	-	-
	25	-	12	18	19	43	22	-	-	-	-
109	57	-	17	24	25	49	53	-	-	-	-
	37	16	26	34	35	59	35	-	-	-	-
	25	-	15	21	22	46	22	-	-	-	-
106	57	12	20	27	28	53	53	-	-	-	-
	37	19	30	38	39	63	35	-	-	-	-
	25	-	18	24	26	50	22	-	-	-	-
103	57	14	23	31	32	57	53	-	-	-	-
	37	23	34	42	43	66	35	-	-	-	-
	25	12	21	28	29	54	22	-	-	-	-
100	57	17	27	35	36	60	53	-	-	-	-
	37	26	38	46	47	69	35	-	-	-	-
	25	14	24	32	33	58	22	-	-	-	-
97	57	21	31	39	41	64	53	-	-	-	-
	37	30	42	50	51	72	35	-	-	-	-
	25	17	28	36	38	61	22	-	-	-	-
94	57	25	36	44	45	67	53	-	-	-	-
	37	35	46	54	55	75	35	-	-	-	-
	25	21	33	41	42	65	22	-	-	-	-
91	57	29	40	48	49	71	53	-	-	-	-
	37	39	51	58	59	77	35	-	-	-	-
	25	25	37	45	46	68	22	-	-	-	-
88	57	33	45	53	54	74	53	-	-	-	13
	37	44	55	62	63	80	35	-	-	-	13
	25	29	42	50	51	72	22	-	-	-	-
85	57	38	50	57	58	77	53	-	-	-	11
	37	49	59	66	67	82	35	-	-	-	11
	25	34	47	54	56	75	22	-	-	-	-
82	57	43	54	62	63	79	53	-	-	-	14
	37	53	64	70	71	84	35	-	-	-	15
	25	39	51	59	60	78	22	-	-	-	-
79	57	48	59	66	67	82	53	-	-	-	14
	37	58	68	73	74	86	35	-	-	-	14
	25	44	56	63	64	80	22	-	-	-	-

+ = Greater than 90%
 - = Less than 10%

Table 7 (continued)

Population Percentages for Pushing Tasks Initial Forces

		Male					Female					
		Frequency: One Push Every					Frequency: One Push Every					
		30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	
76	57	53	64	70	71	84	53	–	–	19	25	34
	37	63	72	77	77	88	35	–	–	19	25	34
	25	50	61	68	68	83	22	–	–	–	–	–
73	57	59	68	74	74	86	53	–	–	24	31	40
	37	67	75	80	80	+	35	–	–	25	31	41
	25	55	66	72	72	85	22	–	–	–	–	11
70	57	63	72	77	78	88	53	–	12	31	38	47
	37	71	78	82	83	+	35	–	12	31	38	48
	25	60	70	75	76	87	22	–	–	–	–	15
67	57	68	76	80	81	+	53	–	17	38	45	54
	37	75	82	85	85	+	35	–	17	39	46	55
	25	65	74	79	79	89	22	–	–	–	14	21
64	57	73	79	83	84	+	53	14	23	46	53	61
	37	79	84	87	88	+	35	13	24	46	53	62
	25	70	78	82	82	+	25	–	–	14	19	27
61	57	77	83	86	86	+	53	20	30	54	60	68
	37	82	87	89	+	+	35	19	31	54	61	68
	25	74	81	85	85	+	22	–	–	20	26	35
58	57	80	85	88	89	+	53	27	39	61	67	74
	37	85	89	+	+	+	35	26	39	62	68	74
	25	78	84	87	88	+	22	–	–	27	34	44
55	57	84	88	+	+	+	53	36	48	69	74	80
	37	88	+	+	+	+	35	34	48	69	74	80
	25	82	87	89	+	+	22	–	15	36	43	52
52	57	87	+	+	+	+	53	45	57	75	79	84
	37	+	+	+	+	+	35	44	57	76	80	84
	25	85	89	+	+	+	22	12	23	45	52	61
49	57	89	+	+	+	+	53	55	65	81	84	88
	37	+	+	+	+	+	35	54	66	81	85	88
	25	88	+	+	+	+	22	19	32	55	61	69
46	57	+	+	+	+	+	53	64	73	86	88	+
	37	+	+	+	+	+	35	63	74	86	89	+
	25	+	+	+	+	+	22	28	42	64	70	76
43	57	+	+	+	+	+	53	73	80	+	+	+
	37	+	+	+	+	+	35	72	80	+	+	+
	25	+	+	+	+	+	22	39	54	73	78	83
40	57	+	+	+	+	+	53	80	86	+	+	+
	37	+	+	+	+	+	35	79	86	+	+	+
	25	+	+	+	+	+	22	51	64	80	84	88
37	57	+	+	+	+	+	53	86	+	+	+	+
	37	+	+	+	+	+	35	86	+	+	+	+
	25	+	+	+	+	+	22	63	74	86	89	+
34	57	+	+	+	+	+	53	+	+	+	+	+
	37	+	+	+	+	+	35	+	+	+	+	+
	25	+	+	+	+	+	22	74	82	+	+	+
31	57	+	+	+	+	+	53	+	+	+	+	+
	37	+	+	+	+	+	35	+	+	+	+	+
	25	+	+	+	+	+	22	83	88	+	+	+
28	57	+	+	+	+	+	53	+	+	+	+	+
	37	+	+	+	+	+	35	+	+	+	+	+
	25	+	+	+	+	+	22	89	+	+	+	+
25	57	+	+	+	+	+	53	+	+	+	+	+
	37	+	+	+	+	+	35	+	+	+	+	+
	25	+	+	+	+	+	22	+	+	+	+	+

+ = Greater than 90%
 – = Less than 10%

Table 9

Population Percentages for Pulling Tasks Initial Forces

		Male					Female					
		Frequency: One Push Every					Frequency: One Push Every					
Initial Pulling Force (pounds)		Hand Height (inches) — Males					Hand Height (inches) — Females					
		30s	1m	5m	30m	8h	30s	1m	5m	3m	8h	
130	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	-	-	13	35	-	-	-	-	-
	25	-	-	-	-	29	22	-	-	-	-	-
127	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	-	-	16	35	-	-	-	-	-
	25	-	-	-	-	33	22	-	-	-	-	-
124	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	-	-	19	35	-	-	-	-	-
	25	-	-	-	11	37	22	-	-	-	-	-
121	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	-	-	22	35	-	-	-	-	-
	25	-	-	13	14	41	22	-	-	-	-	-
118	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	-	-	26	35	-	-	-	-	-
	25	-	-	16	17	45	25	-	-	-	-	-
115	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	-	-	30	35	-	-	-	-	-
	25	-	12	19	20	49	22	-	-	-	-	-
112	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	-	-	34	35	-	-	-	-	-
	25	-	15	23	24	53	22	-	-	-	-	-
109	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	12	13	39	35	-	-	-	-	-
	25	-	18	27	28	58	22	-	-	-	-	-
106	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	-	15	16	43	35	-	-	-	-	-
	25	11	22	31	33	62	22	-	-	-	-	-
103	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	11	18	19	48	35	-	-	-	-	-
	25	14	27	36	38	66	22	-	-	-	-	-
100	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	15	22	24	53	35	-	-	-	-	-
	25	17	31	41	43	70	22	-	-	-	-	-
97	57	-	-	-	-	-	53	-	-	-	-	-
	37	-	18	27	28	58	35	-	-	-	-	-
	25	21	36	46	48	73	22	-	-	-	-	-
94	57	-	-	-	-	12	53	-	-	-	-	-
	37	11	23	32	33	62	35	-	-	-	-	-
	25	26	42	51	53	77	22	-	-	-	-	-
91	57	-	-	-	-	16	53	-	-	-	-	-
	37	14	28	37	39	67	35	-	-	-	-	-
	25	31	47	56	58	80	22	-	-	-	-	13
88	57	-	-	-	-	20	53	-	-	-	-	-
	37	19	33	43	44	71	35	-	-	-	-	11
	25	37	53	61	63	83	22	-	-	-	-	17
85	57	-	-	-	-	25	53	-	-	-	-	-
	37	23	39	49	50	75	35	-	-	-	-	15
	25	42	58	66	68	85	22	-	-	-	14	22
82	57	-	-	-	-	30	53	-	-	-	-	14
	37	29	45	54	56	79	35	-	-	-	12	20
	25	48	63	71	72	88	22	-	-	13	19	28
79	57	-	-	-	11	37	53	-	-	-	12	19
	37	35	51	60	62	82	35	-	-	12	17	26
	25	54	68	75	76	+	22	-	-	18	24	34

+ = Greater than 90%
 - = Less than 10%

Table 9 (Continued)

Population Percentages for Pulling Tasks Initial Forces

		Male					Female						
		Frequency: One Push Every					Frequency: One Push Every						
		30s	1m	5m	30m	8h	30s	1m	5m	30m	8h		
Initial Pulling Force (pounds)	76	57	–	–	15	16	43	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%

Table 10F

Female Population Percentages for Pulling Tasks Sustained Force

		Pulling Distance					7 Feet					25 Feet					50 Feet							
		Frequency: One Pull Every					30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	30s	1m	5m	30m	8h			
Sustained Pushing Force (pounds)	76	53	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		35	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	72	53	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		35	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	68	53	-	-	-	-	25	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-
		35	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		22	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	64	53	-	-	-	-	32	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-
		35	-	-	-	-	29	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-
		22	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	60	53	-	-	-	16	41	-	-	-	-	26	-	-	-	-	-	-	-	-	-	-	-	-
		35	-	-	-	13	37	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-	-	-
		25	-	-	-	-	26	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-
	56	53	-	-	16	23	49	-	-	-	12	34	-	-	-	-	-	-	-	-	-	-	15	-
		35	-	-	13	20	46	-	-	-	-	31	-	-	-	-	-	-	-	-	-	-	12	-
		22	-	-	-	12	35	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-
	52	53	-	12	24	32	58	-	-	12	19	44	-	-	-	-	-	-	-	-	-	-	22	-
		35	-	-	21	29	55	-	-	-	16	40	-	-	-	-	-	-	-	-	-	-	19	-
		22	-	-	12	19	44	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	11	-
	48	53	14	19	34	42	66	-	-	20	28	54	-	-	-	-	-	-	-	-	-	-	32	-
		35	12	16	30	39	63	-	-	17	24	50	-	-	-	-	-	-	-	-	-	-	28	-
		22	-	-	20	28	54	-	-	-	15	40	-	-	-	-	-	-	-	-	-	-	19	-
44	53	23	29	45	53	74	-	16	30	39	63	-	-	12	18	43	-	-	-	-	-	43	-	
	35	20	26	41	50	72	-	13	26	35	60	-	-	-	15	39	-	-	-	-	-	39	-	
	22	12	17	30	39	64	-	-	17	25	51	-	-	-	-	29	-	-	-	-	-	29	-	
40	53	35	41	56	64	80	17	27	42	51	72	-	-	21	29	55	-	-	-	-	-	55	-	
	35	31	38	53	61	79	14	23	38	47	70	-	-	18	25	51	-	-	-	-	-	51	-	
	22	21	27	43	51	73	-	15	28	36	62	-	-	-	16	41	-	-	-	-	-	41	-	
36	53	48	54	67	73	86	28	40	55	63	80	-	-	19	33	42	66	-	-	-	-	66	-	
	35	45	51	65	71	85	25	36	52	59	78	-	-	16	30	38	63	-	-	-	-	63	-	
	22	34	40	55	63	80	16	26	41	50	72	-	-	-	20	28	54	-	-	-	-	54	-	
32	53	62	67	77	81	+	43	55	67	73	86	-	-	33	48	56	74	-	-	-	-	74	-	
	35	59	64	75	80	89	40	51	65	71	85	-	-	29	45	53	74	-	-	-	-	74	-	
	22	49	55	68	74	86	29	41	56	63	80	-	-	19	34	43	66	-	-	-	-	66	-	
28	53	74	78	85	88	+	59	69	78	82	+	-	-	23	50	64	70	84	-	-	-	84	-	
	35	72	76	83	86	+	56	66	76	81	+	-	-	20	46	60	67	83	-	-	-	83	-	
	22	64	69	78	82	+	46	57	69	75	87	-	-	12	35	51	59	77	-	-	-	77	-	
24	53	84	86	+	+	+	74	80	86	89	+	-	-	43	67	77	81	+	-	-	-	+	-	
	35	82	85	+	+	+	71	78	85	88	+	-	-	39	64	75	79	89	-	-	-	89	-	
	22	77	80	87	89	+	64	72	81	84	+	-	-	28	55	68	73	86	-	-	-	86	-	
20	53	+	+	+	+	+	85	89	+	+	+	-	-	64	81	87	89	+	-	-	-	+	-	
	35	+	+	+	+	+	84	88	+	+	+	-	-	61	79	85	88	+	-	-	-	+	-	
	22	87	89	+	+	+	79	84	89	+	+	-	-	51	73	81	85	+	-	-	-	+	-	
16	53	+	+	+	+	+	+	+	+	+	+	-	-	81	+	+	+	+	-	-	-	+	-	
	35	+	+	+	+	+	+	+	+	+	+	-	-	80	89	+	+	+	-	-	-	+	-	
	22	+	+	+	+	+	89	+	+	+	+	-	-	74	86	+	+	+	-	-	-	+	-	
12	53	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	-	-	-	+	-	
	35	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	-	-	-	+	-	
	22	+	+	+	+	+	+	+	+	+	+	-	-	89	+	+	+	+	-	-	-	+	-	
8	53	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	-	-	-	+	-	
	35	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	-	-	-	+	-	
	22	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	-	-	-	+	-	

+ = Greater than 90%
 - = Less than 10%

Table 10M

Male Population Percentages for Pulling Tasks Sustained Force

		Pulling Distance					7 Feet					25 Feet					50 Feet					
		Frequency: One Pull Every					30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	
Sustained Pushing Force (pounds)	105	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		37	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		25	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	100	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		37	-	-	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		25	-	-	-	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	95	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		37	-	-	-	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		25	-	-	-	13	38	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
	90	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		37	-	-	-	13	38	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
		25	-	-	-	19	46	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-
	85	57	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		37	-	-	-	19	46	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-
		25	-	-	-	26	54	-	-	-	-	26	-	-	-	-	-	-	-	-	-	11
	80	57	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		37	-	-	-	27	54	-	-	-	-	27	-	-	-	-	-	-	-	-	-	11
		25	-	-	15	34	61	-	-	-	11	35	-	-	-	-	-	-	-	-	-	17
	75	57	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		37	-	-	16	35	62	-	-	-	12	36	-	-	-	-	-	-	-	-	-	18
		25	-	-	22	43	69	-	-	-	17	44	-	-	-	-	-	-	-	-	-	24
	70	57	-	-	-	11	34	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-
		37	-	11	24	45	70	-	-	-	19	46	-	-	-	-	-	-	-	-	-	26
		25	-	16	31	53	75	-	-	-	25	53	-	-	-	-	-	-	-	-	-	34
65	57	-	-	-	18	45	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	
	37	-	18	34	55	77	-	-	-	28	56	-	-	-	-	-	-	-	-	12	36	
	25	16	25	41	62	81	-	-	16	36	63	-	-	-	-	-	-	-	-	18	44	
60	57	-	-	11	28	56	-	-	-	-	28	-	-	-	-	-	-	-	-	-	12	
	37	18	28	45	65	83	-	-	18	39	65	-	-	-	-	-	-	-	-	20	48	
	25	25	36	53	71	86	-	-	25	47	71	-	-	14	27	55	-	-	-	-	55	
55	57	-	-	19	40	66	-	-	-	15	41	-	-	-	-	-	-	-	-	-	22	
	37	29	40	57	74	87	-	-	29	51	74	-	13	17	32	59	-	13	17	32	59	
	25	37	48	63	78	+	-	12	37	58	79	-	19	23	40	66	-	19	23	40	66	
50	57	-	17	32	53	76	-	-	-	26	54	-	-	-	-	-	-	-	-	11	34	
	37	43	53	68	81	+	-	16	42	63	81	-	23	29	45	70	-	23	29	45	70	
	25	50	61	73	85	+	-	23	50	69	85	-	31	36	53	75	-	31	36	53	75	
45	57	20	30	46	66	83	-	-	20	41	67	-	-	-	22	49	-	-	-	22	49	
	37	57	66	78	87	+	-	29	56	74	87	12	38	43	59	79	12	38	43	59	79	
	25	64	72	82	+	+	14	37	64	79	+	18	46	51	66	83	18	46	51	66	83	
40	57	35	46	62	77	89	-	11	35	57	78	-	17	22	37	64	-	17	22	37	64	
	37	70	77	85	+	+	21	46	70	83	+	26	54	59	72	86	26	54	59	72	86	
	25	76	81	88	+	+	29	53	76	86	+	33	61	66	77	89	33	61	66	77	89	
35	57	54	63	75	86	+	-	26	54	72	86	-	34	40	56	77	-	34	40	56	77	
	37	81	86	+	+	+	39	63	81	89	+	44	70	74	83	+	44	70	74	83	+	
	25	85	89	+	+	+	47	69	85	+	+	52	75	78	86	+	52	75	78	86	+	
30	57	71	78	86	+	+	23	47	71	84	+	27	56	61	73	87	27	56	61	73	87	
	37	89	+	+	+	+	60	78	89	+	+	64	82	85	+	+	64	82	85	+	+	
	25	+	+	+	+	+	67	82	+	+	+	70	86	88	+	+	70	86	88	+	+	
25	57	85	89	+	+	+	48	70	85	+	+	53	75	79	86	+	53	75	79	86	+	
	37	+	+	+	+	+	78	89	+	+	+	81	+	+	+	+	81	+	+	+	+	
	25	+	+	+	+	+	82	+	+	+	+	84	+	+	+	+	84	+	+	+	+	
20	57	+	+	+	+	+	74	86	+	+	+	77	89	+	+	+	77	89	+	+	+	
	37	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	25	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

Table 11F

Female Population Percentages for Carrying Tasks

		Carrying Distance					7 Feet					14 Feet					28 Feet				
		Frequency: One Lower Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h
73	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	31	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	31	-	-	-	-	28	-	-	-	-	70	-	-	-	-	12	-	-	-	-	-
67	40	-	-	-	-	15	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
	31	-	-	-	-	36	-	-	-	-	21	-	-	-	-	18	-	-	-	-	-
64	40	-	-	-	-	22	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-
	31	-	-	-	-	45	-	-	-	-	29	-	-	-	-	25	-	-	-	-	-
61	40	-	-	-	-	30	-	-	-	-	27	-	-	-	-	13	-	-	-	-	-
	31	-	-	-	-	54	-	-	-	-	38	-	-	-	-	34	-	-	-	-	-
58	40	-	-	-	-	40	-	-	-	-	36	-	-	-	-	20	-	-	-	-	-
	31	-	-	-	11	63	-	-	-	-	47	-	-	-	-	43	-	-	-	-	-
55	40	-	-	-	-	50	-	-	-	-	46	-	-	-	-	29	-	-	-	-	-
	31	-	-	14	18	71	-	-	-	-	57	-	-	-	-	54	-	-	-	-	-
52	40	-	-	-	-	60	-	-	-	-	57	-	-	-	-	39	-	-	-	-	-
	31	-	14	22	27	79	-	-	11	14	67	-	-	-	12	63	-	-	-	-	-
49	40	-	-	13	17	70	-	-	11	14	67	-	-	-	-	51	-	-	-	-	-
	31	18	22	33	39	85	-	-	18	23	75	-	15	15	20	73	-	-	-	-	-
46	40	-	13	22	27	78	-	-	19	24	76	-	-	-	11	62	-	-	-	-	-
	31	28	34	45	51	89	-	-	29	34	82	12	25	25	30	80	-	-	-	-	-
43	40	17	23	34	40	85	-	-	31	36	83	-	15	15	20	73	-	-	-	-	-
	31	41	47	58	63	+	-	13	42	47	88	22	37	37	43	86	-	-	-	-	-
40	40	29	36	48	54	+	-	15	44	50	89	18	27	27	32	81	-	-	-	-	-
	31	55	60	70	74	+	-	23	55	61	+	35	51	51	57	+	-	-	-	-	-
37	40	44	51	62	67	+	11	27	59	64	+	31	41	41	47	88	-	-	-	-	-
	31	68	72	80	83	+	19	38	69	73	+	50	65	65	70	+	-	-	-	-	-
34	40	60	66	75	79	+	23	43	72	76	+	47	57	57	63	+	-	-	-	-	-
	31	79	82	87	89	+	34	54	80	83	+	65	77	77	81	+	-	-	-	-	-
31	40	74	79	85	87	+	40	60	83	86	+	64	72	72	76	+	-	-	-	-	-
	31	88	+	+	+	+	51	70	88	+	+	78	86	86	88	+	-	-	-	-	-
28	40	85	88	+	+	+	59	76	+	+	+	78	84	84	86	+	-	-	-	-	-
	31	+	+	+	+	+	69	82	+	+	+	87	+	+	+	+	-	-	-	-	-
25	40	+	+	+	+	+	77	87	+	+	+	88	+	+	+	+	-	-	-	-	-
	31	+	+	+	+	+	83	+	+	+	+	+	+	+	+	+	-	-	-	-	-

+ = Greater than 90%
 - = Less than 10%

Table 11M

Male Population Percentages for Carrying Tasks

		Carrying Distance					7 Feet					14 Feet					28 Feet				
		Frequency: One Lower Every					15s	30s	1m	5m	8h	15s	30s	1m	5m	8h	15s	30s	1m	5m	8h
Object Weight (pounds)	99	43	-	-	-	18	50	-	-	-	-	36	-	-	-	-	22				
		33	-	11	22	36	67	-	-	11	21	54	-	-	-	15	47				
	94	43	-	-	12	23	56	-	-	-	12	42	-	-	-	-	28				
		33	-	15	28	42	71	-	-	15	27	60	-	-	11	20	53				
	89	43	-	-	17	29	62	-	-	-	17	49	-	-	-	-	34				
		33	14	20	35	49	75	-	-	21	34	65	-	15	16	26	59				
	85	43	-	-	22	35	66	-	-	11	21	54	-	-	-	-	40				
		33	18	25	40	54	78	-	-	26	39	70	-	19	20	32	64				
	81	43	-	14	27	41	70	-	-	15	27	60	-	-	-	14	46				
		33	23	31	46	59	81	-	13	31	45	73	11	24	25	38	68				
	77	43	13	19	33	47	74	-	-	20	33	65	-	-	-	19	52				
		33	29	37	52	64	84	-	17	38	51	77	15	30	31	44	73				
	73	43	18	25	40	53	78	-	-	26	39	69	-	13	14	25	58				
		33	35	44	58	69	86	11	23	44	57	80	21	37	38	50	76				
	69	43	24	32	46	59	81	-	13	32	46	74	-	18	19	31	63				
		33	42	50	64	74	88	16	29	51	63	83	27	44	45	57	80				
	65	43	31	39	53	65	84	-	19	40	53	78	-	25	26	38	69				
		33	49	57	69	78	+	22	37	58	69	86	34	51	52	63	83				
	61	43	39	47	60	71	87	13	26	47	60	82	16	32	34	46	74				
		33	57	64	74	82	+	29	44	64	74	88	42	58	59	69	86				
57	43	47	55	67	76	89	19	34	55	67	85	23	41	42	54	79					
	33	64	70	79	85	+	37	52	70	78	+	50	65	66	74	88					
53	43	56	62	73	80	+	27	43	63	73	88	31	50	51	62	83					
	33	70	75	83	88	+	46	60	76	83	+	58	71	72	79	+					
49	43	64	70	78	84	+	37	52	70	78	+	41	58	59	69	86					
	33	76	80	86	+	+	55	68	81	86	+	66	77	78	83	+					
45	43	71	76	83	88	+	47	61	76	83	+	51	67	68	76	89					
	33	81	85	89	+	+	64	75	85	89	+	73	82	82	87	+					
41	43	78	82	87	+	+	58	70	82	87	+	61	74	75	82	+					
	33	86	88	+	+	+	72	81	88	+	+	80	86	87	+	+					
36	43	85	87	+	+	+	70	79	88	+	+	73	82	83	87	+					
	33	+	+	+	+	+	81	87	+	+	+	86	+	+	+	+					
31	43	+	+	+	+	+	81	87	+	+	+	82	89	89	+	+					
	33	+	+	+	+	+	88	+	+	+	+	+	+	+	+	+					

+ = Greater than 90%
 - = Less than 10%

Manual Handling Task Evaluation Worksheet

Risk Control from Liberty Mutual Insurance

Instructions:

Use this worksheet to record data when using the Liberty Mutual Tables or CompuTask2™ software.

<i>Customer</i>	<i>Location</i>	<i>Department</i>	<i>Date</i>
<i>Job Title</i>	<i>Task Description</i>	<i>Total Workers Exposed</i>	<i>Coupling (good, fair or poor)</i>
<i>File Name</i>	<i>Evaluated By</i>	<i>Office</i>	Period From: _____ To: _____
<i>Continuous Duration (hrs)</i>	<i>Minimum Rest Period (mins.)</i>	<i>Total Injuries Produced by Task</i>	

Measurements and Observations. Use the Material Handling scale kit if needed.

Component	Hand Height	Distance		Lift, Lower Hand Distance	Object Weight	Push, Pull Force		Task Frequency	Twisting Angle	Comments	
		<i>Lift, Lower (in.)</i>	<i>Push, Pull, Carry (ft.)</i>			<i>Initial (lbs)</i>	<i>Sustained (lbs)</i>				<i>One Every (s, m, h)</i>

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No attempt has been made to interpret any referenced codes, standards, or regulations. Please refer to the appropriate government authority for interpretation or clarification.

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