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Workplace Safety and Health Guidelines

Improving Ergonomics in the Workplace



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1. Introduction

During work, employees often manually lift, carry, push or pull heavy objects, maintain uncomfortable postures, or strain their muscles. Ergonomically-designed jobs, work tasks or work stations, however, can reduce strain and improve productivity and employee well-being. Ergonomics uses human biological sciences in conjunction with engineering sciences to identify and optimise all factors that affect an employee’s work to obtain maximum work satisfaction and enhance overall productivity.

Ergonomics deals with manual lifting, carrying, pushing or pulling of heavy loads, over-exertion, awkward postures and repetitive actions or motions which can lead to an increased risk of musculoskeletal disorders (MSDs). MSDs are painful, often crippling, disorders or illnesses of the hand, arm, neck, shoulder and/ or back. Adverse working conditions such as poorly-designed work stations or working environments can also cause employees to develop MSDs.

Such working conditions can also reduce work efficiency and decrease productivity, causing income losses, increased medical claims, and in some instances even permanent disability. Therefore, an effective ergonomics programme with specific ergonomic interventions should be implemented to reduce MSDs and associated costs, as well as improve productivity and employee well-being.

1.1 What is Ergonomics?

Ergonomics is the term applied to the field of science that studies and designs human-machine, human-tool, human-work environment and human-human interfaces to prevent injury and illness and improve work performance. It is a multi-disciplinary science drawing on anatomy, biomechanics, anthropometry, physiology, psychology, sociology, physics, engineering and medicine.

Ergonomics studies and examines:

- the interface between the employee and the machine;
- the interface between the employee and the work environment;
- the physical and mental demands on the employee necessary for him/ her to perform his/ her job;
- the manual tools required for the job;
- the machine and equipment the employee monitors or controls; and
- the workspace in which the employee must perform his/ her tasks.

Therefore, ergonomics aims to optimise:

- workspace and workstation design to meet the physical characteristics of the employee;
- equipment, tool and machine design to match the physical characteristics of the employee;

- control and display layouts to enable the employee to operate and monitor work machinery efficiently with minimum human error;
- task performance by minimising external forces or stress that may affect the employee in performing his/ her tasks; and
- work procedure development to meet the employee's capabilities.

1.2 Ergonomics Intervention

Putting in place an ergonomics programme in the workplace helps prevent work-related MSDs and injuries. Timely ergonomics intervention can also help employees with existing MSDs reduce the stresses on their bodies so that they can continue working.

This set of guidelines outlines how to develop an in-house ergonomics programme for a company or organisation to manage ergonomics problems and work-related MSDs at the workplace. Employees and employers can also obtain information on good ergonomics practices and the prevention of work-related injury or illness. In particular, through using this guidelines, workplace, equipment, task or job design can be better matched to the capabilities of the working population, including pregnant employees, older workers or those with functional limitations.

The guidelines will cover the legal requirements relevant to ergonomics in the workplace, risk factors of work-related MSDs, how to prevent ergonomics-related injuries and how to implement an ergonomics programme.

1.3 Benefits of Good Ergonomics Practices

The aim of an ergonomic approach is to make work safer, healthier, more efficient and comfortable for workers through improving their relationships with their tools and work environment. Therefore, the task of ergonomics is to develop and optimise conditions for employees through their working environment, physical workloads and working postures to facilitate psychosensorial functions in machine operations and tools. These measures would help minimise human errors, maximise efficiency and improve the quality of working life.

Good ergonomic practices and sound application of ergonomic principles in the design of offices, workplaces, jobs and tasks can have a positive impact on employees, work tasks and the work environment. A company with sound ergonomics practices not only suffers from less injuries and illnesses and their associated costs, but also enjoys increased productivity and quality of work from its employees. This increase is evident not only on the production floor but also in the office workplace.

Consideration and inclusion of ergonomic principles in product and process design can also have an impact on an employee's physical and perceptual environment. The former refers to physical structure and climate while the latter is the employee's perception of his or her fit, responsibility or feeling of importance or "ownership" within the organisation. Good ergonomics design helps an employee feel he or she "fits" the organisation both spatially and emotionally.

2. Legislations and Standards

This section describes the key safety and health legislations that all organisations must be compliant with. However, note that the legislations described in this section are not exhaustive and organisations should proactively identify the legal requirements applicable to them.

2.1 Workplace Safety and Health Act

The Workplace Safety and Health Act (WSHA) and its subsidiary legislations require all stakeholders to take reasonably practicable measures to ensure the safety and health of every employee and others who may be affected by the work being carried out. This Act covers every workplace and every stakeholder, including employers, employees, self-employed persons, occupiers, principals, manufacturers and suppliers. Any party responsible for creating work risks, including ergonomics risks, must take steps to eliminate or reduce them. Those who do not do so or show unsafe work behaviour are subjected to penalties under the WSHA.

Employers are responsible for taking reasonably practicable measures to ensure the safety and health of their employees at work. Employees on their part should cooperate with their employers and others through WSHA compliance, observation of all safe work procedures, and exercising a duty of care to protect themselves from work-related occupational diseases.

For more details on the duties of the various stakeholders, refer to the WSHA on Singapore Statutes Online at statutes.agc.gov.sg or the Ministry of Manpower's website at www.mom.gov.sg

2.2 Workplace Safety and Health (Risk Management) Regulations

Under the WSH (Risk Management) Regulations, all workplaces must conduct risk assessments (RAs) to address the safety and health risks posed to any person who may be affected by activities in the workplace. The RA must be completed before work commences.

RAs identify hazards at the workplace, assess the risks caused by these hazards and implement effective risk control measures to prevent unsafe work conditions from escalating into accidents and injuries. Reasonably practicable steps must be taken to eliminate any foreseeable risk to any person, and where elimination is impossible the risk must be minimised as much as possible through appropriate measures. In descending order of effectiveness based on the Hierarchy of Control, these measures include substitution, engineering controls, administrative controls and personal protective equipment (PPE).

For more information, see Chapter 6.6 Implementation of Control Measures.

2.3 Workplace Safety and Health (Incident Reporting) Regulations

The WSH (Incident Reporting) Regulations specifies that relevant parties are responsible for reporting accidents, dangerous occurrences and occupational diseases at workplaces.

Accidents that are reportable under the WSH (Incident Reporting) Regulations:

- result in death;
- result in injury of an employee requiring more than 3 days of medical leave or hospitalisation for at least 24 hours; or
- result in injury of a member of the public requiring treatment in a hospital.

Dangerous occurrences are serious workplace incidents that do not result in death or injury of any person. Reportable dangerous occurrences include:

- explosions or fires;
- collapse of structures or equipment;
- machinery damage; or
- flooding.

Reportable incidents can be submitted to the Commissioner for WSH via iReport at www.mom.gov.sg/ireport

Under the list of reportable occupational diseases specified in the Second Schedule to the WSHA, work-related MSD of the upper limb is specified and thus reportable. In addition, when an employee is diagnosed with a reportable occupational disease, the employer must submit the written diagnosis prepared by a registered medical practitioner diagnosing the occupational disease to the Commissioner for WSH no later than 10 days after receiving it.

At the same time, any registered medical practitioner who diagnoses any employee with an occupational disease specified in the Second Schedule to the WSHA must also submit a report to the Commissioner for WSH no later than 10 days after the diagnosis.

Employers and medical practitioners are required to submit the notification of occupational disease via iReport.

2.4 Work Injury Compensation Act

The Work Injury Compensation Act (WICA) makes provisions for compensation to employees for injury or illness suffered in the course of their employment. As specified in the Second Schedule to the WICA, an employer may pay compensation to an employee who contracted MSDs of the upper limb if said employee was, during the course of work, exposed to occupational risk factors such as repetitive motion, forceful exertion, awkward postures or vibration affecting the upper limbs. The compensation, if any, is limited to injuries or diseases received at work arising out of and in the course of the relevant appointment.

You can find out more about WICA at <http://www.mom.gov.sg/workplace-safety-health/work-injury-compensation/>

2.5 Approved Codes of Practice

In addition to legislative requirements, Approved Codes of Practice (ACOP) are set out in the WSH (Approved Codes of Practice) Notification 2012. These ACOPs provide practical guidance with respect to the requirements of the WSHA relating to safety, health and welfare at work. Organisations should identify and adopt the relevant ACOPs, or standards equal to or above that of the ACOPs. The following are two ACOPs that recommend good ergonomic practices.

SS 514: 2005 Code of Practice for Office Ergonomics

This ACOP provides information and guidance to users, employers, manufacturers, and those who have control over the introduction of health practices into the office, specification and procurement of office equipment, on the application of ergonomics principles in the workplace. It covers work demands, the physical and social environment and workstation design. It provides guidance on how to achieve a better quality of working life in the office environment by reducing health-related problems such as MSDs, visual discomfort and work stress to motivate employees, lower absenteeism and increase productivity.

SS 569: 2011 Code of Practice for Manual Handling

This ACOP serves as a reference standard of acceptable practices for manual handling operations in Singapore. It provides users, employers, manufacturers and suppliers information on ergonomics principles for manual handling work that reduce the risk of MSD injuries and disorders. It also provides guidance for employers to help them identify manual handling hazards, perform RA, control risks for manual handling activities, and plan and implement an ergonomics programme for manual handling operations at their workplaces.

Both ACOPs can be obtained from the Singapore Standards eShop at: www.singaporestandardseshop.sg

3. Work-related Musculoskeletal Disorders

Musculoskeletal disorders (MSDs) are muscle, tendon or nerve disorders caused by repetitive exertions, rapid motions, awkward postures, high force contact stresses, vibrations, and/ or low temperatures. Work-related MSDs are also referred to as cumulative trauma disorders, repetitive strain injuries, or repetitive motion illnesses. These disorders are characterised by discomfort, impairment, disability, or persistent pains in joints, muscles, tendons or other soft tissues.

Most people experience aches or pain at the affected areas. Symptoms can vary in their severity depending on the level of exposure, and often develop slowly after months or years of repetitive work. Initially, symptoms are mild and may improve with rest although there may be slight pain when performing certain movements. Subsequently, symptoms become more severe as exposure continues. In later stages there may be pain and swelling of affected muscles, tendons or connective tissues. Finally, pain can become so severe that the person is unable to perform physical activity.

The following table shows some common MSDs, their symptoms and causes.

Common MSDs, Symptoms and Causes		
Affected Body Part	Common Symptoms/ Disorders	Causes
Low back	<ul style="list-style-type: none"> Gradual or sudden onset of low back pain which may be associated with pain radiating down the legs. 	<ul style="list-style-type: none"> Heavy lifting, carrying or pushing, sudden overloads, repetitive loading; Awkward posture during work, such as twisting/ side bending of the body; or Whole body vibration such as when driving heavy vehicles.
Hand/ Wrist	<p>Carpal Tunnel Syndrome</p> <ul style="list-style-type: none"> Compression of the medial nerve in the carpal tunnel of the wrist; or Pain, numbness, and/ or tingling in the first three fingers and base of thumb. 	<ul style="list-style-type: none"> Frequent and repetitive hand activity, such as grinding, polishing, sanding, assembly work, hammering and/ or typing or when cashiers move or pack items at checkout counters.
	<p>Cubital Tunnel Syndrome</p> <ul style="list-style-type: none"> Numbness, tingling in the little and ring fingers; weak hand grasp and thumb pinch. 	<ul style="list-style-type: none"> Repeatedly/ Consistently resting forearm near elbow on a hard surface, excessive bending of elbow.

Hand/ Wrist	<p>De Quervain’s Tenosynovitis</p> <ul style="list-style-type: none"> Pain in the wrist (radial or thumb side). 	<ul style="list-style-type: none"> Forceful gripping or hand twisting.
Fingers	<ul style="list-style-type: none"> Trigger finger; Swelling at the bottom of the finger or thumb; or Pain when finger is bent and straightened. 	<ul style="list-style-type: none"> Using tools with sharp edges pressing into the hand or handles too wide for a comfortable grip; or Repetitive use of pliers, inserting screws in holes, grinding, pressing, forceful hand wringing.
Elbows	<p>Epicondylitis</p> <ul style="list-style-type: none"> Inflammation of the elbow tendon (e.g., tennis elbow, golfer’s elbow). 	<ul style="list-style-type: none"> Frequent use of screwdrivers/ pliers, hammering, meat cutting.
Neck and shoulders	<ul style="list-style-type: none"> Pain and tightness in the neck, shoulders and shoulder blades (interscapular region); or Numbness radiating to arms and fingers. 	<ul style="list-style-type: none"> Prolonged static bent posture, extension or twisting of neck (e.g., telephone operators, data entry clerks, using microscopes); or Work done with hands extended above head (e.g., maintenance work on lights, overhead auto repair, overhead welding).

Table 1: Common MSDs and their causes.

While MSDs can affect employees in all workplaces, some occupations are especially at risk. These include machine operators, parts assembly operators, movers, nurses, warehouse operators, stock keepers, typists, and musicians.

From a WSH standpoint, the objective of ergonomics is to study the nature of work tasks to prevent work injury and work-related diseases or illnesses from the design stage.

4. Risk Factors of Work-related Musculoskeletal Disorders

Workplace risk factors associated with MSDs include the force or intensity of work, the duration of work, the frequency of work repetition and work posture. These risk factors, along with personal factors such as physical limitations or existing health conditions, may contribute to the development of MSDs. The following sections discuss some of these risk factors and make recommendations for good practices.

4.1 Forceful Exertions

Force is an important causal agent in injuries from manual material handling activities.

Heavy Loads

Lifting heavy loads below the waist level or above the shoulders strains the back. Carrying heavy loads over long distances can also increase the risk of excessive strain on the back.

Good practices for handling heavy loads:

- Store heavier objects on shelves at waist level if these objects are frequently handled.
- Use mechanical aids and tools to lift or move heavy objects (see Figures 1 and 2).
- Get the help of another person to lift or move heavy objects where appropriate.
- Apply correct lifting techniques (see Annex A).
- Where feasible, slide, roll or push heavy objects instead of carrying them.
- Wear appropriate footwear to prevent slips, trips and falls.



Figure 1: Using a vacuum lifter to lift heavy objects.



Figure 2: Using a pallet jack or hand trolley to transport heavy goods.

A Case in Point

At an outdoor catering event, a restaurant manager had to lift and carry about 100 carton boxes of food and cases of water over a 2-hour period. That evening, he went to see the doctor complaining of acute back pain. He received 3 months of medical leave. His intensive manual lifting tasks had exposed him to excessive risk of work-related low back pain. Following the incident, height-adjustable trolleys were used and all staff were trained on proper manual handling techniques.

Bulky Loads

Lifting and carrying bulky objects increases the strain placed on various muscles and tendons of the back and arms as these objects cannot be brought close to the body. The risk of injury is increased when any dimension of the object exceeds shoulder width. Bulky objects also obstruct the carrier's vision, increasing the risk of slipping and tripping.

Good practices for handling bulky loads:

- Pack goods in smaller boxes to reduce the weight and size of each box.
- Ensure that the travel path for moving objects is kept dry and free from obstacles (including people).
- When a colleague is assisting with the task, ensure that both lift the load at the same time (to achieve even distribution of load).
- Avoid slopes, stairs or other obstacles.
- Use mechanical aids or tools where appropriate, for example, a trolley.

Unstable Loads

Loads with shifting contents (e.g., drums partially filled with liquid) or the movement of persons and animals can be hazardous. It is difficult to control and manoeuvre such loads as they may shift and move abruptly during the lift or transport, placing unprepared employees at risk of injuries.

Good practices for handling unstable loads:

- Fill containers or drums for holding liquids or powders to the brim. This will prevent the weight of the load from shifting considerably during transportation and reduce instability.
- Use slings (see Figure 3) or other aids to maintain good control of the load.
- Possess knowledge of the proper handling techniques and use appropriate equipment for handling persons or animals where necessary.



Figure 3: Using a patient lift to lift a patient.

Static Muscle-load

When the arms have to be stationary for extended periods during the use of equipment or tools, the muscles of the shoulders, arms and hands will sustain a static load. This can result in fatigue, reducing the worker's ability to continue working leading to sore muscles and, in more severe manifestations, MSDs.

Good practices for handling static muscle-loads:

- Avoid undesirable static muscle effort of the upper limbs for prolonged periods.
- Keep a static load as close to the body as possible to minimise muscle effort.

Absence of Proper Handholds

The lack of handholds or improper handholds (e.g., awkwardly shaped, difficult grip positions) can affect a person's ability to control and handle a load properly. As the risk of losing grip on the load is high, greater effort is needed to grip the load which may strain muscles excessively.

Good practices to ensure proper handholds:

- Provide handles, hand grips, indents or any other features to improve the grip of the employee on the load (see Figures 4, 5 and 6).
- Ensure the hand fits comfortably within the handhold.
- Ensure that the surface of the handhold is free from oil, dust or grit for a better grip.



Figure 4: Carrying a heavy sack without proper handhold.



Figure 5: Trays with proper handholds for better grip.



Figure 6: Wearing gloves with rubber dots or pads can improve grip on loads.

4.2 Awkward Postures

An awkward posture is a position where the body, arms and legs are not in their natural relaxed position. Work which requires holding awkward positions for long periods or with great frequency can stress muscles, joints or tendons, resulting in aches and pains in affected body parts (see Figure 7 and Figure 8).



Figure 7: Overstretching, twisting the back and overhead reaching can result in MSDs.



Figure 8: Awkward sitting posture at the office workstation can potentially lead to MSDs in the areas indicated by the arrow.

Affected Body Part	Causes	Examples of work activities
Back	<ul style="list-style-type: none"> Forward or side bending of back; or Twisting about the waist. 	<ul style="list-style-type: none"> Cashiers twisting or bending their waists to reach for items along conveyor belts; or Working on low surfaces (below waist level).
Neck and shoulders	<ul style="list-style-type: none"> Forward or side bending of neck; or Lifting of shoulders. 	<ul style="list-style-type: none"> Telephone operators cradling phone between ear and shoulder; or Laboratory staff using microscopes.
Arms	<ul style="list-style-type: none"> Lifting of arms. 	<ul style="list-style-type: none"> Maintenance workers performing work with the hands extended over the head.
Hand/Wrist	<ul style="list-style-type: none"> Bending of wrist. 	<ul style="list-style-type: none"> Work surface is above the elbow; or Using hand tools that result in bending of the wrist, for example, computer mouse, hand saw, electronic pipette.

Table 2: Overstretching, twisting the back and overhead reaching can result in MSDs.

Good practices to reduce awkward postures:

- Have adjustable workstations/ equipment so that items and equipment can be rearranged to reduce the need to stretch or reach for things.
- Have work surfaces with adjustable heights (e.g., scissor lift tables) to allow the feet to rest comfortably on the floor or footrest (see Figure 9).
- Place all required work items and equipment in front of the employee (e.g., cashier or assembly operator) to eliminate the need to turn to the side.
- Use mechanical aids to improve posture, for example, headphones for telephone operators.
- Use ergonomically-designed hand tools.
- Store bulky and/ or heavy items on shelves near waist level for easier retrieval because this will reduce the need to stretch above the elbow or over the head (see Figure 10 on the next page).



Figure 9: Use an adjustable table to adjust the height of the work platform.

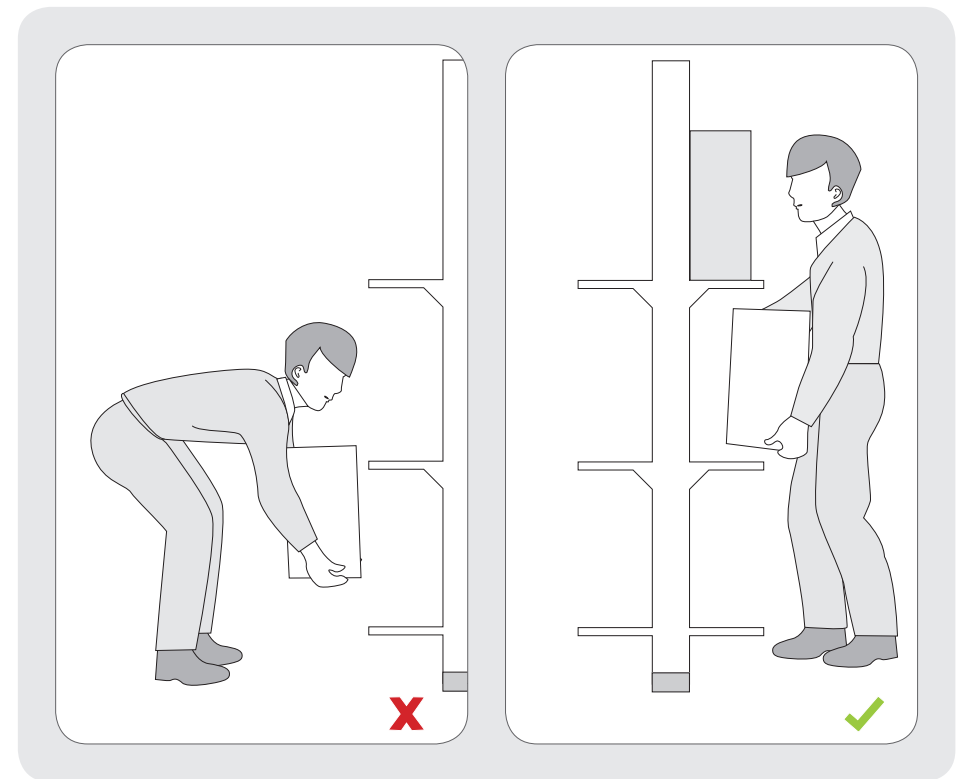


Figure 10: Store bulky, heavy, or more frequently used objects at waist level to reduce the need to stretch.

4.3 Static Postures

Static postures occur when employees are required to stand or sit in the same position for long hours in the workplace. When the body is in the same position or posture for a long period of time, excessive stress is placed on particular parts of the body. For example, standing for long hours may cause muscle fatigue and blood pools in the legs and feet, leading to painful and swollen feet, weakened muscles and varicose veins. Standing on a hard surface such as a concrete floor also causes contact trauma or pain to the feet.

Good practices for static postures:

- Provide footrest bars for employees who sit when they work so that they can alter their posture when necessary, such as by raising one foot.
- Provide anti-fatigue mats or sit or stand stools for employees to stand or sit on.
- Allow employees to sit and rest at regular intervals.
- Encourage employees to change position, stand up, stretch or walk around whenever they feel tired.

A major consideration in the design of the workplace is the employee's working position. The following are general rules to determine whether the employee should work from a sitting, standing or a combined sitting and standing position.

Sitting is desirable where work requires:

- a relatively fixed body posture for extended periods;
- fine manipulative hand movement;
- a high degree of body stability and equilibrium;
- all materials and tools to be retrievable from within the seated workstation;
- no heavy material handling; or
- foot control actions, that is, when one foot or both feet is/ are used for operating controls.

Standing is necessary where work requires:

- mobility and reach;
- extended reaches and substantial movements;
- frequent handling of heavy objects;
- manual downward forces of substantial magnitude; or
- monitoring large areas.

Work could also require a combined sit-stand position. This is best done by providing a high stool to enable the employee to move from one position to another quickly (see Figure 11).

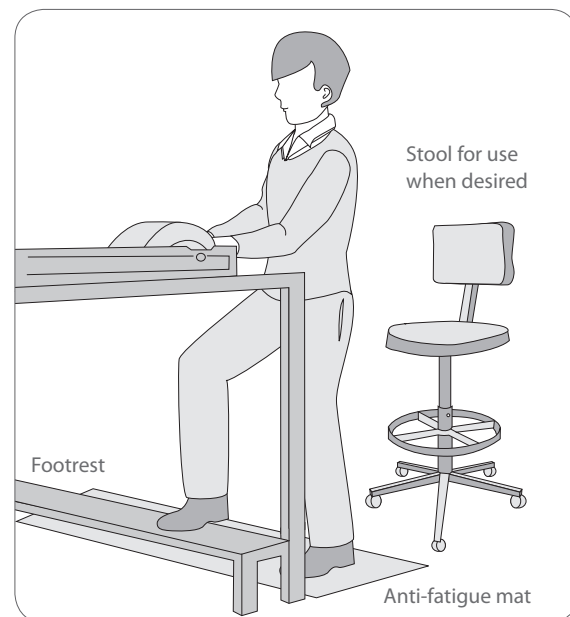


Figure 11: A stool, footrest and anti-fatigue mat for a standing workstation.

4.4 Repetitive Movements

Repetitive movements can become hazardous when the same action is repeated too often or quickly over an extended time period. Injuries occur when too much stress is placed on the same set of muscles, joints or tendons repeatedly without providing sufficient recovery time. The risk of injury increases with the amount of force required. The body needs to rest from time to time to recover, and more rest time should be given after activities which require higher amounts of exertion.

Some common highly repetitive activities include folding carton boxes, clicking control buttons, packing goods along process lines and labelling items.

Good practices to mitigate risks from repetitive movements:

- Plan work schedules to include adequate short rest breaks.
- Encourage employees to do simple stretching exercises to relax working muscles.
- Perform job rotations to ensure a different set of muscles is used for each work activity.

4.5 Vibration

Vibration is the mechanical oscillation of an object about its normal stationary position. Work can potentially expose persons to hand-arm vibration or whole-body vibration.

Hand-arm Vibration

Hand-arm vibration due to the use of vibrating hand tools (e.g., saws, grinders, drills, polishers, jack hammers, concrete vibrators and chain saws) over a long duration and at high intensity could progressively damage finger and arm nerves and blood vessels. If not treated or stopped, these damages could progress to MSDs such as hand-arm vibration syndrome (which includes a particular vascular disorder known as vibration-induced white fingers), as well as neurological disorders (abnormal nerve conduction speeds and reduced tactile sensitivity) and vibration-induced bone and joint deformation.

Whole-body Vibration

Whole-body vibration arises from work activities such as driving buses, lorries or tractors, and/ or operating forklifts, excavators, loaders or dumpers. Whole-body vibration tires the lower back muscles, increasing the risk of back disorders such as low back pain. However, these symptoms are difficult to distinguish from the effects of incorrect sitting postures, heavy lifting and ageing, meaning they may not be appropriately treated until damage is severe or irreversible. Prolonged exposure to vibrations has damaging effects such as disk degeneration, abdominal pain, digestive and urinary problems, headaches, visual disorders, balance problems and sleeplessness. Even low-frequency oscillations (below 0.5 Hz) of the body can cause motion sickness with symptoms like dizziness, nausea and vomiting.

Measures against Vibration

There are two ways to reduce vibration exposure – reducing vibrations at their source and reducing vibrations transmitted to employees.

Methods of reducing vibration at source:

- Use belts instead of chains for rotating machinery;
- Use rotating instead of reciprocating machine parts;
- Add mass to the machine to lower its natural frequency;
- Move vehicles along maintained roads;
- Use pneumatic pressing tools instead of pneumatic riveting hammers;
- Use rotating wrenches instead of impact wrenches; and
- Maintain machinery or vibrating tools regularly as worn bearings, shaft misalignment, unbalanced parts, loose bolts, damaged gear teeth, and blunt cutting tools can increase vibration levels.

Methods of reducing vibration transmission:

- Use pneumatic tyres instead of hard tyres;
- Use a suspended cabin or cab;
- Use suspended seats;
- Maintain vehicle suspension systems;
- Inflate tyres at the correct air pressure;
- Mount vibrating machines on appropriate vibration isolators;
- Equip vibration tools with anti-vibration handles, such as pneumatic rammers, breakers and chain saws with suspended handles or elastic mounting devices; and
- Use a minimum grip strength consistent with the safe operation of power tools.

Wear PPE such as:

- suitable anti-vibration gloves to protect against hand-arm vibration; or
- vibration-reducing safety shoes to protect standing persons against machine vibration.

5. Workspace and Workstation Design

As ergonomics is the science and engineering of fitting jobs to people young and old, ergonomic job design and redesign encompasses the physical abilities, limitations and other human characteristics of workers. It aims to make the most efficient use of employee capabilities while ensuring that job demands do not exceed those capabilities. By applying ergonomic design principles to work tasks, equipment and environment, workplace design can be optimised for safety, health and efficiency.

5.1 Workspace Layout and Design

Ergonomics principles are essential in workspace layout and design, especially in areas like seating, work posture and tool design, and environmental factors such as lighting and ventilation.

When designing a workstation, it is necessary to consider:

- if the layout of the workplace accommodates the required equipment;
- the flow of work and movement of people;
- the work position that best suits the task;
- material storage and handling;
- if space permits employee access to materials, tools and work items;
- the work motion and work posture; and
- the location of controls and displays.

The overall work area or space should accommodate the employee. Sufficient clearance should be provided for the movement of the head, shoulders and/ or knees when employees are carrying out the task.

Good practices in designing a workstation:

- Keep the number of items (tools, parts and controls) that are touched by the hand to a minimum.
- Arrange items so that the employee can adjust his or her posture frequently; consider the employee's dominant hand and preferences in hand movements.
- In a seated working area, provide sufficient leg room to allow stretching of legs to reduce fatigue.
- Locate frequently used tools, equipment and work items near employees to lessen overreaching or muscle strain.
- Locate less frequently used tools, equipment and work items further from the employee, preferably in a secondary work zone within the employee's reach, approximately 60 cm away from the employee. See Annex B for more details.

- Choose a type of control (e.g., levers, switches, knobs, buttons, pedals, or hand-wheels) appropriate to the requirements of the task.
- Select or design displays that provide the necessary information to the employee (e.g., dials, scales, counters, meters, bells and/ or lights).

A Case in Point

In a concrete testing laboratory, workers had to lift some 150 concrete cubes weighing 8kg each daily. As a result of such lifting, workers often complained of backache. After a RA, the task was found to be unacceptable due to excessive and prolonged bending of back and overstretching of limbs. This indicated that controls were required to improve lifting safety. A detailed ergonomic evaluation was subsequently performed to redesign the task to mitigate the risk. The base of the tank was raised and an inverted L-shaped recess added (see Figure 12 for details). These modifications reduced the need for employees to bend their backs or overstretch their limbs, and the lifting task became safer and acceptable.

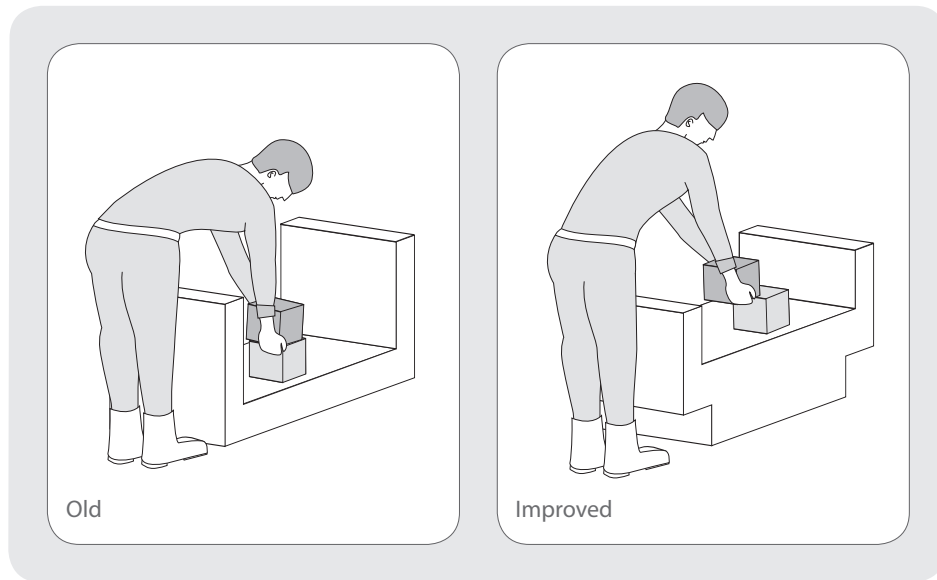


Figure 12: Schematic diagram of old and improved tanks.

5.2 Physical Characteristics and Design Criteria

The workplace should be designed such that the maximum number of employees can perform their work effectively without unnecessary physical and/ or mental stress.

To design a job or task, individual differences such as employee height, strength and other physical characteristics should be considered. It is a good practice to first determine the range of physical characteristics of the employees involved in the task at the work design stage. Some of these characteristics include the maximum and minimum heights of the employees, and the maximum weight most employees can carry. The design should ergonomically fit 80-90% of all the employees involved in the task.

Adjustable equipment or furniture such as tables and chairs in the workstation can also be used to allow for individual differences. Using adjustable equipment ensures convenience for employees, especially heavy or tall employees.

5.3 Hand Tools

Ergonomic design of powered and non-powered hand tools is important to avoid awkward postures of the hand and arm and prevent the user from experiencing excessive exertion and/ or vibration. Non-powered hand tools include pliers, screwdrivers, hammers and knives. Powered hand tools such as chainsaws and powered screwdrivers can be electric or pneumatic. Use of poorly designed hand tools, such as hand tools with small grip areas, can lead to poor hand-wrist posture and place excessive pressure on the hand.

Good practices for the selection and use of hand tools appropriate for the job:

- Select or design tools that can be operated with the wrist in a neutral position, that is, straight wrist (see Figure 13).
- Avoid short tool handles that press into the palm of the hand.
- Avoid narrow tool handles that press deeply into the hand when the tool is used.
- Select or design tools that can be used with either the right or left hand.
- Select or design tools that require less effort or rotational movement to use, improve postures and reduce holding time.
- Select tools with handles made of slip-resistant materials.
- Counterbalance or support heavy tools, for example, by hanging heavy tools from a support.
- Ensure that the hand and fingers are able to easily grasp the tool.

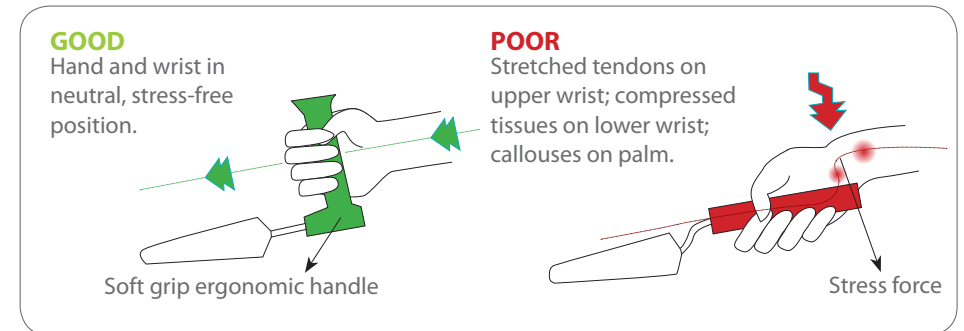


Figure 13: Examples of a well-designed and a poorly-designed hand tool.

5.4 Displays and Controls

Appropriate design and arrangement of display panels, monitors, control buttons, levers and so on are essential to minimise employee error and discomfort during machine operation. Where placed in inappropriate environments or locations, displays and controls could cause visual or postural strain in employees.

Types of Display

Displays and signals supply information about the work process and are necessary to help employees carry out their operations correctly. A cluster of numerous signals can overburden the visual system of employees and confuse them, reducing their ability to pick up important messages. Employees could also experience psychological and physical stress due to their inability to cope with the signals received and give correct inputs. It is important to select a suitable display for the different types of information to be given to employees.

Auditory information such as announcements or alarms are preferred when:

- The message is short and simple;
- Immediate action is required;
- There is insufficient lighting in the work environment;
- The job requires employees to move around the workplace;
- Too many visual signals or stimuli are present;
- Visual acuity is limited; or
- Information must be presented independent of where the employee is facing.

Visual displays such as control panel display and monitors are preferred when:

- The message is long and complex;
- Immediate action is not required;
- Noise limits the use of auditory signals, for example, in a noisy environment;
- The job allows employees to remain in one location;
- Relative or quantitative values are desired;
- There is a need to monitor a number of displays;
- The display is representative of the actual situation;
- The location of one object relative to another object is desired; or
- There is a need to refer to the information at a later time.

Good practices for displays:

- Ensure that employees can easily identify the display of a normal operation, and differentiate it from that of an abnormal operation.
- Ensure that employees can read displays required for normal operation from the normal work position.
- Use simple and clear lettering or fonts for numbers, letters, and symbols.

- Use a digital display when a precise value or reading is needed.
- Use analog displays, for example, dials and scales, for approximate values, rates of change or comparisons within limits.

Types of Controls

Closely linked with displays of information are control devices such as knobs, levers, on/ off switches, and push/ pull buttons. Rotary controls are useful for work which requires extensive movements and accuracy. If speed is important, reciprocating controls such as levers or joysticks should be used. Common employee perceptions should determine the relationship of controls and displays. For example, if a lever that controls a vertical scale is moved to the right, then the majority of subjects will expect the pointer on the scale to move upward, not downward.

There are basically two types of controls – hand controls and foot controls.

Hand Controls

Hand controls are preferred when:

- The accuracy of the control is important;
- The speed of control positioning is important; and/ or
- Application of continuous or prolonged force is not necessary.

Foot Controls

Foot controls are recommended when:

- Continuous or non-precise control is required;
- Moderate to large force is required; and/ or
- Hands are likely to become overburdened.

Control Design Principles

The following are some general control design principles:

- The number of controls should be minimised;
- Control movement should be simple and easy to perform;
- Controls should have sufficient resistance to reduce the possibility of inadvertent activation;
- Control movement should be as short as possible and consistent with the requirements of accuracy and feel;
- Where a single application of force or short continuous force is required, the maximum resistance should be half the employee's maximum strength. For example, if a button needs to be pressed, an employee should only have to use half his/ her maximum strength to press it;
- The maximum force, speed, accuracy or range of the control should not exceed the limits of the least capable employee;
- The force, speed, accuracy or range required for normal control operation should be considerably less than the maximum capability of most employees;
- Natural control movements are more efficient and less tiring;
- If the controls are continuously operated over long periods, they should be calibrated at a lower resistance;

- Controls should be designed to withstand abuse; and
- Controls should provide a positive indication of activation so that malfunctions can be identified.

Good practices for controls:

- Use fingers and hands for precise and quick control actions and arms and legs for actions which require strength.
- Place hand-operated controls at easily reachable locations in full view, between elbow and shoulder.
- Use long levers, hand wheels and leg pedals for operations that take a long time and require comparatively little precision.
- Avoid clustering control buttons/ levers for different functions together; control buttons/ levers for different control functions should be differentiable by shape, texture or mode of operation, for example, levers for one set of control functions and buttons for another set of control functions to avoid confusion.
- Show consistency in control functions by positioning and designing like functions similarly in all workstations.
- Ensure control design is intuitive to users.
- For foot controls where only light pressure is required, employees should be seated.
- Avoid machines with both hand and foot controls, except for the ON/ OFF switch controls which are usually found on the foot pedal.

5.5 The Physical Environment

The physical aspects of the work environment have important implications for the safety, health, comfort, and productivity of employees. Physical environmental factors at the workplace include temperature, lighting, noise and ventilation. If poorly managed, they can pose safety and health concerns. They can also affect the comfort and consequently the job performance and productivity of the employee.

Temperature

A hot or humid environment increases the physical demands of the work on the employee and may rapidly tire him/ her (see Figure 14). On the other hand, cold working environments may prevent muscles from warming up properly and increase the risk of injury.

The conditions of the indoor environment can also have an impact on employee comfort and well-being, and hence should be assessed and monitored. For instance, indoor temperatures should be kept within a comfortable range of 24°C to 26°C.

More information on Indoor Air Quality can be found in the ACOP, Singapore Standard SS 554: 2009, *Code of Practice for Indoor Air Quality for Air-conditioned Buildings*.



Figure 14: Chef exposed to a hot environment.

More information on Air-conditioning and Ventilation can be found in the ACOP, Singapore Standard SS 553: 2009, *Code of Practice for Air-conditioning and Mechanical Ventilation in Buildings*.

More information on managing heat stress can be found in *Workplace Safety & Health Guidelines – Managing Heat Stress in the Workplace*.

Lighting

Sufficient and suitable lighting, whether natural or artificial, should be provided for employees to perform their tasks. Lighting should allow employees to see displays, move and use equipment and controls safely, accurately and efficiently. Glare should be avoided to enable a comfortable visual environment for employees.

More information on providing adequate lighting can be found in the ACOP, Singapore Standard SS 531 *Code of Practice for Lighting of Work Places*.

Noise

Noise is generated by machines and equipment during processes, operations and work activities. Exposure to excessive noise is one of the most common occupational health hazards and can result in noise-induced deafness (NID). Below levels that could damage hearing, noise can also affect job performance, interfere with speech communication and perception of warning signs, and cause annoyance.

More information on Noise Control can be found in *CP 99: 2003, Code of Practice for Industrial Noise Control*.

5.6 Work Organisation

Work organisation is an important factor to be considered when reducing occupational health problems such as MSDs in the workplace. Work arrangements such as work-rest regimes, shift work, and work pace should be carefully managed to ensure that employees can work safely and productively in the work environment.

Work-rest Regime

The arrangement of working hours (including shift work and night work) and the number of work hours can impact an employee's quality of life. Long working hours or work regimes without sufficient rest breaks can tire employees, which may lead to higher injury rates. The negative effects of long hours of work may be compounded by poor safety and health conditions at the workplace.

Shift Work

Shift work is essential in many industries due to a variety of reasons, including the need for processes to run continuously or provide critical services or support. Shift work can be rotating or permanent with two to four shifts a day. However, working outside normal daylight hours disrupts the circadian rhythm or human biological clock, possibly leading to sleep deprivation, digestive or heart problems. WSH could also be affected as operators become less alert, especially when working night shifts and during transitional periods.

Good practices for work-rest regime and shift work:

- Limit shift work to not more than 12 hours including overtime.
- Schedule complex tasks to be performed only during the day and limit the night shift to jobs and tasks that can only be completed at night.
- Schedule critical safety work activities outside the 2am to 6am window.
- Keep consecutive night shifts to a minimum.
- Avoid quick shift changeovers, such as finishing at 11pm and starting again at 7am.
- Allow time for communication in-between shifts for handovers.
- Keep the shift schedule regular and predictable to facilitate employees' family and social activities.
- Provide rest facilities and adequate breaks.
- Introduce job rotation.
- As far as possible, encourage employees to sleep on a set schedule to obtain sufficient sleep, adhere to regular eating patterns with good nutrition and keep a regular exercise regime.

Work Pace

The work pace of employees varies among individuals. Realistic work targets should be set to ensure that they are within the physical and psychological capabilities of the employees. For instance, as conveyor belts determine work pace in production lines, employees could be subjected to substantial stresses to keep up.

Good practices for work pace:

- If the work cycle for a task is short, different tasks that use different muscle groups could be assigned to employees; this would help reduce fatigue in overloaded muscle groups.
- Buffer zones or stores of assembled items can be provided along a production line so that employees can carry out tasks at their own optimal paces.

More information on shift work and work pace can be found in *Workplace Safety & Health Guidelines – Fatigue Management*.

5.7 Office Ergonomics

In an office workplace, most people spend the majority of their time indoors in an air-conditioned environment. A significant amount of work is completed at a workstation using a computer. Workplace design and conditions, including the workstation, work postures and the physical environment, affect the well-being and comfort of an office employee.

Workstation

An office workstation mainly comprises the work table, chair and computer. The workstation should be designed to suit the height and reach requirements of all or most employees, and allow employees to maintain good working postures without restricting their movements and requiring posture changes. A workstation should also be flexible so that employees can perform all their tasks and optimised for use in a variety of tasks.

Good practices for the workstation:

- Adjust the height of the working surface to suit the needs of the employee.
- Provide sufficient space for the knees and legroom under the worktable and a footrest for shorter employees where necessary.
- Ensure that the work surface is not reflective and is large enough to accommodate all equipment and stationery comfortably.
- Arrange equipment on the workstation to minimise awkward overstretching by placing frequently used items in the accessible primary reach zone and less frequently used items in the secondary reach zone.
- Use a chair which is stable and adjustable, with armrests and backrest.

For further information, see Annex B.

Work Posture

Office employees commonly complain of tiredness and stiffness in the neck, shoulders, arms, wrists, and so on. These are frequently associated with risk factors such as fixed and awkward working postures, prolonged work and repetitive work. Working on computers can cause headaches, eyestrain and tired, dry or irritated eyes in some employees.

Good practices for work posture:

- Place the monitor directly in front of the employee, with additional working space at the sides, if the employee uses the computer most of the time.
- Ensure that wrists are kept straight while using the keyboard and mouse, with some space provided between the table edge and keyboard for wrist support.
- Avoid working or sitting for long periods of time. Employees should be encouraged to change posture, stretch and stand or walk around whenever they feel tired.

Work Environment

Several physical aspects of the office environment can have implications on the safety, health, comfort and productivity of employees. Rooms which are too warm or cold, and insufficient lighting or poor housekeeping can distract, discomfort or sicken employees. For example, visual discomfort can result from the glare of visual displays such as monitors, intense bright lights, or the contrast between daylight and artificial light sources.

Good practices for the office environment:

- Isolate noise sources such as photocopiers and printers where possible, such as in a separate printer room.
- Install curtains at windows and skylights, and place monitors perpendicular to windows to reduce glare from daylight (see Figure 15). Position monitors parallel to and in-between overhead lights to reduce glare from overhead lights.
- Install diffusers or louvers in lights to limit glare.

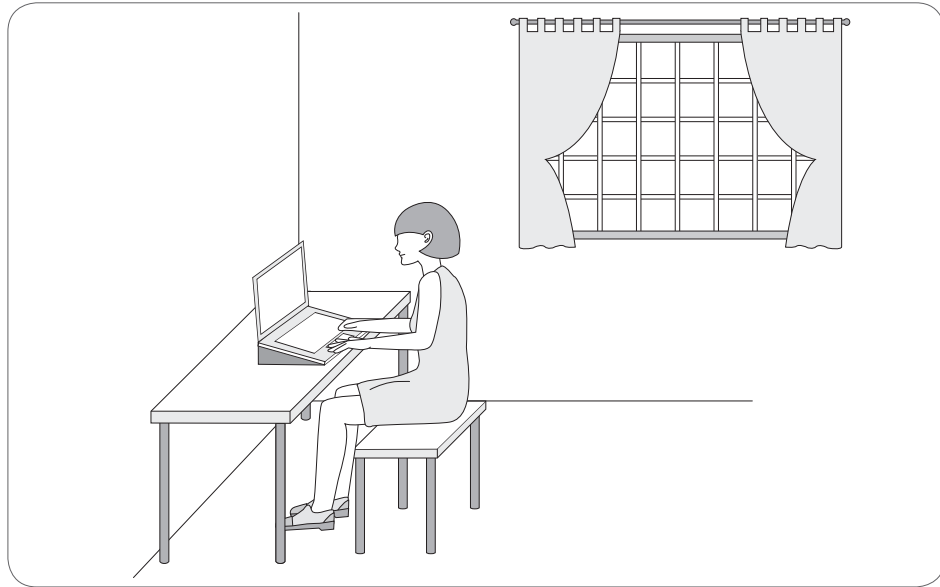


Figure 15: Position the monitor to avoid window glare.

See Checklist A for a sample checklist on good practices in the office environment.

More information on office ergonomics can be found in the ACOP, Singapore Standard SS 514: 2005, *Code of Practice for Office Ergonomics*.

5.8 Workplace Design for Special Groups

Older Employees

As we age, our physical performance (e.g., muscle strength and stamina), sensory (e.g., vision and hearing), mental and social abilities deteriorate. Similarly, as employees age, they experience a decline in strength and ability due to decreased cardiac, respiratory and muscular capacities. Older employees are also less able to deal with multiple or complex tasks, requiring more time and practice before they can master a new task or learn new information. They have less tolerance for extreme or adverse physical environments such as hot, noisy or extremely bright environments.

Applying ergonomic principles in the design of workplace equipment, tasks and jobs is therefore important to enable older employees to perform their tasks safely and effectively.

Good practices for an ageing workforce:

- Tasks should be ergonomically designed (matching the nature of the job with the design of equipment, machinery and tools) to ensure that tasks are within the physical and mental capacities of the workforce.
- For work tasks that demand a high physical workload, measures that reduce the amount of forceful exertion should be implemented, such as reducing the weight of the load or using mechanical aids.
- For workplaces where visual tasks are frequently performed, higher illumination levels (i.e., upper values in the range of recommended illumination levels) could be provided for individuals aged over 55 years.
- Appropriate sensory aids such as magnifying glasses, larger screens, high contrast displays and larger font sizes could be used at workstations to enhance the working environment for older employees and reduce eyestrain and errors. Self-paced work that can accommodate an older employee's decreased physical ability could substitute line or team-based work.
- The work area should allow more space for older employees to manoeuvre when performing their tasks.
- Tasks should be designed such that any procedures and/ or objectives are clear. Where possible, older employees should not be assigned complex tasks.
- Memory aids such as notices, signs or visible flowcharts should be used to reduce memory strain.

Functionally-limited Employees

Some employees have hearing, visual, physical, speech or cognitive impairments.

For employees with functional limitations that may prevent optimal or safe performance of their tasks, the design of the workplace, equipment, tasks and jobs needs special attention. This can be achieved by providing the employee with:

- tools (e.g., prosthetics or orthotics) or assistive devices (e.g., wheelchairs, telecommunication devices for the hearing impaired) that maximise the use of residual skills and abilities and compensate for any missing abilities;
- training and development of new techniques and strategies that allow employees with functional limitations to work better; and/ or
- a more universal and accessible workplace design. For example, a redesign of the workplace to accommodate employees in wheelchairs can be considered.

6. Ergonomics Programme

An ergonomics programme provides a systematic approach for the organisation to manage ergonomic hazards and issues at the workplace. The establishment of a programme allows the organisation to make better informed choices and help create a safety culture that promotes good ergonomics at work. An effective ergonomics programme can reduce work-related injuries, illnesses and associated costs, as well as improve productivity and employee well-being. Both the organisation and individuals will eventually benefit from the programme.

A team should be formed to establish and implement the ergonomics programme. The team should have both employees and management representatives including safety and health personnel, operation personnel and relevant technical personnel.

There are seven key elements in an ergonomics programme:

1. management commitment and policy;
2. employee involvement;
3. training and education;
4. hazard identification;
5. workplace monitoring, reporting and medical management;
6. implementation of control measures; and
7. evaluation and review.

For a sample checklist which could be used during the implementation of a workplace ergonomics programme, refer to Checklist B.

6.1 Management Commitment and Policy

Management commitment is key to the success of any health and safety effort. Management must demonstrate leadership commitment to developing and implementing an ergonomics programme at the workplace. The management should establish the goals for the programme, communicate the programme's importance to all employees, and make available resources for ergonomic improvements.

There should also be a policy statement to demonstrate the commitment of the company towards managing ergonomics risks in the workplace and to set the programme direction. Management should put in place policies or practices that encourage employees to participate in the programme's activities, make reports or give suggestions.

Practical Guidance

- A company's safety and health policy can include ergonomics as an area of concern and treat ergonomic efforts as part of the company's goal to create a safer and healthier working environment for all.

- Resources can be allocated to train employees to become more aware of ergonomics risk factors and to implement ergonomic improvements.
- Management should assign and communicate responsibilities for setting up and managing the ergonomics programme so that managers, supervisors and employees know what is expected of them and how they are accountable for discharging those responsibilities.
- Management should provide assigned persons with the authority, resources, information and training necessary to meet their responsibilities.

It is emphasised that ergonomics should be considered during the design stage of work processes, or before work commences. Such a proactive or anticipatory approach to the management of ergonomics at work prevents problems from developing at the outset. For instance, identification of ergonomics risk factors and assessment of the associated risks prior to work commencement can help prevent ergonomic-related health issues like MSDs.

Practical Guidance

- Management can emphasise in policy to consider ergonomics when designing and selecting tools, job methods, workstation layouts and materials.
- Managers for new work processes and procurement can be trained in ergonomics factors and principles. They should also have adequate information and understanding on MSDs, risk factors and control measures. Records of current ergonomic issues employees are facing are useful sources of information.
- Management should communicate regularly with employees about the ergonomics programme and their concerns about work-related MSDs.

6.2 Employee Involvement

Employees should be involved in the programme to improve workplace conditions. Their involvement will enhance employee motivation and job satisfaction, and increase the likelihood of them accepting job changes. An ergonomics team can be formed with participation from all levels of the organisation to address ergonomic issues. Employees should also be encouraged to give suggestions on how to improve existing work conditions.

Practical Guidance

- A dedicated ergonomics team should be appointed to take the lead in ergonomics, with roles and responsibilities specified clearly. This team may be an existing team, or a new team.
- Companies should have a system in place for employees to report signs and symptoms of work-related MSDs.
- Employees should have a way to report hazards associated with manual operations, material handling or any ergonomics problems at workplace.
- Employees should be encouraged to give suggestions or make recommendations on ways to improve manual work or operations that may cause excessive strain or fatigue.
- Employees should have access to information about ergonomics and the company's management programme.
- There should be avenues available for employees to be involved in hazard identification and control, training and education, and evaluating the effectiveness of the programme and control measures.

6.3 Training and Education

The ergonomics team should be trained in methods of identification of ergonomics risk factors, appropriate RA techniques, controls for ergonomics risks, and how to evaluate the effectiveness of ergonomics initiatives.

All employees, especially those in affected jobs, for example, manual handling jobs where a known MSD hazard exists, should be trained and equipped with basic ergonomics knowledge such as how to recognise MSDs and their associated symptoms (see Figure 16). They should also be briefed on the proper reporting procedures for ergonomics-related injuries and issues.



Figure 16: General ergonomic training needs of employees.

Practical Guidance

- Basic ergonomics knowledge would include understanding risk factors (e.g., forceful exertions, repetitive movement, and awkward postures), common MSDs, control measures and good practices.
- Training should focus on particular higher risk areas identified from past injury records. For instance, assembly line employees who repetitively use their hands and/ or fingers when assembling products should be trained to recognise hand and finger-related injuries like repetitive strain disorders.
- Basic ergonomics knowledge can be included as part of the induction training programme for new employees.
- Job-specific training such as proper manual handling techniques can be implemented for targeted employees. See Annex A for examples.
- Where mechanical aids and equipment are used, training on their safe and proper use should be provided as well. If adjustable tables and chairs are used, advice on correct methods of adjustment and appropriate workstation layout should be provided.

6.4 Hazard Identification

The ergonomics team should identify work-related MSDs and their associated risk factors in manual operations and material handling jobs, analyse the identified risk factors and implement measures to control the risks as far as is reasonably practicable. This includes prioritising job tasks based on job hazard analysis and controlling the risk factors where necessary. Identifying ergonomics risk factors in job tasks typically starts from direct observation of a particular group of employees or a particular work process. Areas of note include workstation design, work load, tools used and employee postures.

The ergonomics team should look into areas and work tasks where there could be underlying ergonomics issues. There may be some areas where evidence of work-related injuries and symptoms is insufficient or less obvious to the general workforce. In situations where there are few cases of injury, employee feedback on the body stresses and strains they experience may be used as a basis to decide on areas of analysis.

Whenever there is a change, modification or redesign in processes, facilities, workstations and tools, or whenever new equipment and machines are purchased, the ergonomics team should anticipate or identify ergonomics risk factors to prevent new problems from being brought into the workplace.

Practical Guidance

- The ergonomics team needs to be trained in ergonomics risk factor identification. Regular inspections should be conducted by the ergonomics team to identify areas of concern. These inspections can cover manual handling activities, machinery operations, and the general working environment.
- The areas of concern identified are those where there are risk factors, such as heavy lifting and repetitive movement involved. The ergonomics team has to investigate further by seeking employees' opinions on their experiences of discomfort or pain arising from these identified areas at work.

For hazard identification, the following steps could be carried out:

1. Conduct a hazard identification exercise together with employees who are involved in the job.
2. Break the job down into its various work tasks. Observe employees performing the tasks, and identify and evaluate job factors such as workplace conditions and physical work activities to determine which ones are reasonably likely to be causing or contributing to the problem.
3. Identify risk factors in each work task. Start with a qualitative identification to find out the contributing risk factors in each task.
4. Identify risk factors from the posture, movement, load, and work environment of the people doing the work. See Checklist C for a sample checklist for risk factor identification.
5. Certain work tasks are prioritised for more detailed analysis:
 - work tasks where cases of MSD were identified based on past records;
 - work tasks that have garnered employee complaints or feedbacks of excessive body discomfort like strain; and/ or
 - work tasks with significant or multiple risk factors identified.
6. Further analysis of the identified work tasks is conducted to determine the safe acceptable limits for an action. This is usually conducted by personnel trained in ergonomic assessments.
7. Ratings of high or extreme risk factors, especially with multiple occurrences within a single work step or within the work task, indicate a need for control measures.

The information obtained from injury and symptoms records would help determine which work tasks could have ergonomics problems. Areas which require immediate attention, such as those with the highest rate of injuries, should be first priority for job analysis and intervention. Work tasks associated with complaints of fatigue and discomfort would be ranked next.

Where significant risk factors are present, more detailed analysis should be done to assess potential downstream problems. Even without any medical data or symptoms from employees, preventive steps should be taken to reduce potential risk factors. Resources can then be allocated to the work tasks to remedy ergonomics issues accordingly.

To know more about hazard identification and risk evaluation, the WSH Council's ACOP for WSH Risk Management can be referred to for more details.

6.5 Workplace Monitoring, Reporting and Medical Management

Monitoring and Reporting

Employees with aches and pains due to job tasks are tell-tale signs of ergonomics issues in the workplace. Information about ergonomics hazards and recognising and reporting the signs and symptoms of MSDs should be provided to all employees in those jobs. A dedicated ergonomics team should proactively track aches and pains complaints, injuries, and other ergonomic problems that employees experience in the workplace. Monitoring ergonomics problems and similar practices promotes awareness of ergonomics hazards, engages employees in symptom reporting and encourages them to make suggestions on how to improve their work environment.

Practical Guidance

- Identify at least one person to receive and respond promptly to reports about signs and symptoms of work-related MSDs and ergonomics hazards.
- Simple procedures can be established to encourage employees to report their symptoms and injuries, particularly work-related MSDs. Employees should be encouraged to report even if they find the pain acceptable. Reporting signs and symptoms early allows corrective measures to be implemented before problems worsen.
- Periodic surveys could also be carried out to research employee opinion on workplace conditions and any symptoms they could be experiencing. See Checklist D for a sample symptoms survey which can be used to identify at-risk employees.
- Records of reports and feedback should be kept as a source of reference for ergonomics issues in the workplace. If and when similar symptoms or feedback arise, they indicate a greater need to look into that particular area or job scope.

Medical Management

Whenever a work-related MSD is identified, the employer should make available prompt and effective management of the affected employee's treatment. Early detection, prompt treatment and timely recovery from injuries can prevent the employee from being permanently impaired or disabled.

By providing education and training on recognising the symptoms of MSDs and reporting procedures, the employer can help ensure employees evaluate their symptoms and visit a healthcare provider for evaluation in a timely manner. The employer can help by modifying work tasks for employees who may have functional limitations. The employer can also work together with the healthcare provider to ensure that existing or modified work tasks are suitable for employees.

Practical Guidance

- When an employee reports signs or symptoms of a work-related MSD, the employer should review the report to determine whether medical management should be provided.
- The employer should provide employees with prompt access to healthcare providers for effective evaluation, treatment and follow-up.
- The employer should also provide information on work tasks and work demands to the healthcare provider for employees with reported symptoms.
- The employer should obtain a written opinion from the healthcare provider and ensure that the opinion is shared with the employee. The written opinion should include the work-related medical conditions related to the MSD reported, recommended work restrictions where indicated, and follow-up for the employee during the recovery period. The employer should work with the healthcare provider(s) to modify work tasks to suit employees who may have functional limitations.

6.6 Implementation of Control Measures

From the identified risk factors, specific measures or a series of measures could be implemented to control ergonomic risks. Effective measures or improvements can lower the physical demands of the work and decrease the risk of injuries.

Risk control measures are undertaken to eliminate or reduce foreseeable risk to any person. Preferably, risks should be eliminated or reduced at source. These control measures should be selected based on the Hierarchy of Control (see Figure 17).

Elimination and substitution are the most effective ways to control ergonomic risks. Engineering controls are usually preferred to manage ergonomic risk factors. Administrative controls reduce risk through reduction of exposure time, and good work practices can be an important part of a successful ergonomics control plan. PPE may be used as an interim control, but not as a permanent control when other controls are feasible.

It may be necessary to implement more than one risk control measure when a single measure is insufficient to reduce risk to an acceptable level. For example, engineering controls such as mechanical aids can be implemented together with administrative controls like employee training. Some examples of risk controls are detailed in the table on the next page.

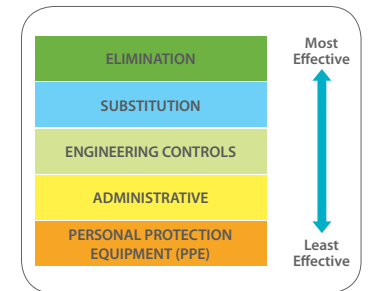


Figure 17: The Hierarchy of Control shows the order of effectiveness of different control measures.

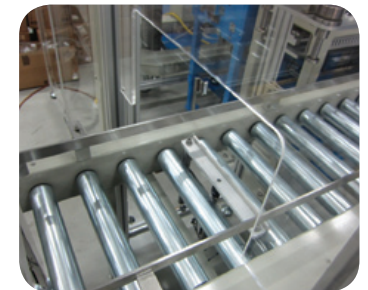


Figure 18: Engineering control: use of a mechanised system to transport objects.

Type of Control (based on Hierarchy of Control)	Control Measures	Examples
Elimination/ Substitution	<ul style="list-style-type: none"> Automation to eliminate lifting or carrying. 	<ul style="list-style-type: none"> Conveyor belts or carousels to transport objects.
Engineering controls <ul style="list-style-type: none"> Physical changes to jobs to control exposure to MSD hazards. 	<ul style="list-style-type: none"> Use of mechanical aids and tools to eliminate or reduce exertions required. 	<ul style="list-style-type: none"> Load elevators, scissors lift tables, hand trolleys to transport and lift objects; Powered stackers, hoists to lift items, vacuum lifts; and Industrial tilters, air-ball tables, rollers.
	<ul style="list-style-type: none"> Select tools or redesign work processes to reduce exertions or holding time required, and improve postures. 	<ul style="list-style-type: none"> Reduce the load and its bulkiness, for example, packaging using smaller, lighter cartons for easier handling.
	<ul style="list-style-type: none"> Use of ergonomically friendly equipment; and Provide user-adjustable workstations to reduce reach and improve postures. 	<ul style="list-style-type: none"> Ergonomically designed pliers with bent handles; and Adjustable tables, self-levelling work surfaces.
Administrative <ul style="list-style-type: none"> Procedures and practices that reduce exposure to MSD hazards by altering the way in which work is performed. 	<ul style="list-style-type: none"> Scheduling sufficient rest breaks between tasks. 	<ul style="list-style-type: none"> Short breaks between work tasks.
	<ul style="list-style-type: none"> Job rotation to reduce repetitive movements. 	<ul style="list-style-type: none"> Rotate employee tasks, for example, between administrative work and physically demanding work.
	<ul style="list-style-type: none"> Training to raise awareness of ergonomic risks and knowledge. 	<ul style="list-style-type: none"> Training on correct lifting postures; and Training on proper use of tools, proper arrangement of materials on workstations.
	<ul style="list-style-type: none"> Adjust work pace. 	<ul style="list-style-type: none"> Slower work pace to reduce frequency of exertion.
Personal protective equipment (PPE) <ul style="list-style-type: none"> Interim control devices worn or used to protect persons from exposure to MSD hazards. 	<ul style="list-style-type: none"> PPE against whole body vibration; and PPE against hand and arm vibration. 	<ul style="list-style-type: none"> Vibration isolated seat for a tractor driver; and Anti-vibration gloves for a jack hammer operator.

Table 3: Examples of risk control measures for ergonomic hazards.

6.7 Evaluation and Review

The programme activities should be evaluated and reviewed periodically to ensure that all elements of the ergonomics programme remain relevant and effective in mitigating ergonomics risks at the workplace. The review may take place once every three years, when there are changes in the work processes, or when new information surfaces.

Effectiveness indicators, both activity and outcome-based measures, should be used to assess whether an ergonomics programme and its controls are successfully controlling MSD risk factors and reducing the number and severity of MSDs.

Activity-based indicators can be used to measure interim accomplishments when establishing and maintaining an ergonomics programme. These indicators can, for example, assess how various activities in the programme have been functioning, such as the number of employees trained or number of work stations or tasks redesigned.

Outcome-based indicators can be used to assess interventions that have been put into place and provide a quantitative measure of the long-term success of the programme, for example, work productivity rate or number of medical leave days reduced.

Baseline measurements should be established as a starting point for measuring the effectiveness of the programme.

Deficiencies in the programme should be corrected promptly if the evaluation indicates the programme is not controlling MSD hazards in problem jobs.

Practical Guidance

- The original surveys and analysis methods can be employed to evaluate the effectiveness of control measures in reducing ergonomics risks.
- The following questions could be asked:
 - Has the control measure reduced the physical discomfort caused to the employee?
 - Is the employee trained in safe work procedures that encompass control measures to mitigate ergonomics risk factors?
 - Do employees embrace and use the control measures implemented?

Recordkeeping

Written records of the ergonomics programme should be kept for at least three years. These include:

- employees' reports and management's responses;
- the results of job hazard analysis;
- plans for controlling MSD hazards and ergonomic problems;
- medical management records; and
- programme evaluation and review reports.

7. Checklists

Checklist A - Sample Checklist for Good Practices in the Office Environment

If your answer is “No” to any of the checklist questions, it may indicate the need for action or control to be implemented to mitigate any possible risk or ill-health.

Work Surface		Yes	No
1	Can the height of the work table be adjusted?		
2	Is there space to accommodate the knees and legroom under the table?		
3	Is the monitor placed directly in front of employees who work on computers most of the time?		
4	Is the work surface large enough to accommodate the work and all necessary equipment?		
5	Are frequently accessed items like telephones and files within easy reach?		
6	If the work table has a keyboard tray, is it easily adjustable and does it accommodate the use of a mouse?		
Chair		Yes	No
1	Can the height of the chair be adjusted?		
2	Can the back rest of the chair recline slightly (100° to 120°)?		
3	Is the depth and width of the seat pan suitable?		
4	Does the seat pan have a rounded front edge?		
5	Can the height of the armrests be adjusted?		
6	Does the chair have five legs with castors and is it able to swivel?		
7	Are all chair adjustments easy to access and operate?		
8	Are footrests available to employees who need them?		
Monitor		Yes	No
1	Is the monitor placed such that the top of the monitor is at eye level or slightly below?		
2	Is the monitor located about an arm's length in front of the worker?		
3	Can the monitor be adjusted, for example, tilt forwards and backwards, rotate?		
4	Is the monitor free from glare and flicker?		

Input Devices		Yes	No
1	Is the mouse located beside or close to the keyboard?		
2	Is the mouse at the same height as the keyboard?		
3	Can the wrist be kept straight while using input devices, such as keyboard and mouse?		
4	Is the wrist supported by the table surface or keyboard and mouse pad?		
Work Environment		Yes	No
1	Is sufficient lighting provided for the task?		
2	Are employees shielded from direct and/ or reflected glare, for example, light from the monitor screen or sun?		
3	Is the work environment free from disturbing noise from equipment or machines that affect the concentration of employees?		
4	Are noisy equipment or machines kept isolated or enclosed?		
5	Is the temperature of the work environment comfortable for employees?		

Checklist B – Sample Checklist for a Workplace Ergonomics Programme

1	Management Commitment and Policy	Yes	No
a)	Is there a policy on the company's commitment to manage ergonomics issues endorsed by the management?		
b)	Are there resources dedicated to training employees towards improving their knowledge on ergonomics risk factors and implementation of ergonomic improvements?		
c)	Are ergonomics principles recognised and considered in the design and selection process of new tools, machines, job methods, workstation layouts and materials?		
2	Employee Involvement	Yes	No
a)	Are employees involved in the programme efforts to improve workplace conditions?		
b)	Is there a committee formed, with employees from all levels of the organisation, to address ergonomic issues such as designating a dedicated team to take the lead in ergonomics with clearly specified roles and responsibilities?		
c)	Are employees encouraged to give relevant suggestions on jobs which strain or fatigue them excessively and on ways to improve them?		
3	Training and Education	Yes	No
a)	Are all employees educated in general ergonomics awareness?		
b)	Are all employees familiar with the procedures for reporting ergonomics problems?		
c)	Is there job-specific training for employees depending on their tasks, for example, proper lifting/ carrying techniques for employees engaged in manual lifting tasks?		
d)	Are the ergonomics team members trained in job analysis, risk factors and their associated controls?		

4	Hazard Identification	Yes	No
a)	Does the ergonomics team conduct regular inspections, surveys and/or interviews to identify areas of concern?		
b)	Does the ergonomics team directly observe the work processes and tasks of employees during workplace assessments?		
c)	Are the various work tasks of a job assessed separately?		
d)	Are risk factors in work tasks identified through qualitative assessments?		
e)	Are work tasks with a record of previous MSDs given priority for detailed analysis and implementation of control measures?		
f)	Are work tasks with significant or multiple risk factors identified and prioritised for detailed analysis and implementation of control measures?		
g)	Are employee feedback and suggestions taken into account during all phases of the assessment?		
5	Workplace Monitoring, Reporting and Medical Management	Yes	No
a)	Are there procedures in place for employees to report, suggest and give feedback on their symptoms and injuries in the workplace?		
b)	Are there periodic surveys conducted to find out the ergonomics issues, symptoms or injuries at the workplace that employees are experiencing?		
c)	Are records of injuries, employee suggestions, feedback, and ache and pain symptoms kept?		
d)	Does the employer work with healthcare provider(s) to tailor work tasks for employees who may have functional limitations?		
6	Implementation of Control Measures	Yes	No
a)	Are control measures implemented to eliminate or minimise ergonomics risks where possible?		
b)	Are elimination or engineering control methods considered first, before other risk control methods?		
c)	Are administrative control methods used where engineering methods are not practicable?		
7	Evaluation and Review	Yes	No
a)	Is the effectiveness of implemented control measures evaluated using the same assessment checklists and tools?		
b)	Are ineffective control measures modified or replaced?		
c)	Are programme elements and control measures reviewed at least once every 3 years, or when there is a change in work process, to ensure their relevance and effectiveness?		

Checklist C – Sample Checklist for Risk Factor Identification

Work Location: _____ Checked by: _____

Task Description: _____ Designation/Signature: _____

Task Frequency and Duration per Workday: _____

Date: _____

If your answer is “Yes” to any of the following questions, it may indicate the need for action or controls to be implemented to mitigate any possible risk or ill-health.

Load		Yes	No	Remarks
1	Is the weight of the load too much for most employees to handle?			
2	Are strong pushing or pulling forces involved in the work?			
3	Is the load difficult or awkward to handle, for example, due to its shape, size, temperature or instability?			
4	Is it difficult to get an adequate grip on the load or tool?			
5	Are large, heavy objects being placed or stored at awkward heights (below mid-thigh level or above shoulder height)?			
Posture		Yes	No	Remarks
1	Is there frequent or prolonged forward bending where the hands are stretched below the thighs?			
2	Is there frequent or prolonged reaching for items or objects above the shoulder?			
3	Is there frequent or prolonged forward reaching of the body?			
4	Is there frequent or prolonged twisting of the back?			
5	Is there frequent or prolonged sideways bending of the body or handling of a load with one hand?			

6	Is there frequent or prolonged bending of the neck, shoulder, elbow, wrist or finger joints?			
7	Is the same work posture, for example, standing or sitting, maintained for a long period of time without any rest break in between?			
Standing Work		Yes	No	Remarks
1	Do employees have to stand in a fixed location for more than 4 hours a day?			
2	Are employees unable to change their work posture, for example, by moving around or alternating between sitting and standing?			
3	Are employees who are obese, pregnant or with a history of varicose veins required to work in fixed standing positions for the whole shift?			
Movement		Yes	No	Remarks
1	Are there repetitive, forceful or sudden movements of the hands, arms or back?			
2	Is manual work performed frequently or for a prolonged period of time?			
3	Are loads moved or carried manually over long distances?			
4	Do employees complain or give feedback that the rest or recovery period between tasks is insufficient?			
5	Is physically demanding work done continuously by the same employee without rotation?			
Hand Tools		Yes	No	Remarks
1	Does the handheld tool require excessive force or expose the employee to excessive vibration during use?			
2	Does the tool slip out of the hand easily during use and/ or is it unevenly balanced?			
3	Does using the tool require excessive bending/ twisting of the wrist?			
4	Does use of the tool produce excessive pressure on a small area of the palm or fingers?			
5	Is the handle of the tool too small or too big to accommodate the hand sizes of most employees?			

The Physical Environment		Yes	No	Remarks
1	Is the work environment particularly hot or cold?			
2	Is the floor surface that employees work on uneven or slippery?			
3	Is the work area cluttered or cramped such that access to it and employee movement is restricted?			
4	Are unstable or unsuitable stepping aids such as stools or chairs used to access high places?			
Individual Factors		Yes	No	Remarks
1	Is the employee new to the job task or has he/ she just returned to work from an extended period away?			
2	Are there age-related factors, disabilities, health issues or other special factors that may affect task performance?			
3	Are there complaints of body aches, pain, discomfort or numbness from employees which they feel are caused or made worse by their work?			
4	Have any employees been unable to carry out their normal activities because of body aches, pain, discomfort or numbness?			
Others		Yes	No	Remarks
1	Does employee clothing or personal protective equipment interfere with manual handling work?			
2	Have the employees been trained in manual handling techniques such as proper lifting and carrying?			

Checklist D – Sample Symptoms Survey Checklist

Name: _____

Sex/ Age: _____

Designation/ Job title: _____

Average no. of working hours per day: _____

Company: _____

Date: _____

1. What are the tasks that you perform at work? (You may list more than one task.)

2. Among the tasks listed above, which one do you spend the most time doing?

3. How long in total have you worked in this type of job?

_____ years _____ months (previous company)

_____ years _____ months (current company)

4. How often do you lift or carry objects weighing 25-50kg?

- Almost daily
- At least once a week
- At least once a month
- Almost never

5. How often do you lift or carry objects weighing more than 50kg?

- Almost daily
- At least once a week
- At least once a month
- Almost never

6. How often do roll, pull or push goods manually without trolleys?

- Almost daily
- At least once a week
- At least once a month
- Almost never

7. How often are you very tired after work?

- Never
- Less than once a month
- More than once a month but less than once a week
- Once or more a week

8. How often do you work overtime in a month (paid or unpaid)?

- Never
- Less than 10 hours
- 10 hours or more but less than 50 hours
- 50 hours or more

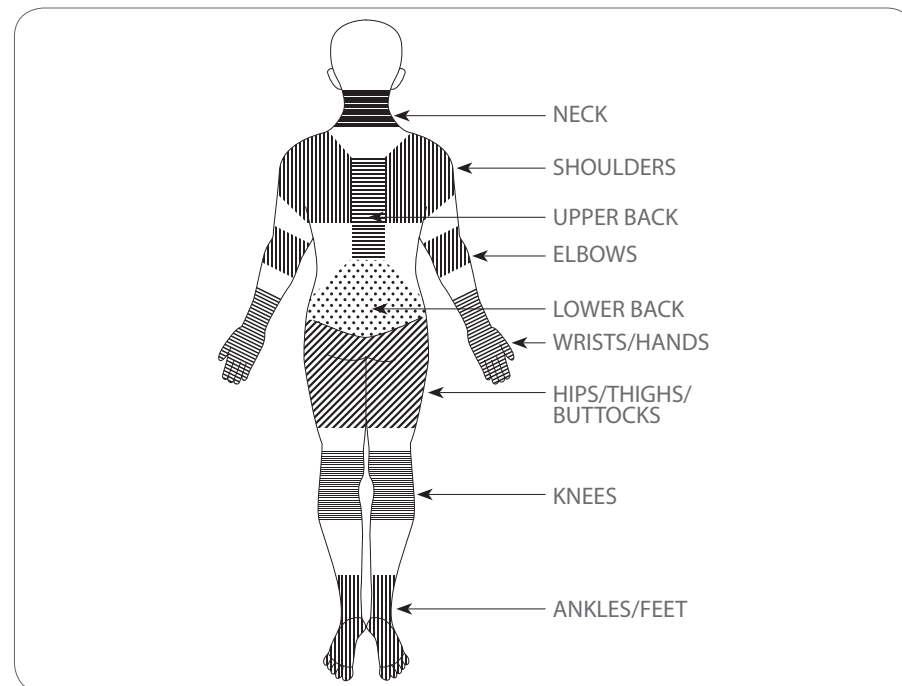
9. Do you do any of the following at least once a week?

- | | | |
|----------------------|------------------------------|-----------------------------|
| Housework | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| Carry young children | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| Sports | Yes <input type="checkbox"/> | No <input type="checkbox"/> |

10. Did you have any aches, pains or discomfort during the past 12 months?

- Yes (Please proceed to Question 11)
- No (If No, you may stop here)

11. Please circle the area(s) that bothers you.



a. Please put a tick by the word(s) that best describe your problem:

- | | | | | | |
|-------------------|--------------------------|---------------------|--------------------------|----------------|--------------------------|
| Aches | <input type="checkbox"/> | Numbness | <input type="checkbox"/> | Weakness | <input type="checkbox"/> |
| Burning sensation | <input type="checkbox"/> | Pain | <input type="checkbox"/> | Cramping | <input type="checkbox"/> |
| Swelling | <input type="checkbox"/> | Tingling sensation | <input type="checkbox"/> | Loss of colour | <input type="checkbox"/> |
| Others: | <input type="checkbox"/> | (e.g., turned pale) | | | <input type="checkbox"/> |

(please list: _____)

b. When did you first notice the problem? _____

c. What do you think caused the problem?

d. Have you had this problem in the last 7 days? Yes No

e. Have you had medical treatment for this problem? Yes No

8. Acknowledgements

The Workplace Safety and Health Council and Ministry of Manpower would like to thank Baxter Healthcare SA, Cameron (Singapore) Pte Ltd and Peacehaven Nursing Home for their valuable assistance with the images used in these Guidelines.

9. Annexes

Annex A – Proper Steps and Postures for Lifting and Carrying

Steps	Notes
<p>Step 1 Place one foot on one side of the object and the other foot behind the object.</p> 	<ul style="list-style-type: none">• Before you lift the load, check the weight of the load and clear the path of any obstructions.
<p>Step 2 Grasp the object firmly and hold the object as close to the body as possible.</p> 	<ul style="list-style-type: none">• Bend your knees and keep your back straight.• Distribute your body weight equally between both feet.

Step 3

Lift the object by pushing up on your legs.



- Keep the back as straight as possible.
- Avoid jerking to lift the object higher.

Step 4

Make sure you have a firm grip on the object before moving off.



- Hold the object close to the body.
- Ensure that the object does not block your vision.

Annex B – Recommended Workstation Design and Work Posture

