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Supplemental Information

This section contains indices which have additional information on subjects that are mentioned briefly throughout the eTool.

The indices are listed below:



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Supplemental Information: Tool Index

The tools listed below may be useful to help electricians reduce discomfort and possible injuries.



Aerial lifts

Aerial lifts provide a level work platform and allow workers to reach high places with ease, reducing the amount of overhead and horizontal reaching that is required. These lifts come in boom, reach, and scissor models.



Bent handles

Some tools have handles that are bent or angled. These tool designs maximize leverage and reduce the need to bend the wrists.

Battery-powered tools

Battery-powered tools, like this cable cutter, speed up tasks and reduce the strain that occurs from using a comparable hand-powered tool. This is especially helpful when workers must do many cutting or crimping operations over a short span of time. Battery-powered tools are usually lighter and more portable than hydraulic tools.



Digging tools

There are different shovels and spades for different jobs, including square-blade, round-nose, triangular, and trenching/hole-digging shovels. Use the right tool, with a handle in good repair, without splinters.

Extension handles

Extension handles reduce the amount of reaching required to do certain tasks. This reduces back and shoulder strain.



Foot pumps

This hydraulic foot pump allows the operator to use foot power and free the hands to hold the work piece.



Forklifts

In a warehouse setting, a forklift is essential for lifting large loads that have not been broken down.



Gloves

Gloves reduce contact stress on fingers and palms. There are a variety of gloves for different situations. There are rubber gloves (pictured, center) that are insulated for energized work, gloves with no cuff, medium cuff and long cuff. Cut-resistant Kevlar® gloves provide extra protection against cuts and scratches.



Hydraulic tools

Hydraulic tools reduce the hand power needed for cutting, wire-stripping, and crimping operations. This tool uses a remote hydraulic pump so only the tool needs to be lifted, instead of the whole pump mechanism as well.



In-line grip

Some tools are designed with handles that run the same direction as the length of the tool. This design is ideal when the tool is used in a vertical position.

Kickback clutch

Tools equipped with a kickback clutch are safer and reduce the risk of having a tool jump or move unpredictably.

Knee pads

When kneeling is required, knee pads ease the stress on knees and allow workers to kneel for longer periods of time.



Ladders and stools

Ladders and stools allow workers to get closer to their work and keep hands and arms closer to the body. This reduces strain placed on the arms, shoulders, and back.

Fiberglass ladders (pictured) are preferred in electrical work because they are lightweight and non-conducting.



Manual conduit benders

Manual conduit benders are lighter, less expensive and more portable than mechanical conduit benders. They are useful for smaller gauges of conduit.

These benders should be fitted with long, rigid handles without scratches or dents. Use manual conduit benders correctly and let the tool do the work instead of the back.



Material lifts

Material lifts serve the same function as forklifts, but they are more portable and can be taken to the work site. Manual and powered models are available.



Mechanical conduit benders

Mechanical conduit benders make bending conduit easy. The machine does the work, so workers don't have to bend conduit manually. They are often mounted on wheels so they can be rolled to different locations.



Mechanical wire pullers

Mechanical wire pullers do the work of pulling, reducing the strain that would occur from doing this manually. They also save time and increase productivity.



Motorized hand trucks

These special hand trucks climb stairs, lift into tailgates, and make moving easy. The initial investment pays off in time saved and injury costs avoided.



Padded tool belts and suspenders

Padded tool belts reduce potential contact stress by evenly distributing the weight that tool belts and bags place on hips. Suspenders ease the burden of tool belts and bags by distributing some of the weight to the shoulders.



Padded tool handles

Tools like this cutting/stripping tool are fitted with padded handles that ease the stress placed on hands. They provide a good grip, which reduces slipping.



Pistol grip

Many tools are designed with a pistol-style grip. This design is ideal for using the tool in a horizontal orientation.

Ratcheting tools

Tools like this PVC cutter are equipped with a ratcheting mechanism. This allows an easier, incremental squeezing effort to operate the tool, easing strain on hands and wrists.



Reach forklifts

Reach forklifts can lift materials to great heights, and place large loads into trucks or on platforms.



Roll-out truck bed decks

Roll-out truck bed decks allow easy access to the contents of a truck bed. This eliminates the need to climb in a cramped truck bed area or reach over the sides of the truck.



Storage tools

Storage units like this one allow easy access to tools and supplies. Some are mobile and can be placed close to the work area, reducing the distance tools and supplies must be carried.



Tool stands

This battery-powered cable cutter rests in a stand that frees hands and improves the cutting process. This stand may remain unattached or it may be fastened to a work bench.



Transport devices

Transport devices, like this spool cart, make moving smaller loads easy. Other moving tools include hand trucks, utility carts, and platform trucks.



Truck bins

Truck bins give easy access to equipment without the need to crawl into the back of a truck or van.



Truck ramps

Truck ramps reduce the amount of lifting required to move heavy materials into the back of a truck. Materials may instead be wheeled or pushed.



Vehicle lifts

Vehicle lifts allow heavy loads to be moved in and out of trucks and vans with ease, requiring less manual lifting to unload vehicles.



WAGO connectors

Wire is pushed into the holes of these connectors and require no tools. This saves time and reduces wrist strain.



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Supplemental Information: Hazard Index

Electricians may be exposed to the hazards listed below. These are common hazards that occur in the construction trades.



Awkward postures

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 workers 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 performing overhead work, bending or twisting to lift an object, typing with bent wrists, and squatting.

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 can result in ergonomic injuries, 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:

- Bent handles that allow work to be done with straight wrists.

Contact stress/trauma

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



Some contact stress problems include:

- Prolonged use of tools that vibrate, which can cause contact trauma in the palms and fingers.
- Standing for long periods of time, which increases the "static load" placed on the legs and back. Circulation is reduced, blood pools, and localized fatigue increases the longer employees must stand. Muscles and tendons become more susceptible to strain as they become fatigued from prolonged standing.

General controls to reduce contact stress:

- Use electric or power tools.
- Attach well-designed handles to tools.
- Wrap or coat tool handles and grips with cushioning material.
- Use palm pads.
- Use sit/stand stools to reduce static loading on legs and back.
- Use shoes with thick or cushioned soles.

Crouching and kneeling

Electrical workers 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.



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.

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 workers 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 workers 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.

Lifting heavy loads

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



How much weight a worker can safely lift depends on a number of factors. When the factors are such that the worker can assume an "ideal" body posture during the lift, the worker 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 worker can safely lift is reduced. Factors affecting how much weight a worker 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 lift (vertical distance).	The lift is at waist height.	The lift must be made from below the knees or above the shoulder.
How much the worker must twist to lift and move the load.	The lift is performed in front of the body.	The worker 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 workers 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 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 workers 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.

Static postures

Muscle exertions help to circulate blood throughout the body, especially the lower extremities. Continuous blood flow is necessary to deliver nutrients and to remove waste products. Maintaining the same standing posture for an extended period of time can reduce circulation allowing blood to pool in the legs. This can lead to pressure creating varicose veins and reduce nutrients resulting in fatigue in muscles.

Temperature

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

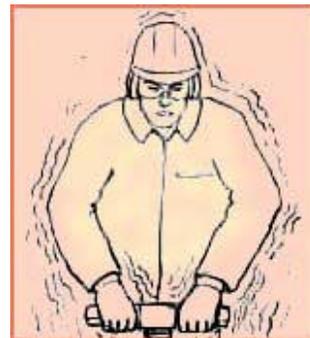
Twisted torso

Twisting the torso and spine while working can cause spinal misalignment, muscle pain, and disc ruptures.



Vibration

Although using powered hand tools may help reduce employee exposure to 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 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.

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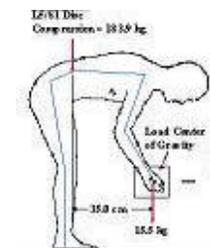
Supplemental Information: Ergonomic Principles Index

This index includes many general ergonomic principles that apply to this eTool and smart practices that increase productivity and decrease risks of injury.



Correct, neutral posture

Maintaining good posture helps workers to avoid injuries. Neutral posture means that the spine is aligned, postures are not exaggerated and do not strain the muscles and back. Neutral wrist posture is also important.



Adapted from Park and Chaffin, 1974

Economic benefits

Economic benefits are a by-product of practicing smart ergonomic practices. Productivity goes up as injury claims and missed workdays are reduced. Over time, insurance costs are reduced. Turnover is reduced when workers enjoy their jobs more and experience less injury.

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

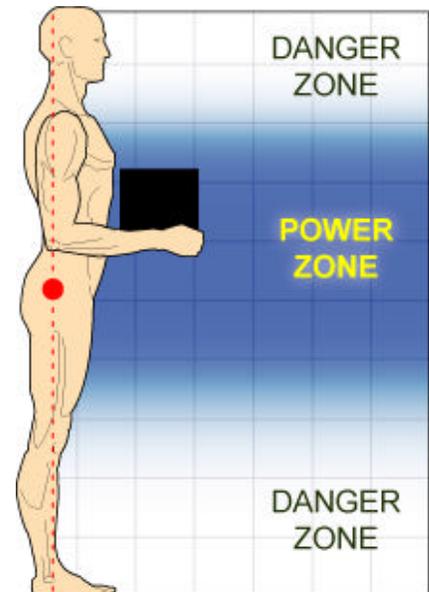
Lifting properly is important. While there are some general lifting guidelines, a different approach may be needed for each load to be lifted. Sometimes it is appropriate to lift with the legs, and other times the back should be used to lift. These techniques depend on the size and shape of the load, and the frequency of lifting that is required. The [OSHA lifting calculator](#) and [Snook tables](#) are ways to help determine guidelines on lifting.

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.

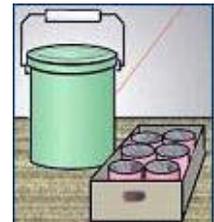
Power zone

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 handholds

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 vs. Pushing

Pushing is generally preferable to pulling. Pushing allows the worker 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 workers can utilize the power zone to take materials from storage.

Task Rotation

Rotating repetitive tasks allows different muscle groups to be used and reduces the risk of cumulative damage. Good planning makes this possible.



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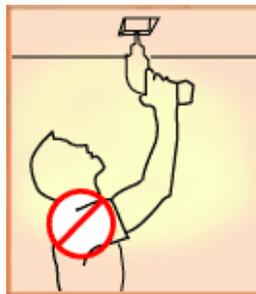
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Supplemental Information: Hazard Recognition and General Ergonomic Solutions

Injury and Illness Data

The information below helps in understanding the risks that may be present in many jobs. It also proposes general solutions to minimize the identified risk factors.

Select the body areas of interest to learn about possible risk factors and general solutions.



[Shoulder, Upper Back, and Neck](#)



[Lower Arm, Hands, and Wrist](#)



[Back](#)



[Lower Extremities](#)

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Supplemental Information: General Solutions: Shoulders, Back, and Neck

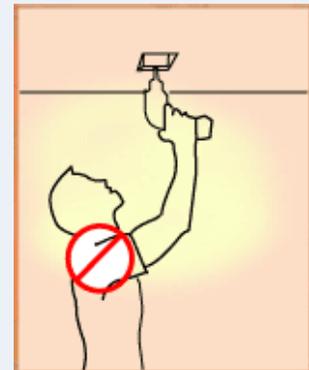
The following describes common risk factors (such as reaching and tilting the head back) that may increase the chance of injury and pain to the shoulder, neck, and upper back. General solutions that may minimize the possibility of injury and pain are also presented.

- [Shoulders: Extended Reaches](#)
- [Neck: Awkward Postures](#)



Shoulders: Extended Reaches

Repeatedly lifting the arms or reaching can irritate the tendons or Bursa of the shoulder leading to an increased risk of developing of chronic injuries such as Bursitis or Rotator Cuff Tendinitis. Holding, lifting or supporting a load with the arm pulled away from the body in an elevated or extended posture increases the risk of developing acute injuries such as muscle strain or rotator cuff tears. Working for prolonged periods with the arms in an elevated posture or behind the back can lead to increased risk of developing impingement injuries of the blood vessels or nerves such as Thoracic Outlet Syndrome.



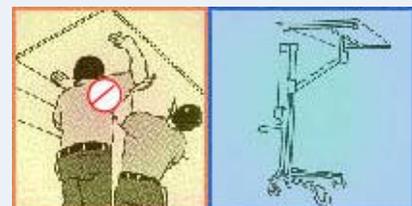
Potential Hazards:

Overhead Reaches

- Working with the elbow above shoulder height for prolonged periods can trap nerves and blood vessels under bone and muscle, leading to numbness and tingling in the hands, and can fatigue the muscles of the shoulder and upper arm.
- Repeatedly lifting or applying force with arms above shoulder level can strain the muscles and tendons of the shoulder and neck, making them more susceptible to



Adjustable-height platforms



Use lift assist equipment.

tears and fatigue. Bursitis and tendinitis can result from irritation as these tasks are repeatedly performed.

Possible Solutions:

- Use height-adjustable work platforms to elevate employees and reduce the need for elevated or extended reaches. An employee who is optimally elevated in relation to a work table or conveyor will be able to perform the task with the elbow in close to the body instead of lifting the arm to work on tasks that are too high.
- Use stools or ladders to elevate the worker so the task can be performed with the elbows close to the body. For example, library ladders elevate the person so he or she can reach a book rather than forcing him or her to reach upper shelves.
- Provide assist equipment to mechanically lift and hold materials above the head so employees do not maintain awkward postures for extended periods. For example, a sheet rock lift holds the panel in place while it is secured to the ceiling.
- Use extending tools or handles to eliminate working with arms above shoulder level. The extended handle (shown at right) allows employees to access the upper reaches of work areas while still keeping the elbows in close to the torso.

Potential Hazards:

Horizontal Reaches

- Using repetitive or prolonged forward reaching that pulls the elbow away from the body forces the shoulder to support the weight of the arm and any load in the hand. This is a weak position for the shoulder, making it more susceptible to muscle strain and tears. Repeatedly performing these tasks can irritate the tendons, increasing the risk of tendinitis and bursitis.
- Performing horizontal motions such as pushing materials down a conveyor line with the arms extended increases the risk of muscle and tendon strain and overexertion.

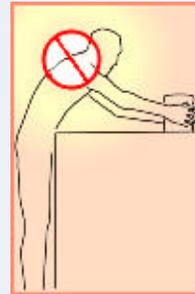
Possible Solutions:

- Redesign work stations so control

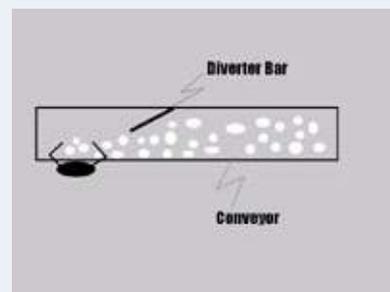
Use lift assist equipment.



Extended tool handles



Repositioned work station



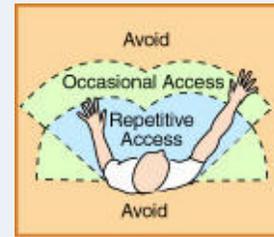
Conveyor diverters



Reaching behind

equipment and products can be reached while maintaining the elbows in close to the body. In the example at the right the task has been rotated 90 degrees so the employee does not need to reach to perform the task.

- Use conveyors, roller tables, or low-friction surfaces when moving a load to another area instead of manually pushing it across a standard work bench. Pushing motions across the front of the body should be avoided.
- Reduce the width of conveyor belts or use diverters to keep materials close to the worker's body. Most functions should be performed with the elbows in close to the torso.
- Support the arms or the weight of the object to take the stress off the shoulder area. For example, a counterbalance will support the weight of a tool so the employee does not have to support it.
- Position work areas to allow elbows to be kept close to the body. Impediments such as work tables, bins, or power equipment should be removed so employees can move closer to the task.



Keep most work activities within repetitive access area.



Mail cart

Potential Hazards:

- Reaching and lifting behind the plane of the body stretches and kinks nerves and blood vessels and places the shoulder in a weak posture. This increases the risk of acute injuries such as muscle tears and strain.
- Performing tasks that pull the shoulders back and down, for example, postal worker carrying a letter carrier bag.

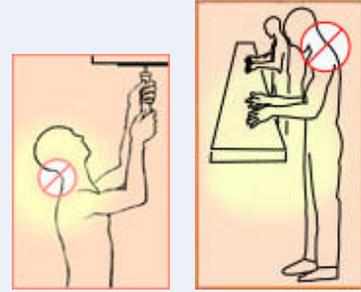
Possible Solutions:

- Arrange most materials and supplies that must be accessed repetitively so they are in front of the body and can be easily reached with the elbows in close to the torso. These items should be within the "windshield wiper area" created when you sweep your arms in front of the body and at your side. Materials that are accessed only occasionally can be placed further out.
- Lift items that weigh more than a few pounds in front of the torso. For example, place your briefcase in the front seat so you do not need to reach behind your body to retrieve it, or get out of the car and open the back door so you can lift the briefcase while it is in front of your body.
- Use a cart, not your shoulders, to support and carry loads.
- Use shoulder strap bags to minimize the load to be carried.
- Use dual, instead of single, straps to carry loads such as a backpack since this will place less weight on each shoulder.
- Use broad padded strap supports to distribute and minimize pressure.
- Use waist straps to transfer the load from the shoulders to the waist.

Neck: Awkward Postures

Potential Hazards:

- Repeatedly tilting the head forward, backward, or to the side, or holding it in these positions for prolonged periods can fatigue the shoulder and upper back muscles. Examples are, tilting the head forward to perform assembly line work, tilting the head backward to perform overhead work, or looking to the side to use a poorly placed computer monitor. These postures can also pinch the nerves as they radiate out from the spine and must pass through clenched muscle groups.



Awkward neck postures

Possible Solutions:

- Use height-adjustable work platforms so employees can be raised or lowered to minimize forward or backward head tilting.
- Use height-adjustable work surfaces or lift tables to minimize tilting of the head and bending of the neck. For example, computer monitors should not be above eye level.
- Tilt work surfaces toward employee such as drafting tables so the head can be held straight.
- Minimize prolonged overhead activity by rotating employee tasks that require prolonged awkward head postures or by providing rest periods.



Height-adjustable platforms



Raise and tilt worktables

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Supplemental Information: General Solutions: Lower Arm, Hands, and Wrists

This section describes common risk factors such as forceful pinching or pressure on the palm from a tool, which may increase the chance of injury and pain to the lower arm, hand, and wrist. General solutions that may minimize the possibility of injury and pain to these body parts are also presented.



- [Bending the Wrist](#)
- [Forceful, Prolonged, Repetitive Finger Exertion](#)
- [Contract Trauma to the Hand or Fingers](#)
- [Exposure to Vibrating Hand Tools](#)
- [Forearms: Bending, Rotation and Contact Trauma](#)

Bending the Wrist

Performing hand-intensive tasks with a bent wrist, either up and down or side to side, creates considerable stress on the tendons and their sheaths as they are bent across the harder bones and ligaments that make up the outside structure of the wrist.

Potential Hazard:

- Bending the wrist while performing repetitive finger actions such as typing pulls the tendon over the bones and ligaments in the wrist. This creates irritation to the tendon and especially the tendon sheath, which is caught between the tendon and bone or ligament. This action creates irritation, inflammation, and eventually tendonitis or Tenosynovitis.



Possible Solutions:

- Train employees to keep the wrist as straight as possible while performing finger-intensive tasks. When the wrist is straight, the tendons can slide easily through the sheath.
- Use appropriately designed hand tools so

Ergonomic Knives



30-degree bend



Upright handle



Pistol grip



45-degree bend

the wrist can remain straight such as ergonomic knives or bent -handled pliers.

- Use **pistol grip** tools when working on vertical surfaces to maintain neutral wrist positions.
- Use **inline tools** when working on horizontal surfaces to maintain neutral wrist positions.

Potential Hazard:

- Bending the wrist while performing prolonged forceful finger exertions such as forcefully sanding an object or forcefully holding a piece of slippery meat while trimming it.

Possible Solution:

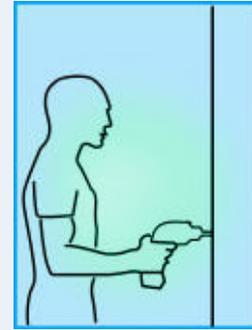
- To minimize forceful finger exertions, use adjustable jigs or stands to hold work instead of holding it in the hand. Jigs or stands should hold the work securely and have a wide range of adjustability. This allows workers to place objects in a position where wrist bending can be minimized while working on the task.

Potential Hazards:

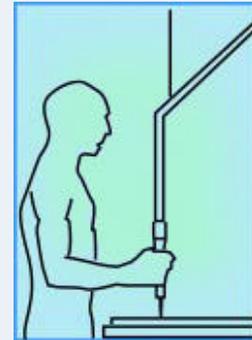
- Bending the wrist while performing tasks that require repeated rotation or twisting of the forearm, for example, using a manual screwdriver, can stretch and pull the tendon connection at the elbow. Repeated stress at this connection can cause irritation and swelling, leading to either lateral or medial Epicondylitis (tennis or golfer's elbow).

Possible Solution:

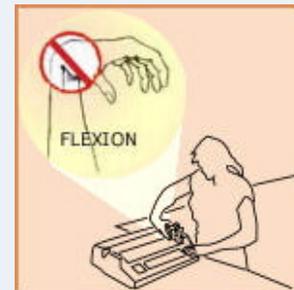
- Use tools that allow the wrist to remain in a straight posture if manual operations must be performed. Using a "T" handle instead of a straight handle will help maintain straight wrists.
- Use power tools instead of performing highly repetitive manual motions for example, use power screwdrivers instead of manual screwdrivers.



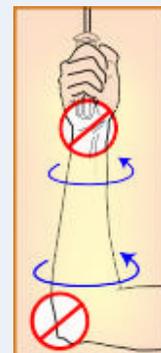
Use pistol grip tools for vertical surfaces.

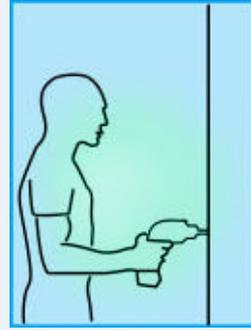


Use inline tools for horizontal surfaces.



Neutral wrist maintained with product realigned by placement of work jig.





Forceful, Prolonged, Repetitive Finger Exertion

Exertion of high finger force, either on a prolonged or repetitive basis, can stretch and potentially fray the tendons. This kind of damage can make it difficult for the tendon to slide through the tendon sheath, which can lead to further irritation and swelling. Irritation and swelling can lead to restriction of the tendon movement through the sheath, eventually causing stenosing Tenosynovitis or Trigger Finger. Highly repetitive finger tasks which may not use great force, such as typing, can still create irritation, especially in older workers.

Contact with sharp edges of tools or bending the wrist will greatly increase the hazard associated the use of forceful finger exertions.

Potential Hazards:

- Pinch grips that keep the fingers relatively straight while exerting force, such as when holding the box as shown in Fig. 1, or grasping too many items at a time, Fig. 2, place the hand in a weak posture that requires excessive force exertion by the tendons in order to generate adequate finger force. Excessive force exertion can lead to fraying and pain.
- Tools that are too large or too small require excessive finger force to hold and control.
- Using tools or performing tasks that isolate force and repetition, such as using a single-point trigger or a mouse, may not provide adequate time for recuperation.

Possible Solutions:

- Avoid the use of forceful pinch grips and straight-finger pinch grips by using hand cutouts or handles when carrying boxes.
- Use tools with appropriately sized handles if high finger force is necessary. Sized tool handles should be provided for workers who have small or large hands. The hand



Fig. 1
Pinch-grips used to support heavy loads.

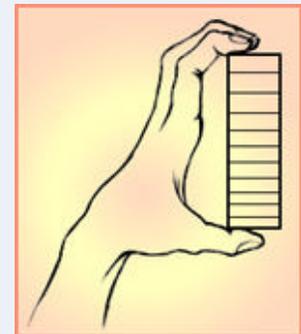


Fig. 2
Pinch-grips.



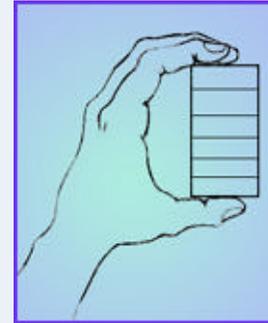
Single point trigger requires all force to be exerted by a single finger.

should be able to maintain the shape of a "C" while grasping the tool.

- Minimize elongated grasping postures by lifting fewer items at a time.
- Use a vice or fixture to hold items while they are being worked on instead of holding the item in the hand.
- Use power tools to reduce the amount of finger force exerted. For example, using powered shears requires less finger force than using manual tin snips.
- Use **trigger levers** instead of single-point triggers so the force exertion is spread over several fingers.
- Activate tools using a foot pedal instead of a trigger.
- Alternate hands to perform the task whenever possible.
- Redesign processes to alternate tasks so muscles are not used for prolonged periods.



Use handholds.



"C" hand posture



Trigger lever



Potential Hazard:

- Prolonged repetitive hand work can damage the tendons and tendon sheaths of the fingers, especially if recuperation periods are not adequate or if the wrist is bent. These repetitive motions can lead to Tendinitis, Tenosynovitis, and Carpal Tunnel Syndrome.

Possible Solutions:

- Redesign processes to vary tasks for example, alternate highly repetitive tasks with those tasks that do not require high repetition.
- Alternate hands or fingers for tasks like mousing.
- Take frequent, short breaks, instead of less frequent, longer breaks.
- Maintain straight wrist postures by assuring proper height of the keyboard, mouse, or other working surfaces.
- Provide a keyboard tray that is easily adjustable so straight wrist postures can be maintained.



Straight wrist postures

- The work surface may need to be lowered to keep the operator's arms in a comfortable position. This can be achieved by installing a keyboard extender or tray.



Adjustable keyboard tray

Contract Trauma to the Hand or Fingers

The hand and arm have several areas, such as the sides of the fingers, palm, and bottom of the forearm, where nerves, blood vessels, and tendons are close to the surface and unprotected.

Potential Hazard:

- Contact trauma to the palm of the hand can be caused by tools that press into the palm, such as short-handled pliers or screwdrivers. Scissors have hard surfaces that contact the side of the fingers when they are repeatedly used. This trauma can damage nerves, causing tingling of fingers, or damage tendons or muscles, leading to pain and difficult hand movement.

Possible Solutions:

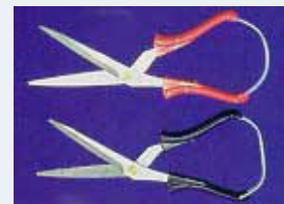
- Use tools with handles that are long enough to span the entire hand. This design equalizes and spreads contact force across the entire palm and fingers and allows all fingers to provide force, which reduces the force by any single finger.
- Use padded tool handles so there are no sharp edges that can press against the hand or fingers.
- Use pneumatic or spring-loaded scissors with handles that extend across the palm and do not create contact trauma to the sides of the fingers.
- Use power tools such as power screw drivers to perform tasks. These usually allow the hand to remain in a straight neutral posture and spreads contact stress across the entire hand.
- Use padded gloves to protect the inside of the palm and the fingers.



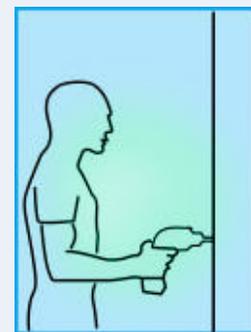
Contact trauma to the palm



Padded tool handles



Spring-loaded scissors

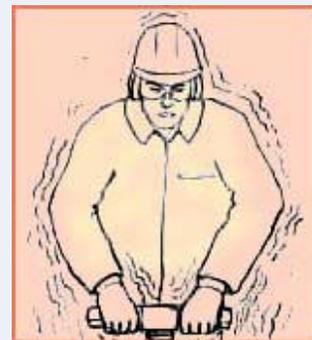


Power drill

Exposure to Vibrating Hand Tools

Potential Hazard:

- Repeated use of vibrating hand tools can damage blood vessels and reduce nutrient flow to the hand. Loss of circulation leaves fingers cold and numb and if continued for long periods can lead to tissue and nerve damage and hypersensitivity to cold. See Raynaud's Phenomenon.



Possible Solutions:

- Use vibration-dampening gloves.
- Use handle coatings that suppress vibration.
- Use vibration isolation between the attachment and tool to isolate vibration.
- Avoid extended use of vibrating machinery, such as chain saws or pneumatic tools.

Forearms: Bending, Rotation and Contact Trauma

Tendons, muscles, and nerves of the elbow and forearm are stressed when employees must repetitively bend or rotate the lower arm. For example, activities that require forceful rotation of the forearms such as tennis can cause elbow pain. When the elbow comes in contact with hard work surfaces the nerves that run through the inner part of the elbow can be compressed causing pain or numbness in the ring and little fingers similar to when one strikes their "funny bone" on a hard surface.



Potential Hazard:

- Repeated bending of the elbow due to pulling levers, lifting, or working on a task that is too close to the body can lead to irritation of tendon-bone connections and nerves.



Possible Solutions:

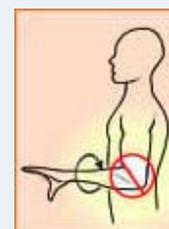
- Consider alternative operation controls, such as foot pedals or joysticks, to replace pull levers.
- Position most work so the arm can be maintained close to the body and the upper and lower arm are at about 90-120 degrees to each other.



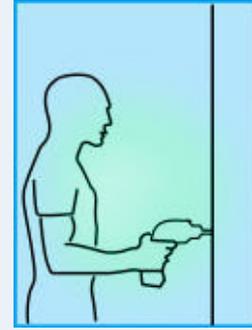
Potential Hazards:

- Contact of the lower arm or elbow with hard or sharp surfaces can compress the ulnar nerve and may lead to tingling or numb fingers.

Possible Solutions:



- Pad the edge of work surfaces that come into contact with the elbow or forearm.
- Arrange work tasks so the arm is not laying on the work surface.



Potential Hazards:

- Tasks requiring repetitive twisting or rotation of the forearms, particularly when the wrist is bent, such as the motion used to drive screws using a manual driver can lead to irritation and pain around the elbow, commonly known as Epicondylitis, or *Golfer's* or *Tennis elbow*.

Possible Solutions:

- Eliminate repeated forearm rotation by using power tools such as electric screwdrivers.
- Take breaks or rotate through tasks that do not involve repetitive pushing, pulling, and twisting.
- Decrease the risk of injury when the forearm must be rotated by minimizing bending the wrist.

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Supplemental Information: General Solutions: Back

The following describes common risk factors (such as reaching and tilting the head back) that may increase the chance of injury and pain to the shoulder, neck, and upper back. General solutions that may minimize the possibility of injury and pain are also presented.

- [Working with the Torso Bent or Twisted](#)
- [Lifting Loads That Are Too Heavy](#)
- [Whole Body Vibration](#)
- [Pushing and Pulling Carts](#)



Working with the Torso Bent or Twisted

Potential Hazards:

- When the torso is bent forward or to the side, the weight of the upper body must be supported as well as any other objects held in the hands. Employees who must work for prolonged periods of time in a bent-at-the-waist posture put significant strain on the back even if they are not lifting significant weight.
- Twisting and bending pulls the back out of its normal alignment. This can pinch and alter the discs, making them more susceptible to bulging and rupture. This also forces the muscles of the back to work singularly instead of in tandem, making them more susceptible to overexertion and strain.
- Finally, maintaining static postures for prolonged periods slows nutritional flow and removal of wastes to the muscles and tendons. This can create fatigue making them more susceptible to injury.



Awkward postures



Static Postures

Possible Solutions:

- Keep the load directly in front of the body. Avoid reaching to the side or twisting when lifting.

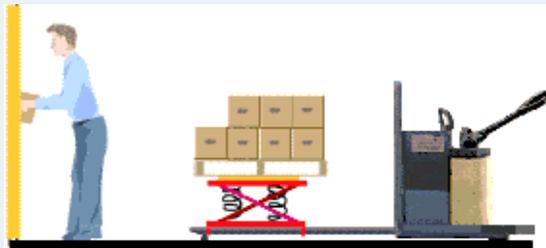
- Keep the load close to the body when lifting.
- Use automation whenever possible to reduce repetition and duration of lifting tasks performed in awkward postures.
- Reposition loads so most lifts can be performed at about waist height with the elbows in close to the body.
- Use positioning devices, such as scissor lifts, lifter/tilters and palletizers, to raise and position loads so they can be lifted while close to the body with the back in a straight alignment.
- Use devices with rotating platforms so loads can be easily positioned close to the body before lifting.
- Use elevating and tilting bins, which elevates the load and keeps it close to the body.



Pallet rotates and wrapping automatically moves up and down, eliminating operator twisting and bending.



Scissors lift platform with rotating top



A palletizer on a pallet jack. Palletizers and scissor lift platforms, raise or lower working height as materials are added or removed.



Shock cords raise hamper floor as weight is removed.

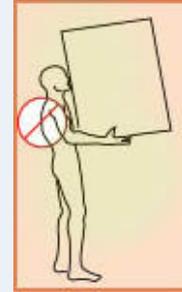


Lift/tilter

Lifting Loads That Are Too Heavy

Potential Hazards:

Some loads are too heavy for most of the population to lift, even if all lifting conditions are ideal. Some studies suggest that even under ideal conditions, loads heavier than about 50 to 60 pounds may increase the risk of injury. In addition, the following factors may reduce the amount of weight that can be lifted safely.



- Bending the torso forward moves the load away from the body and forces the back to support the weight of the upper body.
- Reaching to access and lift a load also moves the load away from the body.
- Frequent repetition of lifting motions leads to poor lifting techniques and muscle fatigue.
- Twisting while lifting places the back in a less-stable posture and places the back in a less-stable posture.
- Lifting for long periods of time leads to fatigue.
- Previous back injury.



Powered barrel dumper



Vacuum hoist

Possible Solutions:

- Evaluate lifting tasks to determine the maximum weight that can safely be lifted. A variety of analysis tools can be used to make this determination.
- Do not manually lift excessively heavy loads. For most people, loads heavier than about 50 to 60 pounds should be considered heavy. Situations that involve awkward postures such as bending, reaching, or twisting or repetitive lifting will reduce the weight people can lift.
- Use lifting assist devices to lift loads that are determined to be excessive. These devices allow loads to be lifted by mechanical means rather than forcing employees to support the weight. Some examples of such devices include:
 - Powered barrel dumpers eliminate heavy lifting. Employees use a hand truck to load a heavily loaded barrel onto the device. It then automatically lifts the barrel and dumps the contents.
 - A counterweighted device, such as a vacuum hoist, allows employees to lift significant weight. Employees must exert only a few pounds of force to guide the load around the work space while mechanical means support most of the weight.
 - Conveyor systems or carts allow employees to transport items around the work station without repeated lifting and carrying.

Use of proper lifting techniques when performing manual lifts will minimize the risk to the back, but a heavy load still can cause injury even with perfect technique.

- Maintain neutral spine alignment whenever possible. Usually, bending at the knees, not the waist, helps maintain proper spine alignment.
- Keep the load close to the body. For large bulky loads, it may be better to bend at the waist instead of the knees because this will keep the load closer to the body. Do not reach to access a load.
- Minimize bending of the body by keeping the load between shoulder and thigh height when lifting. Keep heavier loads off the floor.
- Do not twist the body when lifting. Keep the load in front of the body
- Lift heavier or bulky loads with a buddy.
- Strengthen back and abdomen muscles that support your spine.

Whole Body Vibration

Potential Hazards:

- Whole body vibration occurs while standing or seated in vibrating environments, such as trucks or heavy machinery.
- Whole body vibration in a seated position has been found to increase the prevalence of reported low back pain. Operations such as tractor driving, forklift operating, truck driving, and driving earth moving machines have been found to result in increased back pain.



Whole body vibration

Possible Solutions:

- Provide vibration isolation for operator seats.
- Provide padded seats with dampening material.
- Remove debris and repair damage to flooring. Smoother driving surfaces will reduce vibration.

Pushing and Pulling Carts

Potential Hazards:

- Pushing and pulling loads, such as carts, dumpers and gurneys, places stress on the back, especially when generating sufficient force to start and stop the devices. Factors such as the weight being moved, height of the handles, maintenance of equipment and flooring surfaces can greatly increase the risk of injury.



Possible Solutions:

- Limit the weight of loads to be moved manually. Generally, loads that require more than about 50 pounds of force to move require mechanical assists.

- Use powered movers such as tugs to move heavy loads.

- Keep carts, hampers, gurneys, etc., well maintained to minimize the amount of force exerted while using these items.

- Use carts with large, low rolling resistance wheels. These can usually roll easily over mixed flooring as well as gaps between elevators and hallways.

- Keep handles of devices to be pushed at waist to chest height.

- Keep floors clean and well maintained.

- Use a pendant handle when performing pulling tasks. This allows operators to lean away from the load so their body weight can assist in moving the load. This also reduces the chance of the cart running into their legs.

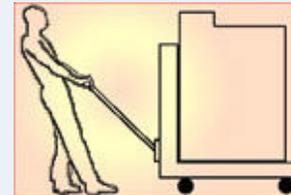
- Push rather than pull whenever possible.



Tug mover to assist with heavy loads



Well maintained carts with handles at convenient heights



Pendant handle

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Supplemental Information: General Solutions: Lower Extremities

The following information describes common risk factors (such as standing and kneeling) that may increase the chance of injury and pain to the lower extremities. General solutions that may minimize the possibility of injury and pain to these body parts are also presented.

- [Static Postures](#)
- [Push/Pull Operations](#)
- [Crouching and Kneeling](#)
- [Sitting](#)



Static Postures

Potential Hazards:

- Continuously standing in one position causes muscle fatigue and pooling of blood in the lower extremities. This can be painful, lead to the development of varicose veins, and weaken muscles, making them more susceptible to injury.
- Standing on hard work surfaces, such as concrete, creates contact trauma and pain to feet.



Possible Solutions:

- Provide sit/stand stools at work stations. This provides an opportunity to shift weight from the feet while still maintaining reach and accessibility.
- Use anti-fatigue mats.
- Use shoes with well-cushioned insteps and soles where mats are not practical.
- Provide a foot rest bar so employees can continually alter their posture by raising one foot.

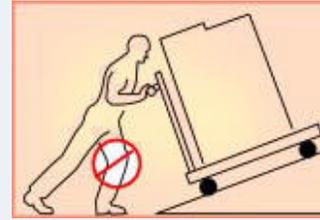


Sit/stand stool

Push/Pull Operations

Potential Hazard:

- Lower extremity injuries occur to the knees and ankles during push/pull operations when significant force must be exerted to push heavy loads, or push across non-even or damaged work surfaces, when pushing poorly maintained carts, or when stopping a load.



Possible Solutions:

- Use push/pull aids, such as tugs, when moving heavy loads.
- Break down large loads to several smaller loads.
- Use a buddy system when pushing heavy loads.
- Clear ice, snow, or other debris from travel path before lifting or carrying.
- Provide clean floors and well-maintained equipment to minimize forces needed to push.
- Maintain a good coefficient of friction between the floor surface and shoes. Wear shoes with good grips to maintain firm footing.



Tug mover



Clean floors and well-maintained equipment

Crouching and Kneeling

Potential Hazard:

- Performing prolonged or repeated work activities in the crouching/kneeling position causes reduced blood flow to the lower extremities and contact pressure injuries to the part of the knee coming into contact with hard surfaces.



Possible Solutions:

- Knee pads or foam padding should be used by workers performing prolonged kneeling activities.
- Stools should be used instead of crouching.
- When lifting in a cramped area, such as in an aircraft luggage compartment, it is best to perform lifting tasks from a kneeling position and push/pull tasks from a crouched position.



Knee pads



Using kicker

Potential Hazard:

- Carpet layers are subject to "Carpet Layer's Knee" as a result of the contact trauma with the kicker.

Possible Solution:

- Automatic devices should be used if available (for example, carpet layers should use "power stretchers" instead of "knee kickers" to avoid contact trauma and Carpet Layer's Knee).

Sitting

Potential Hazard:

Improper chair height, seating position, or materials may create contact trauma to buttocks and thighs. This may result in uneven weight distribution, contact trauma, decrease in circulation to the lower extremities, irritation, and improper posture.



Possible Solutions:

- The seat pan should be slightly concave with a padded, rounded, or "waterfall" edge. This design will help distribute the weight and may also prevent sliding forward in the chair. A waterfall front edge will reduce contact trauma to the back of the legs.
- Chairs should be height adjustable, especially in work areas where they are shared by a number of employees.
- The chair height is correct when the entire sole of the foot can rest on the floor or footrest and the back of the knee is slightly higher than the seat of the chair. This position allows blood to circulate freely in the legs and feet.
- Where seating must be elevated, provide footrests to support the feet.



Ergonomic chair

For more information on ergonomic chairs see OSHA's Computer Workstations eTool.

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