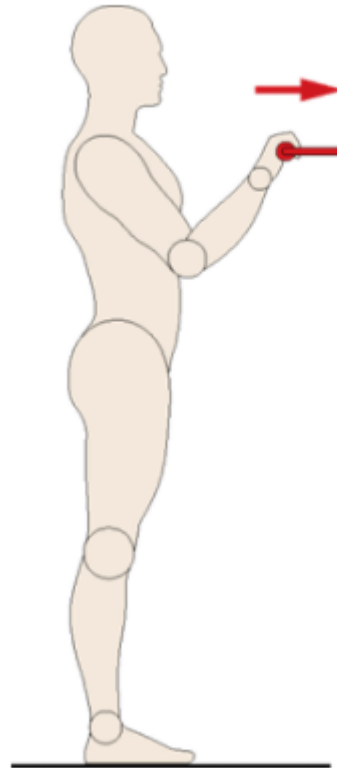


### ARM STRENGTH



**Push out at shoulder height,  
1 hand**

**Frequent ( $\geq 2$ /minute)**

Recommended: 6.8 lb (3.1 kg)

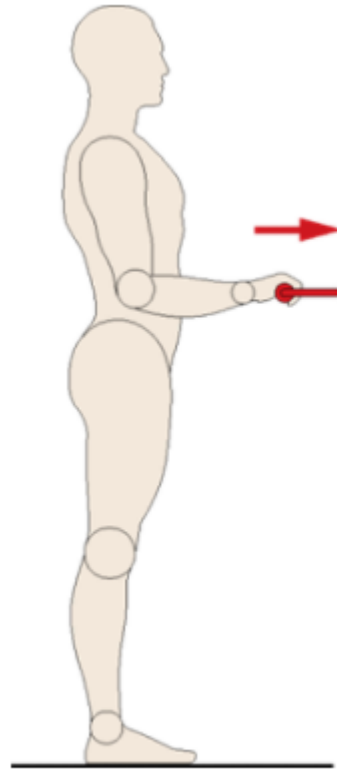
Acceptable: 10.2 lb (4.6 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 17.0 lb (7.7 kg)

Acceptable: 22.1 lb (10.1 kg)

### ARM STRENGTH



**Push out at elbow height,  
1 hand**

**Frequent ( $\geq 2/\text{minute}$ )**

Recommended: 7.4 lb (3.4 kg)

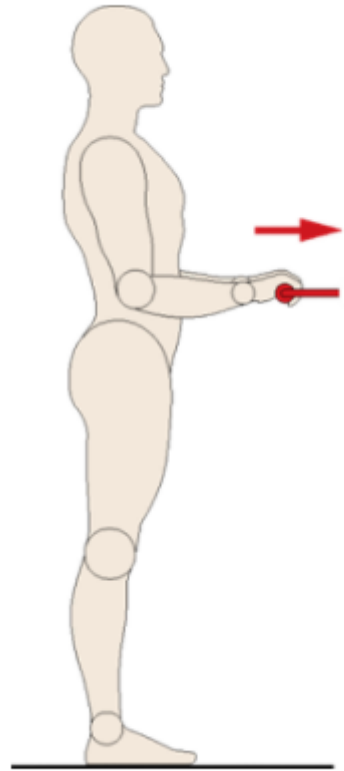
Acceptable: 11.1 lb (5.1 kg)

**Infrequent ( $< 2/\text{minute}$ )**

Recommended: 18.5 lb (8.4 kg)

Acceptable: 24.1 lb (11.0 kg)

### ARM STRENGTH



**Push out at elbow height,  
2 hands**

**Frequent ( $\geq 2/\text{minute}$ )**

Recommended: 11.8 lb (5.4 kg)

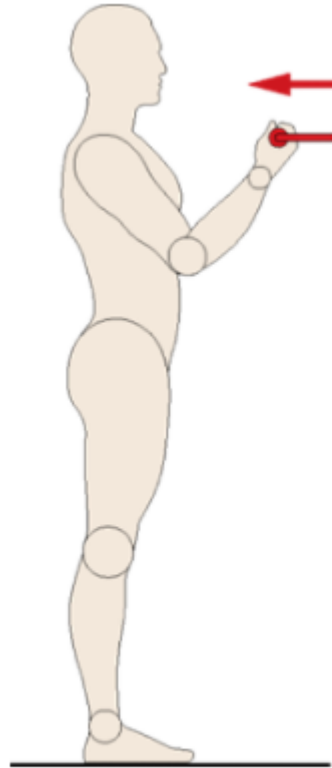
Acceptable: 17.7 lb (8.0 kg)

**Infrequent ( $< 2/\text{minute}$ )**

Recommended: 29.5 lb (13.4 kg)

Acceptable: 38.3 lb (17.4 kg)

### ARM STRENGTH



**Pull in at shoulder height,  
1 hand**

**Frequent ( $\geq 2$ /minute)**

Recommended: 7.0 lb (3.2 kg)

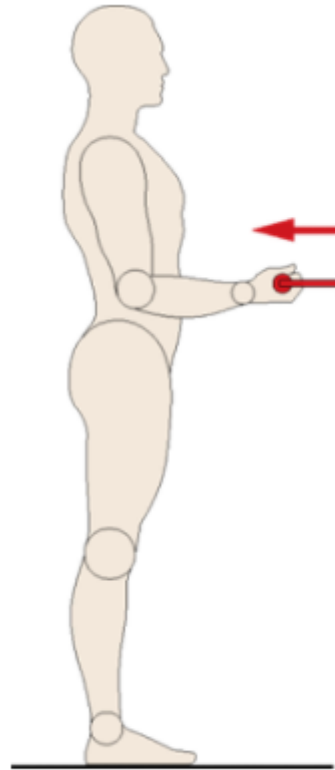
Acceptable: 10.5 lb (4.8 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 17.6 lb (8.0 kg)

Acceptable: 22.8 lb (10.3 kg)

### ARM STRENGTH



**Pull in at elbow height,  
1 hand**

**Frequent ( $\geq 2$ /minute)**

Recommended: 7.5 lb (3.4 kg)

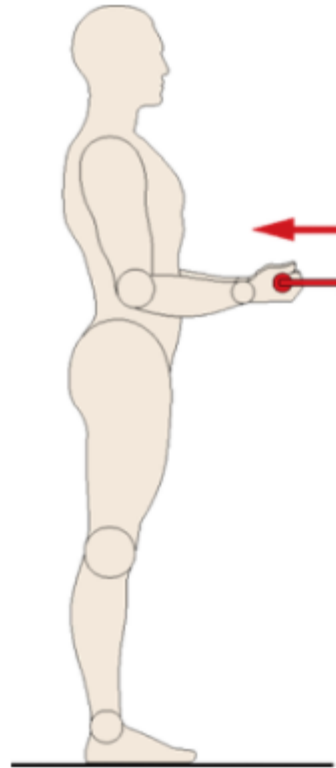
Acceptable: 11.2 lb (5.1 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 18.7 lb (8.5 kg)

Acceptable: 24.3 lb (11.1 kg)

### ARM STRENGTH



**Pull in at elbow height,  
2 hands**

**Frequent ( $\geq 2$ /minute)**

Recommended: 13.1 lb (5.9 kg)

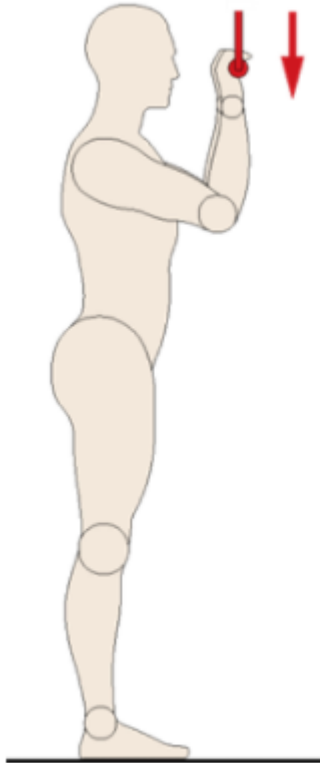
Acceptable: 19.6 lb (8.9 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 32.7 lb (14.8 kg)

Acceptable: 42.4 lb (19.2 kg)

### ARM STRENGTH



**Pull down from overhead,  
2 hands**

**Frequent ( $\geq 2$ /minute)**

Recommended: 17.9 lb (8.1 kg)

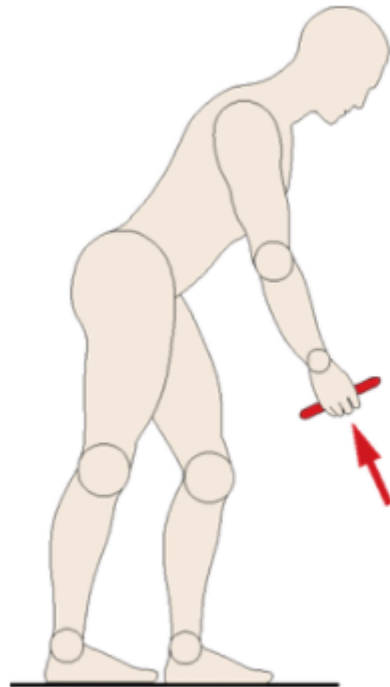
Acceptable: 26.8 lb (12.2 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 44.7 lb (20.3 kg)

Acceptable: 58.1 lb (26.4 kg)

### ARM STRENGTH



**Pull up from knee height,  
1 hand**

**Frequent ( $\geq 2$ /minute)**

Recommended: 6.3 lb (2.9 kg)

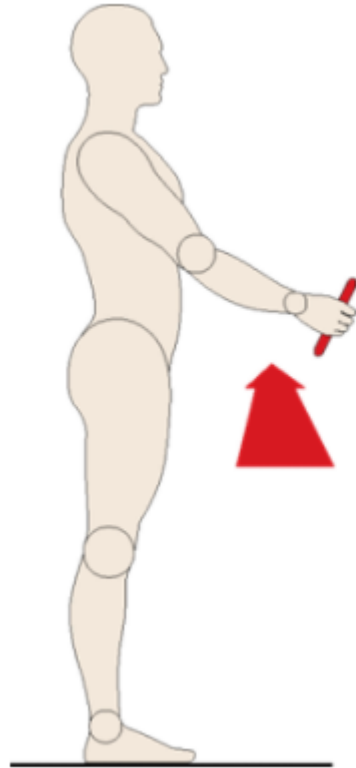
Acceptable: 9.5 lb (4.3 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 15.8 lb (7.2 kg)

Acceptable: 20.5 lb (9.3 kg)

### ARM STRENGTH



**Pull across body at waist height,  
1 hand, elbow fully extended**

**Frequent ( $\geq 2/\text{minute}$ )**

Recommended: 2.5 lb (1.1 kg)

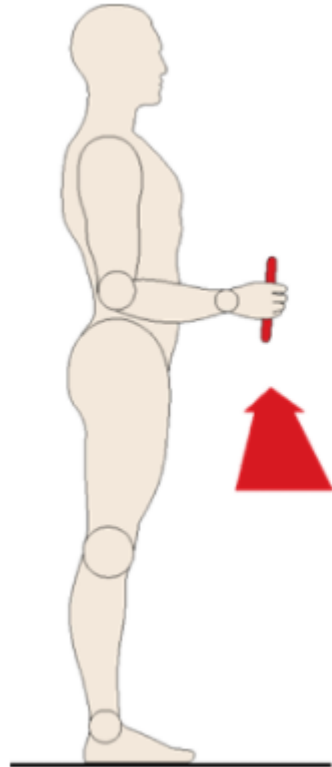
Acceptable: 3.8 lb (1.7 kg)

**Infrequent ( $< 2/\text{minute}$ )**

Recommended: 6.3 lb (2.9 kg)

Acceptable: 8.2 lb (3.7 kg)

### ARM STRENGTH



**Pull across body at waist height,  
1 hand, elbow at 90°**

**Frequent ( $\geq 2$ /minute)**

Recommended: 3.3 lb (1.5 kg)

Acceptable: 5.0 lb (2.3 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 8.4 lb (3.8 kg)

Acceptable: 10.8 lb (4.9 kg)

### ARM STRENGTH



**Lift up at shoulder height,  
2 hands**

**Frequent ( $\geq 2/\text{minute}$ )**

Recommended: 4.7 lb (2.1 kg)

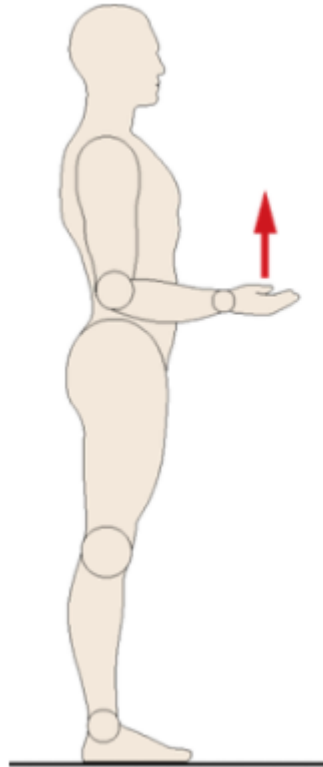
Acceptable: 7.0 lb (3.2 kg)

**Infrequent ( $< 2/\text{minute}$ )**

Recommended: 11.7 lb (5.3 kg)

Acceptable: 15.3 lb (6.9 kg)

### ARM STRENGTH



**Lift up at elbow height,  
2 hands**

**Frequent ( $\geq 2/\text{minute}$ )**

Recommended: 7.7 lb (3.5 kg)

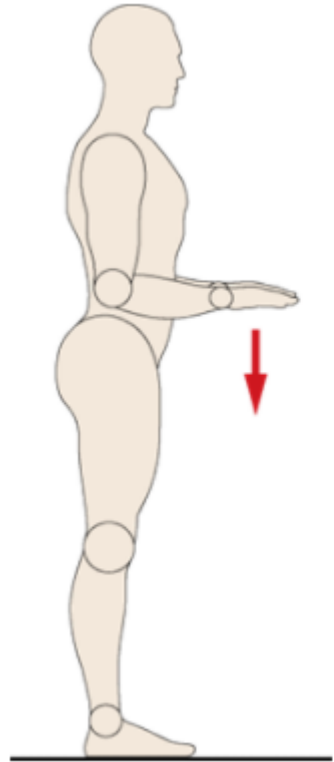
Acceptable: 11.5 lb (5.2 kg)

**Infrequent ( $< 2/\text{minute}$ )**

Recommended: 19.1 lb (8.7 kg)

Acceptable: 24.9 lb (11.3 kg)

### ARM STRENGTH



**Press down at elbow height,  
2 hands**

**Frequent ( $\geq 2$ /minute)**

Recommended: 12.8 lb (5.8 kg)

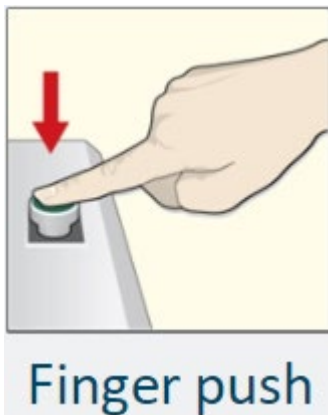
Acceptable: 19.2 lb (8.7 kg)

**Infrequent ( $< 2$ /minute)**

Recommended: 30.0 lb (13.6 kg)

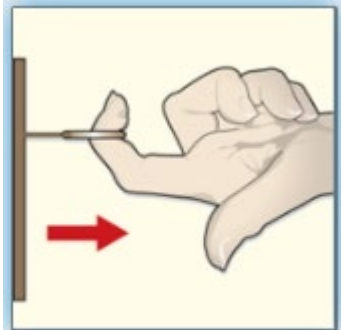
Acceptable: 41.6 lb (18.9 kg)

## HAND STRENGTH



| Finger Push Force               |                                   |                  |                                  |                   |
|---------------------------------|-----------------------------------|------------------|----------------------------------|-------------------|
| Force Exertions:<br>Finger Push | Frequent ( $\geq 2/\text{min.}$ ) |                  | Infrequent ( $< 2/\text{min.}$ ) |                   |
|                                 | Recommended                       | Acceptable       | Recommended                      | Acceptable        |
| 1 index finger                  | 3.4 lb (1.5 kg)                   | 5 lb (2.3 kg)    | 8.6 lb (3.9 kg)                  | 11.2 lb (5.1 kg)  |
| 2 fingers, same hand            | 5.0 lb (2.3 kg)                   | 7.5 lb (3.4 kg)  | 12.5 lb (5.7 kg)                 | 16.3 lb (7.4 kg)  |
| 2 fingers, different hands      | 11.0 lb (5.0 kg)                  | 16.5 kg (7.5 kg) | 27.5 lb (12.5 kg)                | 35.8 lb (16.3 kg) |

## HAND STRENGTH



Finger pull

| Finger Pull Force               |                                   |                  |                                  |                   |
|---------------------------------|-----------------------------------|------------------|----------------------------------|-------------------|
| Force Exertions:<br>Finger Pull | Frequent ( $\geq 2/\text{min.}$ ) |                  | Infrequent ( $< 2/\text{min.}$ ) |                   |
|                                 | Recommended                       | Acceptable       | Recommended                      | Acceptable        |
| 1 finger                        | 3.9 lb (1.8 kg)                   | 6.0 lb (2.7 kg)  | 9.6 lb (4.3 kg)                  | 12.5 lb (5.7 kg)  |
| 2 fingers, same hand            | 8.4 lb (3.8 kg)                   | 12.5 lb (5.7 kg) | 20.9 lb (9.5 kg)                 | 27.1 lb (12.3 kg) |

## HAND STRENGTH



Thumb push

| Thumb Push Force               |                                   |                  |                                  |                   |
|--------------------------------|-----------------------------------|------------------|----------------------------------|-------------------|
| Force Exertions:<br>Thumb Push | Frequent ( $\geq 2/\text{min.}$ ) |                  | Infrequent ( $< 2/\text{min.}$ ) |                   |
|                                | Recommended                       | Acceptable       | Recommended                      | Acceptable        |
| 1 thumb                        | 5.3 lb (2.4 kg)                   | 8.0 lb (3.6 kg)  | 13.3 lb (6.0 kg)                 | 17.3 lb (7.8 kg)  |
| 2 thumbs                       | 10.0 lb (4.5 kg)                  | 15.0 lb (6.8 kg) | 25.0 lb (11.3 kg)                | 32.5 lb (14.7 kg) |

### HAND STRENGTH



\* Thumb opposing pads of index, middle fingers

† Noticeable flexion, extension, ulnar, radial

‡ Thumb opposing side of index finger

#### One-handed pinch grip

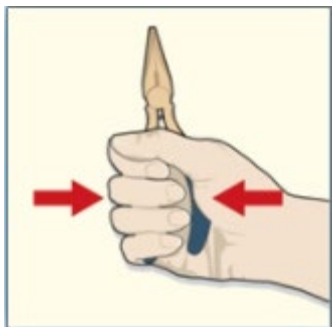
| Force Exertions:<br>Pinch Grip               | One-Handed Pinch Grip Force       |                 |                                  |                  |
|----------------------------------------------|-----------------------------------|-----------------|----------------------------------|------------------|
|                                              | Frequent ( $\geq 2/\text{min.}$ ) |                 | Infrequent ( $< 2/\text{min.}$ ) |                  |
|                                              | Recommended                       | Acceptable      | Recommended                      | Acceptable       |
| Chuck pinch grip*<br>(with wrist deviation†) | 2.0 lb (0.9 kg)                   | 2.4 lb (1.1 kg) | 4.0 lb (1.8 kg)                  | 5.1 lb (2.3 kg)  |
| Chuck pinch grip<br>(no wrist deviation)     | 3.2 lb (1.4 kg)                   | 4.7 lb (2.1 kg) | 7.9 lb (3.6 kg)                  | 10.3 lb (4.7 kg) |
| Key pinch grip‡<br>(with wrist deviation)    | 2.0 lb (0.9 kg)                   | 2.9 lb (1.3 kg) | 4.8 lb (2.2 kg)                  | 6.3 lb (2.9 kg)  |
| Key pinch grip<br>(no wrist deviation)       | 3.9 lb (1.8 kg)                   | 6.0 lb (2.7 kg) | 9.7 lb (4.4 kg)                  | 12.6 lb (5.7 kg) |

\* Thumb opposing pads of index, middle fingers

† Noticeable flexion, extension, ulnar, radial

‡ Thumb opposing side of index finger

## HAND STRENGTH



*\* Noticeable flexion,  
extension, ulnar, radial*

**Power grip****Power Grip Force**

| Force Exertions:<br>Power Grip | Frequent ( $\geq 2/\text{min.}$ ) |                   | Infrequent ( $< 2/\text{min.}$ ) |                   |
|--------------------------------|-----------------------------------|-------------------|----------------------------------|-------------------|
|                                | Recommended                       | Acceptable        | Recommended                      | Acceptable        |
| 1 hand (with wrist deviation*) | 6.4 lb (2.9 kg)                   | 9.5 lb (4.3 kg)   | 15.9 lb (7.2 kg)                 | 20.7 lb (9.4 kg)  |
| 1 hand (no wrist deviation)    | 12.7 lb (5.8 kg)                  | 19.1 lb (8.7 kg)  | 31.8 lb (14.4 kg)                | 41.3 lb (18.7 kg) |
| 2 hands (with wrist deviation) | 9.0 lb (4.1 kg)                   | 13.5 lb (6.1 kg)  | 22.6 lb (10.2 kg)                | 29.3 lb (13.2 kg) |
| 2 hands (no wrist deviation)   | 18.0 lb (8.2 kg)                  | 27.1 lb (12.3 kg) | 45.1 lb (20.5 kg)                | 58.6 lb (26.7 kg) |

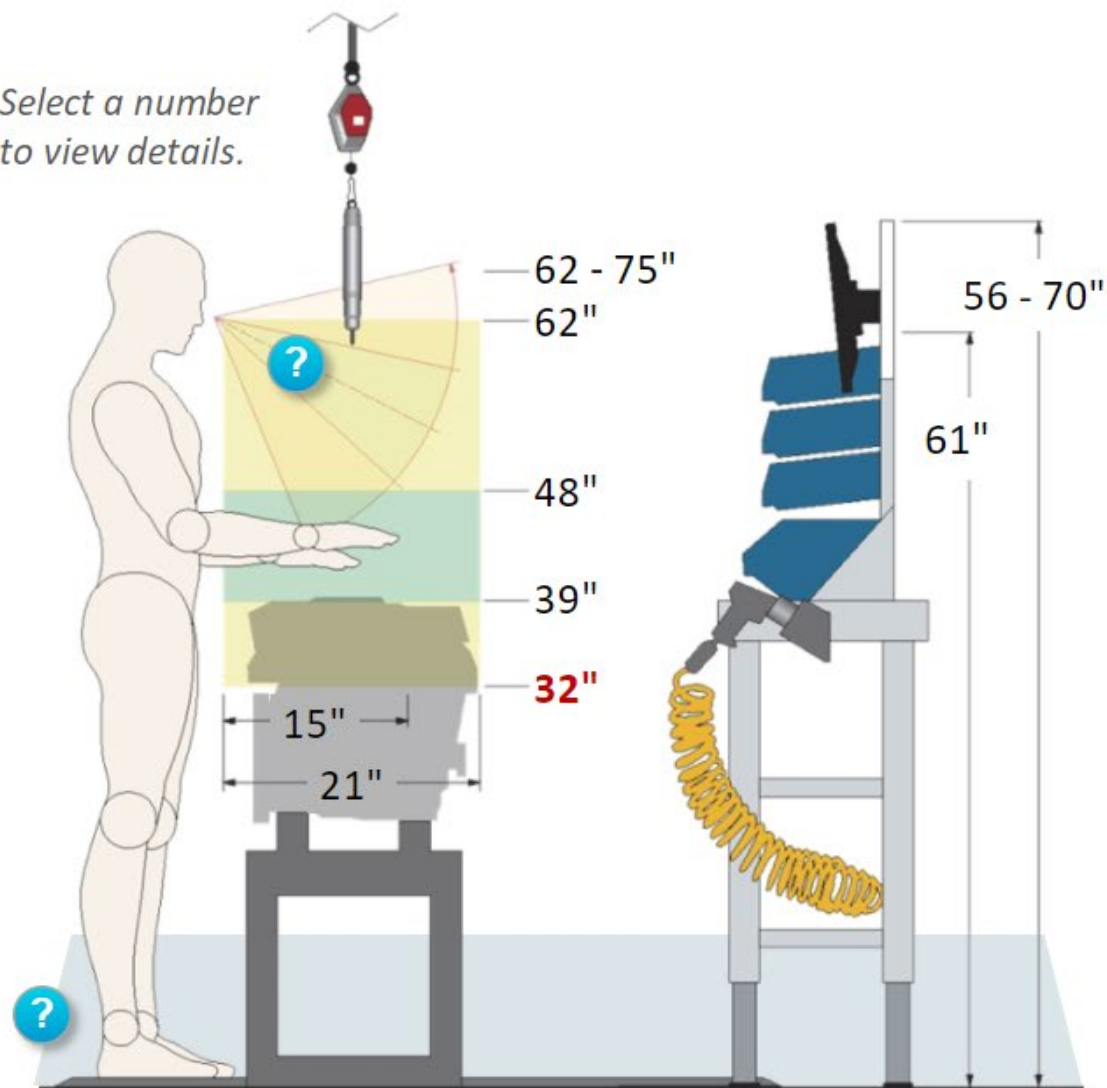
*\* Noticeable flexion,  
extension, ulnar, radial*

## HAND STRENGTH

**Insertion/  
removal****Insertion/Removal Force**

| Force Exertions:<br>Insertion/Removal    | Frequent ( $\geq 2/\text{min.}$ ) |                  | Infrequent ( $< 2/\text{min.}$ ) |                   |
|------------------------------------------|-----------------------------------|------------------|----------------------------------|-------------------|
|                                          | Recommended                       | Acceptable       | Recommended                      | Acceptable        |
| With 1-handed grip<br>on plastic surface | 6.7 lb (3.1 kg)                   | 10.1 lb (4.6 kg) | 16.9 lb (7.7 kg)                 | 21.9 lb (9.9 kg)  |
| With 1-handed grip<br>on rubber surface  | 8.0 lb (3.6 kg)                   | 12.0 lb (5.4 kg) | 20.0 lb (9.1 kg)                 | 25.9 lb (11.8 kg) |

Select a number  
to view details.



## Standing Assembly Line

### Hand working height

Vertical distance from standing surface  
to hand working height

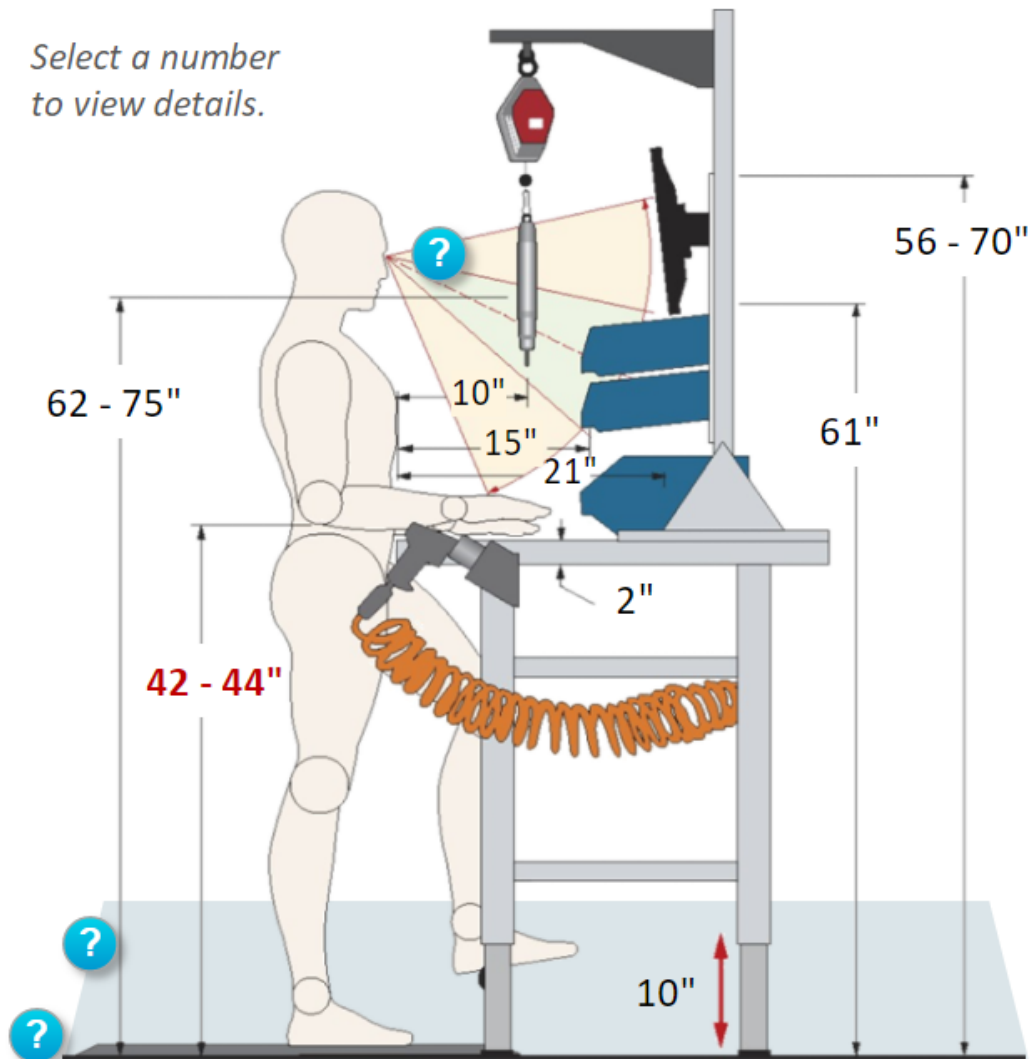
### Acceptable zone

Minimum: 32" (813 mm)

*Note: Data includes a 25 mm (1") shoe allowance.*

## STANDING WORK STATION

Select a number  
to view details.



## Standing Workstations

### Hand working height

Vertical distance from standing surface to hand working height

### Optimal zone

Fixed height surface: 42 - 44" (1074 - 1124 mm)

Adjustable height surface: 39 - 48" (981 - 1216 mm)

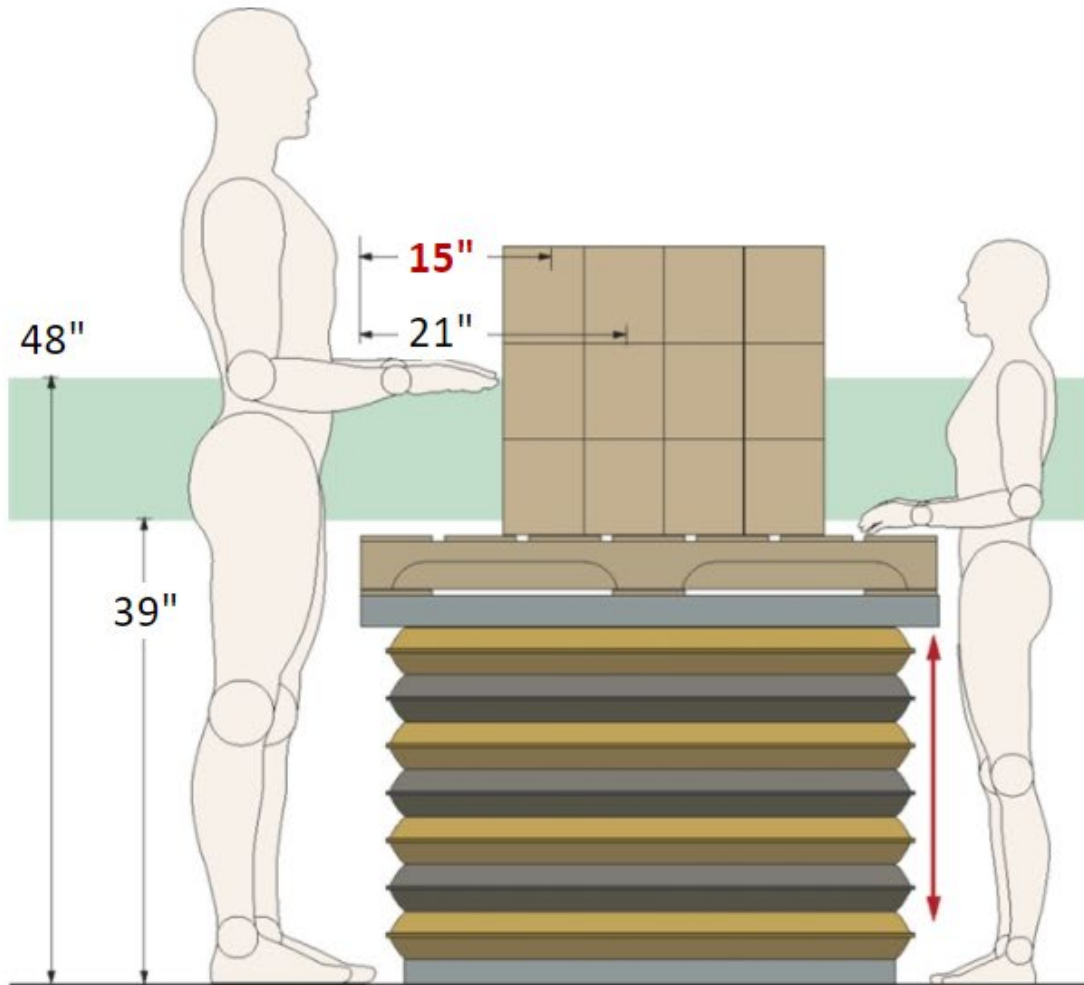
### Precision or visually demanding tasks

Fixed height surface: 45 - 47" (1150 - 1200 mm)

Adjustable height surface: 41 - 52" (1032 - 1318 mm)

*Note: Data includes a 1" (25 mm) shoe allowance.*

Select a number to view details.



## Material Handling - Adjustable Height Surface

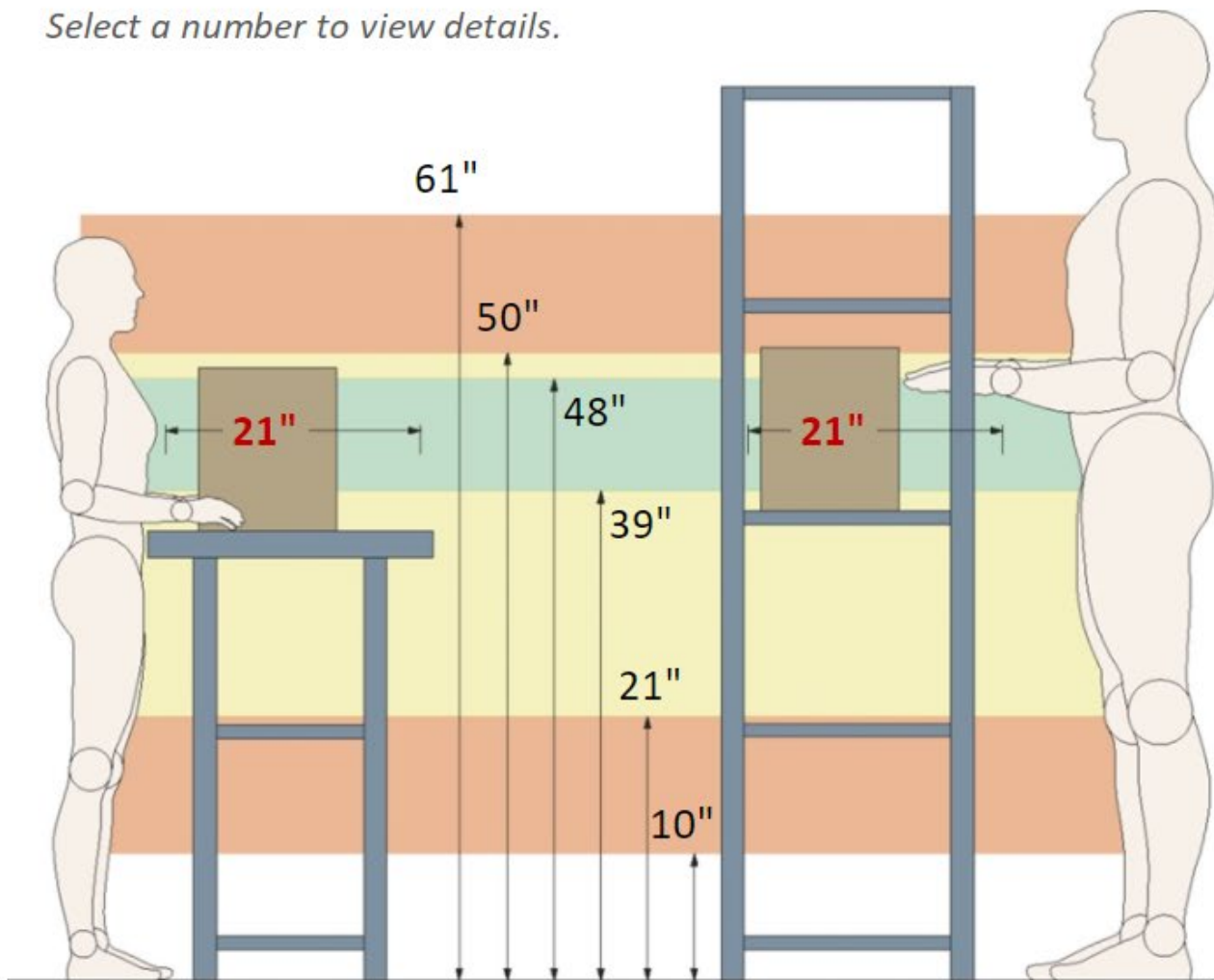
### Horizontal reach

Horizontal reach distance from front edge of workstation to hand grasping point

Optimal: 15" (379 mm)

*Note: Data includes a 25 mm (1") shoe allowance.*

Select a number to view details.



## Material Handling - Fixed Height Surface

### Horizontal reach

From front edge of workstation to hand grasping point

Maximum: 21" (531 mm)

Note: Data includes a 1" (25 mm) shoe allowance.

### MATERIAL HANDLING



Hand cart/hand truck

#### Hand cart/hand truck guidelines

- Vertical handles (preferred for smaller carts that turn easily):
  - Length minimum 5" (127 mm)
  - Height 36 - 49" (0.9 - 1.24 m)
  - Position 16 - 20" apart (406 - 508 mm)
- Horizontal handles (preferred for turning larger carts):
  - Length  $\geq$  24" (609 mm)
  - Height 38 - 45" (0.95 - 1.14 m)
- Handle diameter: 2" (51 mm)
- Handle offset for foot placement:  $\geq$  8" (203 mm) preferred

### TOOLS



**In-line**

#### **In-line tool priority guidelines**

- Handle (grip) cross-sectional shape: cylindrical
- Handle (grip) shape: cylindrical
- Handle (grip) diameter: 2" (51 mm); provide larger diameter flange at bottom of handle
- Handle angle: in line with tool-aiming axis
- Handle (grip) surface, texture, material: high-friction or slightly etched, slightly soft composite or rubber
- Dynamic reaction force (torque):  $\leq 2.36$  lb-ft (3.2 Nm)
- Hydraulic pulse systems or automatic shut-off to reduce torque reaction peak, duration. Faster shut-off mechanisms reduce peak reaction torques.

#### **General guidelines**

- Weight:  $\leq 4$  lb (1.8 kg) or suspended
- Finger(s) trigger design: push to start

### TOOLS



**Pistol-grip**

#### Pistol-grip tool priority guidelines

- Handle (grip) cross-sectional shape: cylindrical
- Handle (grip) shape: cylindrical (symmetrical diameter)
- Handle (grip) diameter: 2" (51 mm); provide larger diameter flange at bottom of handle
- Handle (grip) length: 4 - 6" (102 - 152 mm)
- Handle angle: 102° angle from handle to aiming axis
- Handle (grip) surface, texture, material: high-friction or slightly etched, slightly soft composite or rubber
- Dynamic reaction force (torque):  $\leq 5.02$  lb-ft (6.8 Nm)
- Hydraulic pulse systems or automatic shut-off to reduce torque reaction peak, duration. Faster shut-off mechanisms reduce peak reaction torques.

#### General guidelines

- Weight:  $\leq 4$  lb (1.8 kg) or suspended
- Finger(s) trigger design: 2-finger (index, middle) trigger, recommended length 1.5 - 2.5" (38 - 64 mm)
- Finger(s) trigger force: 2-finger,  $\leq 5$  lb (2.3 kg); 1-finger,  $\leq 2.5$  lb (1.1 kg)

### TOOLS



#### Pliers and snips

#### Pliers and snips guidelines

- Handle grip span:  $\geq 2"$  (51 mm) when fully closed,  $\leq 3.5"$  (89 mm) when fully open
- Handle (grip) diameter: 0.3 - 0.6" (8 - 15 mm); provide larger diameter thumb stop at top of handle
- Handle (grip) shape: oval or flattened
- Handle (grip) length: 5.5" (140 mm)
- Handle angle: bent handles, with angle between jaw head and handle 105 - 135°
- Handle (grip) surface, texture, material: high-friction or non-slip, slightly soft composite or rubber

### TOOLS



**Wrenches**

### Wrench guidelines

- Handle (grip) diameter: 1.2 - 2" (30 - 51 mm)
- Handle (grip) shape: circular
- Handle (grip) length: 4 - 6" (102 - 152 mm)
- Handle (grip) surface, texture, material: high-friction, non-slip, or slightly etched, slightly soft composite or rubber