

Lifting and handling loads, reducing hazards

OHS information for employers and workers

Also known as manual handling or manual materials handling, the lifting and handling of loads include lifting, lowering, pushing, pulling, carrying, holding, dragging, and supporting objects. The injuries caused by such work are referred to as musculoskeletal injuries, or MSIs.

Key information

Material handling hazards are reduced or eliminated primarily by effective design of the workstation, tools, and job.

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The purpose of performing a workplace hazard assessment is to identify specific workplace hazards related to materials handling injuries and to then reduce worker exposure to those hazards.

Each identified hazard should be reduced to the degree technologically and economically feasible. The methods used to reduce the hazard(s) should not primarily rely on changes in worker behaviour to be successful.

Table 1 of this Safety Bulletin was prepared by the State of Washington, Department of Labor and Industries as a resource of ideas to employers trying to control the ergonomic hazards highlighted by the assessment. Other equally effective approaches may exist and should be used when appropriate. Tables 2 through 7 list additional ideas and

suggestions from other sources for eliminating or reducing materials handling injuries.

Table 2, 3, and 4 list design principles for lifting and lowering tasks, pushing and pulling tasks, and carrying tasks respectively. Table 5 describes the principles to be applied when trying to modify a worker's body movements. Table 6 lists a number of recommendations for the design of the workplace and Table 7 summarizes recommended heights for storage, shelving and racks. The tables in this document are to be used for guidance purposes only.

Key information

The methods used to reduce the hazard(s) should not primarily rely on changes in worker behaviour to be successful

Table 1 Suggested methods of reducing ergonomic hazards

Ergonomic Hazard	Reduction Methods
AWKWARD BODY POSITIONS	
Working with hand(s) above the head or the elbow(s) above the shoulder(s), more than 4 hours total per day	<ul style="list-style-type: none"> • Raise the worker up with elevated work platforms or ladders • Make tools longer with articulating arms or extension handles • Bring the work down and tilt it on its side for better access • Provide adjustability where possible for multiple users • Design reach distances for the shortest worker • Provide arm supports • Use sloping platforms with overhead conveyers to adjust for variable worker heights
Repetitively raising the hand(s) above the head or the elbow(s) above the shoulder(s) more than once per minute, more than 4 hours total per day	<ul style="list-style-type: none"> • Limit overhead storage to infrequently used items • Raise the worker up with elevated work platforms or ladders • Make tools longer with articulating arms or extension handles • Bring the work down and tilt it on its side for better access • Provide adjustability where possible for multiple users • Design reach distances for the shortest worker
Working with the neck bent more than 45° (without support or the ability to vary posture), more than 4 hours total per day	<ul style="list-style-type: none"> • Raise and tilt objects being viewed to keep neck more upright • Use magnifiers when working on objects with the hands in order to keep the arms and shoulders down • Support the head with a chin/forehead cradle • Use monitor arms or stackers to raise up monitors • Use video or mirror systems to view objects or locations that are difficult to see (dental/medical/surgical tasks, forklifts)
Working with the back bent forward (without support or the ability to vary posture) more than 30° for more than 4 hours per day, or more than 45° for more than 2 hours per day	<ul style="list-style-type: none"> • Raise and tilt the work to provide better access • Use a sit/stand stool to lower the worker • Make tools longer with articulating arms or extension handles • Alternate between bending, sitting, kneeling, and squatting • Use a chest pad to support the weight of the upper body • Locate objects well within arms' reach • Use body carts for ground level work
Squatting more than 4 hours total per day	<ul style="list-style-type: none"> • Raise the work to provide better access • Make tools longer with articulating arms or extension handles • Alternate between bending, sitting, kneeling and squatting • Use body carts for ground level work • Use short portable stools for ground level work
Kneeling more than 4 hours total per day	<ul style="list-style-type: none"> • Wear knee pads • Raise the work to provide better access • Make tools longer with articulating arms or extension handles • Alternate between bending, sitting, kneeling, and squatting

HIGH HAND FORCE

<p>Pinching an unsupported object(s) weighing 900 grams or more (2 lbs) per hand or pinching with a force of 180 Newtons or more (4 lbs) per hand, combined with highly repetitive motions for more than 3 hours total per day</p>	<ul style="list-style-type: none"> • Redesign hand-tool interface for use of a power grip • Reduce weight of tool or object • Use clamps, vices, jigs, or fixtures to eliminate forceful pressing or pinching • Use fasteners requiring minimal pinch force e.g. plastic rather than metal Use fasteners that can be inserted by or with a tool
<p>Pinching an unsupported object(s) weighing 900 grams or more (2 lbs) per hand or pinching with a force of 180 Newtons or more (4 lbs) per hand, combined with wrists bent in flexion 30° or more, or in extension 45° or more, for more than 3 hours total per day</p>	<ul style="list-style-type: none"> • Redesign hand-tool interface for use of a power grip • Redesign hand-object interface to reduce slipperiness Reduce weight of tool or object • Change tool, work surface orientation, or worker location to reduce bent wrist postures
<p>Pinching an unsupported object(s) weighing 900 grams or more (2 lbs) per hand or pinching with a force of 180 Newtons or more (4 lbs) per hand for more than 4 hours total per day</p>	<ul style="list-style-type: none"> • Redesign hand-tool interface for use of a power grip • Reduce weight of tool or object • Rotate jobs between workers • Use clamps, vices, jigs, or fixtures to eliminate forceful pressing or pinching • Use fasteners requiring minimal pinch force e.g. plastic rather than metal • Use fasteners that can be inserted by or with a tool
<p>Gripping an unsupported object(s) weighing 4.5 kg or more (10 lbs) per hand or gripping with a force of 340 Newtons (10 lbs) per hand, combined with highly repetitive motions for more than 3 hours total per day</p>	<ul style="list-style-type: none"> • Reduce weight of tool or object • Use balancers, adjustable fixtures, articulating arms to hold handled items, or minimize weight held in the hand • Use two hands rather than one • Alternate between hands • Sharpen cutting tools to reduce force requirements during use • Rotate workers between tasks
<p>Gripping an unsupported object(s) weighing 4.5 kg or more (10 lbs) per hand or gripping with a force of 340 Newtons (10 lbs) per hand, combined with wrists bent in flexion 30° or more, or in extension 45° or more, or in ulnar</p>	<ul style="list-style-type: none"> • Reduce weight of tool or object. • Change tool, work surface orientation, or worker location to reduce bent wrist postures. • Use balancers, adjustable fixtures, articulating arms to hold handled items or minimize weight held in the hand • Use two hands rather than one • Alternate between hands • Sharpen cutting tools to reduce force requirements during use

<p>deviation 30° or more, for more than 3 hours total per day</p>	
<p>Gripping an unsupported object(s) weighing 4.5 kg or more (10 lbs) per hand or gripping with a force of 340 Newtons (10 lbs) per hand, more than 4 hours total per day</p>	<ul style="list-style-type: none"> • Reduce weight of tool or object • Rotate jobs between workers • Use balancers, adjustable fixtures, articulating arms to hold handled items, or minimize weight held in the hand • Use two hands rather than one • Alternate between hands • Sharpen cutting tools to reduce force requirements during use • Preventive maintenance of tools to reduce high hand forces • Use bench-mounted adapters to provide more leverage
<p>HIGHLY REPETITIVE MOTIONS</p>	
<p>Using the same motion with little or no variation every few seconds (excluding keying activities) more than 6 hours total per day</p>	<ul style="list-style-type: none"> • Rotate jobs with other workers, varying the types of motion • Use job enlargement, increase the number of tasks performed by the worker, vary the types of movement • Reduce the speed of the motions if possible • Use mechanical assists • Use multifunction tools
<p>Using the same motion with little or no variation every few seconds (excluding keying activities) combined with wrists bent in flexion 30° or more, or in extension 45° or more, or in ulnar deviation 30° or more, and high, forceful exertions with the hand(s), more than 2 hours total per day</p>	<ul style="list-style-type: none"> • Re-orient or move objects into positions where bent wrists are eliminated • Rotate jobs with other workers, varying the types of motion • Use tools (with power grip) if exertions are required • Provide clamps, vices, jigs, or fixtures to hold parts, reducing forceful grasping and allowing the use of two hands • Use mechanical assists • Use multifunction tools
<p>Intensive keying for more than 7 hours total per day, or combined with awkward postures for more than 4 hours total per day</p>	<ul style="list-style-type: none"> • Enlarge the job to include tasks other than keying • Provide equipment to reduce awkward postures such as wrist rests, arm rests, adjustable keyboard shelves • Rearrange workstation to eliminate awkward postures e.g. raise monitor, lower keyboard, bring mouse closer to keyboard • Utilize voice-recognition software • Utilize software macros that automate repetitive keystrokes • Schedule breaks

HEAVY, FREQUENT or AWKWARD LIFTING

Heavy lifting	<ul style="list-style-type: none">• Reduce weight of load• Increase weight of load so that it requires mechanical assist• Reduce the capacity of the container• Use slides or gravity chutes to eliminate lifting• Use mechanical assist devices such as overhead hoists, manipulators, vacuum lifts, pneumatic balancers, forklifts• Use telescoping extendible conveyors with powered belts that reach deep into trailers• Reduce the horizontal distance of the load away from the body by reducing the size of the packaging• Reduce the horizontal distance of the load away from the body by removing barriers and obstacles that make access to the object difficult• Team lift the object with two or more workers• Improve layout of work process so the need to move materials is minimized• Provide handholds which increase lifting capability up to 15%
Frequent lifting	<ul style="list-style-type: none">• Use mechanical assist devices such as overhead hoists, manipulators, vacuum lifts, pneumatic balancers, forklifts• Reorganize work method to eliminate repeated handling of the same object• Rotate workers to jobs with light or no manual handling• Use slides or gravity chutes to eliminate lifting• Use mobile storage racks to avoid unnecessary loading and unloading
Awkward lifting	<ul style="list-style-type: none">• Redesign workstation layout to eliminate trunk twisting by locating objects within arm's reach• Design workstation with adjustable heights to eliminate bent forward posture when lifting• Eliminate the use of deep shelves that require a worker to bend and reach for objects.• Store objects at 30" off the floor – lifting should be performed between mid-thigh and shoulder height• Provide sturdy walk-up ladder with handrails to access stored parts on high shelves/racks• Provide rigid containers to better control the load

Table 2 Design principles for lifting and lowering tasks

Optimize material flow through the workplace by	<ul style="list-style-type: none"> reducing the manual lifting or lowering of materials to a minimum ensuring that receiving, storage, and shipping facilities are adequate maintaining adequate clearances in aisle and access areas
Eliminate the need to lift or lower manually by	<ul style="list-style-type: none"> increasing the weight of the load to a point where it must be handled mechanically handling raw materials and products in large quantities on pallets that are moved by mechanical means rather than individually by manual means providing a tilt mechanism or a lifting cart for barrels, mixing bowls, vats, etc. handling raw materials and products in bulk in large bins or containers
Reduce the weight of the object by	<ul style="list-style-type: none"> reducing the weight and size of the container reducing the load in the container limiting the quantity of product in each container
Reduce the hand distance from the body by	<ul style="list-style-type: none"> changing the shape of the object or container, or its orientation, so that it can be held closer to the body making the object's surfaces cleaner, cooler, or warmer, or the edges less sharp so that it can be held closer to the body providing appropriately sized and positioned grips or handles so that the load can be held closer to the body
Convert load lifting, carrying and lowering movements to pushing or pulling by providing	<ul style="list-style-type: none"> conveyors ball caster tables hand trucks four-wheel carts other similar equipment
Modify the object by	<ul style="list-style-type: none"> making it lighter changing its shape or texture so that it is easier to grip changing the shape of the object or container so that it can be held closer to the body ensuring that the contents are securely packed to prevent unexpected shifts in the centre of gravity providing appropriately sized and positioned grips or handles so that the load can be held closer to the body clearly marking the weight of the object on an external surface so that workers are able to decide the best way to move the object making its surfaces cleaner, cooler, or warmer, or the edges less sharp so that it can be held closer to the body

Table 3 Design principles for pushing and pulling tasks

Eliminate the need to push or pull by using the following mechanical aids, where appropriate	<ul style="list-style-type: none"> • conveyors — powered or non-powered • powered trucks • lift tables, slides, or chutes
Reduce the force required to push or pull by	<ul style="list-style-type: none"> • reducing the size and/or weight of the load provide levers to assist workers who are turning or moving heavy, awkward loads such as a manhole cover • using four-wheeled trucks or dollies • using non-powered conveyors • making sure that hand trucks or dollies use larger diameter wheels or casters • making sure that the wheels and casters of hand trucks and dollies are well maintained and lubricated • floors are kept clean and well-maintained to eliminate holes and bumps
Reduce the distance of the push or pull by	<ul style="list-style-type: none"> • moving receiving, storage, production, or shipping areas closer to work production areas improving the production process to eliminate unnecessary materials handling steps
Optimize the technique of pushing or pulling by	<ul style="list-style-type: none"> • providing variable height handles so that both short and tall employees can use the equipment equally well • replacing pulling with pushing whenever possible • using ramps with a slope of up to 5 - 8%

Table 4 Design principles for carrying tasks

Eliminate the need to carry by rearranging the workplace to eliminate the unnecessary movement of materials and use the following mechanical handling aids where possible	<ul style="list-style-type: none"> • conveyors (all kinds) lift trucks and hand trucks tables or slides between workstations four-wheeled carts or dollies
Reduce the weight that is carried by	<ul style="list-style-type: none"> • reducing the weight of the object reducing the weight of the container • reducing the load in the container • reducing the quantity of product in each container
Reduce the bulk of the materials that are carried by	<ul style="list-style-type: none"> • reducing the size or shape of the object or container providing appropriately sized and positioned grips or handles so that the load can be held closer to the body • having the job performed by two or more persons
Reduce the carrying distance by	<ul style="list-style-type: none"> • moving receiving, storage, or shipping areas closer to production areas • using powered and non-powered conveyors
Convert carrying activities to pushing or pulling activities by	<ul style="list-style-type: none"> • using non-powered conveyors using hand trucks and push carts

Table 5 Principles for changing body movements

<p>Reduce bending movements by</p>	<ul style="list-style-type: none"> • using scissor lifts or other similar mechanical aids • making sure that work heights are within an acceptable range for workers. Where possible, provide adjustable height work surfaces and chairs to match individual workers and work tasks (see Safety Bulletin ERG016 Proper Height of Work Surfaces for more information) • providing adjustable equipment such as spring-loaded bins or electric/hydraulic scissor lifts to adjust loads to the correct height for lifting • storing objects on shelves based on their weight and how often they are placed on or retrieved from the shelves (see Table 7 for more information) • positioning all required materials and tools at work level • eliminating excessive reaching by keeping materials and tools within easy reach
<p>Reduce twisting movements by</p>	<ul style="list-style-type: none"> • keeping tools and materials in front of the worker • providing “Lazy Susan” surfaces that allow objects on the far side of the rotating platform to be rotated closer to the worker • improving the layout of the work area • providing chairs or other seating that swivels or pivots
<p>Reduce reaching movements by</p>	<ul style="list-style-type: none"> • positioning all required tools, materials, and machine controls within easy reach of the worker • eliminating the need for workers to reach forward by making work surfaces narrower or shallower. This prevents objects from being stored or positioned far in front of the body. Otherwise, position workers on both sides of the wide work surface • tilting large bins or providing walk-in bins to reduce the need for reaching into them • providing a wrap-around table or cut out a section in the front edge of an existing table so that the work is within a natural reaching arc • providing workers with rakes or other grasping/mechanical aids to help them pull distant objects closer • providing “Lazy Susan” surfaces that allow objects on the far side of the rotating platform to be rotated closer to the worker • moving pallets away from the walls and each other. This way, workers may get at all sides of the pallet and position themselves closer to the objects that need to be handled • redesigning the object to reduce the horizontal reach distance from the body • providing sufficient space to allow workers to move around the load to optimize their position

Table 6 Recommendations for design of the workplace ¹

<p>Keep aisles and corridors wide enough to allow two-way transport</p>	<ul style="list-style-type: none"> • aisles and corridors that are too narrow or have obstacles placed in them restrict the flow of work, may lead to accidents, and can reduce workplace productivity • aisles in which workers pass one another while walking should be at least 125 cm (50 in) wide • aisles in which workers pass one another while pushing hand carts or trollies should be at least 150 - 200 cm (60 - 79 in) wide • minor aisles where transport is infrequent should be at least 75 cm (30 in) wide
<p>Make the surfaces of transport routes even, free of obstacles and non-slip</p>	<ul style="list-style-type: none"> • remove sudden height differences or other stumbling hazards along transport routes. Carrying or moving loads on an uneven surface can cause accidents
<p>Provide ramps with a small inclination instead of small stairways or sudden height differences along transport routes</p>	<ul style="list-style-type: none"> • replace small, sudden height differences or stairways with just a few steps with ramps having a small inclination of up to 5 - 8% ramps should be free of obstacles that could cause a worker to stumble ramps should have a non-slippery surface • ramps permit the use of wheeled transport equipment, reducing the need for manual handling
<p>Improve the layout of the work area so that the need to move materials is reduced</p>	<ul style="list-style-type: none"> • machines and workstations are often installed as production increases, without thought being given to the efficient flow of materials and products through the workplace. Improved layout can reduce the extent to which materials are handled and improve productivity • arrange workstations so that work items coming from one station go directly to the next workstation • arrange workstations according to the sequence in which work is performed • combine workstation operations whenever possible to reduce the movement of materials and to offer workers greater diversity in their work
<p>Use mobile storage racks to avoid unnecessary loading and unloading</p>	<ul style="list-style-type: none"> • use wheeled racks to transport objects between workstations or to storage areas consider using pallets, containers, trays or bins that can be placed on a mobile rack or push cart if appropriate, fit wheels to existing stands or racks to make them mobile and to avoid unnecessary loading and unloading
<p>Eliminate or minimize height differences in production or product preparation areas where materials are moved manually</p>	<ul style="list-style-type: none"> • where possible, eliminate work surface height differences so that objects can be moved between work surfaces at the same level without lifting and lowering use transport systems such as conveyors or rollers to move objects, avoiding the need for lifting and lowering

¹ The information in this table comes from the book *Ergonomic Checkpoints*, published by the International Labour Office.

Table 7 Recommendations for the design of storage, shelving and racks (Pheasant, 1996)

Height	Application and Comments
< 600 mm (23 in)	<ul style="list-style-type: none"> • reserve storage for items that are rarely required • fair accessibility for light objects, poor for heavy objects
600 – 800 mm (23 - 32 in)	<ul style="list-style-type: none"> • fair for heavy items, good for light items
800 – 1100 mm (32 - 43 in)	<i>OPTIMAL ZONE FOR STORAGE</i>
1100 - 1400 mm (43 - 55 in)	<ul style="list-style-type: none"> • fair to good for light items — visibility unimpeded, access fair • poor for heavy items
1400 - 1700 mm (55 - 67 in)	<ul style="list-style-type: none"> • limited visibility and accessibility • most workers will be able to stow and retrieve light items, at least those on the edge of the shelves
1700 - 2200 mm (67 - 87 in)	<ul style="list-style-type: none"> • very limited access • beyond the useful reach of some workers
>2200 mm (87 in)	<ul style="list-style-type: none"> • out of reach for all workers

Notes:

For the purposes of this table, loads greater than 10 kg are considered “heavy”.

1. Shelf depths should not exceed: 600 mm at heights of 800 - 1400 mm; 450 mm at heights less than 800 mm; 300 mm at heights greater than 1400 mm.
2. Minimum acceptable unobstructed space in front of the shelves: 680 mm (27 in) for small items at heights greater than 600 mm; 1000 mm (40 in) at heights less than 600 mm or for bulky items at any height.

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