CTC COMPLIANCE TRAINING ONLINE

Cal/OSHA, DOT HAZMAT, EEOC, EPA, HAZWOPER, HIPAA, IATA, IMDG, TDG, MSHA, OSHA, and Canada OHS Regulations and Safety Online Training

Since 2008

This document is provided as a training aid and may not reflect current laws and regulations.

Be sure and consult with the appropriate governing agencies or publication providers listed in the "Resources" section of our website.

www.ComplianceTrainingOnline.com

Facebook LinkedIn Twitter Website

OSHA®

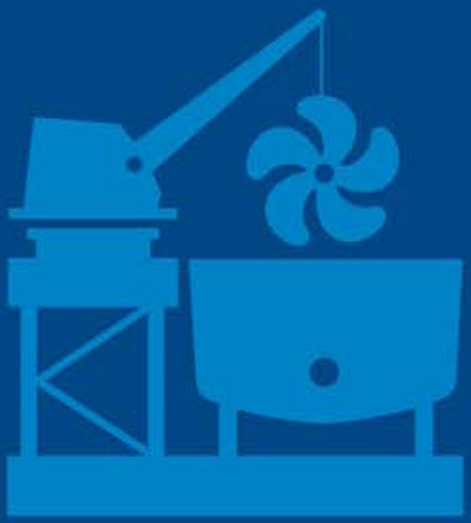
Occupational Safety and Health Administration

U.S. Department of Labor

www.osha.gov

Guidelines *for* Shipyards

OSHA 3341-03N
2008



Ergonomics *for the* Prevention *of* Musculoskeletal Disorders

Employers are responsible for providing a safe and healthful workplace for their employees. OSHA's role is to assure the safety and health of America's working men and women by setting and enforcing standards; providing training, outreach and education; establishing partnerships; and encouraging continual improvement in workplace safety and health.

This publication is in the public domain and may be reproduced, fully or partially, without permission. Source credit is requested but not required.

This information is available to sensory impaired individuals upon request. Voice phone: (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

These guidelines are advisory in nature and informational in content. They are not a new standard or regulation and do not create any new OSHA duties. Under the OSH Act, the extent of an employer's obligation to address ergonomic hazards is governed by the general duty clause, 29 U.S.C. 654(a)(1). An employer's failure to implement the guidelines is not a violation, or evidence of a violation of the general duty clause. Furthermore, the fact that OSHA has developed this document is not evidence of an employer's obligations under the general duty clause; the fact that a measure is recommended in this document but not adopted by an employer is not evidence of a violation of the general duty clause. In addition, the recommendations contained herein were developed with the idea that they could be adapted to the needs and resources of each individual place of employment. Thus, implementation of the guidelines may differ from site to site depending on the circumstances at each particular site.

Occupational Safety and Health Administration

U.S. Department of Labor

www.osha.gov

Guidelines for Shipyards

Ergonomics for the Prevention of Musculoskeletal Disorders

United States Department of Labor
Occupational Safety and Health Administration

OSHA 3341-03N
2008

Contents

Executive Summary **3**

Introduction **4**

A Process for Protecting Employees **5**

Providing Management Support **5**

Involving Employees **5**

Providing Training **5**

Identifying Problems **6**

Implementing Solutions **7**

Addressing Reports of Injuries **7**

Evaluating Progress **7**

Implementing Solutions **8**

Site-wide **9**

Material/Equipment Handling **12**

Tools **31**

Metal work 3**5**

Shipside **38**

Personal Protective Equipment (PPE) **44**

Additional Sources of Information **47**

References **48**

Executive Summary

Many proactive initiatives taken by the shipyard industry have resulted in a reduction in injuries and illnesses. Shipyards have reported that many shipyard tasks are performed in awkward body postures, at nonadjustable workstations, on scaffolds, and in enclosed or confined spaces (1, 2, 3). Even in this environment, the shipbuilding industry has found ways to make shipyard work easier through ergonomic solutions. However, the industry still has higher injury rates than general industry and construction (4).

More remains to be learned about the relationship between workplace activities and the development of musculoskeletal disorders (MSDs). Continuing research and operational experience will provide additional information that will assist in designing further recommendations for reducing the potential for MSDs in workplaces. However, the experiences of numerous shipyards that have successfully addressed this important issue have provided a sufficient basis for taking action to better protect employees.

These guidelines provide recommendations for shipyards to help reduce the number and severity of work-related musculoskeletal disorders, increase employer and employee awareness of ergonomic risk factors, eliminate unsafe work practices, alleviate muscle fatigue, and increase productivity.

In order to develop these guidelines, OSHA reviewed existing ergonomic practices in several shipyards, conducted site visits to observe these practices in action, and interviewed employees in shipyards. Many shipyards addressed ergonomic issues by integrating ergonomics into their overall health and safety programs (1, 2, 3). In addition, the Agency reviewed available scientific information regarding shipyard work activities that may benefit from implementing specific ergonomic solutions.

The general information in these guidelines is intended to provide shipyard employers and employees with effective solutions and a useful reference when determining the need for ergonomic assistance for specific jobs in the shop, yard, or on board a ship. The recommendations and information presented here are intended as general guidelines - a flexible framework to be adapted to the needs and resources of each individual shipyard.

Boat builders who make sailboats or small recreational powerboats are not addressed in these guidelines. However, those industries may find in this document some approaches to help address ergonomic concerns. The ideas presented in these guidelines may also be beneficial in other industries with metal forming and assembly operations.

OSHA realizes that some shipyards, particularly small ones, may need help with the implementation of some of the ergonomic solutions. They may need assistance in setting up a plan to implement an appropriate ergonomics process and to make recommended solutions applicable to their individual situations. Therefore, OSHA emphasizes the availability of its free consultation services to address these needs.

The heart of these guidelines is the description of various solutions that have been implemented by shipyards. OSHA recommends that shipyards consider these solutions in the context of a systematic process that includes the elements described in the pages that follow. Such a process will make it more likely that the solutions implemented in a particular workplace will be successful in reducing injuries and will be cost effective.

These guidelines expand on these recommendations, and include additional information that employers can use to identify problems and train employees. This document includes an introduction; a process for protecting employees; solutions that employers can use to help reduce MSDs in shipyards which are of particular value; and additional sources of information on ergonomics in shipyards.

Edwin G. Foulke, Jr.
Assistant Secretary of Labor for
Occupational Safety and Health

Introduction

The shipyard work environment is very complex. Shipyards work on a variety of vessels including tankers, cargo carriers, fishing vessels, military ships, and barges. In addition, shipyards perform different types of work such as new ship construction, repair, maintenance, and demolition (shipbreaking). Shipyard work typically involves fabrication and forming of large steel plates, beams, and pipes, as well as painting and coating operations. In addition, there are outfitting activities such as electrical work, sheet metal work, and work on propulsion systems. Welding is also a common job in shipbuilding, requiring grinding and chipping of welds. Moreover, most shipyard employees work outdoors and are exposed to adverse conditions, such as extreme temperatures (5).

Small shipyards may employ less than one hundred people, while the large shipyards may have 5,000 or more employees. Shipyard work is divided into three categories: work in the shop, in the yard, and on the ship. In most shipyards, fabrication starts in a shop off the vessel, where the work conditions are similar to some manufacturing or maintenance activities. However, final assembly is completed on the vessel in varying and unique environments. In addition, many shipyards are involved in repair and maintenance work, some of which can be done off the vessel, but the vast majority must be done on a vessel.

Early indications of MSDs include numbness, tingling, pain, restriction of joint movement, or soft tissue swelling. Studies have shown that persistent or recurring general shoulder pain (related to e.g., rotator cuff tendonitis) is commonly reported by shipyard employees (6, 7). In addition, shipyard employees experience lower extremity MSDs, strains and sprains of the low back muscles, and associated low back disorders (6, 8, 9). Moreover, hand-arm vibration syndrome, known as "vibration white finger," is often identified among shipyard employees who use vibrating tools (5, 10, 11).

Some MSDs develop gradually over time as a result of intensive work (3, 7, 12). When the work environment requires employees to assume awkward or static body postures for a prolonged period of time, the employees may be at risk of developing MSDs (7, 13, 14). Activities outside the workplace that involve substantial physical demands may also cause or contribute to MSDs (15). In addition, the development of MSDs may be related to genetic causes, gender, age, and other factors (15, 16). Finally, there is evidence that reports of MSDs may be linked to certain psychosocial factors such as job dissatisfaction, monotony, and limited job control (15, 17). These guidelines address only physical risk factors in the workplace. The ergonomics-related risk factors that shipyard employees are most often exposed to include:

- Force,
- Repetition,
- Awkward and prolonged static body posture,
- Contact stress,
- Vibration, and
- Cold temperatures combined with the risk factors above.

The combination of these risk factors in a job can result in a greater risk of injury (17). However, the presence of risk factors on a job does not necessarily mean that the employees will develop MSDs.

OSHA visited shipyards that had implemented ergonomic solutions and achieved considerable success in reducing work-related MSDs (1). Providing a safer and more comfortable work environment has also resulted in additional benefits including reduced absenteeism, increased efficiency and productivity, decreased fatigue, and improved employee morale (1).

> Due to ergonomic improvements our accident rate from 5 years ago is down about 80%.
> In addition, we have been consistently profitable in the shipyard for 4 years.
>
> Steve Welch, CEO, Todd Pacific Shipyard 2003 (2)

A Process for Protecting Employees

For many operations, the number and severity of injuries resulting from physical overexertion, as well as associated costs, may be substantially reduced (15). OSHA recommends that employers develop a process for systematically addressing ergonomic issues in their work environments and incorporate this process into their existing safety and health programs. To be most effective, the process should be tailored to an individual shipyard's operations.

Shipyard management personnel should consider the general steps discussed below when establishing and implementing an ergonomics program. It should be noted, however, that each shipyard will have different needs and limitations that should be considered when identifying and correcting workplace problems. Shipyards may implement different types of programs and activities and may assign staff from a variety of departments to accomplish the goals of the ergonomics program.

Providing Management Support

Strong support by management is critical for the overall success of an ergonomics process (15). OSHA recommends that shipyards develop clear goals and objectives for the ergonomics process, discuss them with the employees, and assign responsibilities to the designated staff members to achieve those goals, and provide feedback to employees. Implementation of an effective ergonomics process includes a sustained effort, the coordination of activities, and the resources necessary to ensure that the objectives of the ergonomics process will be accomplished.

Many shipyards have successfully integrated more than an ergonomics process into their business; for example, the "lean manufacturing" and "Five S" strategies focus on providing the right material to the right place at the right time in a proper manner (1, 3). These strategies attempt to eliminate non-value steps in the manufacturing process, such as "wasted walking" or "wasted motion" to pick up parts (3, 18, 19). Ergonomics is a good fit with these strategies - ergonomic principles help to identify and control activities that detract from employee performance and may lead to MSDs.

Involving Employees

Employees are a vital source of information about hazards in their workplaces. They have a unique insight into the problems of their jobs and can assist in identifying work-related risk factors. Employees' opinions and suggestions for change are valuable, particularly in such a difficult and complex work environment as a shipyard. Employees can provide early reports of MSD symptoms, submit their concerns and suggestions for reducing exposure to risk factors, and evaluate the changes made as a result of an ergonomic assessment. They can also participate in other activities such as ergonomic task groups and respond to management surveys and questionnaires.

Shipyard employers reported that employee involvement in the ergonomics process enhances employee morale and job satisfaction. Employee involvement leads to greater acceptance when changes are made and to better understanding of ergonomics both on and off the job (1, 20).

Providing Training

Training is also an important element of the ergonomics process. Training ensures that employees are informed about ergonomic concerns in the workplace and ways to minimize the risk of injury. Training is best provided by individuals who have experience with ergonomic issues in shipyards. Training should be provided in a manner and language that all employees can understand.

Training prepares employees for active participation in the ergonomics process, including identifying potential problems, implementing solutions, and evaluating the process. Effective training includes:

- Proper use of equipment, tools, and machine controls;
- Good work practices, including proper lifting techniques;

- Awareness of work tasks that may lead to pain or injury;
- Recognition of MSDs and their early indications;
- Addressing early indications of MSDs before serious injury develops; and
- Shipyard procedures for reporting work-related injuries and illnesses as required by OSHA's injury and illness recording and reporting regulation (29 CFR 1904).

Employees will benefit from orientation and hands-on training received prior to starting tasks with potential ergonomic risk factors. Employees should also be notified of workplace changes, instructed on using new equipment, and notified of new work procedures.

Identifying Problems

It is important to periodically review the job site and the activities of employees to identify possible ergonomic issues. Information about existing problems can be obtained from a variety of sources including analysis of OSHA 300 and 301 injury and illness information, workers' compensation records, and employee reports of problems.

In addition, observations of workplace conditions and work processes, job analyses, workplace surveys, and employee interviews are important in identifying ergonomics-related risk factors. The ergonomics-related risk factors that may lead to the development of MSDs include:

- Force - the amount of physical effort required to perform a task (such as heavy lifting, pushing, pulling) or to maintain control of the equipment or tools.

- Repetition - performing the same motion or series of motions frequently for an extended period of time.

- Awkward and prolonged static postures – assuming positions that place stress on the body, such as repeated or prolonged reaching above the shoulder height, bending forward or to the side, twisting, kneeling, or squatting.

As reported by Gunderson, Inc., awkward postures and long task durations are their greatest ergonomic issues (1).

- Contact stress – pressing the body or part of the body (such as the hand) against hard or sharp edges, or using the hand as a hammer.

- Vibration – using vibrating tools such as sanders, chippers, drills, grinders, or reciprocating saws may result in fatigue, pain, numbness, increased sensitivity to cold, and decreased sensitivity to touch in fingers, hands, and arms. Exposure to whole body vibration may damage the joints of the skeletal system.

Cold temperatures combined with the risk factors above may increase the risk of musculoskeletal disorders (8, 15).

When there are several risk factors in a job, as is often found in shipyards, there can be a greater risk of injury (17). Whether certain work activities put an employee at risk of injury can depend on the duration (how long), frequency (how often), and magnitude (how intense) of the employee's exposure to the risk factors in the activity (17), as well as other factors. These characteristics are particularly important when considering work activities and conditions. For example:

- Grinding welds in a small compartment can involve a combination of vibration, force, and awkward postures.
- Pulling cable through an overhead channel can involve awkward postures and repetition.
- Using a needle gun outdoors can involve awkward postures and vibration in a cold environment.

Additionally, the following types of employee behavior may indicate the presence of ergonomics-related problems:

- Employees shaking arms and hands or rolling shoulders due to discomfort,
- Employees voluntarily modifying workstations and equipment to increase comfort, and
- Employees bringing in ergonomic products to the worksite (such as wrist braces).

Implementing Solutions

Examples of potential solutions for various ergonomic concerns are located in the Implementing Solutions section of these guidelines.

Addressing Reports of Injuries

Addressing reports of injuries is essential to the success of the ergonomics process. The goal of this effort is to ensure evaluation, diagnosis, and treatment of musculoskeletal disorders. Addressing reports of injuries focuses shipyards' efforts on preventing MSDs in those specific jobs where injuries occur most often and are most severe. It also provides needed input into the management of the ergonomics process. Integrating health care providers into shipyard ergonomic efforts promotes returning to work more quickly and successfully. As a part of the ergonomics process, addressing reports of injuries:

- Reinforces employee training on the recognition of the indications of MSDs and the necessary procedures for reporting potential injuries;
- Encourages employees to report MSDs and potential MSDs early. Early reporting, diagnosis, and interventions can limit injury severity, improve effectiveness of treatment, minimize the likelihood of permanent damage, and reduce workers' compensation claims (21). Federal and state laws prohibit discrimination against employees who report a work-related injury or illness [29 U.S.C. 660(c)];
- Provides prompt medical evaluation, medical care, and follow-up care (including rehabilitation services when available); and
- Provides guidance on job modifications, restrictions, or alternative jobs for injured employees.

Work accommodations and alternative duty tasks will help employees recover faster, so that they can return to their usual job without restrictions and risk of reinjury. Health care providers in shipyards, who remain knowledgeable about shipyard operations and work practices by conducting periodic, systematic workplace walkthroughs to observe workplace conditions and processes, can effectively identify potential alternative duty jobs and maintain close contact with the employees (1).

Evaluating Progress

Procedures and mechanisms to assess the effectiveness of the ergonomics process are also important. Evaluation and follow-up are essential to continuous improvement and long-term success. OSHA recommends that the ergonomics process be regularly evaluated to determine whether ergonomic objectives are met, including after new solutions are implemented. Such evaluations should include input from shipyard managers, health care providers, and employees to review goals, suggest changes in the process, and evaluate the effectiveness of ergonomic improvements.

The success of an ergonomics process can be evaluated based on interaction with employees and observations of the work environment, which are likely to be sufficient for small shipyards. Evaluation of more formal processes in larger shipyards can also include activity and outcome measures used as indicators of process performance. Process evaluations may include the following:

- Direct communication with employees during training sessions, interviews during workplace observations, and follow-up medical evaluations.
- Evaluation of each element of the ergonomics process, as determined by activity measures such as:
  - Average time between employee report of injury, risk factors or other ergonomics-related problem and implementation of appropriate solutions,
  - Number of jobs analyzed and number of hazards identified,
  - Number of employees trained, and
  - Number of risk factors reduced or eliminated.
- Evaluation of the success in eliminating or reducing exposure to the ergonomic risks factors as determined by outcome measures that may include:
  - Number of OSHA recordable MSDs,
  - MSD incidence rate,
  - Number of workers' compensation claims,
  - Severity rate of MSDs,
  - Annual medical cost for MSDs,
  - Average workers' compensation costs per

MSD, and
- Number of job transfer requests per trade.

The results of process evaluations can be used to change the goals of the process over time. As some goals are achieved, it may be appropriate to focus efforts on other goals that remain.

Implementing Solutions

The section on ergonomic solutions for shipyards describes changes to equipment, work practices, and procedures that can address ergonomics-related risk factors, help control costs, and reduce employee turnover. These changes may also increase employee productivity and efficiency because they eliminate unnecessary movements and reduce heavy manual work. OSHA recommends that employers use engineering controls, where feasible, as the preferred method of dealing with ergonomic issues in shipyards. The first set of solutions is applicable to all or most areas of the shipyard.

The recommended shipyard ergonomic solutions presented on the following pages have already been implemented in some shipyards. These solutions are not intended to cover all ergonomic challenges in shipyards, nor does OSHA expect that all of these solutions are applicable to each and every shipyard. OSHA recognizes that implementing engineering solutions may present certain challenges in the shipyard environment, which includes work that is performed outdoors and in cramped spaces. However, shipyard personnel are encouraged to use the examples in this document as a starting point for developing innovative solutions tailored to the specific ergonomic challenges in their individual shipyard. The solutions have been categorized according to the locations and jobs in which they are most frequently performed:

- Site-wide,
- Material/Equipment Handling,
- Tools,
- Metal work,
- Shipside, and
- Personal Protective Equipment (PPE).

SITE-WIDE

Task Lighting

Description: Positioning lights directly over a work area and/or equipment.

Advantage:

- Reduces awkward neck and back position required to get close to the work to view it.

Point to Remember:

- Lights on adjustable arms allow accurate positioning and can help avoid shadows and glare.

Reduces awkward postures

Point-of-Use Tool Boards and Rigging Racks

Description: Devices that position work between the knees and shoulders and within easy reach.

Advantages:

- Provide easy access to tools and material.
- Reduce wasted time to untangle parts.
- Reduce forceful exertions to pull tangled tools apart.

Points to Remember:

- Arrange tools so that the most frequently used tools are within easy reach.
- Device can be used any time the work, tools, or equipment is farther than an arm's reach, lower than the knees, or above the shoulders.

Reduce awkward postures and fatigue

Standing Platforms

Description: Small platforms or benches that can be easily transported to the work area.

Advantages:

- Platform use provides more stability for body posture and may decrease the risk of injury when doing overhead work.
- Lightweight platforms can be folded up and carried onto a vessel.

Points to Remember:

- Platform use may reduce the amount of overhead work that may cause shoulder and neck fatigue.
- When possible, employees should work with hands between waist and shoulder height.

BEFORE

AFTER

Reduce physical exertions and awkward postures

MATERIAL/EQUIPMENT HANDLING

Carts, Hand Trucks, Pallet Jacks

Description: Wheeled devices designed to transport and carry materials.

Advantages:

- Reduce lifting, pushing, and pulling forces.
- Allow heavy or awkward materials, tools, or equipment to be moved without carrying.
- Save time.
- Hand trucks and carts are available in many shapes and sizes and can be customized for special applications.

Points to Remember:

- Motorized pallet jacks are preferred for frequent or distant movement of materials.
- Wheels should be appropriate to the floor conditions to minimize push/pull forces. Larger diameter wheels may improve cart maneuvering.
- Swivel wheels on the rear and fixed wheels on the front make pushing easier for longer distances.
- Swivel wheels on both the front and rear make maneuvering in small, cramped areas easier.
- Wheels should be well maintained.
- Handles should be located at the rear of the cart and positioned at waist level.
- Load height on the cart should not obstruct vision.
- Loads should be balanced and load weight kept under the manufacturer's recommended weight limits.
- Pushing is preferred to pulling.

Reduce lifting, pushing, and pulling forces

Drum Movers/Tilters

Description: Overhead handling system that easily lifts and tilts a heavy drum.

Advantages:

- Eliminate manual lifting and tilting of heavy drums.
- Reduce potential for accidental contact with chemicals.
- Reduce forces on back from rolling the drum on its edge (chimming).

Points to Remember:

- Different handling systems and drum grippers are available for many situations.
- Ensure the system/device is rated for the drum weight.

BEFORE

AFTER

Reduce lifting, pushing, and pulling forces

Overhead Cranes

Description: Overhead devices used to lift and transport heavy items.

Advantages:

- Eliminate manual lifting and carrying of heavy objects.
- Eliminate pushing heavy carts of material and equipment (i.e., sheet metal, pipes, and large tools) across rough floors.
- Various adaptors are available to attach items such as drums, boxes, bags, and hooks.

Points to Remember:

- Ensure the system/device is rated for the load weight.
- Movement pattern should be considered prior to installation of the crane.
- Proper design of control buttons may reduce awkward hand position.

Reduce lifting, pushing, and pulling forces

Jib Cranes

Description: Wall, floor, or pillar mounted I-beam with a rolling trolley/hoist used to lift and position equipment and material.

Advantages:

- Eliminate manual lifting, carrying, and positioning of heavy equipment and material.
- Eliminate the need to push heavy carts across rough floors**.**
- May save time.
- Hose handling systems attached to the jib crane keep welding hoses untangled and eliminate dragging hoses across the floor.
- Cranes are capable of rotating 180-360 degrees for maximum versatility.
- A variety of grippers can be attached to the crane for handling different objects.

Points to Remember:

- Jib cranes can be mounted to a wall, floor, or pillar.
- Most jib cranes have a reach capability of up to 20 feet.
- Movement pattern should be considered prior to installation of the crane.
- Proper design of control buttons may reduce awkward hand position.
- Ensure the system/device is rated for the load weight.

BEFORE

AFTER

Reduce lifting, pushing, and pulling forces

Hoists/Balancers

Description: Portable devices used to lift and position heavy objects or tools.

Advantages:

- Reduce the force needed to lift and position heavy objects or tools over the work area.
- Reduce fatigue from frequent lifting.
- Easy to set up at locations where a crane is not installed.

Points to Remember:

- A variety of attachments are available to lift different objects.
- Ensure the hoist is rated for the load weight.
- Many makes and models of hoists and balancers are commercially available (e.g., spring-loaded, pneumatic, electric, or computer-controlled).

BEFORE

AFTER

Reduce lifting, pushing, and pulling forces

Conveyors

Description: Tabletops or work surfaces with manual or powered roller systems.

Advantages:

- Eliminate carrying large sheets of metal or heavy objects between work stations.
- Reduce shoulder and back fatigue caused by frequently carrying objects between work stations.
- Conveyors can be designed to move material around corners.
- Conveyors can be flexible to extend into trucks or pushed together to minimize blocking forklift traffic aisles.

Points to Remember:

- Powered conveyors minimize pushing and pulling forces.
- Manual conveyors require regular maintenance to minimize pushing and pulling forces.
- Objects on a manual conveyor are easier to push or slide when at or slightly below waist height.
- Ensure that employees are aware of pinch hazards.

BEFORE

AFTER

Reduce lifting, pushing, and pulling forces

Roller Ball Surfaces

Description: Tabletops or work surfaces with roller balls.

Advantages:

- Reduce friction force when moving, loading, or positioning large sheets of metal, wood, or pipe into a machine.
- Roller tops can be located on top of existing work surfaces and tables.
- Some rollers are capable of rotating 360 degrees allowing for objects to be rotated and turned easily.
- Powered rollers minimize pushing and pulling forces.
- Pushing or sliding objects eliminates lifting and carrying that can be more strenuous for the arms and back.

Points to Remember:

- Objects are easier to push or slide when they are at waist height.
- Roller ball surfaces require regular maintenance to minimize pushing and pulling forces.
- Ensure that employees are aware of pinch hazards.

Reduce pushing and pulling forces

Moveable Containers

Description: Large containers for storing and transporting materials, tools, and equipment to where they are being used.

Advantages:

- Reduce material handling and improve efficiency.
- Large quantities of material (i.e., cables, welding units, hoses, rigging equipment) can be transported at one time using a forklift or crane.
- Storage containers may be customized for special applications.

Points to Remember:

- Store items between knee and shoulder height whenever possible.
- Avoid using containers with high sides that require reaching.

BEFORE

AFTER

Reduce manual material handling

Pulley System

Description: Pulleys attached to tools or equipment that assist in manual handling and positioning.

Advantages:

- Reduces force needed to lift, position, or operate tools or equipment.
- Pulleys can be attached to various tools, such as a powered saw, to reduce the force required to operate the saw.

Points to Remember:

- One or more pulleys can be used to reduce the forces needed to handle tools and equipment.
- Ensure the system/device is rated for the load weight.

Reduces lifting, pushing, and pulling forces

Automatic Hose Roller

Description: A machine that coils long hoses.

Advantages:
- Reduces the time and effort needed to manually roll up long hoses.
- Increases efficiency.

Points to Remember:
- Machines can be manufactured to meet specific needs.
- Ensure the device is rated for the load weight.

Reduces pushing and pulling forces, and repetitive motions

Hose, Cord, and Cable Management Systems

Description: Reels that coil hoses and cords and store them out of the way.

Advantages:

- Overhead reels reduce the need to drag, bend, and reach for air hoses.
- Retractable reels store pneumatic and electrical hose/cords easily and conveniently.
- Spring retractable devices reduce the need to manually wind the reel.
- Reels can be portable, mounted overhead, or attached to a wall or workstation.
- Manual and powered rewind hose reels are widely available.
- Overhead reels prevent trip hazards by keeping hoses/cords off of the ground/floor.

Points to Remember:

- Minimize tangles and pinch points in the travel path to reduce the pulling forces.
- Provide enough leader on the hose to minimize pulling.

Reduce pulling forces

Turning and Rotating Devices

Description: Turntables and rotating tabletops that allow objects to be easily turned, rotated, and positioned.

Advantages:

- Reduce the forces needed to position, turn, or rotate parts, tools, and equipment on a work-bench.
- Some turntables are capable of rotating completely.
- A pneumatic foot-operated rotating tabletop allows table to be easily rotated and objects to be placed within easy reach.

Points to Remember:

- Turntables come in a variety of sizes, shapes, and configurations.
- Turntables and rollers can be manual or powered.
- Turntables and roller tops can be located on top of existing work surfaces.
- Turning and rotating devices require regular maintenance to minimize the forces needed to position, turn, or rotate objects on a workbench.

BEFORE

AFTER

Reduce forceful exertions

Racks and Shelves

Description: Devices to stage, move, or store materials, tools, or equipment.

Advantages:

- Position materials, tools, and equipment within easy reach.
- Allow objects to be lifted or moved without bending, twisting, or excessive reaching.
- Wheeled rack carts allow for easy movement and maneuverability.
- Moving racks by crane reduces manual carrying of hoses and leads.
- Storing items on racks allows them to be easily lifted from mid-thigh level (instead of the floor).
- The racks also improve organization.

Points to Remember:

- Store items between knee and shoulder height whenever possible.
- Racks and shelves can be customized to meet individual needs.

Reduce manual material handling

Material Positioners

Description: Devices that position and support material at an appropriate level.

Advantages:

- Allow for easy positioning of large sheets of wood, steel, or aluminum.
- A sawhorse with a roller ball top and hinged sides allows employees to easily position and hold heavy sheets of plywood in a horizontal position and slide them through a saw.
- Work surfaces that are easily raised or lowered allow employees to work in neutral posture.
- Hinged work surfaces reduce bending and reaching.

Points to Remember:

- Surfaces must be able to support the weight of the objects or materials.
- Powered devices are easier to operate.
- Material positioners and height-adjustable devices require regular maintenance to ensure their easy use.

BEFORE

AFTER

Reduce awkward body postures

Moving Welding Units

Description: A welding unit with an attached fixture/handle.

Advantages:

- Allows welding unit to be moved without lifting.
- Allows two-person efforts when relocating welding equipment.
- Reduce muscle fatigue and the risk of back injury.

Points to Remember:

- Design of the fixture should allow the weight to be balanced.
- The fixture attached to the welding unit should have easy to grip handles.

BEFORE

AFTER

Reduce lifting forces

Large Hose Reel

Description: Device that provides a mechanical advantage in coiling long hoses.

Advantages:

- Reduces forces needed to roll large hoses.
- Can be transported with a forklift or crane.
- Hose reels can be customized for special applications.

Points to Remember:

- Keep the reels well maintained and easy to turn.
- Saltwater and moisture may make reels more difficult to turn.
- Ensure system/device is rated for load weight.

Reduces lifting and pulling forces

Synthetic Line

Description: Lightweight synthetic lines.

Advantages:

- Up to 75% lighter than steel lines.
- Some synthetic lines can be handled by one person.

Points to Remember:

- Ensure system/device is rated for the load weight.
- Store synthetic lines properly to reduce their deterioration caused by exposure to environmental conditions.

BEFORE

AFTER

Reduces lifting and pulling forces

Tractor and Trailer

Description: Devices used to move multiple units to and from the ship.

Advantages:

- Loading materials and equipment onto a trailer before transporting them to the dock requires fewer trips, saves time, and reduces handling.
- Trailers come in a variety of sizes, types, and load capacities.

Points to Remember:

- Ensure device is rated for the load weight.
- Ensure items are secure and balanced on the trailer to avoid shifting or tipping.

BEFORE

AFTER

Reduce manual material handling

Stack Blower on Wheels

Description: A custom modification that adds wheels and a handle to a conventional stack blower.

Advantage:

- By attaching a handle and wheels to each unit, stack blowers can be easily maneuvered.

Points to Remember:

- Appropriate wheels should be selected based on the floor or ground surface and conditions.
- Using larger diameter wheels is often an easy way to reduce pushing and pulling forces.
- Handles should be located at about waist height for pushing and pulling.
- Ensure that the top of the stack blower does not obstruct vision.
- Pushing is preferred to pulling.

BEFORE

AFTER

Reduces lifting, pushing, and pulling forces

TOOLS

Tool Extension Handles

Description: Long extension handles for hand tools.

Advantages:

- Enable the operator to work standing instead of using the tools in awkward postures (e.g., kneeling or crouching).
- May reduce vibration being transmitted to the hands and arms.
- Can be attached to many types of handheld tools such as needle guns, buffing wheels, and grinders.
- The handle and tool can be attached to wheels or channel sliding plates to reduce the weight and force needed to operate the tool.

Points to Remember:

- Altering the tool may pose hazards and may void the manufacturer's warranty.
- Tools should not be altered in a way that violates the National Electrical Code and must not be altered in a way that violates OSHA standards.

BEFORE

AFTER

Reduce awkward body postures

Power Tools

Description: Tools constructed with durable, light-weight materials.

Advantages:

- Reduce hand and arm fatigue caused by holding a tool for several hours.
- Reduce force required to hold heavier tools.

Points to Remember:

- If lighter tools are not available, tool balancers may be used to reduce the weight held and the forces associated with using heavy tools.
- Select lighter tools with less vibration.

Reduce hand and arm fatigue

Low Vibration Tools

Description: Tools specifically designed to reduce vibration.

Advantage:

- Reduce the vibration being transmitted to the hands.

Points to Remember:

- Tool maintenance should be performed on a regular basis.
- Oiling and cleaning tools daily increases the life of the tool and reduces vibration.
- Out-of-balance or off-center grinding wheels, pads, and spindles are major contributors to vibration.
- Some tools use auto-balancing technology to compensate for off-center pads/wheels.
- Tools should be gripped as lightly as possible while still maintaining control of the tool.
- Cold hands are more vulnerable to the effects of vibration.
- Select gloves that minimize the loss of tactile sensitivity.
- Many low vibration tools are commercially available, such as grinders, sanders, and impact wrenches.

Reduce hand and arm vibration

Tool Balancers

Description: Portable devices used to support and position tools.

Advantages:

- Reduce hand and shoulder muscle fatigue caused by holding a tool for prolonged time.
- May reduce exposure to tool vibration.

Points to Remember:

- Balancers require adjustment and maintenance.
- Ensure system/device is rated for weight.
- Spring-loaded, pneumatic, electric, or computer controlled models are widely available.
- Various adaptors are available to attach to different tool configurations.

Reduce muscle fatigue

METAL WORK

Robotic Welders

Description: Robotic technology applied to welding machines.

Advantages:

- Reduce the fatigue associated with prolonged welding or welding performed in an awkward or constrained position.
- Reduce the amount of manual welding required and may improve efficiency.
- Can be operated by one person with minimal effort.

Point to Remember:

- Not applicable for all welding applications.

Reduce awkward postures and repetitive motions

Electromagnetic and Air Presses

Description: Portable electromagnetic and air presses that hold parts in place during welding operations.

Advantages:

- Reduce awkward postures and forceful exertion associated with manually clamping parts prior to welding operations.
- Can significantly reduce the time needed to complete a job.

Point to Remember:

- Used when welding long seams on butted metal plates.

BEFORE

AFTER

Reduce forceful exertions

Support Bar

Description: A metal bar placed vertically under a long piece of steel for support as it passes through a machine.

Advantages:

- Reduces static and awkward postures.
- Reduces static exertions while loading the steel into the machine.
- Useful on long pieces of steel that would require manual support.

Point to Remember:

- Be sure the bar is stable and can support the load.

Reduces static exertions and awkward postures

SHIPSIDE

Dry Dock Centering Device

Description: Mechanized reel system that pulls ships into position in dry dock.

Advantage:

- Reduces the extreme pulling forces previously required to manually pull a vessel into a dry dock.

Point to Remember:

- Check lines frequently and replace damaged ones.

Reduces pulling forces

Lighter-Weight Blowers

Description: Lighter-weight blowers used to move air in small spaces.

Advantages:

- Reduce the lifting forces associated with carrying blowers onto vessels.
- Have handles for easy carrying.
- The weight is more balanced for easy carrying.

Point to Remember:

- Ensure the air volume is adequate.

Reduce lifting forces

Stools and Creepers

Description: Portable seats that allow the employee to be seated while working.

Advantages:

- Provide support in the right position for hard-to-reach areas, such as underneath ships, decks, or platforms or when working below waist level.
- Tools, equipment, and materials can be attached to the stools/chairs for convenience.

Points to Remember:

- Adjustable stools and creepers are preferred.
- Locking the casters helps prevent the stools and creepers from moving unexpectedly.
- Some stools can be custom made.

BEFORE

AFTER

Reduce awkward postures

Gas Line Connector Rack

Description: A device that allows gas lines to be connected to one central location.

Advantages:

- Reduces the number of gas tanks that are handled.
- The rack can be moved by crane as a single unit.

Points to Remember:

- The gas racks are assembled by the vendor.
- Use of the gas rack is more efficient when used by several employees in the same area.

Reduces material handling

Davit Cranes

Description: Devices mounted to dry docks to move heavy items onto or off of vessels.

Advantage:

- Reduce manual lifting and handling.

Points to Remember:

- Ensure the device is rated for the load weight.
- Many types, sizes, and capacities of overhead cranes are widely available to lift and transport heavy items.

Reduce manual lifting and handling

Block Lifting Device

Description: A hook-like device that allows wood blocks to be lifted by a crane or forklift.

Advantage:

- Reduces the manual lifting, moving, and positioning of very heavy wood blocks.

Point to Remember:

- Ensure device is well maintained.

BEFORE

AFTER

Reduces manual handling

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Anti-vibration Gloves

Description: Gloves with anti-vibration properties.

Advantage:
- Reduce the vibration being transmitted to the hands and arms from vibrating tools such as grinders, needle guns, and sanders.

Points to Remember:
- Optimal fit is essential to reduce unnecessary fatigue.
- Anti-vibration gloves should not dramatically increase grip diameter.
- Gloves should be chosen to minimize the loss of tactile sensitivity.
- Full finger gloves provide the maximum protection.

Reduce hand–arm vibration

Elbow Pads

Description: Pads to protect the elbow from contact stress.

Advantage:
- Useful for working in cramped spaces and/or leaning on the elbows.

Point to Remember:
- Elbow pads should fit snugly but should not compromise circulation in the arm.

Reduce contact stress

Shoulder Pads

Description: Pads that protect the shoulder when carrying objects on the shoulder.

Advantage:
- Reduce the contact stress to the shoulder.

Points to Remember:
- Shoulder pads should be used when an item cannot be transported with a cart or other transport device.
- Carrying heavy objects on the shoulder often causes excessive pressure applied over a small area.

Reduce contact stress

Kneeling Supports

Description: Support devices that distribute weight and reduce knee strains.

Advantage:
- Reduce pressure within the knee while kneeling and prevent the knee from bending too far.

Point to Remember:
- When possible, work surfaces should be raised to minimize kneeling.

BEFORE

AFTER

Reduce contact stress

Kneepads

Description: Pads worn to protect the knee when kneeling on a hard surface.

Advantage:

- Kneepads reduce contact stress.

Points to Remember:

- When possible, work surfaces should be raised to minimize kneeling.
- Kneepads should fit snugly but should not compromise circulation to the lower leg.
- Kneeling on one or both knees can cause contact stress on the bones and soft tissues of the knees.
- Contact stress can reduce circulation and pinch nerves.
- Pad should be replaced when cushion material becomes compacted.
- Select fire-resistant pads when performing hot work.

BEFORE

AFTER

Reduce contact stress

Additional Sources of Information

The following sources may be useful to those seeking further information about ergonomics and the prevention of work-related musculoskeletal disorders in shipyards.

Shipyard Ergonomics Video and Workbook CD
Shipbuilders Council of America. The video cassette and CD are designed to instruct shipyard employees, supervisors, and trainers in identifying ergonomic-related risks and providing tools to allow the development of creative solutions to reduce the hazards.

Easy Ergonomics, A Practical Approach for Improving the Workplace
California Department of Industrial Relations, http://www.dir.ca.gov/dosh/dosh_publications/EasErg2.pdf; ***Ergonomic Guidelines for Manual Handling,*** [NIOSH Publication No. 2007-131] http://www.cdc.gov/niosh/docs/2007-131/pdfs/2007-131.pdf; ***Easy Ergonomics: A Guide to Selecting Non-Powered Hand Tools,*** [NIOSH Publication No. 2004-164] http://www.cdc.gov/niosh/docs/2004-164/default.html. These documents are designed to provide general ergonomic advice, and are not industry specific. The documents provide a simple, hands-on approach to ergonomics to help employers, supervisors, and employees as they work toward improving ergonomic conditions in their workplace.

Elements of Ergonomics Programs
U.S. Department of Health and Human Services – National Institute for Occupational Safety and Health, (800) 356-4674, http://www.cdc.gov/niosh/docs/97-117/pdfs/97-117.pdf. The basic elements of a workplace program aimed at preventing work-related musculoskeletal disorders are described in this document. It includes a "toolbox," which is a collection of techniques, methods, reference materials, and sources for other information that can help in program development.

Ergonomic Interventions in the Building, Repair, and Dismantling of Ships
U.S. Department of Health and Human Services – National Institute for Occupational Safety and Health, (800) 356-4674, http://www.cdc.gov/niosh/ergship/ergship.html. This NIOSH web page includes a number of shipyard ergonomic research documents, including ergonomic injury rates, recommendations for ergonomic interventions at eight shipyards, and a Compendium of Ergonomic Analyses of Shipyard Work Processes and Associated Appendices.

Many states and territories operate their own occupational safety and health programs under plans approved by OSHA. Information on specific state shipyard initiatives and compliance assistance, as well as state standards that may apply to shipyards is available on OSHA's website at www.osha.gov/dcsp/osp/index.html on specific state shipyard initiatives and compliance assistance, as well as state standards that may apply to shipyards.

A free consultation service is available to provide occupational safety and health assistance to businesses. OSHA Consultation is funded primarily by federal OSHA but is delivered by the 50 state governments, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands. The states offer the expertise of highly qualified occupational safety and health professionals to employers who request help to establish and maintain a safe and healthful workplace. Developed for small and medium-sized employers in hazardous industries or with hazardous operations, the service is provided at no cost to the employer and is confidential. Information on OSHA Consultation can be found at www.osha.gov/dcsp/smallbusiness/consult.html.

References

(1) Report of OSHA site visits to shipyards.

(2) Videotape, "Shipyard Ergonomics" 2003, produced by John Sabella and Associates, Inc., Seattle, Washington, Stewart Prezant Ergonomics Group, Seattle, Washington, and Shipbuilders Council of America; http://www.shipbuilders.org/.

(3) National Shipbuilding Research Program (NSRP). Shipyard evaluation for ergonomics and applications. Awareness and intervention efforts. Report 2004.

(4) Bureau of Labor Statistics. U.S. Department of Labor, December 2006.

(5) Jae-Yeon, J., Soyeon, K., Sang Kyu, P., Jaehoon, R., Tae-Young, L., Jeong Taek, Y., 2002, Quantitative exposure assessment for shipyard workers exposed to hand-transmitted vibration from a variety of vibration tools. *AIHA Journal*. 63, pp 305-310.

(6) Lowe, B.D., Wurzelbacher, S.J., Shulman, S.A., Hudock, S.D., 2001, Electromyographic and discomfort analysis of confined-space shipyard welding process. *Applied Ergonomics*. 32, 255-269.

(7) Torell, G., Sanden, A., 1988, Musculoskeletal disorders in shipyard workers. *J. Soc. Occup. Med.* 38, pp 109-113.

(8) Mooney, V., Kenney, K., Leggett, S., Holmes, B., 1996, Relationship of lumbar strength in shipyard workers to workplace injury claims. *Spine*. Vol. 21, No. 17, pp 2001-2005.

(9) Lindberg, H., Montgomery, F., 1987, Heavy labor and occurrence of gonarthrosis. *Clinical Orthopedics and Related Research*, 214: 235-236.

(10) Cherniak, M., Brammer, A.J., Lundstrom, R., Mayer, J., Morse, T.F., Nealy, T., Nilsson, Peterson, D., Toppilla, E., Warren, N., 2004, Segmental nerve condition velocity in vibration-exposed shipyard workers. *Int Arch Occup Environ Health*. 77, pp 159-176.

(11) Johnson, K.L., Hans, J.C., Robinson, M.A., 1996, Development of a vibratory white finger prevention program for shipyard workers: An exploratory study. *American Journal of Preventive Medicine*. Vol. 12, No. 6, pp 478-481.

(12) Hoozenmans, M.J.M., Van der Beek, A.J., Frings-Dresen, M.H.W., Van der Woude, L.H.V., Van Dijk, F.J.H., 2002, Pushing and pulling in association with low back and shoulder complaints. *Occup Environ Med*. 59, pp 696-702.

(13) Frost. P., Andersen, J.H., 1999, Shoulder impingement syndrome in relation to shoulder intensive work. *Occup Environ Med*. 56, pp 494-498.

(14) Nahit, E.S., Macfarlane, C.M., Pritchard, C.M., Cherry, N.M., Silman, A.J. 2001, Short-term influence of mechanical factors on regional musculoskeletal pain: a study of new workers from 12 occupational groups. *Occup Environ Med*. 58 (6), pp 374-381.

(15) National Research Council and Institute of Medicine. 2001. Musculoskeletal Disorders and the Workplace – Low Back and Upper Extremities. National Academy of Sciences. Washington, DC: National Academy Press.

(16) Eriksen, W., Natvig, B., Knardahl, S., Bruusgaard, D., 1999, Job characteristics as predictors of neck pain. *J Occup. Environ Med*., Vol. 41, No. 10, pp 893-902.

(17) Musculoskeletal Disorders and Workplace Factors – A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the neck, upper extremity and low back. U.S. Department of Health and Human Services. National Institute for Occupational Safety and Health (NIOSH), 1997, Publication # 97-141.

(18) Liker, J.K. 2002, What is lean ship construction and repair? *Journal of Ship Production*, Vol. 18, No. 3, pp 121-142.

(19) DiBarra, C. 2002, 5S – A tool for culture change in shipyards, *Journal of Shipyard Production*, Vol. 18, No. 3, pp 143-151.

(20) Marras, W.S., 2000, Occupational low back disorder causation and control. *Ergonomics*. Vol. 43, No. 7, pp 880-902.

(21) Pope, M.H., Goh, K.L., Magnusson, M.L. 2002, Spine Ergonomics. *Annu. Rev. Biomed. Eng.* 4, pp 49-68.

OSHA®

Occupational Safety and Health Administration

U.S. Department of Labor

www.osha.gov