APPENDIX 5

Recommendations

APPENDIX 5

This Appendix corresponds with Step 5: Recommendations. It provides information on:

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

The *Using Design Criteria to Implement Major Purchases* section is to be used in situations where you are asked to provide ergonomics criteria for selecting a new, potentially major piece of equipment such as a chair, monitor support, or other item. Since the focus of this section is on design and selection criteria for major purchases, and since a shop may not be able to implement this type of recommendation right away, you may only need this in special situations. Each time you do an assessment, you may still want to make the shop supervisor aware that you can provide assistance in helping to evaluate future purchases to help them select equipment with features that provide the most benefit to employees while providing the most value to the shop. Again, the "Implementation Reference" column on the Corrective Action List refers directly to information provided in this section.

The *Implementing Minor Modifications* section provides you with guidance on how to actually make or implement the minor modifications - changes and adjustments to existing workstations, chairs, equipment, etc. - that you would have already 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 provided in the case studies and it will be helpful each time you apply the Level I process.

USING DESIGN CRITERIA TO IMPLEMENT MAJOR PURCHASES

Appendix 5

A.5.1 USING DESIGN CRITERIA TO IMPLEMENT MAJOR PURCHASES

In this section, design criteria have been "converted" into evaluation criteria which you may use when selecting new or replacement tools or equipment. Criteria are provided for:

- Lifting Devices (e.g., hoists, cranes); and,

- Hand Tools/Power Tools.

To enable you to use this information correctly and efficiently in the future, a "Product Evaluation Worksheet" is provided for each item. The worksheets are provided at the end of the section as "forms" which you may copy. In the past, some individuals have sent similar worksheets to product manufacturers or vendors to request information on the ergonomics features of their products. The remainder of this section provides you with the information upon which the worksheets are based.

A.5.1.1 Criteria for 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 which must be considered when selecting a lifting device: convenience and safety.

- ***Convenience***. If the lift device is time consuming to use, the task requires more time to perform and increases the frustration of personnel. This often discourages personnel from using the device.

- ***Safety.*** If the lift device itself contributes to high forces or static and awkward body postures, this can result in musculoskeletal injuries. 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 following criteria specify convenience and ease of use requirements for the lifting device.

1. 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 and return to manual handling. Using a lift device with a lower capacity than the items handled creates serious safety hazards.

2. The lift device **must be easy to use**. The lifting device should make the work easier, not harder. This means using the lift device should take a minimum amount of time to move and attach. The following features assist with ease of use.

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

    - The lift device should maneuver easily and quickly without causing the person 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.

1. The lift device must allow the person to perform the 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. This requires a lift device with slow speed options. If not, the person can waste a large amount of time positioning the lift device because it keeps overshooting its target.

A.5.1.1.2 Ergonomic/Safety Specifications. The following criteria specify ergonomic requirements for the lifting device. Consideration of these criteria help ensure that musculoskeletal risk factors are not created during use of the equipment.

- Lift devices (particularly gantry cranes and jib cranes) should not require excessive force to operate. For instance, a jib or gantry crane should not require the user to exert to get it to move. Figures A-1 and A-2 depict typical jib and gantry cranes.

- 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 which could come in contact with the hand or other part of the body.

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

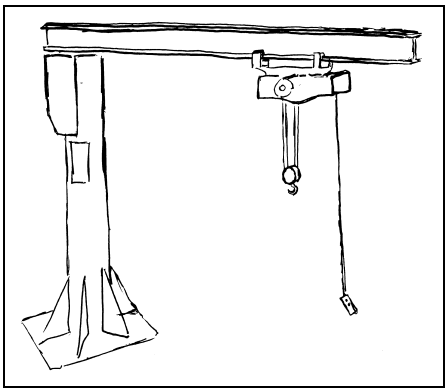


Figure A-1
Jib Crane

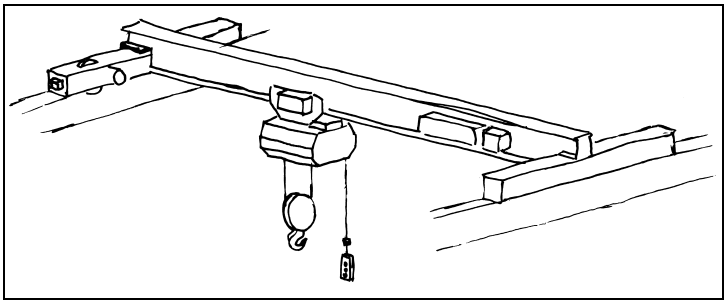


Figure A-2
Gantry Crane

Lift Device Evaluation Worksheet

Table A.1 presents a worksheet to determine whether a lift device has basic ergonomic features. This worksheet is provided to help you systematically evaluate 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 which 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 in to 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.			
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 which 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***. In other words, if a tool can be used in a number of situations, it reduces the number of tools required, 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.*** Criteria are defined below.

- ***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 that are sized for the hand (e.g., some alynn wrenches) tend to cause hard edges which press into the hand and increase grip forces.

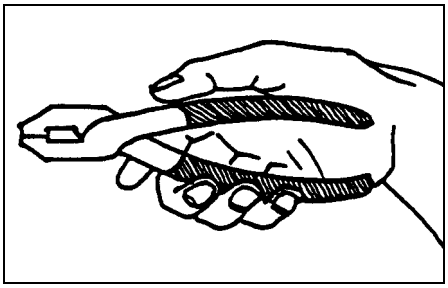
- Where more than a minimal amount of force is required to perform the task, a power grip (i.e., full hand) handle is generally preferred over tools which require a pinch (i.e., fingertip) grip.

- For low-force high-precision tasks, a pinch grip is generally preferred.
- Tools should be able to be easily used 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 (hammers, pliers).



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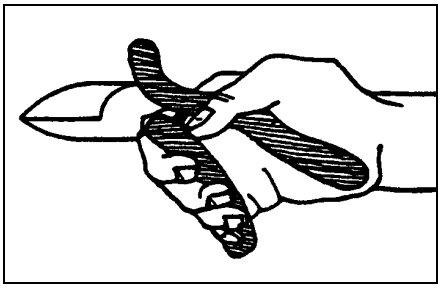

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Figure A-3
Handle Angle Criteria

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.

- 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.

Table A.2 provides recommended grip angles for different required tool axis directions and different expected ways in which the tool would be handled.

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 handle which can be oriented for different work situations. By reducing the number of tools required, this allows the tool to be more flexible and easy to use. In addition, the handle location and orientation must take into account visual access to the work. 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 which minimizes applied forces. The basic concept is to ensure that forces required to use the tool are minimal.

- 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 when applied 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 tool support. 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 over doing it manually.

- 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.

- The number of cables and hoses attached to the tool should be minimized and they should be minimal in 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.

- Cables and hoses 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 in proportion to the amount force required. That is, longer torquing tools reduce required forces 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 force 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.).
- The forces required to connect/disconnect the power tool should be insignificant. For example, forces required to connect to electrical outlets or air supplies should be insignificant.

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

- 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 1-1.5" (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 surface to the 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 0.25-0.5" (0.6-1.3 cm.).

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

- The handle length should be at least 4" (10.2 cm.). 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). This also increases the control of the tool and reduces grip forces required. The 4-5" (10.2-12.7 cm.) is based on a large person's hand to ensure that the handle will be long enough regardless of the size of the hand.

- There should be no hard/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.

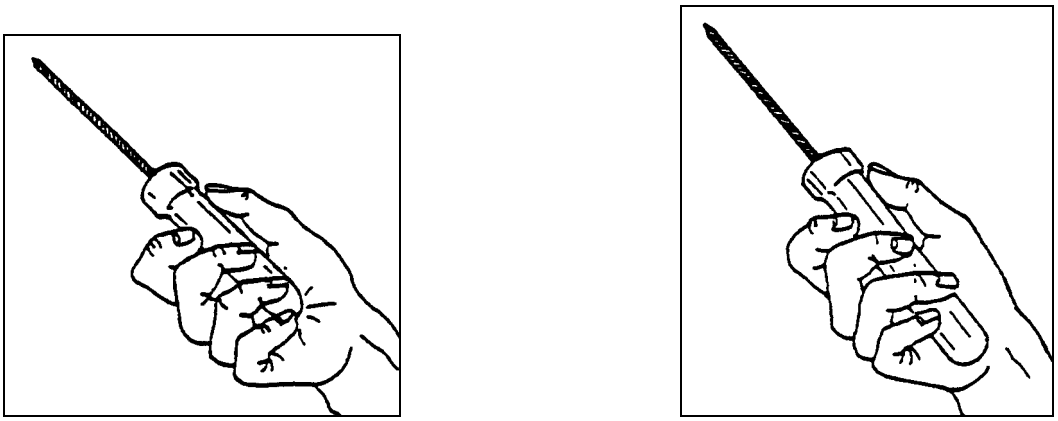

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Figure A-4
Handle Length Criteria

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 which have triggers but also can be applied to buttons on tools in some cases.

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

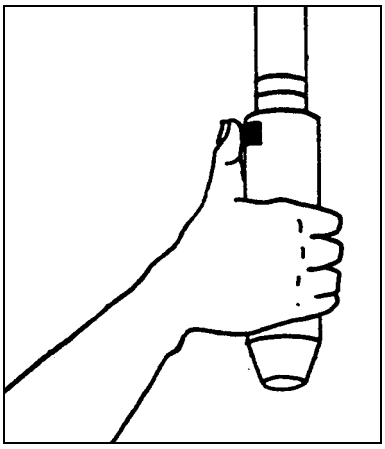
- The minimum trigger length is 1.5" (3.8 cm.). 2-2.5" (5.1-6.4 cm.) is preferred. This permits two finger activation of the trigger.

- The recommended trigger width is 0.5-1" (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 0.125-0.375" (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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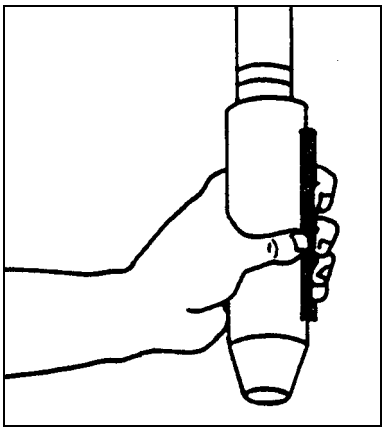

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Figure A-5
Trigger/Button Location Criteria

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

- Handle materials should prevent heat from being conducted away from the hand. Tool should not have bare metal handles. Handles which are coated with a rubberized insulating surface are preferred.

- Air powered tools should not cause cold air to blow on hands. Exhaust air should be routed away from the user. Exhaust from gasoline powered tools should similarly 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 use reciprocating or rotating frictional working ends to remove material. This is how drills, saws, and sanders work. Very few manufacturers have been successful in eliminating all perceptible vibration from such types of tools. So, if vibration can be felt during a tool trial, the user should not get the impression that the tool is not ergonomically designed. Exposure to vibration can actually be assessed to determine whether or not prolonged use of the tool exposes the user to vibration that is well under the recommended limits (see below). The tool should be durable and easy to maintain in order 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 in order to perform the task, the maximum amount of the vibration, torque, or impact should be absorbed by:

    - damping mechanisms internal to the tool; and/or

    - damping materials built in to the tool handle; and/or

    - mechanical tool support mechanisms.

- In general, try to avoid the use (or purchase) of impact tools, when feasible, when choosing a power solution. 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 like 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, employees should be briefed on the tools capabilities and unique performance characteristics. The "feel" is different and, without a briefing, many employees 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.

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 being exposed to torque levels in excess of these maximums. Ideally, employee exposure to torque should be minimized. These guidelines are provided as maximum torque levels, worst-case exposure scenario (e.g., as a nut is "torqued" into final (tight) position).

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 you systematically evaluate 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	Meets Criteria 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.			
	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.)			

Comments:

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	Trigger Force	Force required to activate the trigger should be insignificant (considerably 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	Trigger/ Button Location	Triggers and buttons should be positioned to prevent extension of fingers or the thumb.			
	Trigger/ Button Shape	Trigger should have large smooth curves. No hard edges or points (particularly at the end of the trigger).			
	Trigger Length	1.5" (3.8 cm.) minimum, 2-2.5" (5.1-6.4 cm.) preferred			
	Trigger Width	0.5-1.0" (1.3-2.5 cm.).			
	Trigger Ridge Depth	0.125" - 0.375" (0.318-0.953 cm.)			
	Trigger Range of Movement	Trigger should have a small range of movement.			

Comments:

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
Misc.	Heat Conduction	Tool handle should be coated or rubberized (tool handles should not be bare metal)			
	Routing of Air Exhaust	Air powered tools should not blow cold air on hands.			
	Torque/ Impact	Tool should not expose the user to excessive torque or impact.			
	Vibration	Tool should not expose the user to excessive vibration.			

Comments:

IMPLEMENTING MINOR MODIFICATIONS

Appendix 5

A.5.2 IMPLEMENTING MINOR MODIFICATIONS

This section is presented as a concise "how-to" manual for constructing (or working toward) an ergonomically correct work station given different types of furniture, different types of task, and different sizes of people.

A.5.2.1 General Considerations and Approach. When modifying the work station, tools or equipment at a work area, it is important to consider all of the tasks performed that may be impacted by that modification. The following must always be kept in mind:

- 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); and
- Rely on employees to help identify quick fix improvement possibilities.

Whenever possible, try to build in adjustability and flexibility at the work station as this will allow a variety of tasks to be performed more comfortably by a number of employees. For example, an individual who is 5'2" will have different requirements for worksurface height (lower to the ground) than a fellow employee who is 6'0". Adjustability enables each employee to accommodate the work area to suit his/her specific needs. Prior to equipment, tool or work station modification it is important to avoid creating a maintenance or other safety hazard. For example, constructing a "too small" platform may create a tripping hazard; an individual could fall off the platform. Placing a piece of anti-fatigue matting in a high traffic area may create a tripping hazard. Employee input is important to help define the specific modification and monitor its effectiveness. To maximize the effectiveness of employee input and avoid creating false expectations several statements can be made prior to problem-solving. For example:

- 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 that can be made need to 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); and
- Remind employees that, since they are all different, an adjustment which 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 make them a better fit for the hand. When contemplating 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, that padding may create a safety hazard. The idea of building up the handle diameter is valid. A better solution may be to add a slip-on rubber sleeve. There are several things that can be considered for improving existing tools: tool maintenance, handle diameter, handle length, air hose connection, and anti-vibration materials.

A.5.2.2.1 Tool Maintenance. Maintaining or servicing existing tools is often a good start at improving tool performance and employee comfort. Consider the factors listed below.

- Tool blades, grinding stones, and bits should be regularly checked and replaced to ensure that they are sharp for optimum performance. A dull bit or blade will impact the quality of finish and often require 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, where necessary, lubrication should be performed regularly as specified by the manufacturer of the tool.

- Tool balancers should be regularly adjusted to balance the weight of the tool. Adjustment will be required when the employee appears to be pulling ("fighting the pull"). When a tool is not balanced the weight of the tool must be compensated by the user in order 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.

- Optimum tool diameter is between 1.5 to 2.2 inches (although some special purpose tools such as a pencil grinder may require a smaller diameter). Select the most appropriate handle diameter that will fit the employee. Increasing tool diameter can be accomplished using sponge padding or commercial grips. It is important the adaptation is secure and snugly fits around the tool. Also consider that the material added takes 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 increase the mechanical advantage.

- A recommended minimum handle length is 5 inches. It is important that the handle travel through the palm and not end in the palm.

- Adapting a tool that is too short can be accomplished by welding an extension to a steel handle. If this is done one must ensure 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 handle, which is longer in length from the manufacturer.

- Adaptation can also 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 hammers, for example. For power tools, commercial handles may be available, 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. Utilize 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. This will also reduce drag along the floor and make the tool easier to position.

A.5.2.2.5 Anti-vibration Materials. Anti-vibration materials used as grip covers or sleeves should be used with caution. Adding these materials may increase the handle diameter to an inappropriate size. In addition, anti-vibration grips may not control vibration at the frequencies which impact the hand the most at the operating frequency of the tool. The benefits may actually be in grip force reduction since a compressible grip can make the tools easier to control.

A.5.2.3 Getting Closer to the Work. The individual should be able to get as close as possible to the work to avoid excessive reaching which can create stress on the muscles of the back and shoulders. There are two primary strategies that you can use to modify the work area: remove obstructions from the floor, and, from the employee and the work.

A.5.2.3.1 Remove Obstructions from the Floor

- Poor housekeeping is often the main contributor to obstacles in the work area. In order to keep the employee as close to the work as possible, help him or her identify and then remove obstructions from the floor such as air hoses, boxes, tools and carts. The work area should be maintained and items should be placed in designated storage areas.

A.5.2.3.2 Remove Obstructions Between the Worker and the Work. There are several strategies to consider.

- If another part (or panel) is in front of the area that needs to be accessed, remove that part prior to working inside the area.

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

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

A.5.2.4 Adding Variety to the Work Position. One of the most effective strategies for improving comfort/preventing fatigue in the low back and legs is to build in task variety/alternating standing and seated tasks. Below are factors which you may consider 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.

A.5.2.4.1 Sitting. The desirable seated posture is shown in Figure A-6. Sitting is most appropriate when the following conditions are present:

- All items needed in the short term task cycle can be easily supplied and handled within the seated work place;

- No large forces are required, such as handling heavy objects;

- Fine assembly is required.

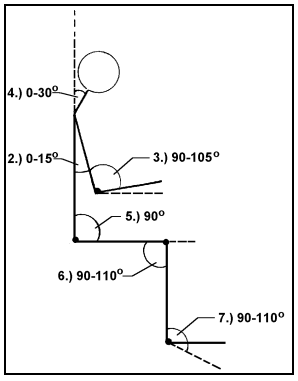


Figure A-6
Recommended Seated Posture

A.5.2.4.2 Standing. The desirable standing posture is shown in Figure A-7. 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; and,

- 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).

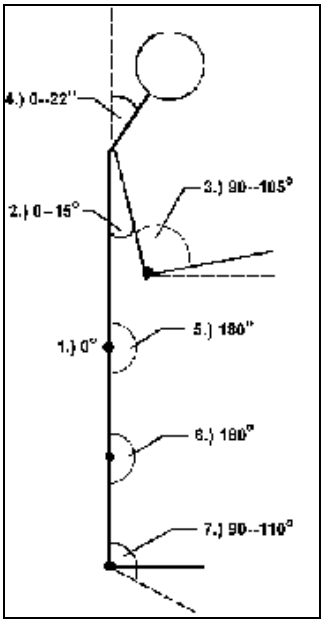


Figure A-7
Recommended Posture

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. Rather, your goal is to try to optimize the relationship between the height of the employee and the height of the primary work location.

A.5.2.5.1 Single-Employee Use 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 work table is low enough to handle the largest work piece and allow the employee to work in a neutral position. (For aircraft, establish the work platform so that it is low enough to enable the employee to 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 table top 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 adjust the leg height if the table has adjustable leg extenders.

A.5.2.5.2 Multiple-Employee Use Workbench. When more than one employee must use the work area, flexibility is the key.

- If the work table is a fixed height, consider setting up for taller employees-raise table up on blocks.

- Provide a stable platform for shorter employees.

A.5.2.5.3 Fixed Position Point of Operations (e.g., Aircraft)

- Consider adding temporary but stable risers for shorter employees who work on elevated platforms.

- Suggest the use of a stool or chair to have employee sit to do a task which may be too low for comfortable standing work.

A.5.2.6 Improving Comfort with Foot Pedal Use

A.5.2.6.1 Standing Work. The primary objective 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 factors should be considered.

- **Option 1** - 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 degree angle between the foot and the lower leg). To provide adequate leg room, you may need to remove obstructions to allow a distance of at least 10 inches between the end of the foot and the closest vertical surface.

- **Option 2 -** Add a heel riser (block of wood) to the heel end of the foot pedal. This option may not be as effective as Option 1 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. The position of 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.

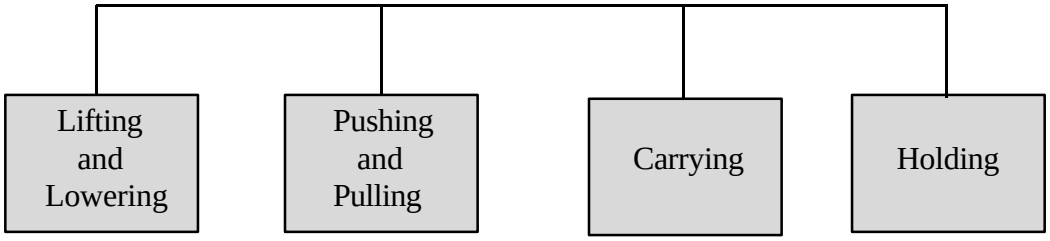
- The foot pedal should be height, angle and horizontally adjustable to accommodate multiple employees. Build a riser out of wood, place under the foot pedal to enable height adjustability.

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

- You may need to remove leg obstructions (like the under table scrap chute on a sewing machine table or garbage can under a worksurface).

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 general types of activities.



Typically, MMH tasks in maintenance and inspection tasks 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; and,
- 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, 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 light weight 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.

- If a tool belt is used, distribute tools evenly on both sides. Encourage the employee to remove the tool belt and place it on a small work table, 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 be made to reduce exposure to risk factors.

- Reduce excessive forces by distributing the weight/items evenly in a container.
- Container should have 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 employees can be encouraged to make to how they work 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.
- During lifting or transferring loads, turn with the feet rather than twist the trunk.
- Share the load/lift with another employee (buddy lift).
- Avoid quick movements when two people are lifting an object, make sure both employees have a firm hand hold before starting the lift. Lift the load with a smooth body motion.
- When lifting, keep the load as close to the body as possible.
- 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.

LEVEL I ERGONOMICS ASSESSMENT
SUMMARY AND RECOMMENDATIONS
SAMPLE

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 FORM 190 X

- Findings are consistent with employee reports of discomfort and/or illness: ☐ Yes ☐ No
  Comment: COMPLAINTS OF BACK DISCOMFORT ARE SUPPORTED BY RESULTS X

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) ☐ Health/Safety ☐ Productivity/Quality X	Expected Benefits (Check all that apply) ☐ Health/Safety ☐ Productivity/Quality X

BEF (Sign) _____