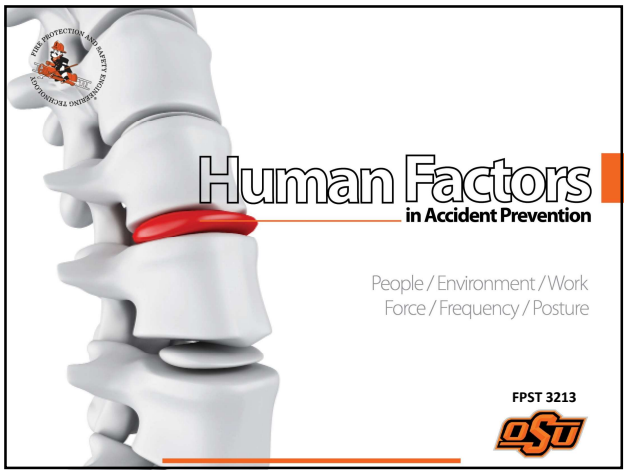
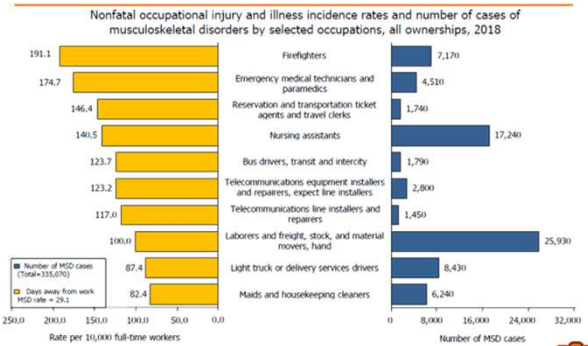


1

Manual Materials Handling (MH)

2

MSD Summary



3

Types of Musculoskeletal Injuries - MH

- Muscle Overexertion Injuries
- Muscle Overuse Injuries
- Work-Related Musculoskeletal Disorders

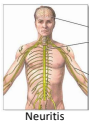
4

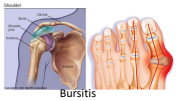
MSD Summary


Planter Fasciitis


Tendonitis

Achilles' Tendonitis

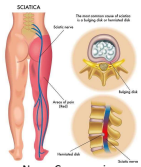

Neuritis


Bursitis


Carpal Tunnel

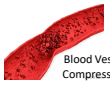
Guyon Canal


De Quervain's



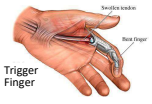
Nerve Compression


Cubital Tunnel


Blood Vessel Compression

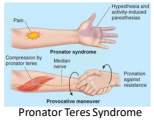
5

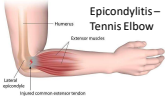
MSD Summary


Trigger Finger

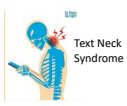

White Finger (Raynaud's Disease)


Ganglion Cyst


Pronator Teres Syndrome


Epicondylitis – Tennis Elbow


Neck Tension Syndrome


Text Neck Syndrome

Thoracic Outlet Syndrome


Chronic Low Back Pain

6

Reduce Manual Handling

- Remove non-value-added operations
- Design a system that minimizes the amount of manual handling

7

Reduce Manual Handling

- Materials Flow Analysis
  - Unit load
  - Mechanization
  - Standardization
  - Adaptability
  - Dead Weight
  - Gravity
  - Automation

8

Education of Handlers

- Guidelines for lifting training
  - Two-person handling
  - One-on-one lifting and force exertion
  - Use of handling assist devices
  - Use of back belts

9

Selection

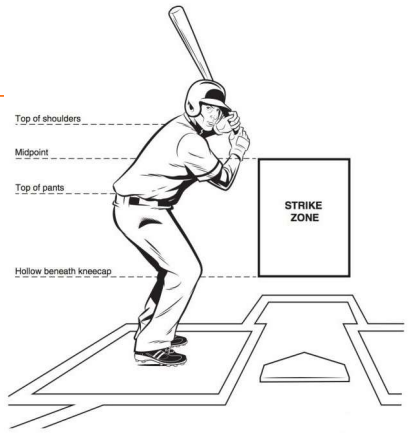
- Select only people capable of lifting
- Disadvantages
  - Limited flexibility
  - Abilities decrease with age

10

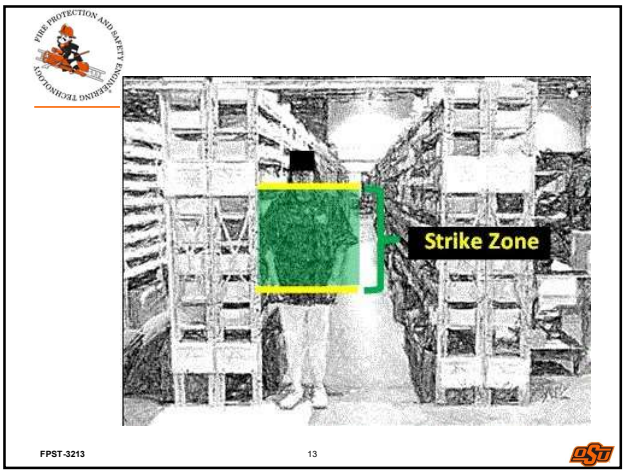
Redesigning Jobs and Workplaces

- Majority of the workforce
- Manual handling tasks into the safe lifting zone "Ergonomic strike zone"

11



12


Strike Zone
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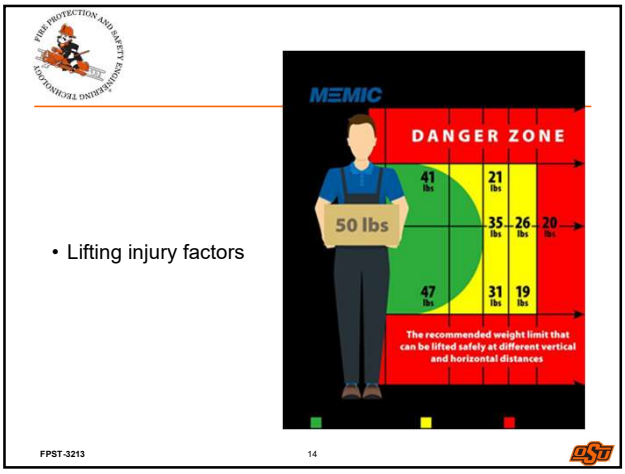
13

13


• Lifting injury factors
MEMIC
DANGER ZONE
41 lbs
21 lbs
50 lbs
35 lbs
26 lbs
20 lbs
47 lbs
31 lbs
19 lbs
The recommended weight limit that can be lifted safely at different vertical and horizontal distances
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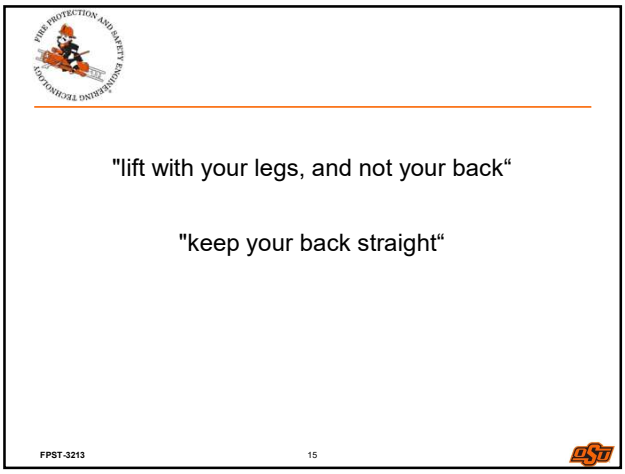
"lift with your legs, and not your back“
"keep your back straight“
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15

15

Manual Handling 8 basic steps to correct lifting technique

https://www.youtube.com/watch?v=Lq2dJKw6-Uk

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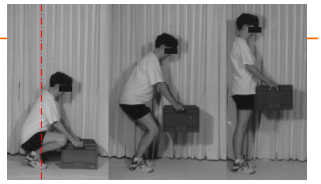
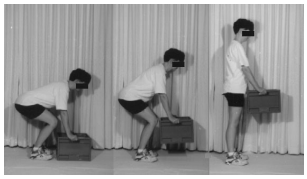
Proper Lifting. Which one is correct?





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Safe Lifting

3:10 – 9:00 https://www.youtube.com/watch?v=901uQgfiuVk

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NIOSH

- Work Practices Guide for Manual Lifting- Determining Acceptable Weights of Lift

The National Institute for Occupational Safety and Health (NIOSH)

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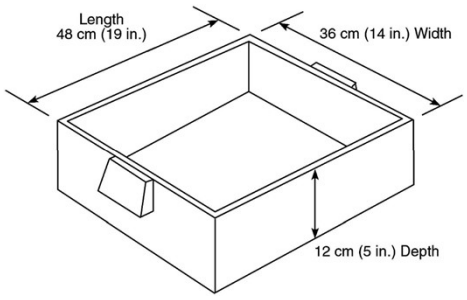
Factors That Contribute to Acceptable Weights for Lifting

- Configuration of the load
- Size of the load
- Tray design

20

Recommended Maximum Dimensions of a Tray



21

Factors That Contribute to Acceptable Weights for Lifting

- Tray design
  - Width determines the horizontal distance of the center of mass of the load from the handler's lumbar spine
  - Length affects which muscle groups take the load when it is handled manually
  - Depth is often determined by the volume of parts, product, or supplies desired in a production process or over a given time period

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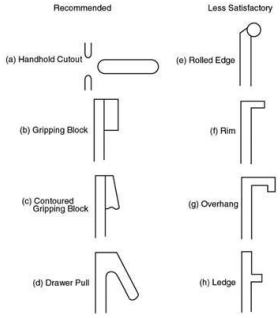
Examples of tray handholds



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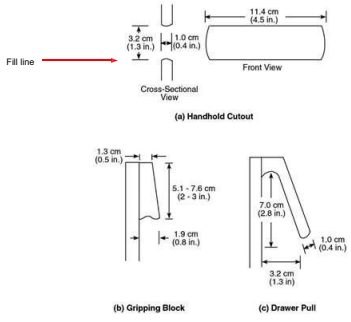
Recommended dimensions for handholds on trays



24

Cases

- What if there are no handholds?
- Adding handholds
  - Increase recommended weight by 10%
  - Metabolic work load is 1% less
  - Fatigue in low back and forearms is reduced

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Guidelines for the Design of Occasional Lifts

- The 1994 NIOSH Guidelines for the Design of Manual Lifting Tasks
  - Maximum weight to be handled manually is 51 lb.

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Guidelines for the Design of Frequent Lifting Tasks

- Acceptable weights for workers determined by:
  - Biomechanical stresses
  - Strength requirements
  - Local muscle fatigue
  - Metabolic demands of lifting

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Frequent Lifting

- Possible accumulation of fatigue over time
- Muscle fatigue accumulates quickly at frequencies of 15 per minute

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Example

Loading a tractor trailer, where the handler moves a pallet-load of 40 cases into the trailer, unloads it, moves the pallet out, and gets another full pallet.

- The pallet unloading takes 2 minutes at a lifting rate of 20/min
- 3 minutes of recovery time before the next pallet is ready to unload
- Muscle fatigue?

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Example

- How many lifts per each pallet unloading cycle?
- What is the total time of the pallet unloading cycle?

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Example

- Average rate per minute is 40/5 = 8/min
- 8 per minute < 15 per minute
- No muscle fatigue

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Lifting Risk Factors

- Weight
- Location/site
- Frequency/duration/pace
- Stability
- Coupling
- Workplace geometry
- Environment

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The NIOSH Lifting Equation

- In 1981, NIOSH published the Work Practices Guide for Manual Lifting.
- The equation was then reformed in 1991 and was called the revised NIOSH lifting equation.
  - Added asymmetry and coupling

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The NIOSH Lifting Equation

- Answers the question… "Is this weight too heavy for the task?"

Recommended Weight Limit (RWL)

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The NIOSH Lifting Equation

- Answers the question… "How significant is the risk?"

Lifting Index (LI)

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NIOSH Lifting Equation

RWL = LC x HM x VM x DM x AM x FM x CM

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Load Constant (LC)

- 51 pounds / 23 Kg

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NIOSH Lifting Equation

RWL = 51 x HM x VM x DM x AM x FM x CM

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Task Variables and Multipliers

		US	Metric
Load Constant	LC	51 lb	23 kg
Horizontal Multiplier	HM	10 / *H*	25 / *H*
Vertical Multiplier	VM	1 – (0.0075|*V* – 30|)	1 – (0.003|*V* – 75|)
Distance Multiplier	DM	0.82 + (1.8 / *D*)	0.82 + (4.5 / *D*)
Asymmetric Multiplier	AM	1 – (0.0032*A*)	1 – (0.0032*A*)
Frequency Multiplier	FM	From Table 5	From Table 5
Coupling Multiplier	CM	From Table 6	From Table 6

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Task Variables

- Weight of object

- H = Horizontal location of the object relative to the body
- V = Vertical location of the object relative to the floor
- D = Distance the object is moved vertically
- A = Asymmetry angle or twisting requirement
- F = Frequency and duration of lifting activity
- C = Coupling or quality of the workers grip on the object

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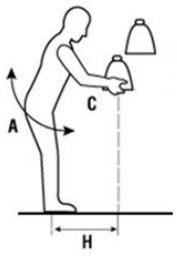
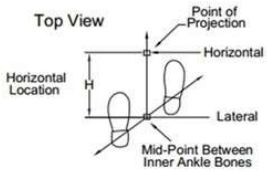
(H) Horizontal Location of the Object





10 in < (H) < 25 in

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Table 1
Horizontal Multiplier

H	HM	H	HM
in		cm	
≤10	1.00	≤25	1.00
11	.91	28	.89
12	.83	30	.83
13	.77	32	.78
14	.71	34	.74
15	.67	36	.69
16	.63	38	.66
17	.59	40	.63
18	.56	42	.60
19	.53	44	.57
20	.50	46	.54
21	.48	48	.52
22	.46	50	.50
23	.44	52	.48
24	.42	54	.46
25	.40	56	.45
>25	.00	58	.43
		60	.42
		63	.40
		>63	.00

$$HM = {}^{10}/_{H}\ inches$$

$$HM = {}^{25}/_{H}\ cm$$

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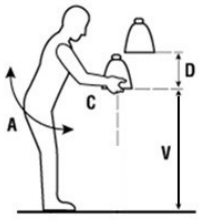
(V) Vertical Location of the Object

- The vertical location is measured from the floor (or standing surface) to the vertical mid-point between the hands as they grasp the object.



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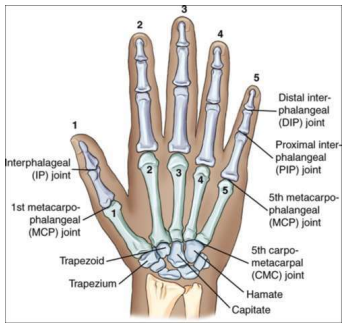
(V) Vertical Location of the Object

- Measure taken at the 3rd MCP joint



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(V) Vertical Location of the Object

- Parallel hands
- Offset hands

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Table 2
Vertical Multiplier

V in	VM	V cm	VM
0	.78	0	.78
5	.81	10	.81
10	.85	20	.84
15	.89	30	.87
20	.93	40	.90
25	.96	50	.93
30	1.00	60	.96
35	.96	70	.99
40	.93	80	.99
45	.89	90	.96
50	.85	100	.93
55	.81	110	.90
60	.78	120	.87
65	.74	130	.84
70	.70	140	.81
>70	.00	150	.78
		160	.75
		170	.72
		175	.70
		>175	.00

$$VM = \left(1 - (0.0075|V - 30|)\right)$$

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(D) Vertical Travel Distance

Origin - beginning or starting point

- the point at which the weight of the object is loaded onto the hands and moved vertically.

Destination - ending point

- the point at which the weight of the object is unloaded from the hands and stops moving vertically.

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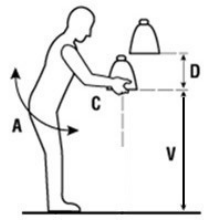
(D) Vertical Travel Distance



10 in < (D) < 70 in

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Table 3
Distance Multiplier

D	DM	D	DM
in		cm	
≤10	1.00	≤25	1.00
15	.94	40	.93
20	.91	55	.90
25	.89	70	.88
30	.88	85	.87
35	.87	100	.87
40	.87	115	.86
45	.86	130	.86
50	.86	145	.85
55	.85	160	.85
60	.85	175	.85
70	.85	>175	.00
>70	.00		

$$DM = \left(0.82 + \left(\frac{1.8}{D}\right)\right)$$

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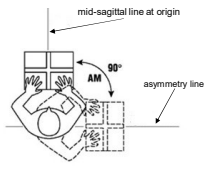
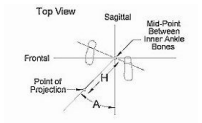
(A) Asymmetric Angle





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(A) Asymmetric Angle

- The best time to measure for (A) is when you are measuring the Horizontal (H) position of the hands by projecting on the floor directly below the hand grasps.
- You will use a goniometer to determine the angle between the asymmetric line and the mid sagittal line, this measurement can easily be done at the floor level
- Assume that workers will not pivot
- If no twisting is required, then A is 0º

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(A) Asymmetric Angle

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Table 4
Asymmetric Multiplier

A deg	AM
0	1.00
15	.95
30	.90
45	.86
60	.81
75	.76
90	.71
105	.66
120	.62
135	.57
>135	.00

$$AM = 1 - (0.0032A)$$

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(F) Frequency

- Frequency is defined by
  - Number of lifts per minute
  - Amount of time engaged in the lifting activity
  - The vertical height of the lift from the floor
- Use the average number of lifts per minute during an average 15 minute sampling period.
  - For example, count the total number of lifts in a typical 15 minute period of time and divide that total number by 15.

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Table 5
Frequency Multiplier Table (FM)

Frequency Lifts/min (F) ‡	Work Duration					
	≤ 1 Hour		>1 but ≤ 2 Hours		>2 but ≤ 8 Hours	
	V < 30†	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

†Values of V are in inches. ‡For lifting less frequently than once per 5 minutes, set F = .2 lifts/minute.

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Work Duration

- **1 = Short** - lifting 1 hour with recovery time of 1.2 X work time
- **2 = Moderate** - lifting between 1 and 2 hours with recovery time of 0.3 X work time
- **3 = Long** - lifting between 2 and 8 hours with standard industrial rest allowances for lunch and rest breaks.

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- If the recovery time requirement is not met, and another lifting session is immediately required, then the total work time must be added together. If the total work time exceeds 1 hour, then the job must be classified as a moderate-duration lifting task.
- If a worker continuously lifts for 2 hours, then a recovery period of at least 36 minutes (120 minx .3 = 36 min) would be required before initiating a subsequent lifting session.
- If the recovery time requirement is not met, and another lifting session is subsequently required, then the total work time must be added together. If the total work time exceeds 2 hours, then the job must be classified as a long-duration lifting task.

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Example

A worker performs lifting task continuously for 25 minutes, then performs light work tasks for 15 minutes, and then lifts for an additional 45-minute period.

1. In this case, the recovery time between lifting sessions (15 minutes) is less than 1.2 times the initial 25-minute work time (25 minx 1.2 = 30 min).
2. Therefore, the two work times (25 minutes and 45 minutes) must be added together to determine the duration.
3. Since the total work time (70 minutes) exceeds 1 hour, the job is classified as moderate-duration.

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In class exercise

A worker performs lifting tasks continuously 90 minutes, then performs light work for 15 minutes, and then subsequently performs the lifting tasks for another 90 minutes.

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Table 5
Frequency Multiplier Table (FM)

Frequency Lifts/min (F) ‡	Work Duration ≤ 1 Hour		>1 but ≤ 2 Hours		>2 but ≤ 8 Hours	
	V < 30†	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

†Values of V are in inches. ‡For lifting less frequently than once per 5 minutes, set F = .2 lifts/minute.

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(C) Coupling

- Hand to object coupling can affect the max force a worker must exert during the lift
- Good coupling = low grasp forces
- Poor coupling = high grasp forces.

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Good Coupling

Optimal Container Design

≤ 16 inches (40 cm) frontal length

≤ 12 inches (30 cm) height a smooth non-slip surface

Optimal Handle Design

- 0.75 - 1.5 inches (1.9 to 3.8 cm) diameter
- greater than or equal to 4.5 inches (11.5 cm) length
- 2 inches (5 cm) clearance
- cylindrical shape
- smooth, non-slip surface

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Fair Coupling

- Handles or hand-hold cut-outs of less than optimal design
- No handles, or cut outs or irregular object where the hand can be flexed about 90 degrees

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Poor Coupling

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Coupling Modifier

Table 6 Coupling Multiplier		
Coupling Type	**Coupling Multiplier (CM)**	
	V< 30 inches (75 cm)	V ≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

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