

Choosing the Right Tool(s)

Hand Tools - Potential Hazards:

Poorly designed or improperly used hand tools may require excessive force and cause [awkward postures](#) resulting in tendonitis in hands, wrists and elbows.

Short handles may press or rub against the palm and fingers (Figure 1) causing [contact stress](#). Small handle diameter may increase force requirements of tool leading to fatigue, discomfort and pain.

Tools with wide handle spans require extended thumb and finger positions (Figure 2) to activate the tool.

These postures require increased finger force to provide adequate activation force increasing fatigue, discomfort and pain.

Improper orientation of the tool handle may result in awkward position of the hand, [wrist](#), or arm and increase force requirements of the task.

Possible Solutions:

Use [power tools](#) (Figure 3) to do the job when repetitive or prolonged force exertion is required.

Use a properly designed tool to promote neutral posture of the wrist and hand. (Figure 4). Generally, an inline tool is best on horizontal surfaces at about waist height, and a pistol grip is preferable for vertical surfaces at about waist height. Bent handled tools can be designed to accommodate differing work positions and angles.

- Use tools with padded grips and handles that extend across the whole palm of the hand to minimize contact pressure.

Ensure that tools such as screwdrivers have appropriately sized and shaped handles. Generally, handles should be about 1 1/2 inches to 3 inches in diameter. Triangular handles with rounded edges provide a better grip.

Use tools that do not require an extended grip. The hand should be in the shape of a "C" while gripping the tool. A span of 2 1/2 to 3 1/2 inches is best.

Ergonomic Design for People at Work, Volume 2. Eastman Kodak Company, (1986).

Replace tools if handles are damaged.

Take regular breaks and rotate tasks when using a hand tool for an extended period of time.

Use fitted gloves which protect the hands from contact stress.

Keep tools well maintained and in good repair.



Figure 1
Wire clipper rubbing the palm.



Figure 2

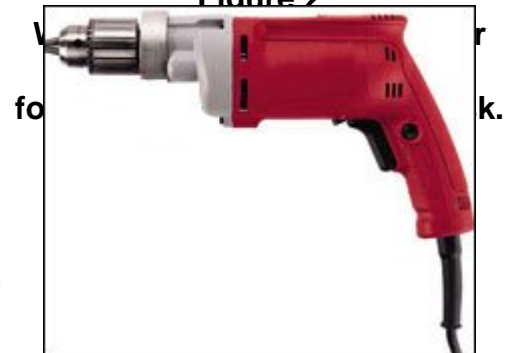


Figure 3

Power drill



Figure 4
Bent-handled tool.

Portable Power Tools
Potential Hazards:

Some portable power tools, such as pipe threaders (Figure 5), may be heavy or require extreme effort to counteract torque forces. Sustained use of these tools puts stress on the back, hands, arms, and shoulders. Tools such as jack hammers or large saws that transmit vibration may cause hand-arm vibration syndrome (HAVS). Early signs of HAVS are feelings of numbness or tingling in the fingers, hands, or arms, or numbness and whiteness in the tips of fingers when exposed to cold.

When using tools employees may assume awkward postures including bending, stooping or extended reaching. Awkward postures maintained for long periods of time may cause fatigue, discomfort and pain, especially when heavy tools are used.

Improper orientation of tool handles may cause awkward position of the hand, wrist, or arm and increase force requirements of the task.

Repeatedly using a single finger to activate triggers on power tools may cause overuse of tendons and muscles leading to irritation, swelling, pain and eventually immobility.

Possible Solutions:

Use tools with a proper handle orientation that allows neutral wrist position. Generally, use tools with a pistol grip for vertical surfaces and an in-line grip for horizontal surfaces.

Use torque bars (Figure 6) on tools such as drills or pipe threaders to minimize the exertion required to control the tool.

Use trigger-levers on power tools. These have a longer trigger to accommodate three fingers, rather than those with single finger trigger action.

Maintain equipment and tools in proper working order. Unbalanced rotating parts or poorly sharpened cutting tools may create excessive vibration and increase force requirements when in use.

Support the weight of heavy tools (Figure 7) by using overhead or under-tool supports.

Avoid older power tools that were not designed with ergonomics in mind and may vibrate excessively. Consider reduced-vibration tools when making new tool selection.

Wear proper anti-vibration gloves when using power tools and use only as much finger force as necessary to provide proper control of the



Figure 5
A heavy pipe threader.



Figure 6
Drill with torque bar.



Figure 7
Vice mounted on a three-legged stand.

tool.

Learn proper tool usage and safety practices. Employees should allow the tool or machine to do the work and should arrange the work so that they can stand upright and use the tool with the elbows close to the body.

Keep hands warm and dry.

Use platform ladders, regular ladders or lifts to reach higher work areas so that arms may be kept closer to the body. The arms may then safely support tools when in the power zone.

Wear kneepads when kneeling is required.

To reduce crouching and kneeling, sit on a stool while working on lower areas.

Minimize the time of continuous use when operating a vibrating tool. Appropriate operating times will vary depend on the magnitude of vibration, however limiting sessions to 10 to 15 minute of continuous use with no more than 2 hours of total operating time per day is generally recognized as a prudent work/rest schedule. Other means of dampening or reducing vibration should still be observed even during shortened sessions.

Keep cutting surfaces of tools sharp and lubricated.

Awkward Positions

Awkward postures means working with various parts of the body in bent, extended or flexed positions rather than in a straight or neutral position. Working in awkward postures increases the exertion and muscle force that employees must apply to complete a task and compresses tendons, nerves and blood vessels. In general, the more extreme the posture the more force is needed to complete the task.

Examples of awkward postures include any task that may:

- pull the elbows away from the torso such as performing overhead work or reaching in front, to the side, or in behind the body;
- bending the elbow past about 90 degrees for prolonged periods of time;
- bending or twisting the torso to lift an object from low or distant locations;
- extending, flexing, or bending a wrist to the side while using tools or performing connection tasks;
- bending the neck backward or forward for prolonged periods while working overhead or on low surfaces; and bending the knee or ankle to work in a squatting or kneeling position.

Bending the Elbow

Repetitive elbow bending can irritate nerves and tendons in the forearms, and even lead to epicondylitis, or "tennis elbow"



Bent Wrist

Working with wrists in a bent rather than straight position increases the risk of injury especially where the task also involves high hand force. Working with bent wrists puts stress on the tendons and tendon sheaths in the hands and wrists.

When the wrists are bent the tendons and sheaths rub against hard bones and ligaments. If this happens repeatedly, the tendons and sheaths can become irritated and inflamed, resulting in injuries such as tendonitis. The inflamed tendons and sheaths can also press against the nerves that run through the wrist to the hand, resulting in carpal tunnel syndrome.

General controls to reduce awkward wrist postures:

Tool handles may be bent or modified depending on the task to allow the user to maintain a straight, neutral wrist.

Contact Stress

Contact stress results from prolonged or repeated contact between hard or sharp objects/surfaces and sensitive body tissue, such as soft tissues of the fingers, palms, thighs and feet. This contact creates localized pressure for a small area of the body, which can inhibit blood flow, nerve function, movement of tendons and muscles and create localized irritation.



Some contact stress problems include:

- Use of tools with short handles which can press into the palm of the hand.
- Standing for long periods of time on hard and small areas such as ladder rungs which may create pressure on the arch of the foot.
- Carrying hard or sharp items such as ladders or conduit on the shoulder where muscles and tendons can be irritated.

General controls to reduce contact stress:

- Use electric or power tools to minimize repeated hand activations.
- Purchasing tools with appropriately-designed handles (should have a span of about 2 inches, a diameter of about 1.5 inches, should be long enough to extend across the palm, and may be bent to minimize wrist bending).
- Wrap or coat tool handles and grips with cushioning material.
- Use gloves with palm pads.

Use shoes with thick or cushioned soles to spread the force over a wider area.

Crouching and Kneeling

Electrical employees will frequently need to bend or crouch to reach the work space. This kind of activity can contribute to poor circulation of blood, and may injure the knees where they come in contact with the floor.

Lifting Heavy Loads

Many tasks require employees to lift, push, pull and carry heavy loads. Heavy lifting can result in overexertion and injury to the lower back.

How much weight an employee can safely lift depends on a number of factors. When the factors are such that the employee can assume an "ideal" body posture during the lift, the employee is able to lift greater loads. However, when the body posture is not ideal (e.g., back is bent or arms are outstretched), then the amount of weight the employee can safely lift is reduced. Factors affecting how much weight an employee can safely lift include:

Lifting factors	More weight can be safely lifted when:	The amount of weight that can safely be lifted is reduced when:
How far from the body the load is held (horizontal distance).	The load is close to the body and not too large/bulky, which allows the arms and elbows to be close to the torso during the lift.	The load is farther away from the body or is large/bulky, forcing the arms and elbows away from the torso during the lift.
How high or low is the	The lift is at waist height.	The lift must be made

lift (vertical distance).		from below the knees or above the shoulder.
How much the employee must twist to lift and move the load.	The lift is performed in front of the body.	The employee must twist the torso to lift and move the load.
How often the lift is repeated.	The lift is performed only occasionally.	The lift is performed repeatedly (several times a minute).
How far the load is carried.	The lift does not involve carrying.	The load must be carried a distance (more than 3 feet).
How the load is gripped.	The load has handles.	The load does not have handles or is slippery.

General controls to reduce lifting hazards:

- Use lift assists such as hand trucks, carts, and forklifts.
- Reduce size of product boxes to lighten load.
- Arrange work space so employees can move closer to loads and perform lifts with arms close to the body.
- Use pallets that can rotate.
- Put objects to be lifted at waist level.
- Arrange workstation so lifting is done in front, without twisting.
- Put handles or grips on boxes.

Use gloves that aid in holding slippery objects.

Reaching

A number of tasks require employees to work with their hands above their head or shoulders, their arms extended to arm's length, or their elbows raised out from their body. These kinds of tasks place stress on the shoulders, elbows and back, and can result in an ergonomic injury.

Elevated reaches - Examples of jobs and tasks that require employees to repeatedly reach or work with their hands above their head or their elbows above their shoulders include:

- Installing ceiling fixtures
- Pulling wire in a plenum space

Extended reaches - Employees also have to perform extended reaches when there is not adequate access to the work area, extending the elbows away from the body. Examples include:

- Lifting a bulky, large load
- Providing improper hand tools may force employees to raise their elbows away from the torso in order to prevent wrist deviation.
- Using in-line tools on horizontal surfaces can force shorter employees to lift their elbows as high as shoulder height in order to keep their wrists straight.

General controls to reduce reaching hazards:

- Ladders and lifts to reduce reaching.

Bent handled tools that allow straight wrists and elbows close to the body.

Repetitive Motion

Some tasks involve repeating the same actions with little variation. When motions are repeated frequently for prolonged periods, such as several hours without any break or over an entire work shift, there may be inadequate time for muscles and tendons to recover. If the repetitive tasks also involve other ergonomic risk factors, muscles and tendons become extremely strained or fatigued more quickly.

Highly repetitive tasks often involve the use of only a few muscles or body parts while the rest of the body is unaffected. To reduce the strain that repetitive tasks pose to those body parts, use these solutions:

- Rotate employees into several different jobs during the course of a work shift is a way to distribute work so that each employee spends less time performing the same repetitive tasks. In order for job rotation to reduce muscle/tendon strain and provide adequate recovery time, the different jobs into which employees rotate need to involve the use of different muscles or body parts.
- Design jobs so they include a wider variety of tasks (longer motion pattern) is another way to reduce the frequency and duration of repetitive motions.

Build short micro pauses between motions or tasks is another way to give muscles and tendons recovery time.

Static Postures

Maintaining the same posture for an extended period of time can cause problems including pooling of blood and fatigue in muscles. Long periods of standing can cause pain and contact stress to the feet.

Temperature

Extreme temperatures can cause problems for employees. Cold temperatures make the muscles less flexible, resulting in muscle strain and pulls. Hot temperatures lead to dehydration and muscle fatigue.

Twisted Torso

The back is designed to operate efficiently with both hands lifting loads directly in front of the body. In this manner muscles work symmetrically in tandem across a balanced spine.

Twisting the torso creates an asymmetry which stretches some sets of muscles while compressing others forcing smaller, isolated groups of muscles to provide the needed force for the task. Twisting the spine creates non-symmetrical forces on the fibers of the disc which weakens the structure making it more susceptible to bulging and rupture from the compressive force created during lifting.

Supporting a load with the torso bent forward greatly increases both the muscle force which must be exerted and the compressive force on the spine. When significant force exertion is combined with the structural instability created from twisting, the opportunity for injury is greatly increased.

Vibration

Although using powered hand tools may help reduce employee exposure to ergonomic risk factors such as repetition and force, they can expose employees to vibration. Vibration

restricts the blood supply to the hands and fingers, which, depending on the vibration level and duration of exposure, can contribute to an ergonomic injury. Signs and symptoms of vibration-induced injury, such as Reynaud's phenomenon, start with occasional numbness or loss of color in the fingertips. They progress to more frequent and persistent symptoms affecting a larger area of the fingers and resulting in reduction in feeling and manual dexterity.

Factors that increase the amount of employee exposure to vibration include:

- Bad power tool design - Even new tools can expose employees to excessive vibration if they are not designed with devices that dampen or shield employees from vibration.
- Poor power tool maintenance.
- Old power tools.

General controls to reduce vibration:

- Use low vibration tools.
- Use vibration dampeners or shields to isolate source of vibration from employee.
- Inspect and maintain power tools regularly.

Limit the duration of tasks that involve vibration, and rotate tasks.

Correct, Neutral Posture

Postures where the body is aligned and balanced, while sitting or standing. The head is kept upright and is not turned to either side more than about 30 degrees or tilted forward or backward more than about 15 degrees. When the worker is standing, the torso is not bent more than 10 to 20 degrees from the vertical position and the natural curves of the spine are maintained. The pelvis and shoulders should face straight ahead to avoid twisting the torso. The shoulders are relaxed and knees slightly bent. The arms hang normally at the side, with elbows close to the body. The elbows are not bent more than about 90 degrees and the palms face in toward each other and the center line of the body. The wrists are in line with the forearms and are not bent sideways, forward (towards the palm), or backward (towards the back of the hand.) When the worker is seated, the buttocks and feet are firmly supported.

Housekeeping

Establishing a strong housekeeping program will keep the work place tidy and reduce the risk of tripping over cords and debris. It also extends the life of tools and equipment, and results in increased productivity.



Lifting

Lifting properly is important. While there are some general lifting guidelines, a different approach may be needed for each load to be lifted. Sometimes it is appropriate to lift with the legs, and other times the back should be used to lift. These techniques depend on the size and shape of the load, and the frequency of lifting that is required.

Planning

Planning should be done with ergonomics in mind. Items to be planned include determining routes between staging areas and work spaces, scheduling for members of other trades, and knowing what services and utilities will be provided.

Power Zone

The power zone for lifting is close to the body, between mid-thigh and mid-chest height. Comparable to the strike zone in baseball, this zone is where arms and back can lift the most with the least amount of effort.

Proper Hand Holds

Proper handholds make lifting easier and reduce the risk of injury. Handholds should be made large enough to accommodate larger hands and should not dig into fingers and palms.

Pulling and Pushing

Pushing is generally preferable to pulling. Pushing allows the employee to use large muscle groups and apply more force to the load. Pulling carries a greater risk of strain and injury.

Staging

Staging is an important step in any electrical project. Proper staging includes placing materials as close as possible to work spaces, and storing materials at ideal heights so employees can utilize the power zone to take materials from storage.

Task Rotation

Many stressors can not be engineered out of a task, short of complete automation. Rotation of assignments can be an effective means of limiting the amount of time employees are exposed to these stressors. This will often reduce the chance of injury, because the risk of injury is proportional to the amount of time one is exposed to a stressor.

Caution: Rotation of assignments should never be used before significant attempts to eliminate the stressors have been investigated. The job should always be modified to expose the employee to the least amount of stress possible. Analysis of the job is essential, because moving an employee between tasks that affect the same part of the body does not provide any periods of rest.

Rotate to jobs that affect different parts of the body or have different intensities.

Many tasks primarily affect different parts of the body. Some example are:

- Lifting a heavy load.
- Repeatedly bending generally affects the low back.
- Reaching to access or to place items in positions that require the elbows to be pulled away from the body often affects the shoulder.
- Grabbing, turning, squeezing or finger strikes can affect the hand, wrist, and elbow.
- Looking down or to the side repeatedly for a prolonged time can affect the neck, head, and shoulders.
- Tasks that require standing for a long time can affect the legs, feet, and back.

Rotation of employees between tasks that affect different parts of the body allows employees to have periods of rest and recuperation while still remaining on the job. An example of a possible rotation scheme might be to move an employee who spends most of the day attaching fixtures or other overhead task to a loading and moving job where the arms are down at their sides. While on the lifting task the hands, shoulders and arms can rest if the loads lifted are not too large and proper hand holds are provided.

Work areas may have tasks of differing intensities, such as using #12 wire which requires more force exertion rather than using #14 wire which is easier to bend. Look for opportunities to rotate between tasks that are less intense and more intense.