Manual Material Handling:

An Ergonomic Approach

Provided by
Workers Health & Safety Division

TEXAS WORKERS' COMPENSATION COMMISSION

HS95-052B (02-04)

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Although technology has advanced industrial production techniques, manual handling of materials has remained essentially the same. Most jobs require some handling, but about 10 percent require extensive manual materials handling.

Tightly linked to the manual handling of materials is the possibility of back injuries. Throughout the country, the number of workers' compensation claims for back injuries remains high. According to the Bureau of Labor Statistics, back injuries in the state of Texas account for 24% of workers' compensation claims. The average compensation claim costs $15,000, but back injury claims can be much more expensive.

As staggering as these figures seem, there are other losses to consider. Lost income to employees, lost productivity for employer, and the pain, suffering and lengthy disabilities that go along with these injuries are all part of the cost.

Another consideration is inexperienced or replacement employees who have a higher probability of accidents because they are new to the job and its techniques.

The typical course of action industry has taken to deal with this complex problem has been to initiate lifting programs in which the employee is trained to make a certain type of lift aimed at preventing back injuries. Although training is a major component of back injury prevention, it must be accompanied by changes to the working conditions in order to minimize the actual number of back injuries.

The new line of thinking incorporates advanced ergonomic (science seeking to adapt work or working conditions to fit the worker) trends in manual material handling. Most importantly, specific procedures now evaluate and improve existing manual material handling tasks. Ergonomic risk factors, such as awkward postures and repetitive motions, are taken into account more seriously through this evaluation.

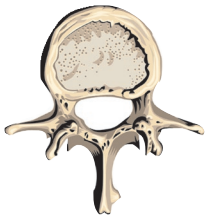
Anatomy of the Back

The back has 300 muscles, 33 vertebrae, 30 discs between the vertebrae, and many ligaments. Each vertebra has two main parts: the body and the bony extensions, which encase the spinal cord. The spinal cord branches out in the open spaces at each side of the vertebrae. These offshoots are nerve roots.

Numerous muscles and ligaments hold the vertebrae together. The discs, which fit between the vertebrae, are made of tough, fibrous cartilage surrounding a softer, gelatinous material. Their purpose is to maintain alignment of the vertebrae and to cushion forces imposed by daily activities.

Over a period of time, undue stress can create very small tears in the fibrous outer casing of the discs. Since the discs have no blood supply for healing, the number and extent of these small tears gradually increases.

Eventually, the inner contents may leak out, causing the disc to narrow. The result of this disc narrowing is occasional root pinching, deterioration of the joints, inflammation and pain. The disc may also suddenly rupture (usually toward the rear), with the inner disc material pressing on the nerve root.



Almost all industrial back injuries are referred to as "back strains," which is defined as an overexertion or stretching of the muscles. Generally, strains are the result of a physically traumatic event causing an acute injury. Thus back injury prevention programs focus on the prevention of "one shot" strains; that is, injuries resulting from single lifting incidents in which employees may overexert or overextend themselves.

Normally when back pain is reported, an investigation focuses on the immediate incident responsible for the back injury. However, consideration must be given to any ergonomic risk factors (i.e., repetitive motions) that may have led to muscle fatigue, leaving muscles more susceptible to injury.

Back pain has many causes and it is often difficult and costly to pinpoint the factors responsible. One emerging theory states that most industrial back pain results from cumulative strains to the discs caused by repeated, stressful work, such as manual material handling.

Workers' compensation recognizes these cumulative back injuries are caused by weeks, months, or years of ergonomic stressors, such as lifting in an awkward posture or a repetitive lifting job assignment.

The underlying factors responsible for these strains take on much greater importance than trying to fix the one-shot incidents, and finding those factors needs to become a primary goal to reduce back injuries.

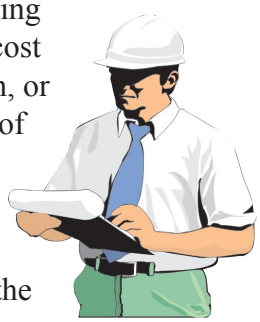
Analysis of jobs finds injuries can be sustained through repeated, awkward, or unnecessary handling of materials, so review all material handling tasks, regardless of their extent, in order to make improvements.

When continuously exposed to an operation, we sometimes become oblivious to the possibilities of improving it, so a fresh and completely objective view of the job is needed. Do not be afraid to think of various possible solutions that might not seem practical at first.

Using a systematic method of reviewing jobs for reducing material handling injuries usually pays dividends through increased productivity and a reduction in operating costs.

Analyze Management Operations

First, recognize that material handling often composes one of the largest cost components of a product, operation, or service, and unnecessary handling of materials costs time and money.



Understanding the relationship between the workers, the workstations, and the jobs, assists the individual responsible for designing workstations. These individuals must pay particular attention to the details of the tasks to ensure the greatest possible harmony between the work and the worker.

The purchasing agents are an important part of the material handling program. They control such details as size, weight, packaging, and convenience for handling.

Use "sold to/ship to" arrangements to eliminate in-plant handling wherever possible. Products being shipped to your company for distribution may be more wisely shipped directly from your supplier to the customer, saving freight and handling.

Reduce overall work-in-progress quantities relieving problems such as overcrowding, extra handling, using larger containers, or stacking parts higher. Housekeeping problems may develop, increasing possibilities of material handling vehicle accidents and damage to materials or finished goods.

In order to reduce work-in-progress quantities, tighten controls and shorten forecasting for inventory, scheduling, ordering, and shipping. Manufacture products on an "as-ordered" basis instead of stockpiling for anticipated use.

Perform product analysis. Changes in the product sometimes result in reduced material handling. Consider lightening the product, allowing a worker or conveyor to handle more pieces at one time.

Plan for future expansion or changes. Production usually suffers under crowded conditions.

Top management creates policy and procedure, therefore, they must initiate the first step in analyzing material handling operations. Even in the absence of management's analysis, personally analyze and implement changes in certain situations.

Material Flow

It is usually not enough to simply observe and study a specific manual material handling operation. Key questions arise regarding how the material is routed through the facility or worksite that can only be answered by looking at the big picture.

Eliminate unnecessary material handling by combining operations or shortening the distances that material must be moved.

Look for crossing paths, loops, backtracking, and a

general lack of direction as production of a material goes from start to finish. Short distances enable workstations to link by conveyors and reduce carrying distances. In addition, less mechanical handling means fewer opportunities for accidents. Walk through your operations with an employee. Make simple changes immediately. (Make written suggestions for observed "cost saving" and "people-saving" changes that need approval or further evaluation.)

Simplify, rearrange, or change processes. Simplify processes so similar material handled differently can be worked in a similar fashion, improving material flow. Listen to suggestions made by employees to simplify processes.

Establish disposal and storage methods, as well as ways to improve material flow from scrap, waste materials, containers, tools, and equipment. Each workstation must be analyzed.

Plan adequate aisleways for intended material flow and emergency access. Personnel must be able to evacuate quickly in an emergency, and cramped aisleways may restrict exits causing panic. Emergency vehicles must also be able to gain access quickly. Adequate aisleways and exits facilitate the orderly movement of materials.

Avoid the necessity of working in aisleways.

Prioritize Job Analysis

Once we understand material flow, break the work processes into smaller job elements, established on a priority basis, with the worst or most strenuous tasks being examined first. It easily becomes obvious which job elements to analyze first.

Review accident statistics to determine priorities. Take the time and examine the current accident investigation procedure to see if it really collects useful information for analysis.

Often underused in job analysis, the employees usually have useful and crucial input and should be asked for their views on where the most strenuous, demanding, and dangerous material handling tasks exist. Likewise, supervisors and other management personnel should be polled for their observations.

Analyze the Job – Tasks

Once priorities have been set, break the job down into elements known as "tasks," which are the simplest single actions needed to define the process at a particular stage of an operation. Among the considerations are:

- Fit the task to the worker - the ergonomics approach.
- Recognize manual material handling is more than just lifting. It includes lowering, pushing, pulling, holding, carrying, and transferring activities.
- Measure the frequency and duration of the task. Determine the frequency of the task in activities-per-minute. Be sure to note how the activity varies. Be careful in estimating an average frequency which may be cyclical; that is, very fast then very slow. Note the average duration of the task.

Be aware of the trade off between frequency and weight. As loads become lighter and are lifted more frequently, fatigue becomes a factor. As loads become heavier and are lifted less frequently, considerations regarding the structure and strength of the back rise in importance. Allow the employee as much time as possible to complete the task, considering the needs of production.

Determine the type of pacing. Additional allowances should be made for forced pacing. One example might require removing evenly spaced loads as they come off the end of the conveyor.

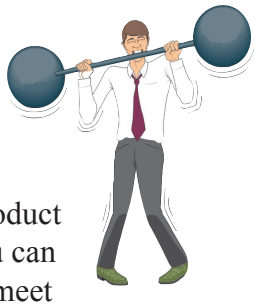
Minimize reach requirements. Design the operation to accommodate the smallest person's reach. Avoid unnecessary material stacking, storing, or placement for work-in-progress material (such as neatly orienting parts in containers when they will be dumped out in the next operation).

Structure equipment so gravity moves materials wherever feasible.

Simplify tasks by combining operations and steps.

Analyze the Job – Load

Remove an employee's doubt about whether an object should be handled manually or mechanically by utilizing obviously small and large containers. Plan for outgoing materials to leave in suitable containers minimizing product handling. Ask customers how you can best design product packaging to meet their material handling needs.



Consider the weight of containers repeatedly handled and transferred versus the parts inside. The weight of the container should be minimal compared to the weight of the product. Keep containers handled manually as small as possible, giving particular attention to their dimensions. Ensure load heights of less than 30 inches, preventing obstructed vision when manually handling materials.

Position the load's center of gravity (or balancing point) as close as possible to the person handling it. Stress on the back increases as the distance from your center of gravity increases. For example, a 10-pound dictionary held 30 inches away from the body's center of gravity is equivalent to a 50-pound load held close to the body.

Ensure that the load is easy to grip. Order cardboard boxes with handle cutouts; use containers with handles, lift straps or textured containers; and avoid awkwardly designed items. Stabilize contents of containers to reduce sudden shifting of contents by inserting vertical baffles or dividers, balancing the weight in the box, or using packing materials. Minimize the potential for injury by protecting the employee from loads with sharp edges or projections. Potential for injury also exists with reactive loads such as metal shavings.

Worker

Avoid making assumptions by including worker feedback on required material handling necessary for the job.

Bring only enough material to complete the job in the immediate work area. Extra material will either need additional handling to get back into storage or will create congestion. Likewise, too little will require extra handling.

Consider the following in jobs with considerable manual material handling:

- Rotate employees to keep individuals from continuously working strenuous jobs.
- Split work among two or more employees.
- Institute appropriate work/rest schedules.

The worker should receive specific training in the following areas:

- Using of mechanical handling aids. Employees may avoid mechanical aids because they simply do not know how to use them.
- Recognizing material handling problems in the workplace.
- Identifying procedures that can prevent excessive manual material handling.

Workplace - Work Space

Check floor surfaces. For carts to move on poor surfaces, the force required doubles or triples. Repair damaged flooring and surfaces to prevent overexertion. Also keep wheels in good repair. Worn-out or damaged wheels can also increase the required force.

Poor housekeeping only increases material handling obstacles. Keep floor surfaces clean. Water, oil, grease and material scrap reduce traction and increase the force required to push or pull carts. Insist on good housekeeping.

In material handling, "what goes down must come up." To prevent repeated stooping and bending, bring both incoming and outgoing materials at each process to a suitable work height, at least 20 inches from the floor, but ideally to knuckle height of about 30 inches.

Reduce the need to raise or lower materials from above shoulder height. If you must raise or lower materials above shoulder height, store lighter objects on top shelves.

Remove constraints that prevent materials from being positioned close to the body. Allow enough space for feet to get under tables and conveyor belts. Provide clear access to shelves and adequate space to go

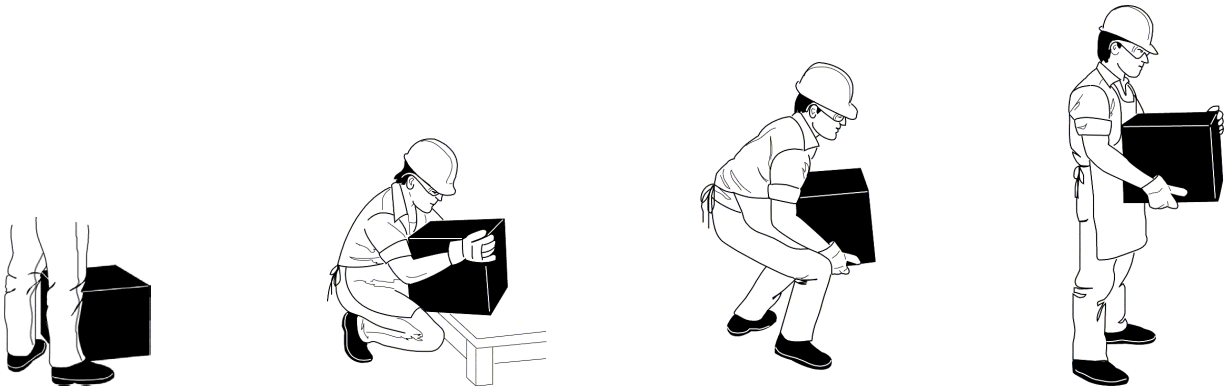
around pallets.

Reduce height differences during load travel. Keep loads between knuckle and shoulder height from the origin of the lift to its destination.

Slide objects rather than lifting and lowering them.

Arrange to lower an object rather than lift it.

Provide adjustable chairs for all operations, whether they are located in the company president's office or on the small-parts assembly line. Chairs should offer maximum adjustability providing support for any lifting that will be done from that workstation.



Equipment

Consider the use of mechanical aids whenever possible to assist employees in their material handling needs. Some examples are:

Pallet Jack	Lift Table
Two-wheeled Hand Truck	Lift and Tilt Table
Four-wheeled Cart	Winch
Motorized Hand Truck	Manipulator
Hoist	Positioner
Crane	Up-ender
Conveyor	Dumper
Powered Industrial Vehicle	Chute

Try to incorporate concepts that fit the job to the worker. Consider maintenance and setup needs when planning, designing, purchasing and installing equipment. Build equipment around material handling requirements.

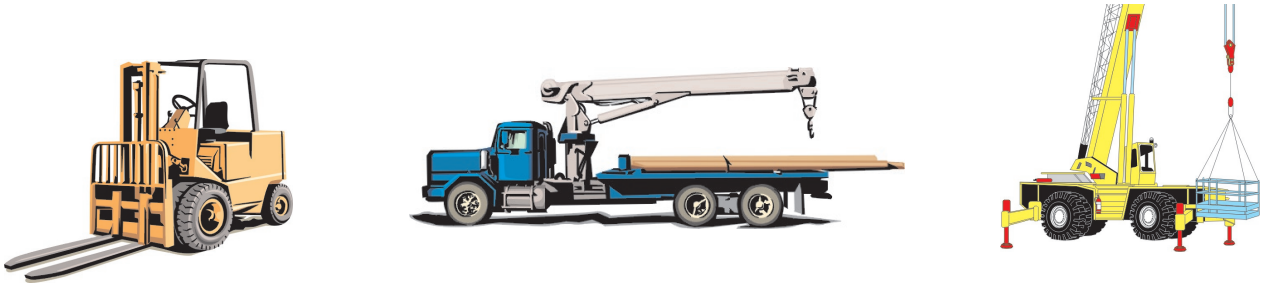
Review work areas for proper illumination levels. Poor lighting can contribute to accidents and injuries and diminish quality of products.

Make allowances for weather conditions:

- Issue appropriate clothing, such as gloves.
- Take measures to prevent cold and heat stress.
- Maintain aisles.
- Shield storage areas from mud and rain.

Evaluate noise levels to ensure that mechanical-handling warning signals can be heard.

Be sure air-contaminant levels are not excessive. This can be achieved through routine monitoring in high-exposure areas.



Recommend, Review and Implement Changes

Once workers, staff and line personnel have identified problems, these problems must be eliminated. At this point, deficiencies have been identified with possible solutions in mind. The process is broken down into two stages:

- Prioritize – Categorize priorities by degree of hazard and risk associated with an operation. Determine these priorities as part of the initial management analysis of the material handling process, essentially a historical approach. Risk itself is based on the frequency of worker exposure to the hazards of any given task and the number of workers routinely exposed.
- Review - Establish a company policy to review the material handling safety programs as part of the planning procedure for any proposed process. This review should also be ongoing since new material handling equipment comes on the market continuously, and "state of the art" in ergonomic equipment is changing rapidly.

The most effective review is conducted in an atmosphere of participatory management. There should be strong involvement and representation from all levels of management and employment. This can be accomplished generally through established committees or quality circles.

Two key elements of the review process are determining the impact the proposed changes will have on other jobs and what new problems will arise as a consequence of these changes. Considering these elements ensures a successful result for the newly emphasized material handling process.

- After review, changes will either be accepted and implemented, or rejected. When suggestions are accepted, assign target dates for completion, put them into action as soon as possible, and communicate any intended changes to all affected employees. If changes have been rejected, the persons responsible for the suggestions deserve and will appreciate feedback concerning its their rejection.

In a broader context, the possibility for change should be viewed not just departmentally, but throughout the plant. Build on the successes of the program and share your success stories with others.

These actions mark a dramatic departure from the way we viewed material handling in the past. Reducing back injuries requires a comprehensive look at the facility to include the jobs, workstations, and the workers. Technology and management approaches have been continuously changing and ergonomics incorporates those changes to create safer, healthier work environments.