APPENDIX 5

Recommendations

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APPENDIX 5

This Appendix corresponds with *Step 5: Recommendations*. It includes the following sections:

- Using Design Criteria to Implement Major Purchases (Section A.5.1)
- Implementing Minor Modifications (Section A.5.2)
- A Sample Completed Level I Ergonomics Assessment Summary and Recommendations Form

The section entitled *Using Design Criteria to Implement Major Purchases* is to be used in situations where ergonomics criteria are required for selecting a new, potentially major piece of equipment such as a lift table, cart, or other item. The "Implementation Reference" column on the Corrective Action List refers directly to information provided in this section.

The focus of this section is on design and selection criteria for major purchases. Because a shop may not be able to implement these types of recommendations immediately, this section may only be needed in special situations. Each time an assessment is performed, however, it may be useful to inform the shop supervisor that the BEF can provide assistance in selecting equipment that is beneficial to employees and of value to the shop. This information may also be useful to the person or organization responsible for procurement.

The section entitled *Implementing Minor Modifications* includes guidance on how to actually make or implement the minor modifications (i.e., changes and adjustments to existing materials, handling tasks, etc.) that have already been identified using the case studies. The "Implementation Reference" column on the Corrective Action List refers directly to the information provided in this section. The information complements that found in the case studies and will be helpful each time the Level I process is applied.

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A.5.1 USING DESIGN CRITERIA TO IMPLEMENT MAJOR PURCHASES

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A.5.1 USING DESIGN CRITERIA TO IMPLEMENT MAJOR PURCHASES

Many of the corrective actions in the case studies refer to the tools and equipment that help reduce the risk of WMSDs and improve performance of the tasks. Criteria for the most commonly recommended equipment are included in this section. To make this Guide Supplement as complete as possible, the criteria for Overhead Lifting Devices and Hand Tools/Power Tools, which originally appeared in the M/I Guide, are also provided.

The design criteria included are as follows:

- Overhead Lifting Devices (e.g., Hoists, Cranes) (Section A.5.1.1)
- Hand Tools/Power Tools (Section A.5.1.2)
- Height-Adjustable Lift Tables (Section A.5.1.3)
- Manual And Powered Carts (Section A.5.1.4)
- Wheels/Casters For Heavy Equipment And Carts (Section A.5.1.5)
- Patient Handling Devices (Section A.5.1.6)

The Administrative Guide includes other criteria related to seating and work spaces for reference.

A "Product Evaluation Worksheet" is provided at the end of each section as forms which you may copy to use in the future. In the past, some individuals have sent similar worksheets to product manufacturers or vendors to request information on the ergonomics features of their products.

A.5.1.1 Criteria for Overhead Lifting Devices

The following criteria are for overhead lift devices such as cranes or hoists in which a load hangs from a hook, strap, or other connector (e.g., articulating arm).

Lifting devices are often critical for providing assistance in handling heavy loads. There are two major issues that must be considered when selecting a lifting device: convenience and safety.

- ***Convenience***. If the lift device requires more time to use than manual lifting, personnel are generally reluctant to use the device.

- ***Safety.*** If the lift device itself contributes to high forces or static and awkward body postures, musculoskeletal injuries can result. Other safety issues such as guarding and alarms must be considered as well.

Additional guidance for lifting devices is also provided in AFOSH Standard 91-46, *Manual Material Handling*.

A.5.1.1.1 Ease of Use Specifications. The lift device **must be easy to use**. The lifting device should make the work easier, not harder. This means the lift device should take a minimum amount of time to move and attach. The following criteria specify convenience and ease of use requirements for the lifting device.

- The capacity of the lifting device should match the weight range for the items handled. Using a lift device with a much higher capacity than the items handled usually results in a lift device which is difficult to use and requires too much time to hook-up. This discourages the employee from using the lift device. Using a lift device with a lower capacity than the items handled creates serious safety hazards.

- Quick connect/disconnects for slings or end-effectors are critical to minimize time necessary to attach or remove the hoist from the item being handled. Safety features to prevent the item from being accidentally disconnected are critical.

- The lift device should maneuver easily and quickly without causing the operator to lose control of the load.

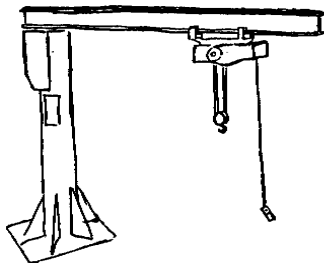
- Controls used to operate the lift device (on-off, up-down, fore-aft) should be clearly labeled, easy to understand, and easy to actuate.

- The lift device must allow the operator to perform specific handling tasks. This means the lift device must be designed for its specific applications. For instance, some tasks require careful positioning of the load prior to placement. A lift device with slow speed options is required to avoid wasting time because it keeps overshooting the target.

A.5.1.1.2 Safety Specifications. The following criteria specify safety requirements for the lifting device. Consideration of these criteria helps ensure that musculoskeletal risks are not created during use of the equipment.

- Lift devices (particularly gantry cranes and jib cranes) should not require excessive force to operate or move. Typical jib and gantry cranes are depicted in Figures A.1 and A.2.

Figure A.1
Jib Crane



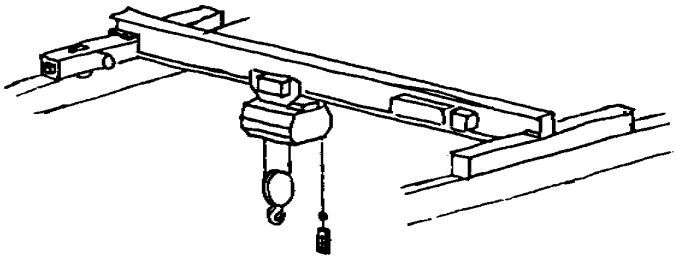


Figure A.2
Gantry Crane

- Controls should not require excessive hand forces or cause the fingers to be stretched or extended during operation.

- Controls should not require awkward wrist, arm, back, or neck postures to operate.

- The lift device should not have hard or sharp edges that could come in contact with the hand or other part of the body.

- Lift devices should meet all applicable safety requirements, which include preventing exposure to pinch/crush hazards and providing appropriate guards for all moving parts. In addition, the strength of hooks, straps, or other connectors must be designed so that the risk of unintentionally releasing/dropping the item being lifted is eliminated. Lift devices that move loads over head or that can reverse direction suddenly should be equipped with an alarm or other warning signal (such as a flashing light) to alert others that the lift device is in use. There may be other health and safety criteria not mentioned here that should be examined as a part of a complete equipment evaluation.

A.5.1.1.3 Lift Device Evaluation Worksheet

A worksheet to determine whether a lift device has basic ergonomic features is presented in Table A-1. This worksheet is provided to assist in the systematic evaluation of various lift device designs.

Table A-1
Lift Device Evaluation Worksheet

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Lift Capacity	Range	Capacity of the lift device should match the range of weights handled.			
Ease of Use	Overall	Time required to use the lift device should be comparable to (or less than) the time required to handle the load manually.			
	Connection/ Disconnect-ion	Connecting/disconnecting the load to/from the lift device should be quick, simple, and easy.			
	Mobility	The lift device should be quick and easy to maneuver without loss of control or stability.			
	Control understand-ability	Controls used to operate the lift device should be easy to identify, understand, and actuate.			
Capabilities	Movement Capabilities	The movement capabilities of the lift device should match the movement requirements of the task (e.g., slow speeds or incremental movement).			
Force Requirements	Transport Forces	Forces required to move or operate the lift device should be negligible.			
	Control Actuation Forces	Controls that require constant pressure to continue operation should not require a significant amount of force. Forces should be substantially below 2 lb. (0.9 kg.).			
	Exposure to hard edges	Lift devices should avoid exposing the operator to hard or sharp edges (particularly those which could press into the hand).			
Posture Requirements	Posture Requirement s	Lift devices should encourage a comfortable and neutral body posture during use. Lift device should not contribute to bent wrists, reaching, and awkward back/neck postures.			

Table A-1
Lift Device Evaluation Worksheet – cont'd

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
Safety Requirements		The lift device should prevent (at least): exposure to pinch/crush hazards, moving internal components, and falling objects.			
COMMENTS:					

A.5.1.2 Criteria for Hand Tools / Power Tools

The following major issues must be considered when developing or selecting a hand tool or power tool:

- The tool must be designed for the task(s) being performed. A tool is not considered to be ergonomically appropriate unless it performs well for specific tasks. For example, it is possible to have a tool which is very well designed for one task and poorly suited for a different task.

- The tool should be flexible enough to be useful in a variety of work situations. If a tool can be used in a number of situations, it reduces the number of tools required, thereby making the work easier.

- The tool should encourage neutral and comfortable body postures. The tool should allow the user to maintain straight wrists, prevent reaching, and encourage an upright back and head posture during performance of specific tasks.

- The tool should not require excessive forces.

- The tool should not expose the user to hard edges, excessive vibration, impact, or torque. The tool should prevent or minimize exposure to these risk factors.

A.5.1.2.1 General Principles. The following general principles apply to tool selection:

- Provide a power or semi-automatic tool for tasks that require high forces or large amounts of repetition.

- A hand tool (or non-power tool) is acceptable when the applied forces are low and the amount repetition is low.

- A tool must have a handle. Tools that do not have handles and are sized for the hand (e.g., some Allen wrenches) tend to cause hard edges which press into the hand and increase grip forces.

- A power grip (i.e., full hand) handle is generally preferred over tools which require a pinch (i.e., fingertip) grip where more than a minimal amount of force is required to perform the task.

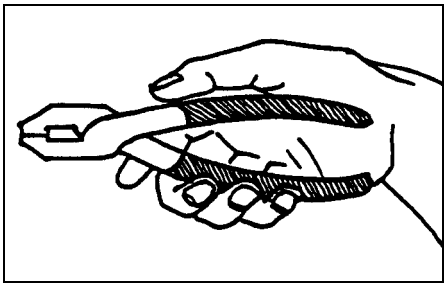
- A pinch grip is generally preferred for low-force, high-precision tasks.

- Tools should be easy to use with either the left or right hand.

- Tools should be easy to use and easy to maintain.

A.5.1.2.2 Grip Angle Guidelines for Different Tasks. The following guidelines direct the selection of a tool grip angle for particular tasks (see Table A-2 below). These guidelines are most helpful for rotary tools (such as power drills and nut drivers), but also can be applied to other types of tools (e.g., hammers, pliers).

The idea behind these guidelines is to ***bend the tool not the wrist*** as shown in Figure A.3. The task requirements determine the necessary direction of the tool. The geometry of the human body determines the necessary direction of the handle.



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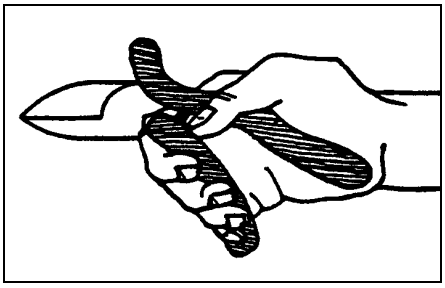

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Figure A.3
Handle Angle Criteria

- If the task being performed requires a vertical tool axis and the tool will be held at elbow height, then an in-line or straight grip will generally provide a neutral arm and wrist position.

- If the task being performed requires a horizontal tool axis and the tool will be held at elbow height, then a pistol-type grip will generally provide a neutral arm and wrist position.

Recommended grip angles for different required tool axis directions and different expected ways in which the tool would be handled are provided in Table A-2.

Table A-2
Recommended Grip Angle for Different Task Requirements

Required Tool Axis Direction	**Approximate Expected Location of Tool**		
	Elbow Height	***Knuckle Height***	***Shoulder Height***
Vertical	in-line/straight grip	pistol-type grip	pistol-type grip*
Horizontal	pistol-type grip	in-line/straight grip	in-line/straight grip*

*Note: Tasks which require use of tools at or above shoulder level create risk factors for the shoulder which should be addressed (i.e., modifying the task or tool, supporting the tool, providing a tool extension).

It may be beneficial if tools have multiple handles or a handle that can be oriented for different work situations. Making one tool more flexible and easy to use not only allows adaptation for multiple uses, but also reduces the number of tools needed. The handle location and orientation must allow the user to see the work without having to tilt or bend the head and/or back.

A.5.1.2.3 Criteria for Tool Forces. The following criteria provide guidelines for selecting a tool that requires minimal force to use.

- Full hand grip force required to use any tool should be less than 8 lb (3.6 kg.).

- Fingertip grip force required to use any tool should be less than 2 lb (0.9 kg.).

- The tool should allow two hands to be used when required forces are high or when additional control is needed. The tool should also allow the user to adjust and vary hand position to minimize the build-up of fatigue.

- The tool should weigh as little as possible. Generally, the tool should weigh no more than 5 lb. (2.3 kg.) without the use of a mechanical tool support device. The only possible exception would be when the tool weight is used to improve tool performance (e.g., sledge hammers). However, even though a power tool may be heavier than a hand tool version, it might be preferable as a long-term solution.

- The center of gravity of the tool should be close to (or at) the grip location. This helps to improve the balance of the tool and prevents unnecessary additional grip forces.

- Cables and hoses attached to the tool should be minimal in number and weight. Generally, hoses and cables should not increase the overall weight of the tool to more than 5 lb. (2.3 kg.) without the use of a mechanical tool support device.

- Cable and hose attachment locations should be positioned to maintain proper tool balance and minimize interference and drag while using the tool. Swivel attachments for cables can further reduce forces associated with supporting or moving the tool.

- Smooth, compressible, high-friction grip surfaces reduce grip forces required to control and use the tool.

- Handle length for torquing tools (i.e., torque wrenches, pry bars) should be proportional to the amount of force required. Longer handles on torquing tools reduce the forces required to perform the torquing task. The handle should be long enough to keep the grip forces below the force guidelines stated above.

- Force required to activate the trigger should be the minimum required to sense the actuation of the trigger and return the trigger quickly to an off position when the trigger is not actuated (typically less than 1 lb. or 0.5 kg.).

- When continuous activation of the trigger is necessary, one option is to provide a "cruise control" feature that allows the trigger to be engaged without constantly holding the trigger. As an alternative, power tools that are activated by pressure can be effective as well. For example, powered nut drivers are available that activate when sufficient pressure is applied to the bit.

- The forces required to connect/disconnect the power tool should be insignificant (e.g., to electrical outlets or air supplies).

- Plier-type tools should have a spring release mechanism to aid in opening the pliers. The spring tension should be established so the plier tool opens when not being compressed. However, the additional force required to close the pliers against that spring tension should be minimal. That is, the spring tension should not make it more difficult to close the tool.

A.5.1.2.4 Criteria for Handle Size and Shape. The following criteria specify the size and shape of the tool handle. These criteria apply for both hand and power tools.

- Grip Diameter for a full hand grip tool should be between 1" and 1.5" (2.5-3.8 cm.). This is based on the grip diameter of a small female hand. Designing for the small person's hand, in this case, makes the tool usable for the entire population. However, for special tasks, it may be desirable to customize the handle diameter by building up the diameter of the grip handle for persons with larger hands. Compressible foam grips are available on the market to accomplish this.

- Grip Diameter for a fingertip grip tool should be between 0.25” and 0.5” (0.6-1.3 cm.).

- Plier-type tools should have a span of less than 3” (7.6 cm.). This prevents excessive span extension of the thumb and fingers to grasp the tool in the open position. The criteria is again based on the small hand.

- The handle length should be at least 4” (10.2 cm.), but 5” (12.7 cm.) is preferred. This is necessary to prevent the end of the handle from pressing in the palm of the hand (see Figure A.4). A longer handle also increases the control of the tool and reduces grip forces required. The length criteria is based on a large person’s hand to ensure that the handle will be long enough for all hand sizes.

- There should be no hard or sharp edges or abrupt curves on the tool that could press into the user’s hand or body. Avoid ridges or channels for individual fingers. Hard edges, which press into the hand over a period of time, can cause a number of musculoskeletal disorders to the hand or arm.

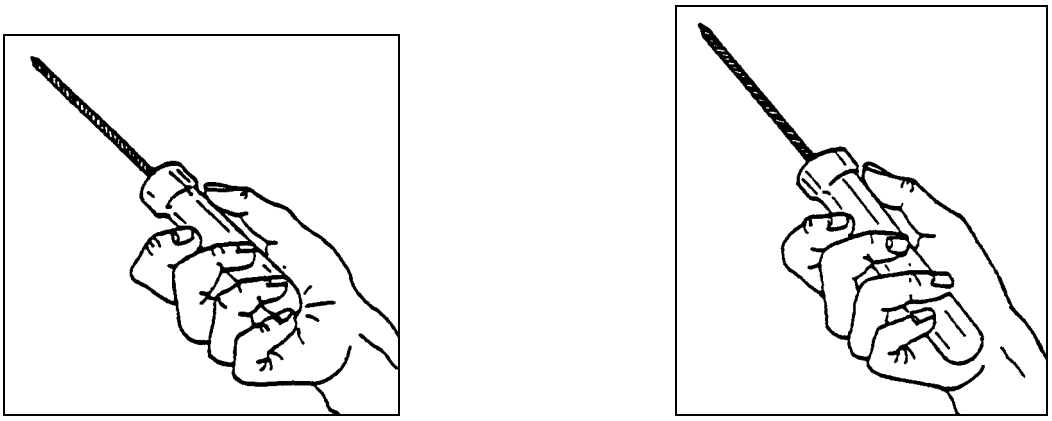

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Figure A.4
Handle Length Criteria

A.5.1.2.5 Criteria for Trigger Size and Shape. The following criteria specify the size and shape of the trigger. These criteria apply to those tools that have triggers, but some can also be applied to tools with button activators.

- Triggers and buttons should be positioned to allow activation without causing isolated extension of the fingers or the thumb. Triggers and buttons should allow the hand to remain in a resting position during actuation (see Figure A.5).

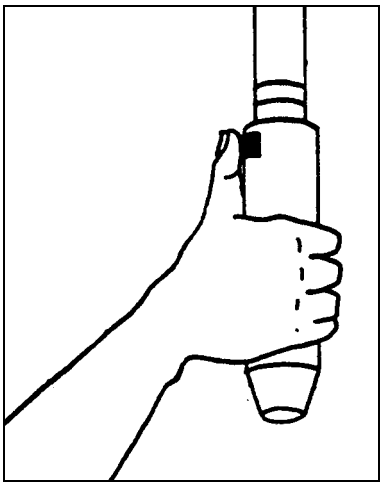
- The minimum trigger length is 1.5” (3.8 cm.), but 2” to 2.5” (5.1-6.4 cm.) is preferred. This permits two-finger activation of the trigger.

- The recommended trigger width is 0.5” to 1” (1.3-2.5 cm.). This minimizes exposure to a hard edge on the trigger and allows the entire pad of the finger to contact the trigger.

- The depth of the trigger should be 0.125” to 0.375” (0.318-0.953 cm.) to minimize extension of the index and middle fingers while pressing the trigger.

- The trigger should have a small range of movement to minimize finger movement.

- The trigger should have large smooth curves. No hard edges or points (particularly at the end of the trigger).



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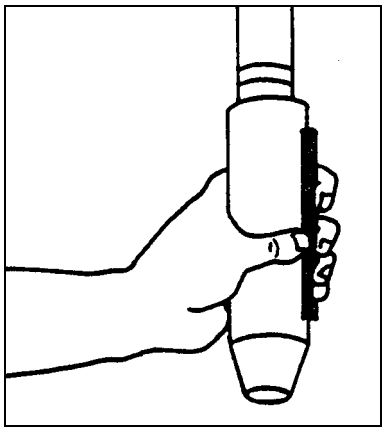

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Figure A.5
Trigger/Button Location Criteria

A.5.1.2.6 Additional Criteria. The following criteria specify other key features of tools.

- Handle materials should prevent heat transfer to the hand. The tool should not have bare metal handles. Handles that are coated with a rubberized insulating surface are preferred.

- Air powered tools should not cause cold air to blow on hands. Exhaust air, including exhaust from gasoline powered tools, should be directed away from the user.

- Ideally, power tools should not expose the user to vibration, torque, or impact while the tool is being used. Some vibration, however, will always be present because most power tools (e.g. drills, saws, sanders) use reciprocating or rotating frictional working ends to remove material. Few manufacturers have been successful in eliminating all perceptible vibration from these types of tools. Feeling vibration during a tool trial does not necessarily imply that the tool is not ergonomically designed. Vibration can be measured to determine whether or not prolonged use of the tool exposes the user to hazardous levels. The tool should be durable and easy to maintain to minimize the increase of vibration, torque, or impact as the tool and contact surfaces wear. If torque or impact is generated by the tool to perform the task, the maximum amount of the vibration, torque, or impact should be absorbed by using one or more of the following:

    - damping mechanisms internal to the tool
    - damping materials built into the tool handle
    - mechanical tool support mechanisms

- In general, avoid the use (or purchase) of impact tools as a power solution choice. Impact wrenches can introduce a significant source of impact stress and vibration by the very nature of the tool's torquing mechanism. In many cases, low impact, low vibration, "pulse" tools may be a solution. Pulse tools and other tools with advanced vibration dampening systems (e.g., counterbalancing mechanisms or piston-spring systems) tend to be much more expensive ($400+) than traditional power tools. In addition, if these types of tools are used to replace existing tools, users should be briefed on the tool's capabilities and unique performance characteristics. The "feel" is different and, without a briefing, many users may find the tool unacceptable when it's capabilities may actually be a direct match to those of the traditional tool.

- Exposure to working levels of vibration over the 50-200 Hz frequency range should be minimal. Measurement of vibration and impact requires special equipment and is generally considered to be best performed as a part of Level II Ergonomics Analysis. For additional information, refer to ANSI Standard S3.34.

- Exposure to torque should be minimized. Torque can be measured with a torque wrench. Maximum acceptable torque for an in-line power tool is 2.4 ft-lb. (3.2 Nm). For a pistol-shaped power tool, the maximum acceptable torque is 6.6 ft-lb. (9.0 Nm) [Joseph and Long (1991)]. One of the purposes of shut-off mechanisms in torquing tools is to prevent the user from being exposed to torque levels in excess of these maximums. These guidelines are provided as maximum torque levels for worst-case exposure scenarios (e.g., as a nut is "torqued" into final, or tight position).

A.5.1.2.7 Hand Tool/Power Tool Evaluation Worksheet. Table A-3 presents a worksheet to determine whether a hand tool/power tool has basic ergonomic features. This worksheet is provided to help in the systematic evaluation of various tool designs.

Table A-3
Hand Tool/Power Tool Evaluation Worksheet

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
General	Handiness	Tool should be easily used with either the left or right hand.			
	Repetition	Tool should minimize repetitive movements.			
	Ease of Use	Tool should be easy to use.			
	Ease of Maintenance	Tool should be easy to maintain.			
Grip Angle	Wrist and Arm Posture	Handle angle and location should allow a straight wrist and neutral arm position while the tool is being used.			
	Back and Neck Posture	Handle angle and location should allow the user to see the work without having to tilt or bend the head or back.			
Force Requirements	Activation Forces	**Full hand** grip forces required to use tool should be less than 8 lb. (3.6 kg.)			
		Fingertip grip force required to use tool should be less than 2 lb.(0.91 kg.)			
	Two hand activation	Tool should allow two hands when applied forces are high or when additional control is needed.			
	Tool Weight	Tool (and associated cables/hoses) should weigh less than 5 lb. (2.3 kg.) or be mechanically supported.			
	Tool Balance	Tool's center of gravity should be close to or at the grip location.			
	Cable/Hose Attachment	Cables and hoses should be attached to minimize interference and drag.			
	Handle Surface	Grip surfaces should be high friction and slip-resistant.			
		Grip surfaces should be compressible.			

Table A-3
Hand Tool/Power Tool Evaluation Worksheet – cont'd

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Force Requirements Cont'd	Handle Shape	There should be no hard/sharp edges or abrupt curves that the contact user's hand or body. Avoid ridges or channels for individual fingers.			
	Handle for Torquing Tools	For torquing tools, the handle should be long enough to prevent grip forces above 8 lb. (3.6 kg.)			
	Trigger Force	Force required to activate the trigger should be insignificant (typically less than 1 lb. or 0.5 kg.)			
	Trigger Function	Tool should avoid continuous activation of a trigger.			
	Connection Force	Force required to connect/disconnect the power tool should be insignificant.			
	Spring Release (Plier-Type Tools)	Plier-type tools should have a spring release mechanism. The spring tension should be minimal.			
Handle Size	Grip Diameter	Grip Diameter for a full hand grip tool should be between 1-1.5" (2.5-3.8 cm.).			
		Grip Diameter for a fingertip grip tool should be between 0.25-0.5" (0.6-1.3 cm.).			
		It should also be possible to increase the diameter of the handle if needed.			
	Handle Span on Plier-Type Tools	Plier-type tools should have a span of less than 3" (7.6 cm.).			
	Total Grip Length	4" (10.2 cm.) minimum, 5" (12.7 cm.) preferred			
Trigger/ Buttons	Location	Triggers and buttons should be positioned to prevent extension of fingers or the thumb.			

Table A-3
Hand Tool/Power Tool Evaluation Worksheet

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
	Shape	Trigger should have large smooth curves. No hard edges or points (particularly at the end of the trigger).			
	Length	1.5" (3.8 cm.) minimum, 2-2.5" (5.1-6.4 cm.) preferred			
	Width	0.5-1.0" (1.3-2.5 cm.).			
	Ridge Depth	0.125" - 0.375" (0.318-0.953 cm.)			
	Range of Movement	Trigger should have a small range of movement.			
Misc.	Heat Conduction	Tool handle should be coated or rubberized (tool handles should not be bare metal)			
	Routing of Exhaust Air	Exhaust air should be routed directly away from user.			
	Torque/ Impact	Tool should not expose the user to excessive torque or impact.			
	Vibration	Tool should not expose the user to excessive vibration.			
Comments:					

A.5.1.3 Criteria for Height-Adjustable Lift Tables.

The following issues and criteria need to be considered when selecting height-adjustable lift tables. Height-adjustable lift tables are used to correctly position work objects. Lift tables can minimize bending and reaching when loading or offloading materials on a pallet, serve as temporary material storage during processing, or facilitate the transfer of materials between storage shelves by changing a manual lift to a slide.

There are several major types of lift tables available. They differ in terms of elevating mechanism (e.g., pneumatic, air bladder, spring loaded, and hydraulic), ease of movement (e.g., stationary or mobile lift tables as illustrated in Figures A.6 and A.7), and integration with other materials handling equipment (e.g., pallet jack or fork truck).

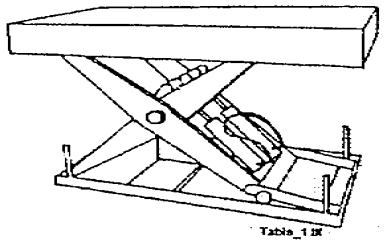

Figure A.6
Stationary Height-Adjustable Lift Table

Height-adjustable lift tables help decrease the stress and fatigue associated with manual materials handling of light weight items (less than 50 lb. or 22.7 kg.) by creating optimal back and shoulder positions. Using a lift table does not completely eliminate the risk of injury since, in many cases, the item's weight or size is greater than can be handled safely. Therefore, it is often recommended that height-adjustable lift tables be used with mechanical lifting devices.

The following issues should be considered when selecting or designing a height-adjustable lift table:

- A lift table should allow all personnel to palletize materials in a neutral and comfortable body posture by preventing reaching, bending, and twisting.

- A lift table must fit into the space allowed.

- A lift table's mechanisms and contact point should be guarded or padded to prevent exposure to pinch points, crush hazards, or trip hazards.

Additional guidance for lift tables and other lifting devices is provided in AFOSH Standard 91-46, *Manual Material Handling*.

A.5.1.3.1 Determining Capacity. The lift table should be able to handle a range of loads with capacity exceeding that of the heaviest expected weight. Additionally, the load range will help determine the most suitable type of lift table. For instance, if the loads being handled will remain relatively constant, a spring-loaded lift table will work very well, as the lift's performance is dependent upon the weight of the load placed on it. However, if there will be a wide variation in loads being handled, a hydraulic or pneumatic lift table will work better.

A.5.1.3.2 Determining the Appropriate Height Range. The table's range of adjustability is dependent on the size and overall stacking height of the material being handled. The overall goal is to keep the lifting height between 30" and 36" (76.2-91.4 cm.) from the floor. If this is not possible, the maximum range of lifting heights should be between 25" and 50" (63.5-127 cm.). This range allows for 90 percent of the work population to handle items between knuckle and shoulder height.

Typical lift tables compress to a 10" (25.4 cm.) thickness. Thus, when using 5" (12.7 cm.) pallets, the material's total thickness should not be greater than 35" (88.9 cm.) to meet the 50" (127 cm.) guideline. If highly repetitive stacking above 35" (88.9 cm.) is currently performed, consider lift tables that can be lowered into the floor or using a fork truck.

A.5.1.3.3 Control Location and Design. The control type and location should also be considered when purchasing lift tables. Many lift tables are controlled by hand-held, foot, and automatic weight sensing controls. The factors that influence decisions about controls include:

- Frequency of the lift
- Need to adjust the lift table with hands full
- Maneuverability requirements of the workstation

If personnel need to readjust the lift table while both hands are full, then a foot control may be necessary. For tasks that require repetitive lifting, automatic weight sensing controls are desirable, while hand controls work well for low frequency lifting tasks.

A.5.1.3.4 Lift Table Mobility. The ability for lift tables to transfer palletized loads between work areas varies. Some can elevate and move loads, while others are only able to lift and lower items (see Figure A.7).

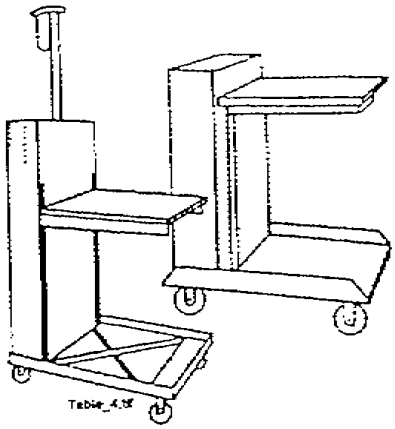

Figure A.7
Mobile Height-Adjustable Lift Table

A.5.1.3.5 Turntable Considerations. A turntable is an excellent addition to a lift table for high-volume palletizing tasks or when loading or offloading any pallet, as it allows for accessibility from all sides. Although turntables work very well in areas with tight space constraints, there must be enough space to allow full rotation. Additionally, the turntable's rotating mechanism should be guarded.

A.5.1.3.6 "Floor-Level" Vs. Standard Lift Tables. A concern with "floor-level" lift tables is that the lifting mechanism is located on one side, thereby preventing access on one or more sides. Additionally, turntable mechanisms are not possible on "floor-level" lift tables because the lift mechanism obstructs the rotation. Turntable options are only possible if the lift table is sunk into a pit. Thus, it is more advisable to purchase standard lift tables as their ability to interface with other materials handling equipment and their turntable options are greater than those of "floor-level" lift tables.

A.5.1.3.7 Lift and Tilt Tables. Tables that lift and tilt are normally used to reduce awkward back positions when the task requires placing or retrieving items from large and deep containers. The container size and orientation can also cause awkward back positions. Providing a table that lifts and tilts may not substantially eliminate these stressors. Further stressor reductions can be achieved by modifying the container. These modifications can include:

- Reducing the box size.
- Placing a fold-down flap on one or, preferably, both sides of a large container.

- Designing the container for side loading and access.

A.5.1.3.8 Height-Adjustable Lift Table Evaluation Worksheet. Table A.4 presents a worksheet to determine whether a height-adjustable lift table has basic ergonomic features. This worksheet is provided to assist in the systematic evaluation of various products.

Table A-4
Height-Adjustable Lift Table Evaluation Worksheet

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
Overall Capabilities	Lift Capacity	Capacity of the lift table should match the range of loads handled.			
	Range of the Height Adjustment	The range of adjustment should allow the loads to be positioned between 30”-36” (76.2-91.4 cm.) or at worst between 25-50” (63.5-127 cm.).			
	Stationary Locks	It should be possible to lock the lift table in position during loading and unloading.			
Ease of Use	Overall	Raising or lowering the table should be able to be completed within the work cycle and should not increase task time significantly.			
	Mobility	The mobile lift tables should be quick and easy to maneuver without loss of control or stability. Stationary lift tables should be transportable using a fork truck or pallet jack without major reconfiguration.			
	Control understand-ability	Controls used to operate the lift table should be easy to identify, understand, and actuate.			
	Control Location	Foot operated controls should be used when both hands will be occupied. Automated control of lift table height using a photo-eye device is recom-mended for highly repetitive tasks.			
Force Requirements	Lift table transportatio n	Forces required to manually push the lift table should be less than 25 lbs. (11.3kg.) Negligible forces are preferred unless some inertia is needed for control.			

Table A-4
Height-Adjustable Lift Table Evaluation Worksheet cont'd

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
	Turntable Rotation	Forces required to manually rotate the turntable table should be less than 25 lbs. (11.3kg.) Negligible forces are preferred unless some inertia is needed for control.			
	Control Actuation Forces	Controls that require constant pressure to continue operation should not require a significant amount of force. Forces should be substantially less than 2 lb. (0.9 kg.).			
Posture Requirements	Overall	Lift tables should encourage a comfortable and neutral body posture during use. The lift table should not contribute to bent wrist, reaching, and awkward back/neck postures.			
	Reach Requirements	Personnel should be able to directly access materials without having to reach across obstacles.			
	Toe Clearance	The lift table should have at least 8" (20.3 cm.) of toe clearance at all access points to prevent jamming of toes.			
Safety Requirements	Moving Internal Components	Lift tables should not have any exposed moving internal components that could create pinch or crush hazards. All moving internal components that could result in a pinch or crush hazard should be guarded.			
	Accidental Activation	Controls should have features built-in to prevent accidental activation of the lift table.			

Table A-4
Height-Adjustable Lift Table Evaluation Worksheet – cont'd

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
	Hard/Sharp Edges	Lift table should not have any exposed hard or sharp edges that could result in a cut or scrape			
	Protrusions/ Cabling	Lift table should not have any exposed blunt or pointed protrusions or barriers that could be a source of a contusion, scrape, or trip. For instance, hoses and cabling should be designed and mounted to minimize the risk of a trip hazard.			
Optional Features	Floor-Level Capabilities	In the floor-level position, a pallet jack should be able to place or remove a pallet without obstacles, interference, or high forces.			
	Lift and Tilt Capabilities	It is preferable if the tilt mechanism can be adjusted independently from the lift mechanism.			
	Turntable	Round turntables are generally preferred to square ones.			
Comments:					

A.5.1.4 Criteria for Manual and Powered Rolling Carts.

The following criteria are for manual and powered rolling carts (walk-behind powered carts only). Rolling carts should be used when transporting loads that would otherwise be lifted and carried (see Figures A.8 and A.9).

Figure A.8
Shelf-Style Rolling Cart

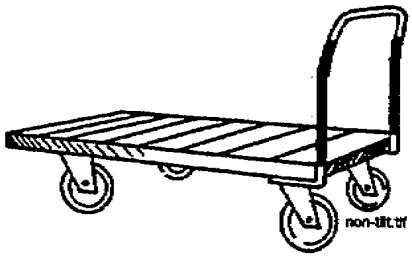

Figure A.9
Flat-Bed Rolling Cart

A.5.1.4.1 Reducing Push Forces. One of the most important considerations for the selection of a rolling cart is the minimization of push forces. The most important strategies for accomplishing this included:

- Increasing the wheel diameter.
- Selecting the appropriate wheel material and bearings for the floor surface being used.
- Reducing the weight of load.
- Maintaining wheels at scheduled intervals.

Additional information on reducing push forces is provided in Section A.5.1.5.

A.5.1.4.2 Wheel Configuration. For a typical four-wheel configuration, it is recommended that all four wheels have a swivel-lock feature that prevents inadvertent turning when handling carts. Ideally, the locking mechanism should be activated by foot pressure. (Please refer to A.5.1.5.5 for more information)

Optimal wheel configuration depends upon the handling situation. For example, to maintain control when pushing down a corridor, it is generally best to have two wheels swivel-locked and two wheels unlocked, with the swivel-locked wheels located on the opposite end from the pushing end. If the task requires maneuvering in tight quarters, then all four wheels should be in swivel mode.

For heavily used carts, such as patient stretchers, a five-wheel configuration is recommended. (Note: the fifth wheel is located in the cart's center and is locked by a hand control). When the cart is being pushed, the four corner wheels are in swivel-mode, and the fifth wheel is lowered to provide stability.

Rolling locks (i.e., locks that prevent movement by compressing a metal coupling against the tread) are necessary when storing carts on inclined surfaces, when loading and offloading contents, or when cart movement could create a safety concern.

A.5.1.4.3 Cart Handles. Handles that allow a "full-hand grip" are generally preferred. A "full-hand grip" means that the operator can grasp the handles with the thumb overlapping fingers. These types of handles are essential in the following situations:

- Push forces are significant
- Control of the cart is crucial
- Frequency of use is high

The grip diameter for a "full-hand grip" handle should be between 1" and 1.5" (2.5-3.8 cm.). This is based on the grip diameter of a small female hand. Designing for the small person's hand, in this case, makes the handle usable for a majority of the population.

There should be at least 4" (10.2 cm.) hand clearance between the handle and the mounting surface. This is based on the hand width of a large male hand. This provides adequate hand clearance for a majority of the population.

There should be no hard/sharp edges or abrupt curves on the handle that could press into the user's hand or body. Avoid ridges or channels for individual fingers. As a general guideline, handles should be mounted at least 36" (91.4 cm.) above the floor. Vertical loop handles designed to accommodate different sized individuals should be between 36" and 50" (91.4-127 cm.) above the floor. The handle should also be mounted close to the vertical center of gravity of the cart (i.e., the higher the center of gravity, the higher the handle height).

A.5.1.4.4 Shelf Requirements. Shelves are a common method for storing materials on carts. Multiple shelves are used to increase the capacity for storing smaller materials on the cart in an organized and stable manner. Task requirements and volume of materials to be handled should determine the number of shelves.

Shelf height will be determined by the size of the materials being handled. The need for visual access and the stability of the cart should also influence shelf heights. For instance, it may be desirable to place shelves higher to minimize bending to access materials. However, the size of the cart may need to be increased to maintain cart stability. Of course, there must be adequate spacing between shelves to allow placement of the largest items. In some cases, one or two shelf spaces can be allocated to larger items, if appropriate.

A.5.1.4.5 Powered Carts. Powered carts are often used for handling heavy loads or transporting loads over long distances. The guidelines for determining the need for a powered cart are listed below. A powered cart should be considered for applications where:

- The weight of load exceeds 1000 lb. (454 kg.).
- The average distance traveled exceeds 100 ft (30.5 m.).
- The frequency of transfers exceeds 100 per day.

It is important to remember that the weight of load is not equal to the forces required to push that load. There are many factors which influence push forces. Examples include:

- Wheel size.
- Wheel composition.
- Wheel shape.
- Bearing type.
- Wheel maintenance.
- Floor composition.
- Floor cleanliness and maintenance.
- Travel speed.
- Space availability.
- Load weight.

A.5.1.4.6 Cart Evaluation Worksheet. Table A-5 presents a worksheet to determine whether a cart has basic ergonomic features. This worksheet is provided to assist in the systematic evaluation of various products.

Table A-5
Cart Evaluation Worksheet

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
Overall Capabilities	Overall	The cart minimizes push forces and optimizes control on all surfaces upon which the cart will be used.			
	Height for Visual Clearance	To allow some visual access, the loaded cart should not be higher than 50" (127 cm.). A higher cart will require some individuals to look around the cart while pushing.			
	Mobility	The lift device should be quick and easy to maneuver without loss of control or stability.			
Wheels	General Requirements	See Wheel/Caster Evaluation Worksheet for additional information			
	Configuration	All wheels have swivel-lock capability.			
		Swivel locks should be able to be engaged and disengaged by stepping on buttons			
Handles	Handle Existence	Cart should have "full-hand grip" handles when: • push forces are significant • control is critical • frequency of use is high Otherwise, handles integrated into the body of the cart are an alternative			
	Handle Orientation	Handles are vertically oriented (in most situations, horizontal handles are also acceptable and may be preferred in specific circumstances)			
	Handle Location	Handles are located on all four corners of the cart (expect where task or environment prohibit)			
	Handle Diameter	1-1.5" (2.5-3.8 cm.).			

Table A-5
Cart Evaluation Worksheet – cont'd

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
	Hand Clearance Under Handle	There should be at least 4" (10.2 cm.) hand clearance between the handle and the mounting surface.			
	Handle Length	Minimum 5" (12.7 cm.). Longer handles are generally preferred to increase flexibility.			
	Handle Heights	Handles should generally be mounted at 36" (91.4 cm.) or higher. The handle should be mounted close to the vertical center of gravity of the cart. The higher the center of gravity, the higher the handle. Vertical handles should range in height between 36"-50" (91.4-127 cm.).			
Shelves	Shelf Design	Shelves should have slightly raised edges if rolling or sliding materials are a possibility (Note: all edges should be rounded). Task requirements and materials being handled should determine the surface material of the shelves.			
	Number of Shelves	Task requirements and volume of materials being handled should determine the number of shelves.			
	Shelf Heights	The size and volume of the materials being handled should determine the shelf heights. Shelf heights should also minimize bending and reaching, provide adequate visual access, and maintain cart stability when fully or partially loaded.			
Force Requirements	Transport Forces	The forces required to manually push the cart			

		should be less than 25 lbs. (11.3 kg.). Negligible forces are preferred unless some inertia is needed for control.			
Posture Requirements	Posture Requirements	The cart should encourage a comfortable and neutral body posture during use. Lift device should not contribute to bent wrists, reaching, and awkward back/neck postures.			

Table A-5
Cart Evaluation Worksheet – cont'd

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category	**Parameter**	**Measure**	**Meets Criteria Yes**	**No**	**N/A**
Safety Requirements		The cart should prevent (at least): exposure to pinch/crush hazards, moving internal components, and falling objects.			
	Hard/sharp edges	All edges should be round. There should be no exposed hard or sharp edges.			
Other Features	Powered Carts	A powered cart should be considered for handling applications where: • The weight of load exceeds 1000 lb. (454 kg.);or, • The average distance traveled exceeds 100 ft. (30.5 m.); or The frequency of transfers exceeds 100 per day.			
Comments:					

A.5.1.5 Criteria for Wheels/Casters for Heavy Equipment and Carts

Proper wheel and caster design can reduce push forces associated with transporting carts, heavy equipment, and other mobile materials. If push forces are critical in the manual handling task, selecting wheels that have been designed and tested to reduce push forces is a good strategy.

A.5.1.5.1 Wheel Size. Small wheels are a common cause of excessive push forces in carts (see Figure A.10, Cart A). In general, the larger the wheel diameter, the less push forces are required. Larger wheels also handle obstructions and debris more easily (see Figure A.10, Cart B). However, if the wheel diameter is too great compared to the distance between wheels, than the stability of the cart is reduced (see Figure A.10, Cart C). Wheel diameter should be substantially less than the distance between centers of the wheels.

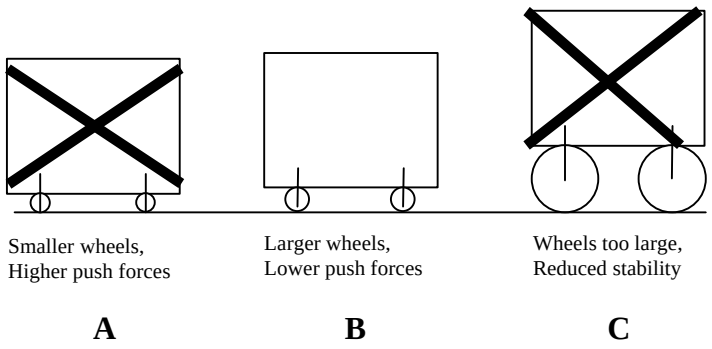

Figure A.10
Impacts of Wheel Size on Stability

The preferred range of wheel diameters for most manually pushed carts and equipment is 4" to 8" (10.1-20.3 cm.), depending upon the weight of the load and the size of the cart. For large carts with heavy loads, 8" (20.3 cm.) is recommended. For small, light-duty carts, 4" to 5" (10.1-12.7 cm.) is recommended.

A.5.1.5.2 Wheel Width. The wheel width is also dependent upon the job or task requirements. Wider wheels generate more friction with the floor (particularly when turning). Thinner wheels tend to concentrate forces (weight of the load) over a smaller surface area. Generally, thinner wheels have to be made of harder material to slow wear and tear.

As the load becomes heavier, a wider wheel generally becomes more favorable to distribute the load over a larger surface area. Thin wheels work well for relatively light loads (as in small carts).

A.5.1.5.3 Wheel Shape. The shape of the wheel profile falls within two preferred patterns (see Figure A.11, Profile A and B): mostly flat on the bottom with rounded sides (better for heavier loads, see Profile A) or almost completely rounded with very little flat (better for lighter loads, see Profile B).

The profile of the wheel should generally not be perfectly square (see Profile C). This increases friction (particular when turning) and, thus, requires more push forces to move the cart.

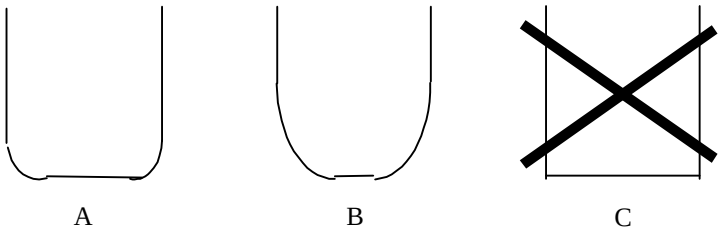

Figure A.11
Wheel Profile Characteristics

A.5.1.5.4 Wheel Composition. Wheels for casters can be made from a number of materials. Rubber and specialized synthetic plastics are the most common. In most cases, it is advisable to avoid wheels that are either very soft or very hard. Very soft wheels tend to create higher friction with the floor and increase push forces. Very hard wheels tend to be obstructed by small particles on the floor. An optimum balance between these extremes is generally the type of wheel material that minimizes push forces (e.g., the material used for in-line skate wheels).

It is important that wheel material and design be compatible with the floor surface(s) being used. For example, if a wheel's bearings and materials were selected for use on concrete surfaces, it may be difficult to push this cart on carpet. Conversely, if a wheel's bearings and materials were selected for carpet, the cart may be easy to push on concrete, but may be difficult to control.

Inflatable wheels are effective for handling very heavy loads, but increase push forces unnecessarily for lighter loads. Inflatable wheels are effective on rough terrain, but are not as effective on hard floors. Like all wheels made of softer material, inflatable wheels have the disadvantage of increased friction with the ground.

There are several types of bearings used in wheel design; ball bearings, sleeve bearings, and precision bearings. The best bearings for a particular application depend upon many factors, including the load, the floor condition, and the frequency of use. Consult the wheel manufacturer for guidance on the best bearing to use for a given application.

A.5.1.5.5 Swivel-Lock Capabilities. It is recommended that all wheels have a swivel-lock feature. This feature allows the user to lock wheels in a fixed orientation that permits movement of the cart or piece of equipment in a straight line for maximum control and stability.

The swivel feature allows the caster to be maneuverable in tight spaces. The wheel should swivel and "follow" the movement of the cart by having the center of the wheel offset from the center point of loading on the caster. This reduces forces required to initiate movement.

It is important that the swivel on wheels is easy to lock and unlock by simply stepping on the lock mechanism. In other words, personnel should not have to get down on their hands and knees to lock or unlock the wheels.

A swivel-lock is different from a rotation lock, which prevents the wheel from turning. Locks on the free rolling of wheels are important for specific cart applications such as when carts are stored on inclined surfaces, when the cart must be stabilized during loading and offloading, or when rolling carts are a potential safety concern.

A.5.1.5.6 Wheel/Caster Evaluation Worksheet. Table A-6 presents a worksheet to determine whether wheels/casters have basic ergonomic features. This worksheet is provided to help systematically evaluate various products.

Table A-6
Wheel/Caster Evaluation Worksheet

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category June		**Measure**	**Meets Criteria Yes**	**No**	**N/A**
Overall Capabilities	Basic Requirement	The wheel should minimize push forces and optimize control on all surfaces upon which the wheel will be used.			
	Wheel Composition	The wheel material and bearings should match the handling application and environment. In general, very soft or very hard materials should not be used.			
	Durability	The wheel should be durable, long lasting, and easy to maintain.			
Wheel Dimensions	Diameter	Wheel diameter should minimize push forces while maintaining stability. Wheels should be 4-8" (10.1-20.3 cm.) in diameter for most manually pushed carts (depending upon the weight of the load and the size of the cart) Wheel diameters for powered carts and trucks depend heavily on the load, size of cart, and floor surface.			

Table A-6
Wheel/Caster Evaluation Worksheet – cont'd

Date:			**Evaluator:**		
Job:			**Type:**		
Manufacturer:			**Model Number:**		
Model Name:			**Price:**		
Category June		**Measure**	**Meets Criteria Yes**	**No**	**N/A**
	Width	The wheel material and bearings should match the load, handling application, and environment.			
	Shape/Profile	The wheel shape should match the load, task, and environment.			
Features	Swivel	The wheel should swivel and "follow" the movement of the cart by having the center of the wheel off-set from the center point of loading on the caster.			
	Swivel-Lock	The wheel should have a swivel-lock feature that allows the wheel to be locked in a fixed orientation while rolling freely. This mechanism should be easily controlled with the foot.			
	Rotation-Lock	A rotation lock is an optional feature that may be critical for specific applications.			
Comments:					

A.5.1.6 Criteria for Patient Handling Devices.

There are several factors that make patient handling difficult work. Adult patients typically weigh more than 100 lb. (45.4 kg). The postures required by staff members to perform transfers are often very awkward and patients are often difficult to grasp. In addition, patients may not be fully in control of their bodies during transfers. Due to these factors, manual lifting of patients on a regular basis should be eliminated whenever possible. Even children can present severe lifting situations when the staff member is in an awkward posture. "Body mechanics" and lifting technique should not be considered primary control measures for preventing WMSDs. Mechanical assistance should be the primary control whenever possible. The overall goal of using these devices is to move toward a "zero-lift" patient care environment in which the staff member does not perform manual lifting of patients.

Many types of devices that can be used to assist in transporting or repositioning patients in a medical environment, including:

- Mechanical lift assist devices.
- Horizontal transfer devices.
- Gurneys/stretchers.
- Wheelchairs/shower chairs.
- Lifting belts.

The following sections provide criteria for these devices. Please refer to Sections A.5.1.4 and A.5.1.5 for additional criteria on rolling devices and wheels.

A.5.1.6.1 Mechanical Lift Assist Devices. Many types of mechanical lift assist devices are available. This discussion focuses on those types of lift devices that are most commonly used and recommended for routine patient transfer tasks, including bed-wheelchair transfers, bed-toilet transfers, wheelchair-toilet transfers, emergency lifts from floor, etc. Other types of specialty lift devices are available for specific tasks, such as ambulation and physical therapy. Although these specialty lift devices are not discussed in detail, the Patient Handling Device Evaluation Worksheet (Table A-7) maybe used in their evaluation.

There are two basic types of sling lift devices available: sitting sling lifts (Figure A.12) and standing sling lifts (Figure A.13). The standing/upright lifts are quicker and easier to use because the sling is secured only around the patient's upper body, rather than underneath the entire patient. Standing sling lifts can facilitate patient toileting more efficiently than a sitting sling lift in most cases. However, standing lift devices generally only function for those patients with some upper body functionality and the ability to bear some portion of their body weight on their legs. Sitting sling lifts are necessary for more dependent patients.

Figure A.12
Sitting Sling Lift

Figure A.13
Standing Sling Lift

The following major issues must be considered when selecting a mechanical lift assist device.

- Assure the comfort, stability, and safety of the patient in the sling. Both the actual safety/stability and the patient's perception of safety/stability are important. To this end, the attachments for the sling must be secure. There should be no opportunities for sling attachments to become disengaged during transfer.

- Assure that the lift device is stable throughout the transfer by having a wide base that does not tip even if the patient is moving.

- Provide for safe operation by one person (particularly if one person performs the corresponding manual task).

- Assure that the lift device can fit into the space required by the task. The lift device should be able to access the origin and destination points of the transfer. For instance, a lift device that is to be used for patient toileting should fit into existing bathrooms. In addition, the lift device should be accessible to beds, wheel chairs, and geriatric chairs. This is often accomplished via leg supports that can slide under beds and straddle various types of chairs.

- Assure that the lift device does not take significantly more time to use than the manual procedure. Accessible storage and adequate numbers of lift devices for the demand is critical.

- Prevent pinch or crush points on the lift device for the patient or the staff member.

- Provide lift devices that can lower to floor level if emergency lifts of patients from floor level may become necessary.

- Consider integrating a scale into the lift if patient weighing is required routinely. Combining the tasks of weighing and transferring the patient, effectively eliminates one lift per patient.

A.5.1.6.2 Horizontal Transfer Devices. There are several types of devices that can be used for transferring patients from one horizontal surface to another, or to reposition a patient on a bed or surgical table. The primary function of these devices is to reduce the sliding friction between the patient and the surface, thereby reducing the forces required to transfer the patient. Without these devices, staff members must simultaneously lift and slide the patient. Several types of sliding devices have been created (with several combinations and variations). These include:

- Sliding boards - large, stiff, flat boards typically made of a low friction plastic material.
- Roller boards - rollers covered with a flexible material.
- Sliding tubes - a flexible, low friction, plastic material manufactured in the shape of a flat tube or sheet.

Figures A.14, A.15, and A.16 illustrate these three devices. In general, stiff sliding boards are preferred for bed-stretcher transfers because they provide a safer transition between the two surfaces. Flexible sliding tubes work well for patient repositioning tasks (such as moving patients up in bed). Roller boards are used chiefly in surgical, ER, and birthing centers (primarily due to the compact size). However, sliding boards are more comfortable for the patient and are preferable if space constraints allow.

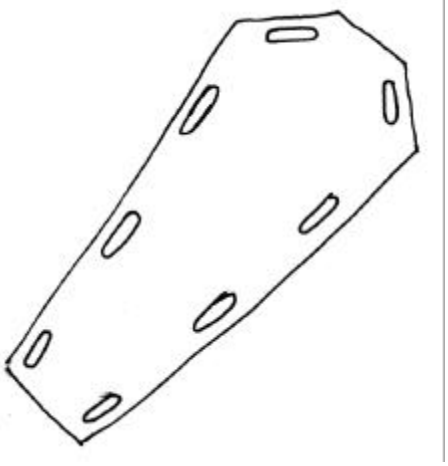

Figure A.14
Sliding Board

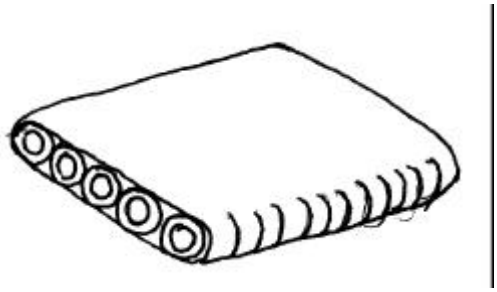

Figure A.15
Roller Board

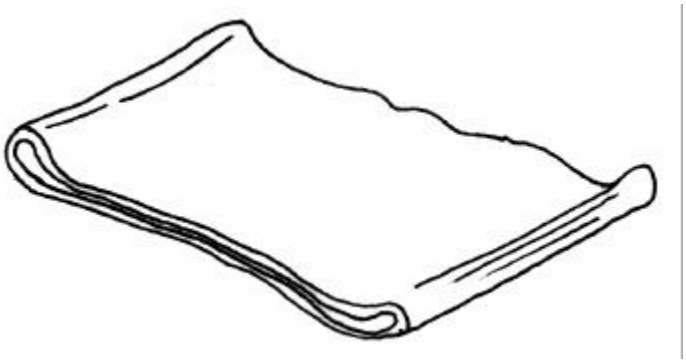

Figure A.16
Sliding Tube

All of these devices generally require the use of a draw sheet to function properly with minimal risk to the patient and staff. Section A.5.2.12.2 provides additional information.

In horizontal transfer devices, the following features are beneficial:

- Assure patient comfort by minimizing the thickness of the device. Devices that are less than 0.25" (0.64 cm) are preferred. To minimize the amount of patient movement required for placement and removal.

- Provide a surface that minimizes frictional forces.

- Provide a surface that is easy to clean.

- Support the entire patient's body when possible. Different sizes will be required for children and adults.

- Provide sufficient capacity to support the weight of the heaviest patient.

- Use materials which are light in weight (i.e., less than 5 lb.).

A.5.1.6.3 Gurneys/Stretchers. Gurneys and stretchers are devices for transferring patients long distances horizontally. For this discussion, the terms, "gurney" and "stretcher" are used interchangeably. Since these devices are in many ways similar to rolling carts, please refer to Sections A.5.1.4 and A.5.1.5 for additional information. This section focuses on those issues unique to gurneys and stretchers.

Gurneys should have the following features:

- Easy rolling capability on the highest friction surface (e.g., carpet).

- Multiple modes of movement (e.g., in long hallways and tight spaces). Long distance movement requires that one or more wheels are swivel-locked to provide easily controlled linear movement. Movement in tight spaces is facilitated when no wheels are swivel-locked. It should be easy and quick (such as with a single foot pedal or hand control) to switch between these modes.

- Easily adjustable side rails which can be locked into position thereby making inadvertent lowering difficult or impossible.

- Easily adjustable heights, allowing efficient patient transfer to fixed height tables (e.g., x-ray).

- Easily loaded into ambulances without exerting high forces or requiring heavy lifting. Forces that are required to load/unload the device from an ambulance should not exceed 50 lb.(22.7 kg.) per person (below 25 lb. (11.3 kg.) is recommended). It is preferable to use tailgate lifts to eliminate lifting altogether.

A.5.1.6.4 Wheel Chairs/Shower Chairs. Wheel chairs and shower chairs are devices used for transporting a partially ambulatory patient in a seated posture. Shower chairs are used specifically for toileting and showering.

Appropriate features for these devices are heavily dependent upon how the device will be used (e.g., home environment, transport, emergency, long-term use, etc.). However, the general features that are important for all uses include the following:

- Provide height adjustable and removable arms to assist in patient transfers

- Provide foot supports which fold out of the way during ingress and egress

- Provide wheels that are easy to lock/unlock, yet difficult to unlock inadvertently

A.5.1.6.5 Lifting Belts. Lifting belts are devices that wrap around the mid-section of the patient and improve the staff member's ability to grasp the patient effectively (Figure A.17). Lifting belts can be used in patient transfers where the patient is capable of assisting in the transfer. Lifting belts are often used for ambulation and other patient movements to encourage the patient to perform the actions independently, or to build or maintain muscle strength.

Caution should be used with lifting belts (and manual transfers in general). If the patient loses strength or control mid-transfer, the staff member may be forced to suddenly bear the entire weight of the patient. This can result in an acute injury for the staff member and/or the patient. Use of lifting belts should be minimized, in general, and only used in specific situations where the patient's condition and abilities are stable and known. Mechanical ambulation assist devices (also called "walkers") are generally preferred for tasks where the patient's condition is less than completely understood and reliable.

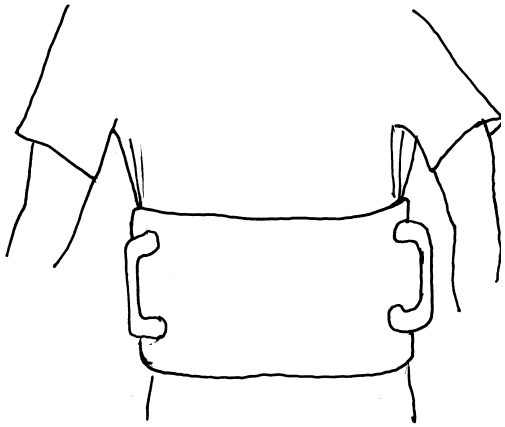

Figure A.17
Lifting Belt

The following features should be considered in lifting belts:

- Provide belts that are at least 6" (15 cm) wide to provide a larger surface area to support the patient without slipping.

- Provide belts that have a high friction surface facing the patient's body to minimize slipping.

- Provide belts that have soft, padded edges to prevent scraping or bruising the patient.

- Provide belts with built-in full-grip handles that are between 1 and 1.5" (2.5-3.8 cm) in diameter and at least 5" (12.7 cm) in length. The handles should be made of a rubberized, high-friction material and should be rounded to avoid hard edges.

A.5.1.6 .6 Patient Handling Device Evaluation Worksheet. Table A-5 presents a worksheet to determine whether a patient handling device has basic ergonomic features. This worksheet is provided assist in the systematic evaluation of various products. The first part of the worksheet (criteria marked with asterisks) applies to most or all of these devices. This is followed by criteria for specific types of devices.

Table A-7
Patient Handling Device Evaluation Worksheet

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
General Safety Requirements	Stability*	Device must be stable throughout the transfer and must be resistant to tipping even if the patient is moving.			
	Moving Internal Components*	Device should not have any exposed moving components that could create pinch or crush hazards. All moving components that could result in a pinch/crush hazard should be guarded.			
	Hard/Sharp Edges*	Device should not have any exposed hard or sharp edges that could result in a cut or scrape.			
Overall Capabilities	Capacity*	Capacity of the device should exceed the heaviest patients.			
	Space Efficiency*	Device must fit into the space required by the task.			
	Posture Requirements*	Device should encourage comfortable and neutral body postures during use. It should not contribute to bent wrists, reaching, and awkward back/neck postures for the patient or staff.			
Ease of Use	Overall*	Device adjustments should be easy to operate and should not increase task time significantly.			
	Mobility*	Device should be easy to maneuver without loss of control or stability.			
	Cleanability*	Device should be easy to clean.			
	Control understand-ability*	Controls used to operate the device should be easy to identify, understand, and actuate.			
Force Requirements	Transporta-tion Forces*	Forces required to manually push the device should be less than 25 lbs. (11.3 kg.) Negligible forces are recommended when appropriate.			
	Control Actuation Forces*	Controls that require constant pressure to allow operation should not require a significant amount of force. Forces should be substantially less than 2 lb. (0.9 kg.).			

Table A-7
Patient Handling Device Evaluation Worksheet (Cont'd.)

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Handles	Handle Existence*	Devices should have "full-hand grip" handles when: · forces are significant. · control is critical.			
	Handle Orientation*	Handles are vertically oriented (in most situations, horizontal handles are also acceptable and may be preferred in specific circumstances).			
	Diameter*	1-1.5" (2.5-3.8 cm.).			
	Clearance Under Handle*	There should be at least 4" (10.2 cm.) hand clearance between the handle and the mounting surface.			
	Handle Length*	Minimum 5" (12.7 cm.). Longer handles are generally preferred to increase flexibility.			
	Handle Composition *	Handles should be covered with a high friction, rubberized surface.			
Criteria for Mechanical Lift Assist Devices	Sling Connections	Connecting/disconnecting the patient to/from the lift device should be quick, simple, and easy. There should be no possibilities for sling attachments to release during transfer.			
	Single Person Operation	Device should allow safe operation by one person (particularly if the corresponding manual task is performed by one person).			
	Wheel Locks	It should be possible to lock the lift device in position during sling attachment/detachment.			
	Range of the Height Adjustment	The range of adjustment should allow patients to be lifted from floor level to more than 45" (114.3 cm).			
	Integrated Scales	Consider scales integrated into the lift device to eliminate unnecessary lifts.			

Table A-7
Patient Handling Device Evaluation Worksheet (Cont'd.)

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Criteria for Horizontal Transfer Devices	Thickness	Thickness less than 0.25" (0.64 cm) is preferred to minimize the amount of patient movement required to place and remove the device.			
	Forces	Minimize frictional forces by providing a low friction surface.			
	Capacity	Device should have the capacity to support weight of the heaviest patient.			
	Size	Device should support patient's entire body when possible. Provide multiple sizes for children and adults.			
	Weight	Device should be light in weight (i.e., less than 5 lb.).			
Criteria for Gurneys/ Stretchers	Rollability	Device should be easy to roll on the highest friction surface (e.g., carpet).			
	Modes of movement	Device should have a mode for traveling straight down long hallways and another mode for maneuvering in tight spaces.			
	Side Rails	Side rails should be easily adjustable, yet difficult to inadvertently lower.			
	Height Adjustability	Device should be easily height adjustable to allow efficient transfers of patients to fixed-height tables.			
	Loading/ Unloading Ambulances	Forces required to load/unload device from ambulance should not exceed 50 lb. (22.7 kg.) per person (less than 25 lb. or 11.3 kg. is preferred).			
Criteria for Wheelchairs/ Shower Chairs	Chair Arms	Chair arms should be height adjustable and removable to assist in patient transfers.			
	Foot Supports	Foot supports should fold out of the way to assist in patient transfers.			
	Wheel Locks	Wheels should be easy to lock/unlock, but difficult to unlock inadvertently.			

Table A-7
Patient Handling Device Evaluation Worksheet (Cont'd.)

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Criteria for Lifting Belts	Size/Width	Belts should be at least 6" (15 cm) wide to cover a larger surface area.			
	Composition	Belts should have a high friction inner surface and soft, padded edges.			
	Handles	Belts should have built in full-grip handles (see the handle criteria above for more information).			
Comments:					

IMPLEMENTING MINOR MODIFICATIONS

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A.5.2 IMPLEMENTING MINOR MODIFICATIONS

This section provides the user with additional information about the corrective actions recommended in the Case Studies.

A.5.2.1 General Considerations and Approach

When modifying the workstation, tools, or equipment at a work area, it is important to consider all of the tasks that may be impacted by that modification. The following are important considerations:

- Keep the work area flexible.
- Avoid creating a different type of safety hazard.
- Make sure that materials used are appropriate for the area (e.g., special considerations for sterile areas).
- Rely on employees to help identify quick-fix improvement possibilities.

Whenever possible, try to build in adjustability and flexibility at the workstation to enable a number of employees to perform a variety of tasks comfortably. For example, an individual who is 5'2" will have different requirements for work surface height (lower to the ground) than a fellow employee who is 6'0". Adjustability enables each employee to adapt the work area to suit his/her specific needs. It is also important to avoid creating a maintenance or other safety hazard. For example, constructing a platform that is "too small" may create a tripping or fall hazard. Similarly, placing a piece of anti-fatigue matting in a high traffic area may create a tripping hazard.

Employee input is important to ensure the effectiveness of proposed modifications. To maximize the effectiveness of employee input and avoid creating false expectations, the following approach is recommended:

- Define the specific issue to be addressed (e.g., reduce the number of times the employee must lift an object, reduce the degree of bending, etc.).
- State that, "at this time" the changes will be limited to adjusting or making better use of the current work area, work platforms, or equipment (i.e., new purchases of new equipment can be suggested, but will not be evaluated until the next budgeting period).
- Remind employees that, since they are all different, an adjustment that works for one of them may not be appropriate for the others.

A.5.2.2 Improving Existing Tools

The purpose of modifying existing tools is to minimize discomfort and the potential for WMSDs. When considering changes to an existing tool, it is important to consider the task being performed, the size of the employee's hand, and the "safeness" of changing a feature of the tool. For example, padding may be added to wrap and build-up a tool handle diameter that is too small for an employee. However, if the padding is loosely fit and the tool will be used around moving equipment, the padding may create a safety hazard. A better solution may be to add a slip-on rubber sleeve.

A.5.2.2.1 Tool Maintenance. Maintaining or servicing existing tools is often a good starting point for improving tool performance and employee comfort. The following factors should be considered:

- Tool blades, grinding stones, and bits should be checked regularly and replaced when necessary to ensure that they are sharp for optimum performance. A dull bit or blade will impact the quality of finish and often requires the employee to work longer on the task to achieve the desired outcome. Maintenance of blades, bits, and grinding stones may be done in the immediate work area according to a maintenance or replacement schedule (provided by the supplier or manufacturer). In some cases, the tool may have to be sent to the manufacturer for precise maintenance routines (replacement tools may be provided).

- Motors should be regularly serviced and lubrication should be performed as specified by the manufacturer of the tool.

- Tool balancers should be regularly adjusted to balance the weight of the tool. Adjustment is required when the employee appears to be pulling the tool ("fighting the pull"). When a tool is not balanced, the weight of the tool must be leveraged by the user to keep it balanced. This increases fatigue and affects the quality of the work.

A.5.2.2.2 Handle Diameter. Establishing the optimum diameter maximizes the strength of the hand. A properly sized tool will reduce grip force requirements. The optimum handle diameter is between 1.5 and 2.2" (3.8-5.6 cm.). Select the most appropriate handle diameter that will fit the employee. Increasing the handle diameter can be accomplished using sponge padding or commercial grips. It is important that the adaptation is secure and fits snugly around the handle. The material added should take into account the thickness of gloves that the employee typically wears.

A.5.2.2.3 Handle Length. Handle length may be increased to reduce pressure points in the palm or to increase the mechanical advantage. The following factors are important considerations:

- The recommended minimum handle length is 5" (12.7 cm.). It is important that handles extend past the palm as illustrated in Figure A.4.

- Adapting a tool that is too short can be accomplished by welding an extension to a steel handle. If this is done, ensure that all edges are smooth and the extension is integrated (in line) with the previous handle. Wooden and plastic handles are very difficult to adapt since there is no secure method to add additional material. For tools made of these materials, employees have sometimes used special purpose tape and wooden extensions. It may be possible to order a new longer handle from the manufacturer.

- Adaptation also can be accomplished by purchasing an inexpensive commercial handle that meets the specification for length and diameter. This method will be a more feasible solution for such tools as hammers. Commercial handles may be available for power tools but in most cases a tool upgrade will have to be examined as the best alternative.

A.5.2.2.4 Air Hose Connection. An appropriate connection can decrease grip force requirements. Use a swivel or universal joint connector to minimize drag on the hose. Another option is to fabricate a simple hanger (like an "I.V." tube stand) to elevate and support air hoses. The hanger will also reduce drag along the floor and make the tool easier to position.

A.5.2.3 Getting Closer to the Work

The individual should get as close as possible to the work to avoid excessive reaching. Removal of obstructions from the work area can often solve problems associated with reaching.

A.5.2.3.1 Remove Obstructions from the Floor. Poor housekeeping is often the main contributor to obstacles in the work area. To keep the employee as close to the work as possible, the following actions may be helpful:

- Help the worker identify and remove obstructions from the floor such as air hoses, boxes, tools, and carts.

- Maintain a clean work area and store items as necessary in designated storage areas.

A.5.2.3.2 Remove Obstructions between the Worker and the Work. There are several strategies that avoid obstructing the work area:

- Remove any part or panel in front of the area that needs to be accessed prior to working inside the area.

- Reorient the work piece or investigate the feasibility of modifying the fixture if any fixture or part restricts access (e.g., removing or relocating a panel or kick-plate).

- Lower a work platform (when used) to provide clear access under the work and allow the employee to stand up straight while moving within the work area or while servicing the part.

A.5.2.3.3 Reduce Congestion by Providing Appropriate Aisles. To reduce congestion in warehouse applications, consider the following aisle guidelines for one way flow:

- For trackers, the aisle width should be at least 12’ (3.66 m)

- For 1-ton to 3-ton fork trucks, the aisle space should range from 9 to 11’ (2.74-3.35m)

- For narrow aisle trucks, the aisle width should be 6’ (1.83 m)

- For manual platform trucks, the aisle width should be 5’ (1.5 m)

A.5.2.4 Adding Variety to the Work Position

One of the most effective strategies for improving comfort and preventing fatigue in the lower back and legs is to provide task variety by alternating standing and seated tasks. The factors for consideration when helping employees identify (or confirm) which of their tasks might be done best from a seated position and which might be done best from a standing position are delineated below.

A.5.2.4.1 Sitting. The desirable seated posture is shown in Figure A.18. Sitting is most appropriate when the following conditions are present:

- All items needed for the task can be easily accessed and handled within the seated work place.

- No large forces (such as handling heavy objects) are required .

- Precise assembly is required.

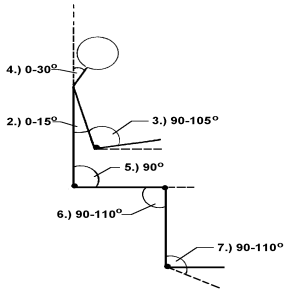

Figure A.18
Recommended Seated Posture

Although many chairs have built in adjustments, examples of additional enhancements are:

- Taping a rolled up towel to the backrest to increase the lumbar support.

- Taping foam or other compressible surfaces around the armrest until the surface matches the width guideline.

For chair selection criteria, refer to Appendix 5, *Design Criteria*, of the Administrative Guide.

A.5.2.4.2 Standing Posture. The desirable standing posture is shown in Figure A.19. Standing is most appropriate when the following conditions are present:

- A greater range of movement is required for reaching
- It is not appropriate or possible to allow knee room
- The point of operation can't be lowered (for sitting)

Although standing has the advantage of providing for a greater range of motion, it has the disadvantage of placing stress on the back and legs, and causing pooling of blood in the lower legs. Employees should be encouraged to avoid locking their knees and to walk or move around periodically to prevent static muscular fatigue. Employees should also be encouraged to use cushioned shoe inserts (e.g., sorbothane material or other impact/shock-absorbing material).

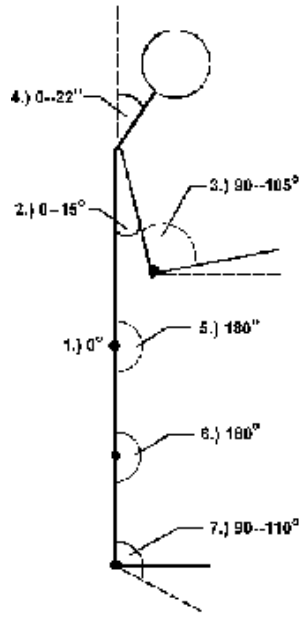

Figure A.19
Recommended Standing Posture

A.5.2.5 Improving the Work Height

Improving the work height can result in significant improvements to low back, shoulder, and, in some cases, wrist comfort. It is not simply a matter of raising or lowering the work. The relationship between the height of the employee and the height of the primary work location should be optimized

A.5.2.5.1 Single-Employee Workbench. When only one employee uses a workstation or bench, the best approach is to help the employee customize his/her work area. The following items should be considered:

- Establish height so the worktable is low enough to handle the largest work piece and allows the employee to work in a neutral position. (For aircraft, establish the work platform so the employee can work on the lowest point from a comfortable seated or standing position. Higher points of work can be reached using additional [stable] risers.)

- Build simple tabletop risers out of wood or a similar material to increase the effective work height for smaller/shorter work pieces.

- Raise the height for taller employees by putting table legs on blocks.

- Lower the height for shorter employees by cutting the legs of the current tables, or by adjusting the leg height if the table has adjustable leg extenders.

A.5.2.5.2 Multiple-Employee Workbench. When more than one employee must use the work area, the following consideration allows for maximum flexibility:

- If the worktable is a fixed height, set it up for taller employees (i.e., raise the table up on blocks) and then provide a stable platform for shorter employees.

A.5.2.5.3 Fixed Position Point of Operations (e.g., Aircraft). In operations where the point of operation cannot be changed, consider the following:

- Add temporary, stable risers for shorter employees who work on elevated platforms.

- Use a stool or chair for work that may be too low for comfortable standing work.

A.5.2.5.4 Table and Counter Heights. Appropriate table and counter heights depend on the nature of the task and the height of the worker. To create small increments of vertical height adjustment, consider using pegs and pre-drilled holes in the legs, or providing electric or mechanical systems. To prevent awkward back postures and reduce visual stress, consider the following general guidelines for table and counter heights:

- Angle the work surface 15° forward for standing tasks requiring visual inspection.

- Set the workstation to adjust between 39 and 43” (99-109 cm) for precision tasks (drafting and fine soldering).

- Set the workstation to adjust between 35 and 37" (88-94 cm) for tasks requiring "light work" (assembly of small parts).

- Set the workstation to adjust between 29 and 35" (74-89 cm) for tasks requiring "heavy work" (drilling or molding).

A.5.2.6 Improving Comfort with Foot Pedal Use

Considerations for improving comfort with foot pedal use in both seated and standing tasks are discussed in the following subsections.

A.5.2.6.1 Standing Work. The primary objective of appropriate foot pedal design is to prevent the employee from maintaining a "flamingo" or single-leg stance. The main concern is for employees who use foot pedals for a significant part of the shift. The following modifications should be considered:

- Build up a simple platform riser and place the foot pedal off the front surface so both heels are on the platform and the action of the foot is down (keep a 90-120° angle between the foot and the lower leg). To provide adequate leg room, remove obstructions to allow a distance of at least 10 inches between the end of the foot and the closest vertical surface.

- Add a heel riser (block of wood) to the heel end of the foot pedal. This option may not be as effective as the first one, but it will help to distribute body weight more evenly across both legs and the back muscles.

A.5.2.6.2 Seated Work. The primary objective is to keep the feet and legs in the neutral position. Most foot pedals (with the exception of vehicles) can be re-positioned. The guidelines are presented below.

- Foot pedal stability is critical. Add a non-slip surface or a weight to the base of the foot pedal to increase stability.

- The foot pedal should be height, angle, and horizontally adjustable to accommodate multiple employees. Build a riser out of wood to place under the foot pedal to provide height adjustability.

- Foot pedal side-to-side position and distance away from the body should be adjusted to maintain angles of 100-110° between the back and the thigh and the lower leg, as well as 100-110° between the foot and the lower leg. Both legs should be centered with the body.

A.5.2.7 Reducing the Demands of Manual Handling

Manual materials handling (MMH) is one of the most important aspects of work to which ergonomic principles should be applied, particularly in the prevention of low back pain and injuries. Manual materials handling involves the general types of activities illustrated in Figure A.20.

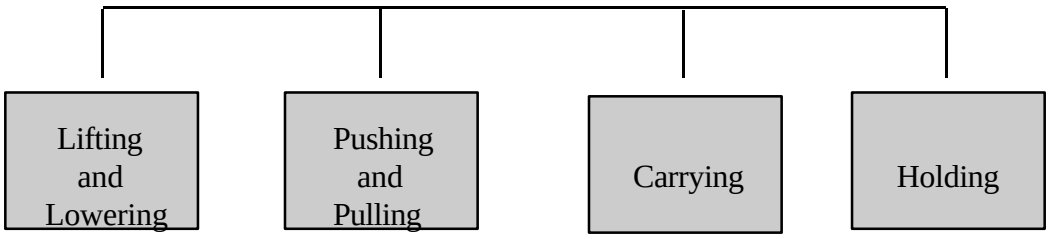

Figure A.20
Manual Materials Handling Activities

Typically, MMH tasks in warehouse and service areas require the worker to perform a combination of the above activities. The ability of the employee to handle materials safely is a function of the following factors:

- Task characteristics.
- Material/container characteristics.
- Worker or handling characteristics.

A.5.2.7.1 Task Characteristics. Consider the following when identifying the types of modifications that can be made to reduce exposure to risk factors:

- Reduce twisting motions by re-organizing the work area to provide sufficient space for the entire body to turn when handling items or when pushing or pulling carts.
- Reduce excessive forces by encouraging the employee to use available mechanical aids such as hoists and cranes. If aids are difficult to use, make a note of the reasons why and communicate this information to the shop supervisor or shop mechanic. It may be possible that a repair or minor modification to the hoist may make it easier to use.
- Limit stacking of lightweight objects to shoulder height.
- Keep heavy objects at knuckle height.

- Keep wheels on carts well maintained.

- Keep objects close to the body when lifting or carrying.

- Distribute tools evenly on both sides of a tool belt. Encourage the employee to remove the tool belt and place it on a small worktable, whenever possible. The goal is to avoid having the tool belt (especially if the weight is unevenly distributed) place an additional load on the spine and muscles of the back.

A.5.2.7.2 Material/Container Characteristics. Consider the following when identifying the types of modifications that can reduce exposure to risk factors:

- Reduce excessive forces by distributing the weight/items evenly in a container.

- Use containers with handles whenever possible.

- Use the minimum size and lightest weight container possible for transferring loads.

- Place containers on carts and push the cart instead of carrying the load.

- Add wheels to small, heavy containers and use a hook to drag/roll them across the floor.

- Clearly label the container or item with its correct weight to help employees to decide how to handle the material.

A.5.2.7.3 Worker and Handling Characteristics. Consider the following when identifying the types of modifications that can be made to reduce exposure to risk factors:

- Maintain a straight back when lifting, using the leg muscles to lower the body and lift the load.

- Keep the body balanced.

- Turn with the feet rather than twist the trunk when lifting or transferring loads.

- Share the load/lift with another employee (buddy lift).

- Avoid quick movements when two people are lifting an object, and make sure both employees have a firm hand hold before starting the lift. Lift the load with a smooth body motion.

- Keep the load as close to the body as possible when lifting.

- Avoid overloading carts.

- Know the weight of the load being lifted. Make sure when using the buddy lift that both people can handle the load. Do not proceed with the lift if one employee is straining to maintain the lift.

- Alternate handling heavy loads with light loads, whenever possible.

A.5.2.8 Reducing Effects of Vibration

Vibrations are mechanical oscillations produced by either regular or irregular periodic movements of a body about its resting position. Vibration is characterized by its frequency, acceleration, and direction. Persons in direct contact with vibrating objects or surfaces may be at risk.

The two types of human vibration exposure are whole-body vibration and hand/arm (segmental) vibration:

- Whole-body vibration is transmitted to the "whole body" usually through the surface that supports the weight of the body. A worker who drives a vehicle is subjected to whole-body vibration through the buttocks and back, if a backrest is used.

- Hand/arm or segmental vibration is vibration transmitted to the hands and arms, generally from hand-held power tools.

The whole body can be considered to be a dynamic mechanical system. Each part of that system (body segment) resonates at a different frequency. Vibrations are "absorbed" by the tissues and organs. Depending on the frequency of the vibration and overall exposure, localized muscle fatigue and even damage to other tissue can occur.

A.5.2.8.1 Provide Anti-vibration Gloves. Anti-vibration gloves attempt to control the transmission of vibration by providing a dampening surface between the tool and the employee. Many times, providing gloves is a more effective solution than damping the tool because gloves are able to protect against cuts and lacerations, provide an effective dampening media, and do not increase the tool's handle diameter. Care must be taken to ensure that glove use does not make an otherwise appropriate handle "too large". Additionally, anti-vibration gloves are available in a variety of glove sizes and types (e.g., full-hand, fingerless), making them suitable for many applications.

A.5.2.8.2 Attach Anti-vibration Adhesive Surfaces. See A.5.2.2.5

A.5.2.8.3 Perform Periodic Maintenance. One cause of vibration-type disorders is due to poor tool or equipment preventative maintenance (PM). Lack of PM results in more vibration being transmitted to the employee than intended. Please see Section A.5.2.1.2 and consult the equipment manufacturer regarding maintenance schedules.

A.5.2.9 Modifying Work Areas to Improve Employee Comfort

The following sections deal with modifying existing work areas to allow for employee comfort.

A.5.2.9.1 Provide Support for the Lower Limbs – Footrests and Footrails. When considering methods for providing support for the lower limbs, consider providing footrests and footrails with the following dimensions:

- The footrest's front edge should be approximately 14" (35.6 cm) and rise at an angle of 10°.
- The footrail's front edge should be level and the diameter should be at least 5" (12.7 cm).

A.5.2.9.2 Provide Undersurface Cut-ins (Toe Spaces). Undersurface cut-ins (toe spaces) allow employees to maintain a neutral back position when standing at counters.

- Toe space height and depth should each be 4" (10.2 cm.).

A.5.2.9.3 Reduce Effects of External Trauma. Resting on hard or sharp edges to support an upper limb is one source of upper limb trauma.

- For tasks that require hand stability and visual access, cover edges with compressible padding to support the upper limb.

A.5.2.9.4 Provide Knee Space for Seated Tasks. It is essential to provide enough space under a surface so that the legs and feet have angle room to move.

- The most important consideration is knee clearance, or the distance between the knees and any object (e.g., table leg, trash can). If the design allows enough room for the legs of a tall male (95^{th} percentile), then the space will also be comfortable for smaller workers.

- When a person is in a sitting position there should be a distance of 39" (99 cm.) from the back of the buttocks to the closest object. Additionally, if the task or job requires that the person turns and places objects on adjacent work surfaces, a 39" (99 cm.) pivoting radius should be provided.

A.5.2.9.5 Provide Anti-fatigue Matting for Standing Work Areas. Prolonged standing without movement can result in the pooling of blood in the lower limbs. Therefore it is essential that anti-fatigue matting be provided at work areas where employees stand while completing their tasks (e.g., checkout counter, meat cutting).

- Depending on the work environment there are different materials and surfaces available. For instance, in food preparation environments, it is essential that the matting have perforations that allow for constant cleaning and rinsing; in industrial environments that involve cutting of metals, durable surfaces are required to prevent metal shards from becoming imbedded.

- The size for anti-fatigue matting is dependent upon the task demands. For tasks that involve standing at a single workstation, ensure that the anti-fatigue matting is at least 24" X 36" (61–91 cm.).

- Appropriate anti-fatigue matting should be replaced approximately every 18 months or less depending on traffic. Additionally, ensure that the matting is no more than 1.5" (3.81 cm.) thick and has beveled edges to prevent potential trip hazards from occurring.

A.5.2.10 Modifying the Work Area to Reduce Visual Demands

Eyestrain is most commonly caused by exposure to excessive or inadequate amounts of light. The sources of eyestrain can include natural (e.g., sun) or artificial (e.g., task lighting) sources. It is possible to reduce eyestrain by modifying existing work areas or providing the appropriate amount of light.

A.5.2.10.1 Reduce Exposure to Glare Caused by Light Sources, Work Surfaces, and Work Surface Orientation or Location. To arrange work surfaces with the intent of minimizing glare, it is important to consider the following:

- When arranging a work surface, locate the sources of overhead light. If a computer is used, place the screen between overhead light sources and perpendicular to the window. Additionally, ensure that the monitor's face is not tilted upwards to prevent glare from the overhead lighting system. If task lights are present, then ensure that they are placed to focus only on the work area and not on the monitor's surface.

A.5.2.10.2 Provide Appropriate Lighting Based Upon Task Demands. Visual demands can be reduced by providing the correct amount of overhead lighting:

- 150 fc for computer based tasks (this can be accomplished with task lighting).
- 50-75 fc for palletizing-type tasks.
- 50-75 fc for baking and kitchen tasks and 50 fc for general illumination.

(Note: The foot-candle measurement should be taken at the surface or point where the work is performed.)

A.5.2.11 Provide Appropriate Gloves

Gloves are used to increase ease of gripping and prevent exposure to risk factors (e.g., chemical or biological). Improperly fitting gloves can result in increased hand stress.

A.5.2.11.1 Glove Texture, Materials, Size, and Task Demands. The following should be considered when purchasing gloves for warehouse and service area environments:

- For tasks that require gripping of boxes or large objects, consider gloves with high friction surfaces to decrease grip forces.
- For tasks which require latex gloves, provide two types: those with powdered lining and those without powdered linings as a means for preventing allergic reactions. Additionally, if double gloving is required, a larger size outer glove should be worn to reduce hand constriction.
- Consider purchasing gloves that are "handed" as a means for providing a more appropriate fit and that are sized numerically rather than small, medium, or large.

A.5.2.12 Patient Handling Equipment

There are a number of ways to reduce the physical demands of patient handling. The following section describes many of these considerations.

A.5.2.12.1 Mechanical Lifting Equipment. A mechanical lift device should be used whenever possible to handle a patient who needs assistance. Even lifting children can lead to WMSD's when the staff member is in an awkward posture. The overall goal is to work towards a "zero-lift" environment, in which staff do not manually lift patients. The following should be considered:

- Use a lift device to complete patient transfers whenever possible. There are two basic types of sling lift devices available: sitting sling lifts and standing sling lifts (see Section A.5.1.6.1). The standing/upright lifts are quicker and easier to use than sitting sling lifts because the sling is secured only around the patient's upper body (rather than going underneath the entire patient). Standing sling lifts are preferred for more independent patients. However, standing lift devices generally require that patients have some upper body functionality and some weight-bearing capabilities in their legs. Sitting sling lifts are necessary for more dependent patients.

- Share the following information with the staff who use the lift devices:

  – Store lifting devices adjacent to common patient handling areas and ensure that adequate lift devices are available to meet workload requirements.

  – Explain to patients that mechanical lifting equipment is more comfortable for them and helps to prevent staff injuries. Ask for their assistance in completing the transfer.

  – Be sure to secure the sling prior to initiating the lift.

  – Move the lift device as close as possible to minimize reaching. Step close to the patient to further reduce reaching. Adjust the bed height to minimize bending while attaching slings.

  – Try to combine transfers to eliminate unnecessary lifts. Use patient scales integrated into lift devices or platform scales to weigh patients.

A.5.2.12.2 Manual Lifting Equipment. There are several devices that can substantially reduce demands in repositioning and transferring patients. Consider the following suggestions:

- When transferring patients between beds and stretchers, use a sliding board and a large draw sheet. A slider board is a large, flat, plastic board that reduces the friction of sliding the patient (see Section A.5.1.5.2). A wide draw sheet can be used to prevent bending and reaching while sliding the patient. A full size top sheet (or two), turned sideways, can serve as an effective draw sheet for this task. Clear the workspace of unnecessary equipment or other obstructions. Raise the bed and equalize the heights of the bed and stretcher. Lock all wheels prior to completing the transfer. Roll up the edge of the draw sheet to obtain a firm grasp. Perform the transfer by stepping and shifting weight rather than with a back movement.

- For repositioning a patient in bed, be sure to raise the bed to a comfortable height. Obtain assistance if necessary. Use a sliding tube when available to reduce sliding friction between the patient and the bed sheets (See Section A.5.1.5.2).

- If mechanical lift devices are not available for patient transfers, use lifting belts to improve the ability to grasp the patient securely. See Section A.5.1.5.5 for more information on Lifting Belts. Obtain assistance in performing transfers if necessary.

A.5.2.12.3 Staff Training and Technique in Patient Handling Tasks. When manually repositioning or transferring patients, there are several guidelines that can reduce the wear and tear on the body. Staff who perform these tasks need the following information:

- The most important consideration while handling patients is to avoid the tendency to rush. Take a deep breath before completing the transfer. Coordinate transfers with other staff members and patients. Initiate the transfer on a count of three. Perform the transfer smoothly. Take the time to complete the transfer safely and effectively.

- It is always better to use the large leg muscles to lift instead of the small muscles of the back. To achieve this, bend the knees and arch the back prior to lifting. Lift by straightening the legs rather than the back. It may be helpful to remember to touch the knees lightly to the side of the bed or wheel chair to make sure they are adequately bent.

- Move in as close to the patient as possible prior to lifting. This will reduce reaching and improve control.

- When rotating, turn with the feet rather than twisting the lower back. Swing one leg and pivot with the other leg. Keep the shoulders in line with the feet.

- When repositioning a patient in bed, work with two or more people, with at least one person standing on each side of the bed. In this way, staff can work together to reduce reaching and bending.

- Prior to completing the transfer, clear the path of travel to prevent obstructions.

- Always attempt to equalize transfer heights as much as possible. Use gravity to assist with the transfer by placing the destination slightly lower than the origin.

- Try to distribute heavy handling tasks throughout the day rather than performing them all at once.

A.5.2.12.4 Patient Training and Education. Enlisting the help of the patient is a powerful strategy for reducing the demands of the task. Staff need the following guidance:

- Understand the patient's capabilities and limitations. Assess the patient's condition immediately prior to the transfer. Ask them how they feel and to tell you immediately if they start to feel weak during the transfer.

- Ask the patient to assist in the transfer whenever possible. Encourage patients to shift to the side of the bed when possible. When moving the patient up in bed, bend the patient's knees and ask them to push with their legs.

- If the patient begins to fall, do not try to support their full weight. Try to guide them slowly to the floor.

LEVEL I ERGONOMICS ASSESSMENT
SUMMARY AND RECOMMENDATIONS
SAMPLE

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LEVEL I ERGONOMICS ASSESSMENT
SUMMARY AND RECOMMENDATIONS

Date (YYMMDD)		Workplace Identifier:	
(*use this space for mechanical imprint)*		Base DOVER AFB	Organization 96 ABW
		Workplace SURVIVAL EQUIPMENT	
		Bldg. No./Location 306	Room/Area A
		AFSC/Job Series	Job Name

CRITICAL TASKS IN PRIORITY ORDER

Task Name	Task Rating	Body Regions and Ratings (Circle one for each region)				
		Shoulder/Neck	Hands/Wrists /Arms	Back/Torso	Legs/Feet	Head/Eyes
1. PACKING	~~High~~ Med	High ~~Med~~	High ~~Med~~	~~High~~ Med	High Med	High Med
2. FOLDING /FITTING	~~High~~ Med	High ~~Med~~	High ~~Med~~	~~High~~ Med	High ~~Med~~	High Med
3.	High Med	High Med	High Med	High Med	High Med	High Med

OVERALL JOB RATING

RATING: ~~High~~ Medium

(Circle one)

PRIORITY BODY REGION: SHOULDER/NECK HAND/WRIST/ARM

(circle one) LEGS/FEET ~~BACK/TORSO~~ HEAD /EYES

- Findings are consistent with results from Job Requirements and Physical Demands Survey (Public Health): ☐ Yes ☐ No ☒ ~~N/A~~

  Comment: INVESTIGATION CONDUCTED IN RESPONSE TO AF OCCUPATIONAL ILLNESS INVESTIGATION

- Findings are consistent with employee reports of discomfort and/or illness: ☒ ~~Yes~~ ☐ No

  Comment: COMPLAINTS OF BACK DISCOMFORT ARE SUPPORTED BY RESULTS

RECOMMENDATION FOR FOLLOW-UP

Modifications and adjustments	Major changes and/or purchases
-Provide appropriate knee protection/knee pads -Provide shoe inserts -require that two employees share the task of lifting raft in and out of packing fixture	-Consider fabricating a simple table to provide an elevated surface for folding raft (keep employees from kneeling on floor) -Consider modifying current packing fixture to tip sideways (roll or slide raft into fixture), tip up to pack, tip back down to unload.

_____ _____ Expected Benefits (Check all that apply) ☒ Productivity/Quality	_____ Expected Benefits (Check all that apply) ☒ Productivity/Quality
BEF (Sign) _____	

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