



Tables for Evaluating Lifting, Lowering, Pushing, Pulling, and Carrying Tasks

# Manual Materials Handling Guidelines



Liberty  
Mutual®

## **Liberty Mutual lifting, lowering, pushing, pulling and carrying guidelines**

### **Introduction**

Since the late 1970's, Liberty Mutual Group Loss Prevention field organization has been analyzing and evaluating lifting, lowering, pushing, pulling and carrying tasks using "Psychophysical Tables" (hereafter called "Tables"). These Tables are based on research by Drs. Stover Snook, and Vincent Ciriello at the Liberty Mutual Research Institute for Safety. Their research used psychophysical methodology and provided important information about capability and limitations of workers and design of manual handling tasks to reduce low back disability.

Psychophysical methodology includes measurements of oxygen consumption, heart rate, and anthropometric characteristics. Subjects were given control of either the weight or force variable. All other task variables such as frequency, size, height, distance, etc., were controlled by the experimenter. The subject then 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).

The Tables used by Loss Prevention were much different from those in the published literature. Some have referred to those in the published literature as "Snook Tables" (Snook, 1978) and later "Snook and Ciriello Tables" (Snook and Ciriello, 1991). Tables used by Loss Prevention provide the male and female population percentages able to perform these tasks while the published articles provided Maximum Acceptable Weights and Forces for 10, 25, 50, 75, 90 percent of the male and female population. Tables used by Loss Prevention are called "Liberty Mutual Tables" and were later developed into an ergonomic software analysis program called CompuTask™.

These Tables were developed with the goal of controlling costs associated with manual handling operations. These costs can be attributed to high low back disability costs, reduced productivity and quality due to poor job design. These Tables provide the user with an objective risk assessment of a problem manual handling job and the foundation on which to build a solution by:

- 1) helping recognize risk factors associated with manual handling activity and,
- 2) 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.

*The illustrations, instructions, and principles contained in the material are based on published research and, to the best of our knowledge, current at the time of publication. No attempt has been made to interpret any referenced codes, standards, or regulations. Please refer to the appropriate code, standard, or regulation-making authority for interpretation or clarification.*

### Using the Tables: Population Percentage Criteria

As a general rule of thumb, designing manual tasks for greater than 75% 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% of the female work population (Snook et al., 1978). Tasks having population percentages of less than 10% should be prioritized for task redesign.

However, for certain jobs and industries, it is very difficult to design jobs that can be performed by 75% of the female work population. These tables are very often 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. Here's an example; suppose you want to find the female population percentage for lifting tote pans. Your measurements show:

- Tote pan weight of 29 lb.(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), and pans are lifted once every 5 min. (Task Frequency)

First you must 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 C.2-3.

Using the object weight of 29 lb. to select the row and hand distance of 7 in. to select the column, locate the large cell, for example:

Lifting Distance	Frequency				
	15s	30s	1m	5m	8h
30	12	18	33	45	75
20	34	39	49	60	83
10	34	45	62	71	89

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

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 lb., it would fall between the 29 lb. cell as shown above and the 32 lb. cell. Interpolation gives a population percentage of 55.

One dimension that is occasionally confusing is Hand Distance. Hand Distance is the distance from the front of the body to the hands. (Note that this is a different measurement from the one used for the NIOSH model). Hand Distance will normally be half the width of the object being handled unless the object is purposely held away from the body.

## Liberty Mutual Manual Materials Handling Guidelines

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, 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. All measurements should be taken at an acceleration representative of the task as performed in the actual operating environment.

Frequency can also be confusing when more than one task component is present, for example, lifting an object, carrying it a distance and putting it back down. Frequency is defined as the average time between handling individual objects. 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.

### A word of caution on using the tables:

Tasks should not be evaluated based solely on population percentages. Other important considerations are:

- **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.
- **Hand-holds** - 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 tasks involving catching or throwing items are physically stressful and, therefore, are good candidates 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 and that's why 75% of the female work population is selected as a design starting point. Do not use population percentages in these tables to determine whether male or female workers can perform certain jobs and then place workers accordingly. Use these tables only for designing manual handling jobs with physical requirements such that as many workers as possible can perform them without risk of injury.

As mentioned, to effectively use these Tables requires training in ergonomics and task evaluation methods. Users of these Tables should be trained in how to collect the hand distance, lifting distance and task frequency measurement. Liberty Mutual Group workers compensation insured customers can call their Loss Prevention Consultant for details.

## Table of Contents

TABLE 1 F - Female Population Percentages for Lifting Tasks Ending Below Knuckle Height (<28").....	1
TABLE 1 M - Male Population Percentages for Lifting Tasks Ending Below Knuckle Height (<31").....	2
TABLE 2F - Female Population Percentages for Lifting Tasks Ending Between Knuckle and Shoulder Height ( $\geq 28$ " and $\leq 53$ ") .....	3
TABLE 2M - Male Population Percentages for Lifting Tasks Ending Between Knuckle and Shoulder Height ( $\geq 31$ " and $\leq 57$ ").....	4
TABLE 3F - Female Population Percentages for Lifting Tasks Ending Above Shoulder Height (>53") .....	5
TABLE 3M - Male Population Percentages for Lifting Tasks Ending Above Shoulder Height (>57") .....	6
TABLE 4F - Female Population Percentages for Lowering Tasks Beginning Below Knuckle Height (<28") .....	7
TABLE 4M - Male Population Percentages for Lowering Tasks Beginning Below Knuckle Height (<31") .....	8
TABLE 5F - Female Population Percentages for Lowering Tasks Beginning Between Knuckle and Shoulder Heights ( $\geq 28$ " and $\leq 53$ ") .....	9
TABLE 5M - Male Population Percentages for Lowering Tasks Beginning Between Knuckle and Shoulder Height ( $\geq 31$ " and $\leq 57$ ") .....	10
TABLE 6F - Female Population Percentages for Lowering Tasks Beginning Above Shoulder Height (>53") .....	11
TABLE 6M - Male Population Percentages for Lowering Tasks Beginning Above Shoulder Height (>57") .....	12
TABLE 7 - Population Percentages for Pushing Tasks Initial Forces .....	13
TABLE 8F - Female Population Percentages for Pushing Tasks Sustained Force .....	15
TABLE 8M - Male Population Percentages for Pushing Tasks Sustained Force .....	16
TABLE 9 - Population Percentages for Pulling Tasks Initial Forces .....	17
TABLE 10F - Female Population Percentages for Pulling Tasks Sustained Force .....	19
TABLE 10M - Male Population Percentages for Pulling Tasks Sustained Force .....	20
TABLE 11F - Female Population Percentages for Carrying Tasks .....	21
TABLE 11M - Male Population Percentages for Carrying Tasks .....	22
References .....	23
Worksheet .....	24

**TABLE 1 F - FEMALE POPULATION PERCENTAGES FOR LIFTING TASKS  
ENDING BELOW KNUCKLE HEIGHT (<28")**

HAND DISTANCE			7 INCHES					10 INCHES					15 INCHES				
FREQUENCY ONE LIFT EVERY			15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h
<b>OBJECT WEIGHT (POUNDS)</b>	65	<b>LIFTING DISTANCE (INCHES)</b>	28	-	-	-	-	13	-	-	-	-	-	-	-	-	-
			20	-	-	-	-	29	-	-	-	-	14	-	-	-	-
			10	-	-	-	-	34	-	-	-	-	20	-	-	-	-
	62	28	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	35	-	-	-	-	19	-	-	-	-	-
		10	-	-	-	-	40	-	-	-	-	26	-	-	-	-	-
	59	28	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-
		20	-	-	-	-	41	-	-	-	-	25	-	-	-	-	-
		10	-	-	-	-	46	-	-	-	-	32	-	-	-	-	-
	56	28	-	-	-	-	29	-	-	-	-	14	-	-	-	-	-
		20	-	-	-	-	48	-	-	-	-	31	-	-	-	-	-
		10	-	-	-	-	53	-	-	-	-	38	-	-	-	-	13
	53	28	-	-	-	-	35	-	-	-	-	20	-	-	-	-	-
		20	-	-	-	-	54	-	-	-	-	38	-	-	-	-	-
		10	-	-	-	12	59	-	-	-	-	45	-	-	-	-	18
	50	28	-	-	-	-	43	-	-	-	-	26	-	-	-	-	-
		20	-	-	-	13	61	-	-	-	-	45	-	-	-	-	14
		10	-	-	-	17	65	-	-	-	-	53	-	-	-	-	25
	47	28	-	-	-	-	51	-	-	-	-	34	-	-	-	-	-
		20	-	-	-	19	67	-	-	-	-	53	-	-	-	-	20
		10	-	-	14	24	71	-	-	-	11	60	-	-	-	-	32
	44	28	-	-	-	11	58	-	-	-	-	42	-	-	-	-	12
		20	-	-	16	27	73	-	-	-	13	60	-	-	-	-	28
		10	14	16	20	32	76	-	-	-	17	67	-	-	-	-	41
41	28	-	-	-	18	66	-	-	-	-	51	-	-	-	-	18	
	20	-	14	24	36	78	-	-	11	20	68	-	-	-	-	36	
	10	21	23	29	41	81	-	-	14	24	73	-	-	-	-	50	
38	28	-	12	16	26	73	-	-	-	13	60	-	-	-	-	27	
	20	16	22	33	46	83	-	-	18	29	74	-	-	-	-	46	
	10	30	33	38	50	85	14	16	22	34	78	-	-	-	-	58	
35	28	17	19	25	37	79	-	-	11	21	68	-	-	-	-	37	
	20	25	32	44	56	87	11	16	27	39	80	-	-	-	-	56	
	10	40	43	49	60	88	22	25	32	44	83	-	-	-	13	67	
32	28	27	30	36	48	84	12	14	20	31	76	-	-	-	-	49	
	20	36	43	55	65	+	19	25	38	50	85	-	-	-	18	66	
	10	51	54	59	69	+	33	37	43	55	87	-	-	12	22	75	
29	28	39	43	49	60	88	21	25	32	44	82	-	-	-	13	60	
	20	49	55	65	74	+	30	38	51	62	89	-	-	18	29	74	
	10	63	65	69	77	+	46	49	55	66	+	11	14	22	34	81	
26	28	53	56	61	70	+	35	38	46	57	87	-	-	14	24	71	
	20	61	67	75	81	+	44	51	63	72	+	-	16	31	43	82	
	10	73	75	78	83	+	59	62	67	75	+	21	26	36	48	87	
23	28	66	69	73	80	+	50	54	60	70	+	14	18	27	39	80	
	20	73	77	83	87	+	59	65	74	81	+	22	30	46	58	87	
	10	81	83	85	89	+	71	73	77	83	+	36	42	51	62	+	
20	28	78	79	82	87	+	66	69	73	80	+	29	35	45	57	87	
	20	82	85	89	+	+	72	77	83	88	+	39	48	63	72	+	
	10	88	89	+	+	+	81	82	85	89	+	54	59	66	75	+	
17	28	87	88	89	+	+	79	81	84	88	+	50	55	64	73	+	
	20	89	+	+	+	+	83	86	+	+	+	59	66	77	83	+	
	10	+	+	+	+	+	88	89	+	+	+	71	74	79	85	+	
14	28	+	+	+	+	+	88	89	+	+	+	71	74	80	85	+	
	20	+	+	+	+	+	+	+	+	+	+	77	81	87	+	+	
	10	+	+	+	+	+	+	+	+	+	+	84	86	89	+	+	

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

**TABLE 1 M - MALE POPULATION PERCENTAGES FOR LIFTING TASKS  
ENDING BELOW KNUCKLE HEIGHT (<31")**

HAND DISTANCE			7 INCHES					10 INCHES					15 INCHES					
FREQUENCY ONE LIFT EVERY			15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	
<b>OBJECT WEIGHT (POUNDS)</b>	96	<b>LIFTING DISTANCE (INCHES)</b>	30	-	-	-	30	49	-	-	-	16	35	-	-	-	-	
			20	-	-	13	34	54	-	-	-	20	39	-	-	-	-	12
			10	-	11	25	48	65	-	-	13	33	53	-	-	-	-	-
	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 (≥28" AND ≤ 53")**

HAND DISTANCE		7 INCHES					10 INCHES					15 INCHES				
FREQUENCY ONE LIFT EVERY		15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h
<b>OBJECT WEIGHT (POUNDS)</b>	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 2M - MALE POPULATION PERCENTAGES FOR LIFTING TASKS  
ENDING BETWEEN KNUCKLE AND SHOULDER HEIGHT (≥31" AND ≤57")**

HAND DISTANCE		7 INCHES					10 INCHES					15 INCHES				
FREQUENCY ONE LIFT EVERY		15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h
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	-	-	-	13	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
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
	30	18	25	38	45											

**TABLE 3F - FEMALE POPULATION PERCENTAGES FOR LIFTING TASKS  
ENDING ABOVE SHOULDER HEIGHT (>53")**

HAND DISTANCE			7 INCHES					10 INCHES					15 INCHES					
FREQUENCY ONE LIFT EVERY			15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	
<b>OBJECT WEIGHT (POUNDS)</b>	40	30	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	
			20	-	-	-	-	26	-	-	-	-	12	-	-	-	-	-
			10	-	-	-	-	40	-	-	-	-	22	-	-	-	-	-
	38	30	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	
			20	-	-	-	-	33	-	-	-	-	17	-	-	-	-	-
			10	-	-	-	15	48	-	-	-	-	30	-	-	-	-	-
	36	30	-	-	-	-	26	-	-	-	-	12	-	-	-	-	-	
			20	-	-	-	11	41	-	-	-	-	24	-	-	-	-	-
			10	-	-	12	21	55	-	-	-	-	38	-	-	-	-	-
	34	30	-	-	-	-	34	-	-	-	-	18	-	-	-	-	-	
			20	-	-	-	18	50	-	-	-	-	32	-	-	-	-	-
			10	-	-	18	29	63	-	-	-	14	46	-	-	-	-	13
	32	30	-	-	-	12	43	-	-	-	-	26	-	-	-	-	-	
			20	-	-	15	24	59	-	-	-	-	41	-	-	-	-	-
			10	-	11	26	38	70	-	-	12	21	55	-	-	-	-	20
	30	30	-	-	11	19	53	-	-	-	-	35	-	-	-	-	-	
			20	11	14	22	33	67	-	-	-	17	51	-	-	-	-	17
			10	11	18	36	47	77	-	-	19	29	64	-	-	-	-	29
	28	30	-	-	18	28	62	-	-	-	13	45	-	-	-	-	13	
			20	18	22	32	44	74	-	-	16	26	60	-	-	-	-	25
			10	18	27	46	57	82	-	13	28	40	72	-	-	-	-	39
	26	30	-	14	27	39	71	-	-	13	21	56	-	-	-	-	21	
			20	28	33	43	54	81	13	17	25	37	69	-	-	-	-	36
			10	28	38	57	67	87	13	21	39	51	79	-	-	-	17	50
	24	30	16	23	39	51	79	-	-	22	33	66	-	-	-	-	32	
			20	40	45	55	65	86	23	27	37	49	77	-	-	-	15	48
			10	40	50	67	75	+	23	33	51	62	84	-	-	17	27	61
	22	30	27	36	52	63	85	13	19	34	46	76	-	-	-	13	45	
			20	53	58	66	74	+	35	40	50	61	84	-	-	16	26	60
			10	53	62	76	82	+	35	46	63	72	89	-	13	28	40	72
	20	30	41	50	65	73	+	24	32	49	59	83	-	-	15	24	59	
			20	65	69	76	82	+	49	54	63	72	89	16	20	28	40	72
			10	66	73	84	88	+	50	59	74	81	+	16	25	43	54	80
	18	30	57	64	76	82	+	39	48	63	72	89	-	15	28	40	72	
			20	76	79	84	88	+	64	68	75	81	+	30	35	44	55	81
			10	77	82	89	+	+	64	72	83	87	+	30	40	58	68	87
	16	30	71	77	85	89	+	57	64	76	82	+	22	30	46	57	82	
			20	85	87	+	+	+	76	79	84	88	+	48	52	61	70	88
			10	85	89	+	+	+	77	82	89	+	+	48	57	72	79	+
	14	30	83	86	+	+	+	73	78	86	+	+	42	50	64	73	+	
			20	+	+	+	+	+	86	88	+	+	+	66	70	76	82	+
			10	+	+	+	+	+	86	+	+	+	+	66	73	83	88	+
	12	30	+	+	+	+	+	85	88	+	+	+	64	70	80	85	+	
			20	+	+	+	+	+	+	+	+	+	+	81	83	87	+	+
			10	+	+	+	+	+	+	+	+	+	+	81	85	+	+	+
	10	30	+	+	+	+	+	+	+	+	+	+	82	85	+	+	+	
			20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
			10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
8	30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
		20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
		10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
6	30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
		20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
		10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

+ = 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	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h		
<b>OBJECT WEIGHT (POUNDS)</b>	77	<b>LIFTING DISTANCE (INCHES)</b>	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 LOWER EVERY			15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	
OBJECT WEIGHT (POUNDS)	51	LOWERING DISTANCE (INCHES)	30	-	-	-	47	-	-	-	-	26	-	-	-	-	-	
			20	-	-	-	17	69	-	-	-	-	50	-	-	-	12	
			10	-	-	-	22	73	-	-	-	-	56	-	-	-	-	16
	48	LOWERING DISTANCE (INCHES)	30	-	-	-	56	-	-	-	-	36	-	-	-	-	-	-
			20	-	-	-	25	75	-	-	-	-	59	-	-	-	-	18
			10	-	-	11	31	79	-	-	-	14	64	-	-	-	-	24
	45	LOWERING DISTANCE (INCHES)	30	-	-	-	14	65	-	-	-	-	46	-	-	-	-	-
			20	-	-	14	35	81	-	-	-	16	68	-	-	-	-	27
			10	-	12	18	41	84	-	-	-	21	72	-	-	-	-	33
	43	LOWERING DISTANCE (INCHES)	30	-	-	-	20	71	-	-	-	-	53	-	-	-	-	14
			20	-	-	19	42	84	-	-	-	22	73	-	-	-	-	34
			10	14	17	24	49	87	-	-	-	28	77	-	-	-	-	41
41	LOWERING DISTANCE (INCHES)	30	-	-	-	26	76	-	-	-	-	60	-	-	-	-	19	
		20	-	12	25	50	87	-	-	-	29	78	-	-	-	-	42	
		10	20	24	31	56	89	-	-	14	35	81	-	-	-	-	48	
39	LOWERING DISTANCE (INCHES)	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	LOWERING DISTANCE (INCHES)	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	-	-	-	13	63	
35	LOWERING DISTANCE (INCHES)	30	15	19	26	51	88	-	-	-	30	78	-	-	-	-	43	
		20	25	34	50	72	+	-	14	29	54	89	-	-	-	14	66	
		10	44	48	56	76	+	22	26	35	60	+	-	-	-	19	70	
33	LOWERING DISTANCE (INCHES)	30	23	27	36	60	+	-	-	17	40	83	-	-	-	-	52	
		20	34	43	59	78	+	14	22	39	63	+	-	-	-	22	73	
		10	53	57	64	81	+	30	35	45	68	+	-	-	-	27	77	
31	LOWERING DISTANCE (INCHES)	30	32	37	46	68	+	13	16	25	50	87	-	-	-	11	62	
		20	44	53	67	83	+	22	31	49	70	+	-	-	11	31	79	
		10	62	66	72	86	+	40	45	55	75	+	-	-	15	37	82	
29	LOWERING DISTANCE (INCHES)	30	43	47	56	76	+	21	25	35	60	+	-	-	-	19	70	
		20	55	63	75	87	+	32	41	59	77	+	-	-	18	41	84	
		10	71	74	79	89	+	51	55	64	81	+	-	13	23	48	87	
27	LOWERING DISTANCE (INCHES)	30	54	58	66	82	+	31	36	47	69	+	-	-	-	29	78	
		20	65	72	81	+	43	53	68	83	+	-	11	28	53	88		
		10	78	80	84	+	61	65	73	86	+	16	22	34	59	+		
25	LOWERING DISTANCE (INCHES)	30	65	69	75	87	+	43	49	58	77	+	-	-	18	41	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	LOWERING DISTANCE (INCHES)	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	LOWERING DISTANCE (INCHES)	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	LOWERING DISTANCE (INCHES)	30	+	+	+	+	83	86	89	+	+	47	54	66	82	+		
		20	+	+	+	+	88	+	+	+	+	59	68	82	+	+		
		10	+	+	+	+	+	+	+	+	+	74	78	85	+	+		
15	LOWERING DISTANCE (INCHES)	30	+	+	+	+	+	+	+	+	+	72	77	84	+	+		
		20	+	+	+	+	+	+	+	+	+	80	85	+	+	+		
		10	+	+	+	+	+	+	+	+	+	88	+	+	+	+		
12	LOWERING DISTANCE (INCHES)	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			7 INCHES					10 INCHES					15 INCHES					
FREQUENCY ONE LOWER EVERY			15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	
<b>OBJECT WEIGHT (POUNDS)</b>	87	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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	<b>LOWERING DISTANCE (INCHES)</b>	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 (≥28" AND ≤53")**

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

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

**TABLE 5M - MALE POPULATION PERCENTAGES FOR LOWERING TASKS  
BEGINNING BETWEEN KNUCKLE AND SHOULDER HEIGHT (≥31" AND ≤57")**

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

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

**TABLE 6F - FEMALE POPULATION PERCENTAGES FOR LOWERING TASKS  
BEGINNING ABOVE SHOULDER HEIGHT (>53")**

HAND DISTANCE FROM BODY			7 INCHES					10 INCHES					15 INCHES					
FREQUENCY ONE LOWER EVERY			15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	
<b>OBJECT WEIGHT (POUNDS)</b>	51	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			20	-	-	-	-	18	-	-	-	-	-	-	-	-	-	
			10	-	-	-	-	33	-	-	-	-	14	-	-	-	-	-
	48	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
			20	-	-	-	-	27	-	-	-	-	11	-	-	-	-	-
			10	-	-	-	-	43	-	-	-	-	21	-	-	-	-	-
	45	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-
			20	-	-	-	-	38	-	-	-	-	19	-	-	-	-	-
			10	-	-	-	17	53	-	-	-	-	31	-	-	-	-	-
	43	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	-	28	-	-	-	-	12	-	-	-	-	-
			20	-	-	-	12	45	-	-	-	-	26	-	-	-	-	-
			10	-	-	-	23	61	-	-	-	-	39	-	-	-	-	-
	41	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	-	36	-	-	-	-	17	-	-	-	-	-
			20	-	-	-	17	53	-	-	-	-	33	-	-	-	-	-
			10	-	-	-	31	67	-	-	-	12	47	-	-	-	-	-
	39	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	11	44	-	-	-	-	24	-	-	-	-	-
			20	-	-	-	24	61	-	-	-	-	42	-	-	-	-	-
			10	-	-	-	39	73	-	-	-	18	55	-	-	-	-	13
	37	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	17	53	-	-	-	-	33	-	-	-	-	-
			20	-	-	-	32	68	-	-	-	15	50	-	-	-	-	14
			10	-	-	15	48	79	-	-	-	26	63	-	-	-	-	19
	35	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	24	61	-	-	-	-	42	-	-	-	-	-
			20	-	-	11	41	75	-	-	-	22	59	-	-	-	-	21
			10	-	-	22	57	84	-	-	-	35	70	-	-	-	-	27
33	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	34	69	-	-	-	16	52	-	-	-	-	15	
		20	-	12	17	51	81	-	-	-	31	67	-	-	-	-	29	
		10	-	16	31	66	88	-	-	13	45	77	-	-	-	-	37	
31	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	12	44	77	-	-	-	24	62	-	-	-	-	23	
		20	16	19	26	61	86	-	-	11	42	75	-	-	-	-	40	
		10	17	24	42	73	+	-	-	20	55	83	-	-	-	13	47	
29	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	20	55	83	-	-	-	35	71	-	-	-	-	33	
		20	25	29	37	70	89	11	13	18	53	81	-	-	-	15	51	
		10	26	35	53	80	+	11	16	30	65	87	-	-	-	21	58	
27	<b>LOWERING DISTANCE (INCHES)</b>	30	12	18	31	66	88	-	-	14	47	78	-	-	-	11	45	
		20	37	41	49	78	+	19	22	29	64	87	-	-	-	25	62	
		10	37	47	64	86	+	19	27	42	74	+	-	-	-	32	68	
25	<b>LOWERING DISTANCE (INCHES)</b>	30	22	29	44	75	+	-	13	24	59	85	-	-	-	21	58	
		20	50	54	61	85	+	30	34	42	73	+	-	-	-	37	72	
		10	50	59	73	+	+	31	39	55	81	+	-	-	13	45	77	
23	<b>LOWERING DISTANCE (INCHES)</b>	30	35	43	58	83	+	17	24	38	71	+	-	-	-	34	69	
		20	63	66	72	+	+	44	48	55	82	+	-	12	17	51	81	
		10	63	71	82	+	+	44	53	67	87	+	11	14	24	59	84	
21	<b>LOWERING DISTANCE (INCHES)</b>	30	50	58	70	89	+	31	38	53	80	+	-	-	15	49	79	
		20	74	77	81	+	+	59	62	68	88	+	21	24	31	65	87	
		10	75	80	88	+	+	59	66	78	+	+	21	27	38	71	+	
18	<b>LOWERING DISTANCE (INCHES)</b>	30	72	78	85	+	+	56	63	74	+	+	19	25	39	71	+	
		20	87	89	+	+	+	78	80	84	+	+	46	50	56	82	+	
		10	87	+	+	+	+	78	83	89	+	+	46	52	63	85	+	
15	<b>LOWERING DISTANCE (INCHES)</b>	30	88	+	+	+	+	79	83	89	+	+	48	55	67	87	+	
		20	+	+	+	+	+	+	+	+	+	+	73	75	79	+	+	
		10	+	+	+	+	+	+	+	+	+	+	73	77	83	+	+	
12	<b>LOWERING DISTANCE (INCHES)</b>	30	+	+	+	+	+	+	+	+	+	+	78	82	88	+	+	
		20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
		10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

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



**TABLE 6M - MALE POPULATION PERCENTAGES FOR LOWERING TASKS  
BEGINNING ABOVE SHOULDER HEIGHT (>57")**

HAND DISTANCE			7 INCHES					10 INCHES					15 INCHES					
FREQUENCY ONE LOWER EVERY			15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	
<b>OBJECT WEIGHT (POUNDS)</b>	73	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	16	42	-	-	-	-	27	-	-	-	-	-
			20	-	-	14	28	56	-	-	-	15	41	-	-	-	-	14
			10	20	23	31	49	72	-	12	18	34	60	-	-	-	-	32
	70	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	-	20	47	-	-	-	-	32	-	-	-	-	-
			20	-	11	17	33	60	-	-	-	19	46	-	-	-	-	18
			10	24	28	37	54	75	12	15	22	39	65	-	-	-	12	37
	67	<b>LOWERING DISTANCE (INCHES)</b>	30	-	-	11	25	52	-	-	-	13	37	-	-	-	-	11
			20	12	15	22	39	65	-	-	11	24	52	-	-	-	-	22
			10	29	34	42	58	78	16	20	27	44	69	-	-	-	16	42
	64	<b>LOWERING DISTANCE (INCHES)</b>	30	11	12	15	30	57	-	-	-	17	43	-	-	-	-	15
			20	16	20	27	45	69	-	-	15	30	57	-	-	-	-	28
			10	35	39	48	63	81	21	25	33	50	72	-	-	-	21	48
	61	<b>LOWERING DISTANCE (INCHES)</b>	30	15	16	20	36	62	-	-	-	22	49	-	-	-	-	20
			20	21	25	33	50	73	-	13	19	36	62	-	-	-	-	34
			10	41	45	53	68	83	26	31	39	56	76	-	-	12	26	54
	58	<b>LOWERING DISTANCE (INCHES)</b>	30	20	22	25	42	67	-	-	13	27	55	-	-	-	-	26
			20	27	31	39	56	76	14	18	25	42	67	-	-	-	14	40
			10	47	51	59	72	86	33	37	45	61	79	-	11	17	32	59
	55	<b>LOWERING DISTANCE (INCHES)</b>	30	26	28	32	49	72	13	15	18	34	61	-	-	-	-	32
			20	33	38	46	62	80	20	23	31	48	71	-	-	-	19	46
			10	53	57	64	76	88	39	43	51	66	82	13	16	22	39	65
	52	<b>LOWERING DISTANCE (INCHES)</b>	30	32	34	38	55	76	19	20	24	41	66	-	-	-	14	39
			20	40	45	53	67	83	26	30	38	55	76	-	-	12	26	53
			10	60	63	69	80	89	46	50	58	71	85	18	22	29	46	70
49	<b>LOWERING DISTANCE (INCHES)</b>	30	40	42	46	62	80	25	27	31	48	71	-	-	-	19	46	
		20	48	52	59	72	86	33	37	45	61	80	-	12	17	33	60	
		10	66	69	74	83	+	53	57	64	76	87	25	29	36	53	75	
46	<b>LOWERING DISTANCE (INCHES)</b>	30	48	50	53	68	83	33	35	39	56	76	-	-	12	26	54	
		20	55	59	66	77	88	41	45	53	67	83	14	17	24	41	66	
		10	71	74	79	86	+	60	64	70	80	+	32	36	44	60	79	
43	<b>LOWERING DISTANCE (INCHES)</b>	30	55	57	61	73	86	41	43	47	63	80	15	16	18	35	61	
		20	62	66	72	81	+	49	53	60	73	86	21	24	32	49	72	
		10	76	79	82	88	+	67	70	75	83	+	41	45	52	67	83	
40	<b>LOWERING DISTANCE (INCHES)</b>	30	63	65	68	78	89	50	52	56	69	84	22	23	26	44	68	
		20	69	72	77	85	+	57	61	67	78	89	29	33	41	57	77	
		10	81	83	86	+	+	73	75	80	87	+	49	53	60	73	86	
37	<b>LOWERING DISTANCE (INCHES)</b>	30	70	72	74	83	+	59	61	64	76	87	31	33	36	53	74	
		20	75	78	82	88	+	65	68	74	83	+	39	43	50	65	82	
		10	85	86	89	+	+	78	80	84	89	+	58	62	68	78	89	
34	<b>LOWERING DISTANCE (INCHES)</b>	30	77	78	80	87	+	67	69	71	81	+	41	43	46	62	80	
		20	81	83	86	+	+	73	75	80	86	+	49	53	60	73	86	
		10	88	89	+	+	+	83	85	87	+	+	67	70	75	83	+	
31	<b>LOWERING DISTANCE (INCHES)</b>	30	82	83	85	+	+	75	76	78	85	+	53	54	57	71	85	
		20	85	87	89	+	+	79	81	84	+	+	60	63	69	79	89	
		10	+	+	+	+	+	87	88	+	+	+	74	77	81	87	+	
28	<b>LOWERING DISTANCE (INCHES)</b>	30	87	87	89	+	+	81	82	84	89	+	64	65	67	78	89	
		20	89	+	+	+	+	85	86	88	+	+	69	72	77	84	+	
		10	+	+	+	+	+	+	+	+	+	+	81	83	86	+	+	
25	<b>LOWERING DISTANCE (INCHES)</b>	30	+	+	+	+	+	87	87	88	+	+	73	74	76	84	+	
		20	+	+	+	+	+	89	+	+	+	+	78	80	83	89	+	
		10	+	+	+	+	+	+	+	+	+	+	86	88	+	+	+	
22	<b>LOWERING DISTANCE (INCHES)</b>	30	+	+	+	+	+	+	+	+	+	+	82	82	84	89	+	
		20	+	+	+	+	+	+	+	+	+	+	85	86	88	+	+	
		10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

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

**TABLE 7 - POPULATION PERCENTAGES FOR PUSHING TASKS  
INITIAL FORCES**

			MALE					FEMALE								
			FREQUENCY ONE PUSH EVERY			30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	
<b>INITIAL PUSHING FORCE (POUNDS)</b>	<b>HAND HEIGHT (INCHES) - MALES</b>	130	57	-	-	-	-	25	<b>HAND HEIGHT (INCHES) - FEMALES</b>	53	57	-	-	-	-	-
			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	17				
	37	49	59	66	67	82	35	-	-	-	11	17				
	25	34	47	54	56	75	22	-	-	-	-	-				
82	57	43	54	62	63	79	53	-	-	-	14	22				
	37	53	64	70	71	84	35	-	-	-	15	22				
	25	39	51	59	60	78	22	-	-	-	-	-				
79	57	48	59	66	67	82	53	-	-	14	19	27				
	37	58	68	73	74	86	35	-	-	14	20	28				
	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			30s	1m	5m	30m	8h	30s	1m	5m	30m	8h		
<b>INITIAL PUSHING FORCE (POUNDS)</b>	76		57	53	64	70	71	84	<b>HAND HEIGHT (INCHES) - MALES</b>			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 8F - FEMALE POPULATION PERCENTAGES FOR PUSHING TASKS  
SUSTAINED FORCE**

PUSHING DISTANCE		7 FEET					25 FEET					50 FEET				
FREQUENCY ONE PUSH EVERY		30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	30s	1m	5m	30m	8h
<b>SUSTAINED PUSHING FORCE (POUNDS)</b>	80	53	-	-	-	23	-	-	-	-	-	-	-	-	-	-
		35	-	-	-	16	-	-	-	-	-	-	-	-	-	-
		22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	76	53	-	-	-	-	28	-	-	-	-	-	-	-	-	-
		35	-	-	-	-	21	-	-	-	-	-	-	-	-	-
		22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	72	53	-	-	-	14	34	-	-	-	-	-	-	-	-	-
		35	-	-	-	-	26	-	-	-	12	-	-	-	-	-
		22	-	-	-	-	13	-	-	-	-	-	-	-	-	-
	68	53	-	-	13	19	40	-	-	-	-	12	-	-	-	-
		35	-	-	-	12	32	-	-	-	-	16	-	-	-	-
		22	-	-	-	-	18	-	-	-	-	11	-	-	-	-
	64	53	-	-	18	25	47	-	-	-	-	17	-	-	-	-
		35	-	-	12	17	39	-	-	-	-	22	-	-	-	-
		25	-	-	-	-	24	-	-	-	-	15	-	-	-	-
	60	53	-	13	24	31	54	-	-	-	-	23	-	-	-	-
		35	-	-	17	23	46	-	-	-	-	29	-	-	-	12
		22	-	-	-	11	30	-	-	-	-	21	-	-	-	-
	56	53	-	19	31	39	60	-	-	-	11	30	-	-	-	14
		35	-	13	23	30	53	-	-	-	15	36	-	-	-	18
		22	-	-	11	17	38	-	-	-	-	28	-	-	-	12
	52	53	16	26	40	47	66	-	-	12	17	39	-	-	-	20
		35	-	19	31	39	60	-	-	16	22	44	-	-	-	25
		22	-	-	17	24	46	-	-	-	15	36	-	-	-	18
48	53	23	35	48	55	72	-	-	18	25	47	-	-	-	28	
	35	16	27	40	47	67	-	12	23	30	53	-	-	-	34	
	22	-	14	25	32	54	-	-	16	23	45	-	-	-	26	
44	53	32	44	57	63	77	13	15	27	34	56	-	-	11	17	38
	35	24	36	49	56	73	12	20	32	40	61	-	-	15	21	43
	22	12	21	34	42	62	-	13	25	32	54	-	-	-	15	35
40	53	43	54	65	70	82	21	24	37	44	65	-	-	19	26	48
	35	34	46	59	65	78	20	29	43	50	69	-	13	24	31	53
	22	20	31	45	52	70	18	22	35	42	63	-	-	17	23	46
36	53	54	64	73	77	86	32	35	48	55	72	-	17	30	37	58
	35	46	57	67	72	83	31	41	54	60	75	-	22	35	43	63
	22	30	43	55	62	77	28	33	46	53	71	-	16	27	35	57
32	53	64	73	80	83	89	45	48	60	66	79	16	29	42	50	68
	35	57	67	75	79	87	44	53	64	70	82	14	35	48	55	72
	22	43	55	66	71	82	41	46	58	64	78	13	27	40	47	67
28	53	74	80	85	87	+	58	61	71	75	85	29	44	56	62	77
	35	69	76	82	85	+	57	65	74	78	86	26	49	61	67	80
	22	57	67	75	79	87	55	59	69	74	84	25	41	54	60	76
24	53	82	86	89	+	+	71	73	80	83	89	46	59	69	74	84
	35	78	83	87	89	+	70	76	82	85	+	43	64	73	77	86
	22	70	77	83	85	+	68	71	79	82	89	42	57	68	72	83
20	53	88	+	+	+	+	81	82	87	89	+	64	73	80	83	89
	35	86	89	+	+	+	81	84	88	+	+	61	76	82	85	+
	22	80	85	89	+	+	79	81	86	88	+	60	72	79	82	89
16	53	+	+	+	+	+	89	89	+	+	+	79	84	88	+	+
	35	+	+	+	+	+	88	+	+	+	+	77	86	89	+	+
	22	88	+	+	+	+	88	89	+	+	+	76	83	88	89	+
12	53	+	+	+	+	+	+	+	+	+	+	89	+	+	+	+
	35	+	+	+	+	+	+	+	+	+	+	88	+	+	+	+
	22	+	+	+	+	+	+	+	+	+	+	88	+	+	+	+

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

**TABLE 8M - MALE POPULATION PERCENTAGES FOR PUSHING TASKS  
SUSTAINED FORCE**

PUSHING DISTANCE		7 FEET					25 FEET					50 FEET					
FREQUENCY ONE PUSH EVERY		30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	30s	1m	5m	30m	8h	
<b>SUSTAINED PUSHING FORCE (POUNDS)</b>	105	57	-	-	-	23	-	-	-	-	-	-	-	-	-	-	
		37	-	-	-	11	28	-	-	-	-	-	-	-	-	-	
		25	-	-	-	-	27	-	-	-	-	-	-	-	-	-	
	100	57	-	-	-	12	29	-	-	-	11	-	-	-	-	-	
		37	-	-	12	15	34	-	-	-	-	-	-	-	-	-	
		25	-	-	11	14	32	-	-	-	-	-	-	-	-	-	
	95	57	-	-	13	16	35	-	-	-	-	16	-	-	-	-	
		37	-	-	17	20	40	-	-	-	-	14	-	-	-	-	
		25	-	-	16	19	39	-	-	-	-	11	-	-	-	-	
	90	57	-	-	18	22	42	-	-	-	-	21	-	-	-	-	
		37	-	-	22	26	47	-	-	-	-	20	-	-	-	-	
		25	-	-	21	25	45	-	-	-	-	16	-	-	-	-	
	85	57	-	-	24	28	49	-	-	-	11	27	-	-	-	-	
		37	-	13	29	33	53	-	-	-	-	26	-	-	-	-	
		25	-	12	28	32	52	-	-	-	-	22	-	-	-	-	
	80	57	-	14	31	36	56	-	-	13	16	35	-	-	-	13	
		37	-	18	36	41	60	-	-	12	15	33	-	-	-	12	
		25	-	17	35	39	59	-	-	-	12	29	-	-	-	-	
	75	57	-	21	39	44	63	-	-	19	23	43	-	-	-	19	
		37	13	25	44	49	67	-	-	18	21	41	-	-	-	18	
		25	12	24	43	47	66	-	-	14	17	37	-	-	-	14	
	70	57	16	29	48	52	69	-	11	27	31	51	-	-	12	15	26
		37	20	33	53	57	72	-	-	25	29	50	-	-	12	14	24
		25	19	32	52	55	72	-	-	21	25	45	-	-	-	11	20
65	57	23	38	57	60	75	-	18	36	40	60	-	-	19	23	34	
	37	28	43	61	64	78	-	16	34	38	58	-	-	18	22	33	
	25	27	42	60	63	77	-	13	29	34	54	-	-	14	18	28	
60	57	33	48	65	68	80	-	26	46	50	67	-	12	28	33	43	
	37	38	52	69	71	82	-	25	44	48	66	-	11	27	31	42	
	25	37	51	68	71	82	-	21	39	44	63	-	-	23	26	37	
55	57	44	58	72	75	85	11	37	56	60	75	-	20	39	43	53	
	37	49	62	76	78	86	14	36	55	58	74	-	19	38	42	52	
	25	47	61	75	77	86	13	31	50	54	71	-	15	33	37	47	
50	57	55	67	79	81	88	20	49	66	69	81	-	32	51	55	62	
	37	59	71	82	83	+	23	47	65	68	80	-	30	50	53	61	
	25	58	70	81	83	89	23	43	61	64	78	-	25	45	49	57	
45	57	66	76	85	86	+	32	61	75	77	86	15	45	62	66	71	
	37	70	78	86	88	+	36	59	74	76	85	19	43	61	65	70	
	25	69	78	86	87	+	35	55	71	73	84	20	38	57	61	67	
40	57	76	83	89	+	+	47	72	82	84	+	28	58	73	76	79	
	37	78	85	+	+	+	50	71	81	83	+	33	57	72	75	78	
	25	78	84	+	+	+	50	67	79	81	88	34	53	69	72	75	
35	57	84	88	+	+	+	62	81	88	89	+	44	71	82	83	85	
	37	85	+	+	+	+	65	80	87	89	+	49	70	81	83	85	
	25	85	89	+	+	+	65	78	86	87	+	50	67	79	81	83	
30	57	+	+	+	+	+	75	88	+	+	+	62	82	88	89	+	
	37	+	+	+	+	+	77	87	+	+	+	66	81	88	89	+	
	25	+	+	+	+	+	77	86	+	+	+	67	79	87	88	88	
25	57	+	+	+	+	+	86	+	+	+	+	77	89	+	+	+	
	37	+	+	+	+	+	87	+	+	+	+	80	89	+	+	+	
	25	+	+	+	+	+	87	+	+	+	+	80	88	+	+	+	
20	57	+	+	+	+	+	+	+	+	+	+	88	+	+	+	+	
	37	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	25	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

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

**TABLE 9 - POPULATION PERCENTAGES FOR PULLING TASKS  
INITIAL FORCES**

			MALE					FEMALE						
			FREQUENCY ONE PULL EVERY			30s	1m	5m	30m	8h	30s	1m	5m	30m
<b>INITIAL PULLING FORCE (POUNDS)</b>	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	22	-	-	-	-	-
	118	57	-	-	-	-	-	-	53	-	-	-	-	-
		37	-	-	-	-	-	26	35	-	-	-	-	-
		25	-	-	16	17	45	25	22	-	-	-	-	-
	115	57	-	-	-	-	-	-	53	-	-	-	-	-
		37	-	-	-	-	-	30	35	-	-	-	-	-
		25	-	12	19	20	49	22	22	-	-	-	-	-
	112	57	-	-	-	-	-	-	53	-	-	-	-	-
		37	-	-	-	-	-	34	35	-	-	-	-	-
25		-	15	23	24	53	22	22	-	-	-	-	-	
109	57	-	-	-	-	-	-	53	-	-	-	-	-	
	37	-	-	12	13	39	22	35	-	-	-	-	-	
	25	-	18	27	28	58	22	22	-	-	-	-	-	
106	57	-	-	-	-	-	-	53	-	-	-	-	-	
	37	-	-	15	16	43	22	35	-	-	-	-	-	
	25	11	22	31	33	62	22	22	-	-	-	-	-	
103	57	-	-	-	-	-	-	53	-	-	-	-	-	
	37	-	11	18	19	48	22	35	-	-	-	-	-	
	25	14	27	36	38	66	22	22	-	-	-	-	-	
100	57	-	-	-	-	-	-	53	-	-	-	-	-	
	37	-	15	22	24	53	22	35	-	-	-	-	-	
	25	17	31	41	43	70	22	22	-	-	-	-	-	
97	57	-	-	-	-	-	-	53	-	-	-	-	-	
	37	-	18	27	28	58	22	35	-	-	-	-	-	
	25	21	36	46	48	73	22	22	-	-	-	-	-	
94	57	-	-	-	-	12	22	53	-	-	-	-	-	
	37	11	23	32	33	62	22	35	-	-	-	-	-	
	25	26	42	51	53	77	22	22	-	-	-	-	-	
91	57	-	-	-	-	16	22	53	-	-	-	-	-	
	37	14	28	37	39	67	22	35	-	-	-	-	-	
	25	31	47	56	58	80	22	22	-	-	-	-	13	
88	57	-	-	-	-	20	22	53	-	-	-	-	-	
	37	19	33	43	44	71	22	35	-	-	-	-	11	
	25	37	53	61	63	83	22	22	-	-	-	-	17	
85	57	-	-	-	-	25	22	53	-	-	-	-	-	
	37	23	39	49	50	75	22	35	-	-	-	-	15	
	25	42	58	66	68	85	22	22	-	-	-	14	22	
82	57	-	-	-	-	30	22	53	-	-	-	-	14	
	37	29	45	54	56	79	22	35	-	-	-	12	20	
	25	48	63	71	72	88	22	22	-	-	13	19	28	
79	57	-	-	-	11	37	22	53	-	-	-	12	19	
	37	35	51	60	62	82	22	35	-	-	12	17	26	
	25	54	68	75	76	+	22	22	-	-	18	24	34	

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

**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%

**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
<b>SUSTAINED PULLING FORCE (POUNDS)</b>	76	<b>HAND HEIGHT (INCHES)</b>	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	
	35	20	26	41	50	72	-	13	26	35	60	-	-	-	15	39	
	22	12	17	30	39	64	-	-	17	25	51	-	-	-	-	29	
40	53	35	41	56	64	80	17	27	42	51	72	-	-	21	29	55	
	35	31	38	53	61	79	14	23	38	47	70	-	-	18	25	51	
	22	21	27	43	51	73	-	15	28	36	62	-	-	-	16	41	
36	53	48	54	67	73	86	28	40	55	63	80	-	19	33	42	66	
	35	45	51	65	71	85	25	36	52	59	78	-	16	30	38	63	
	22	34	40	55	63	80	16	26	41	50	72	-	-	20	28	54	
32	53	62	67	77	81	+	43	55	67	73	86	-	33	48	56	74	
	35	59	64	75	80	89	40	51	65	71	85	-	29	45	53	74	
	22	49	55	68	74	86	29	41	56	63	80	-	19	34	43	66	
28	53	74	78	85	88	+	59	69	78	82	+	23	50	64	70	84	
	35	72	76	83	86	+	56	66	76	81	+	20	46	60	67	83	
	22	64	69	78	82	+	46	57	69	75	87	12	35	51	59	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	
	22	77	80	87	89	+	64	72	81	84	+	28	55	68	73	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
<b>SUSTAINED PULLING FORCE (POUNDS)</b>	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	
	25	16	25	41	62	81	-	-	16	36	63	-	-	-	18	
60	57	-	-	11	28	56	-	-	-	-	28	-	-	-	12	
	37	18	28	45	65	83	-	-	18	39	65	-	-	-	20	
	25	25	36	53	71	86	-	-	25	47	71	-	-	14	27	
55	57	-	-	19	40	66	-	-	-	15	41	-	-	-	22	
	37	29	40	57	74	87	-	-	29	51	74	-	13	17	32	
	25	37	48	63	78	+	-	12	37	58	79	-	19	23	40	
50	57	-	17	32	53	76	-	-	-	26	54	-	-	-	11	
	37	43	53	68	81	+	-	16	42	63	81	-	23	29	45	
	25	50	61	73	85	+	-	23	50	69	85	-	31	36	53	
45	57	20	30	46	66	83	-	-	20	41	67	-	-	-	22	
	37	57	66	78	87	+	-	29	56	74	87	12	38	43	59	
	25	64	72	82	+	+	14	37	64	79	+	18	46	51	66	
40	57	35	46	62	77	89	-	11	35	57	78	-	17	22	37	
	37	70	77	85	+	+	21	46	70	83	+	26	54	59	72	
	25	76	81	88	+	+	29	53	76	86	+	33	61	66	77	
35	57	54	63	75	86	+	-	26	54	72	86	-	34	40	56	
	37	81	86	+	+	+	39	63	81	89	+	44	70	74	83	
	25	85	89	+	+	+	47	69	85	+	+	52	75	78	86	
30	57	71	78	86	+	+	23	47	71	84	+	27	56	61	73	
	37	89	+	+	+	+	60	78	89	+	+	64	82	85	+	
	25	+	+	+	+	+	67	82	+	+	+	70	86	88	+	
25	57	85	89	+	+	+	48	70	85	+	+	53	75	79	86	
	37	+	+	+	+	+	78	89	+	+	+	81	+	+	+	
	25	+	+	+	+	+	82	+	+	+	+	84	+	+	+	
20	57	+	+	+	+	+	74	86	+	+	+	77	89	+	+	
	37	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	25	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

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

**TABLE 11F - FEMALE POPULATION PERCENTAGES FOR CARRYING TASKS**

CARRYING DISTANCE		7 FEET					14 FEET					28 FEET					
FREQUENCY ONE CARRY EVERY		15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	
<b>OBJECT WEIGHT (POUNDS)</b>	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 CARRY EVERY		15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h		
<b>OBJECT WEIGHT (POUNDS)</b>	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%

## Liberty Mutual Manual Materials Handling Guidelines

### References

- Ciriello, V. M., The effects of box size, vertical distance, and height on lowering tasks. *International Journal of Industrial Ergonomics*, 28:61-67, 2001.
- Ciriello, V. M. and Snook, S. H., A study of size, distance, height, and frequency effects on manual handling tasks, *Human Factors*, 25:5, 1983.
- Ciriello, V. M., Snook, S. H. and Hughes, G., Further studies of psychophysically determined maximum acceptable weights and forces. *Human Factors*, 35:11, 175-186, 1993.
- Ciriello, V. M., Snook, S. H., Blick, A. C. and Wilkinson, P. L., The effects of task duration on psychophysically-determined maximum acceptable weights and forces, *Ergonomics*, 33:2, 187-200, 1990.
- Ciriello, V.M., McGorry, R.W., Martin, S., and Bezverkhny, I.B., Maximum acceptable forces of dynamic pushing: comparison of two techniques. *Ergonomics*, 42:1, 32-39, 1999a.
- Snook, S.H., The design of manual handling tasks, *Ergonomics*, 21:12-963-985, 1978.
- Snook, S. H. and Ciriello, V. M.; The design of manual handling tasks: revised tables of maximum acceptable weights and forces, *Ergonomics*, 34:9 1197-1213, 1991.
- 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.





**Liberty  
Mutual.**

Copyright 2004 Liberty Mutual Group  
[www.libertymutual.com](http://www.libertymutual.com)

