

# **Workplace Safety and Health Guidelines**

## **Ergonomics Programme**

DRAFT

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# 1 Introduction

Manual material handling i.e. lifting, carrying, pushing or pulling objects without the assistance of mechanical devices, awkward posture and repetitive work are common in almost all industries and workplaces. An associated risk with such work is the development of musculoskeletal disorders (MSDs) such as low back pain, neck ache and shoulder ache. In addition, exposure to adverse working conditions and poorly designed working environments can contribute to reduced work efficiency, decreased production, loss of income, increased medical claims, and permanent disability.

Musculoskeletal disorders (MSDs) are common occupational or workplace health problems. However, work-related MSDs and injuries are preventable by ergonomics intervention, and manageable through implementing an ergonomics programme. Ergonomics is involved in fitting the jobs and work tasks to the capabilities of the worker, thus minimizing work injury and work-related illness and bring benefits to people at work and the performance of tasks in work environment.

The Workplace Safety and Health Guidelines on Ergonomics Programme was developed with the aim to provide guidance to companies and organisations in developing an in-house ergonomics programme to manage ergonomics problems and work-related MSDs at the workplace. This set of guidelines also provides information to employers and employees on ergonomics principles and ergonomics solutions to prevent work-related injury or illness. The principles of ergonomics may also be applied to the design of workplace, equipment, tasks and jobs that match the capabilities and limitations of different groups of the working population such as pregnant and older workers who may have special needs.

## 1.1 Ergonomics Applications

Ergonomics is the term applied to the field of science that studies and designs the human-machine or tool, human-work environment and human-human interfaces to prevent injury and illness, and to improve work performance. It is a multi-disciplinary science drawing on subjects such as anatomy, biomechanics, anthropometry, physiology, psychology, sociology, physics, engineering and medicine. Ergonomics applies human biological sciences in conjunction with engineering sciences to the worker and his working environment, for the purpose of identifying

and optimizing all the factors which have an effect on the worker, so as to obtain maximum satisfaction for the worker and at the same time, enhance productivity.

Ergonomics is concerned with the following:

- the interface between the worker and the machine
- the interface between the worker and the work environment
- the physical and mental demands on the worker that are necessary to perform the job
- the manual tools that are used to do the job
- the machine and equipment that must be controlled and monitored by the worker
- the work space in which the worker must perform his tasks

Ergonomics therefore deals with the following:

- the design of the work space and workstation to meet the physical characteristics of the worker
- the design of the equipment, tools and machines to match the physical characteristics of the worker
- the design of controls and displays to enable the worker to operate and monitor the machine or process efficiently with minimum human error
- the minimization of external forces or stress that may affect the worker in performing his tasks
- the development of work procedures that meet the capabilities of the worker

## **1.2 Benefits of Good Ergonomics Practices**

The aim of ergonomics approach is to promote and improve efficiency or performance, safety and health as well as comfort at work through a better relationship between man, his tools and the work environment. The task of ergonomics is to develop and optimize conditions for the workers in terms of their working conditions, physical work-loads, and working postures, to

facilitate psycho-sensorial functions in machine-operation and tool-handling, to minimize human errors, to maximize efficiency, and to improve the quality of working life.

Application of sound ergonomics principles in the design of office, workplace, jobs and tasks and good ergonomics practices has a positive impact on workers, work tasks and the work environment.

The economic impact of ergonomics related to the workers can be illustrated through a reduction in injury or illness rates and more importantly, through a reduction in costs associated with injury and illness.

The economic impact of ergonomics related to the tasks or business can be evaluated through increased productivity and/or quality. The increase in productivity is not limited to the production floor but also to the office workplace.

Consideration and inclusion of ergonomic principles in product and process design also has an impact on the physical and perceptual environment. The former refers to the physical structure and climate while the latter is the worker's perception of his or her fit, responsibility or feeling of importance or "ownership" within the organization.

## **2 Legislations and Standards**

Safety and health regulations and standards that are applicable to an organisation's activities, products and services are to be complied accordingly. This serves to remind stakeholders such as employers and employees of their safety and health obligations and responsibilities. Some key legal requirements are highlighted in the following sections. Organisations are to understand and comply with them, and are reminded that these highlighted requirements are not exhaustive. Organisations should proactively identify other relevant regulatory requirements that are applicable to them.

### **2.1 Workplace Safety and Health Act (WSHA)**

The WSHA and its subsidiary legislations cover safety and health at all workplaces. It requires stakeholders to take reasonably practicable measures to ensure the safety and health of workers and other people who are affected by the work being carried out. It covers every stakeholder, including employers, employees, self-employed, occupiers, principals, manufacturers and suppliers. All who are responsible for creating work risks, including ergonomic 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 to take reasonably practicable measures to keep their employees safe when carrying out work. Employees on their part should cooperate with their employers and others to comply with the WSHA, and observe all safe work procedures. The WSHA should be referred to for more details on the duties of the various stakeholders.

### **2.2 Workplace Safety and Health (Risk Management) Regulations**

Under the Workplace Safety and Health (Risk Management) Regulations, risk assessments (RAs) are required to be conducted to address the safety and health risks posed to any person who may be affected by the activities in the workplace, prior to work commencement.

RA allows stakeholders to identify hazards at the workplace and implement effective risk control measures to prevent the unsafe work conditions from escalating into accidents and injuries. All reasonably practicable steps should be taken to eliminate any foreseeable risk to any person. Where it is not possible to eliminate the risk, appropriate measures must be taken

to minimise the risk. These measures include substitution, engineering controls, administrative controls and personal protective equipment, based on the Hierarchy of Controls.

### **2.3 Workplace Safety and Health (Incident Reporting) Regulations**

Work-related MSD of the upper limb is a notifiable occupational disease in Singapore.

Where an employee suffers an occupational disease specified in the Second Schedule to the WSH Act at a workplace, and the employer of that employee receives a written statement prepared by a registered medical practitioner diagnosing the occupational disease, the employer is required to, not later than 10 days after receipt of the written diagnosis, submit a report to the Commissioner for WSH.

Any registered medical practitioner who diagnoses any employee with an occupational disease specified in the Second Schedule to the WSH Act is also required to, not later than 10 days after the diagnosis, submit a report to the Commissioner for WSH.

Employers and medical practitioners may access the iReport at [www.mom.gov.sg/ireport](http://www.mom.gov.sg/ireport) to submit a notification of the occupational disease to MOM.

### **2.4 Work Injury Compensation Act (WICA)**

The WICA makes provisions for compensation to employees for injury or illness suffered in the course of their employment. Compensation may be payable by an employer to an employee who contracted MSDs of the upper limb in an occupation involving exposure to occupational risk factors such as repetitive motion, forceful exertion, awkward postures or vibration, affecting the upper limbs, as specified in the Second Schedule to the WICA. The compensation, if any, is limited to injuries or diseases received at work, arising out of and in the course of the relevant appointment.

### **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 WSH Act relating to the safety, health and welfare at work. Organisations should identify and adopt the relevant ACOPs that are applicable to them, and if not, other documents that are deemed equal to or above the standards prescribed in these ACOPs. Two ACOPs that identify good ergonomics practices are briefly mentioned as follow.

#### **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 introduction of health practices in 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. Guidance is provided on how to achieve a better quality of working life in the office environment, reducing health-related problems, such as musculoskeletal disorders, visual discomfort, work stress, lower worker motivation, absenteeism and lower 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. Information is provided to users, employers, manufacturers and suppliers on ergonomics principles for manual handling work to reduce risk of musculoskeletal injuries and disorders. It also provides guidance to employers on identification of manual handling hazards, assessment and control of risk for manual handling activities, and planning and implementation of an ergonomics programme for manual handling operations at the workplace.

### 3 Work-related Musculoskeletal Disorders

#### Musculoskeletal Disorders

Musculoskeletal disorders (MSDs) are chronic muscle, tendon and nerve disorders caused by repetitive exertions, rapid motions, awkward postures, high force contact stresses, vibrations, and/or low temperatures. Other commonly used terms for work-related MSDs include cumulative trauma disorders, repetitive strain injuries, and repetitive motion illnesses. The 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. They often develop slowly after months or years of repetitive work. Initially, the symptoms are mild and may improve with rest although there may be slight pain when performing certain movements. Usually symptoms become more severe as exposure continues. Later, there may be pain and swelling of the affected muscles, tendons or connective tissues. Finally, pain could become so severe that the person is unable to perform physical activities.

MSDs can affect employees in industrial, commercial, healthcare, hospitality, and service sectors, as well as offices and other workplaces. Occupations at risk to MSDs include machine operators, parts assembly operators, movers, nurses, warehouse operators, stock keepers, VDU users, typists, and musicians.

From the workplace safety and health standpoint, the objective of ergonomics is to study the nature of work tasks so that work injury and work-related diseases or illnesses are prevented, particularly at the design stage.

Affected Body Part	Common Symptoms/ Disorders	Examples
Low back	Gradual or sudden onset of low back pain which may be associated with pain radiating down the legs	Heavy lifting, carrying or pushing, sudden overload, repetitive loading Awkward posture during work: Twisting/ side bending of the body Whole body vibration – driving of heavy vehicles

Hand/Wrist	Carpal tunnel Syndrome – Compression of the medial nerve in the carpal tunnel of the wrist. Pain, numbness, tingling in the first three fingers and base of thumb.	Frequent hand activity, such as moving and packing of items by cashiers, grinding, polishing, sanding, assembly work, hammering and typing
	Cubital Tunnel Syndrome – Numbness, tingling in the little and ring fingers; weakness of hand grasp and thumb pinch.	Resting forearm near elbow on a hard surface, excessive bending of elbow
Fingers	Trigger finger – Swelling at the bottom of the finger or thumb. Pain when finger is bent and straightened	Using tools with sharp edges pressing into tissues or with handles too far apart for user's hands. Using of pliers, inserting screws in holes, grinding, pressing, forceful hand wringing
Elbows	Epicondylitis – inflammation of tendon in the elbow (eg tennis elbow, golfer's elbow)	Frequent use of screwdrivers/pliers, hammering, meat cutting
Neck and shoulder	Tightness and pain in the neck, shoulder and interscapular region. Numbness radiating to arms and fingers	Static posture with prolonged flexion, extension and twisting of neck (eg telephone operators, data entry clerks, use of microscope) Overhead work - Maintenance work on lights, overhead auto repair, overhead welding

## 4 Risk Factors of Work-Related Musculoskeletal Disorders

A number of workplace risk factors are associated with musculoskeletal disorders, which can include, the force or intensity of work, the duration of work, frequency of work repetition and work posture. These workplace 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 of heavy loads below the waist level or above the shoulders increases the strain placed on 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 that are around waist-height if these objects are frequently handled*
- *Use mechanical aids and tools to lift or move heavy objects*
- *Apply the correct lifting technique (See Annex A)*
- *Slide, roll or push heavy objects instead of carrying them where feasible*
- *Wear appropriate footwear to avoid slip, trip and fall hazards*





### A Case in Point

A restaurant manager took 3 months of medical leave for acute low back pain after an outdoor catering event. During the event, he lifted and carried about 100 carton boxes of food and cases of water weighing 22 kg and 8 kg respectively over 2 hours. The intensive heavy manual lifting task exposed the manager to excessive risk of work-related low back pain. Following the incident, height-adjustable trolleys were used and all staffs were trained on proper manual handling techniques.

Using pallet jack to lift heavy goods

### Bulky loads

Lifting and carrying bulky objects increase 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 vision of the worker carrying it, and increase the risk of trip and slip.

*Good practices for handling bulky loads:*

- *Pack goods in smaller boxes to reduce the weight and size of each box*
- *Ensure the travel path for moving objects is kept dry and free from obstacles*
- *Keep good communication with co-worker who is assisting with the lift, to ensure that the load is lifted at the same time (to achieve even distribution of load)*
- *Avoid slopes, stairs or other obstacles that make the carrying of objects difficult*

### Unstable loads

Loads with shifting contents (e.g. drums that are partially filled with liquid) or even the movement of persons and animals can be hazardous. The control and maneuver of such loads is difficult as there may be sudden force exertion during the lift or transport. This sudden exertion can increase the risk of injury to the worker which she/he may be unprepared for.

*Good practices for handling unstable loads:*

- *Fill containers or drums for holding liquids or powders fully where possible, leaving only a small amount of free space. This will prevent the weight of the load from shifting considerably during transportation and reduce instability.*
- *Use slings or other aids to maintain good control of the load*
- *Possess knowledge of the proper handling techniques and using appropriate equipment where necessary for handling persons or animals*

### **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 and reduced capacity in continuation of the work, and may result in soreness in the muscles. The more severe manifestations are MSDs.

*Good practices for handling static muscle-loads:*

- *Avoid undesirable static muscle efforts of the upper limbs for prolonged period*
- *Keep a static load as close to the body as possible to minimize muscle efforts*

### **Absence of proper handholds**

The lack of handholds or improper handholds (e.g. awkward shaped, difficult grip position) can affect a person's ability to control and handle the load properly. This may result in a greater force needed to grip the load and increase the risk of losing grip of the load.



Carrying a heavy sack without proper handhold

*Good practices to ensure proper handholds:*

- *Provide handles, hand grips, indents or any other features to improve the grip of the worker on the load*

- *Have handholds wide enough to clear the breadth of the palm and deep enough to accommodate the knuckles and any gloves worn*



Trays with proper handholds for better grip

## 4.2 Awkward postures

An awkward posture is a position where the body, arms and legs are not in their natural relaxed position. Long duration or frequent occurrence of awkward positions during work add stress to muscles, joints or tendons, and can result in aches and pains in the affected body parts.



Overstretching or twisting the back when retrieving items from shelves can result in musculoskeletal disorders.

Body Part	Hazards	Example
Back	Forward bending/ side bending of back Twisting about the waist	Cashiers twisting the waist/ side bending to reach for items along conveyor belts. Working on low surfaces (below the waist level)

Neck and shoulder	Forward bending/ side bending of neck Lifting of shoulders	Telephone operators cradling phone between ear and shoulder Use of Microscope
Arms	Lifting of arms	Maintenance workers doing overhead work
Hand/wrist	Bending of wrist	Work surface above the elbow Use of hand tools resulting in bending of the wrist, eg. computer mouse, hand saw, electronic pipette

*Good practices to reduce awkward postures:*

- *Have adjustable workstations/equipment or re-arrangement of items and equipment 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*
- *Place all the required work items and equipment in front of the worker (e.g. cashier and assembly operator) to eliminate the need to turn to the side*
- *Use mechanical aids to improve posture e.g. headphones for telephone operators*
- *Use ergonomically-designed hand tools*

### **4.3 Static postures**

Static postures in workplace occur when workers are required to stand or sit in the same position for long hours. When the body is in the same or unchanged 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 fatigue in the muscles and the pooling of blood into the legs and feet. This could lead to painful and swollen feet, weakened muscles and varicose veins. Standing on a hard surface, such as concrete floor, also creates contact trauma and pain to the feet.

*Good practices for static postures:*

- *Provide foot rest bars for workers who are engaged in sitting work so that workers can alter their postures like raising one foot*
- *Provide anti-fatigue mats or sit/stand stools for workers to stand on or sit*
- *Allow workers to sit and rest at adequate time intervals*
- *Encourage workers to change position, stand up, stretch or walk about 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 position, standing position, or a combined sitting and standing position.

**Sitting** is desirable where:

- work tasks require relatively fixed body posture for extended periods
- work tasks require fine manipulative hand movement
- a high degree of body stability and equilibrium is required
- all materials and tools required for the task can be located within the seated workstation
- no heavy material handling tasks are required
- foot control actions are required i.e. when both feet are used for operating controls

**Standing** is necessary where:

- work tasks require mobility to reach and perform operations
- extended reaches and moves of substantial magnitude are frequently required
- frequent handling of heavy objects is required
- manual downward forces of substantial magnitude are frequently required
- where large areas must be monitored
- A combined sit-stand position can be required by the job. This is best done by providing a high stool to enable the employee to move from one position to another quickly.

#### Repetitive movements

Repetitive movements can become hazardous when the same action is repeated too often or too quickly over an extended time period. Injuries due to repetitive movements occur when too much stress is placed on the same set of muscles, joints or tendons and there is not enough time for recovery. The risk of injury increases when the amount of force required increases. The body needs to rest from time to time to recover and more time should be given to activities which require higher amount of exertion.

Some common high repetition activities include folding of carton boxes, clicking of control buttons, packing of goods along process line and labelling of items.

*Good practices to mitigate risks from repetitive movements:*

- *Plan work schedules to include adequate number of short rest breaks*

- *Encourage workers to do simple stretching exercises to relax working muscles*
- *Perform job rotations e.g. rotating different work activities during a work shift to prevent the worker from doing the same repetitive work continuously*

## **4.5 Vibration**

Vibration is the mechanical oscillations of an object about its normal stationary position. Persons at work may be exposed 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, chain saws) over a long duration and high intensity, could lead to damage of the nerves and blood vessels of the fingers and arms progressively. It could further lead to MSDs, such as hand-arm vibration syndrome, which includes vascular disorder (commonly called vibration-induced white fingers), neurological disorder (abnormal nerve conduction speeds and reduced tactile sensitivity), and vibration-induced deformation of bones and joints.

### **Whole-body vibration**

Whole-body vibration arising from work activities, such as driving of buses, lorries, tractors, and operating of fork lift trucks, excavators, loaders and dumpers, could lead to fatigue in lower back muscle and increase risk of back disorder, including low back pain. However, the symptoms are difficult to distinguish from the effects of incorrect sitting postures, heavy lifting and aging. Prolonged exposure of vibration may result in disk degeneration. Other effects of whole-body vibration include abdominal pain, digestive and urinary problems, headaches, visual disorders, balance problems and sleeplessness. 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 - reduction of vibration at source, and reduction of vibration transmission to worker.

#### ***Reduction of vibration at source***

- use belts instead of chains for rotating machinery
- use rotating instead of reciprocating machine parts
- shift or lower the natural frequency of the machine by adding masses

- maintain work access roads for moving vehicles e.g. fork lift trucks
- use pneumatic pressing tools instead of pneumatic riveting hammers
- use rotating wrenches instead of impact wrenches
- maintain machinery or vibrating tools regularly as worn bearings, shaft misalignment, unbalanced parts, loose bolts, damaged gear teeth, blunt cutting tools increase vibration levels

#### ***Reduction of vibration transmission***

- use pneumatic tyres instead of hard tyres
- use suspended cabs
- use suspended seats
- maintain vehicle suspension systems
- inflate tyres with correct pressure
- mount vibrating machines on appropriate vibration isolators or alternatively, construct a suspended floor with low resonance frequency
- equip vibration tools e.g. pneumatic rammers, breakers and chain saws, with anti-vibration handles e.g. suspended handles or elastic mounting devices
- use a minimum hand grip force consistent with safe operation of power tools

#### ***Personal protective appliances***

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

## 5 Workspace and Workstation Design

Ergonomics is the science and engineering of fitting jobs to people, young and old. Ergonomics encompasses the body of knowledge about physical abilities and limitations as well as other human characteristics that are relevant to job design or re-design. Ergonomic design is the application of this body of knowledge to the design of the workplace – work tasks, equipment and environment for safe and efficient use by workers. Good ergonomic design makes the most efficient use of worker capabilities while ensuring that job demands do not exceed those capabilities.

### 5.1 Workspace layout and design

Workspace layout and design should conform to ergonomics principles which are essential in such areas like seating, work posture and tool-design, together with environmental factors such as lighting and ventilation.

In designing a workstation, it is necessary to consider:

- the physical workplace layout to accommodate the required equipment
- the flow of work and the movement of people
- the work position that best suits the carrying out of the task
- the storage and handling of materials
- the space in relation to the worker's access to materials, tools and work items
- the work motion and work posture
- the location of controls and displays

The overall work area or space should accommodate the user. Sufficient clearance should be provided for movement of body segments e.g. head and shoulders and knees in carrying out the task.

*Good practices in designing a workstation:*

- *Keep the number of items (tools and parts) that are touched by the hand to a minimum – minimize the number of hand tools, the number of different parts and the number of controls.*
- *Arrange the items so that the operator can adjust his or her posture frequently; consider preferences in hand movements and handedness.*

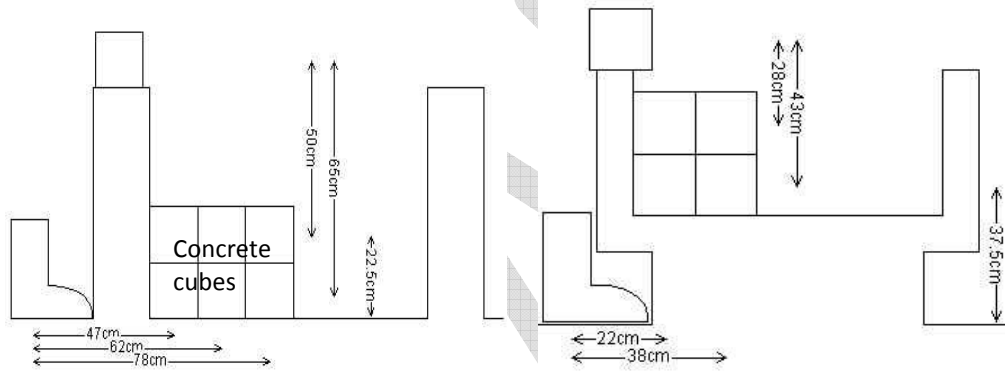
- *Provide sufficient leg room to allow stretching of legs to reduce fatigue for a seated working area.*
- *Locate frequently used tools, equipment and work items directly in front of the user - primary work envelope up to about 40 cm - to avoid strong muscular exertion in reaching and lifting these items*
- *Locate less frequently used tools, equipment and work items further from the user - secondary work envelope within a reaching distance of about 60 cm.*
- *Choose the type of control – levers, switches, knobs, buttons, pedals, hand-wheels – appropriate to the requirements of the task.*
- *Select or design the display – dials, scales, counters, meters, bells, lights – to provide the necessary input to the operator.*

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### A Case in Point

Workers involved in manual lifting of concrete cubes in a local concrete testing laboratory often complained of backache. It was found that the task of lifting concrete cubes out of the tank was unacceptable, considering the location, height and frequency of lift. A detailed ergonomic evaluation was then performed to redesign the task to minimise the lifting hazard. Modifications were subsequently made to the tank where the base of the tank was raised to reduce the vertical distance of lift and a recess (inverted “L” shape) was made to reduce the horizontal distance to the body. After the re-engineering, lifting safety was improved and the lifting task was acceptable for almost everyone.



Schematic diagram of old tank

Schematic diagram of improved tank

## 5.2 Physical characteristics and design criteria

To design a work task or job, equipment and workstation, the differences among individual workers' height, strength and other physical characteristics should be considered. The percentile distribution of the physical characteristics of population (anthropometric data) is needed for the design. This usually ranges from 5% to 95% or from 1% to 99%, depending on the particular job and the desire to suit the size of population.

The objective of ergonomics is to design the workplace such that the maximum number of individuals can perform their work effectively without unnecessary physical and mental stress. Where possible, adjustable equipment e.g. adjustable office chairs should be provided to allow for individual differences.

- *For reach (e.g. height of an emergency shower pull) design, the 5<sup>th</sup> percentile data is normally used to accommodate 95% of the population who can reach further.*
- *For clearance (e.g. height of an emergency shower head) design, the 95 percentile of the relevant dimension is used to accommodate 95% of the population.*
- *For certain products such as tables, cabinets and general furniture or non-critical tasks where adjustability is impractical or where it is inappropriate or costly to design for the extremes, it may be useful to design for the 50% percentile person.*
- *The best design strategy is to design for an adjustable range to accommodate the 5<sup>th</sup> and 95<sup>th</sup> percentile users, whenever it is economically feasible. This avoids uneconomical designs for the extremes while ensuring convenience for 90% of the population.*
- *For a product that may affect the life and safety of the user, it should be designed to accommodate population between the 1<sup>st</sup> and 99<sup>th</sup> percentile.*

### 5.3 Hand tools

Design of powered and non-powered hand tools is important to avoid awkward posture of the hand and arm, and excessive exertion and vibration experienced by the user. Non-powered hand tools include pliers, screwdrivers, hammers and knives. Powered hand tools could be electric or pneumatic, such as chainsaws, powered screwdrivers. Common deficiencies of hand-tool interface include poor hand-wrist posture and excessive pressure due to small contact surface area.

*Good practices for use of hand tools:*

- *Select or design tools so that they can be operated with the wrist in a neutral position i.e. straight wrist.*
- *Avoid short tool handles that press into the palm of the hand.*
- *Avoid narrow tool handles that concentrate large forces onto small areas of the hand.*
- *Select or design tools so that they can be used with either the right or left hand.*
- *Select or design tools that reduce force requirements, improve postures and reduce holding time.*
- *Select tools with handles made of slip-resistance materials.*

- *Select tools with the centre of gravity aligned with the grasping hand to avoid additional torque on the user to hold the tool.*
- *Counterbalance or support heavy tools, e.g. hang from a support*
- *Select tools with sufficient clearance for the hand and fingers when grasping the tool.*

## 5.4 Displays and Controls

An appropriate design and arrangement of display panels, monitors, control buttons and levers etc, is essential for minimising errors and discomfort to users for the safe and correct operation of machines and equipment. Confusing display of a cluster of numerous signals would overburden the visual system of workers and reduce the ability to pick up important messages. Workers could also experienced psychological and physical stress due to inability to cope with the signals received and to give correct inputs. Where the displays and controls are placed in inappropriate environments or locations, workers could experience associated visual and postural strain.

### Types of display

**Auditory** displays, announcements, alarms etc, are preferred where:

- message is short and simple
- immediate action is required
- there is insufficient lighting in the work environment
- job requires workers to move around the workplace
- too many visual signals or stimuli are present
- visual acuity is limited
- information must be presented independent of head orientation

**Visual** displays, control panel display, monitors etc, are preferred where:

- message is long and complex
- immediate action is not required
- noise limits the use of auditory signals e.g. in a noisy environment
- job allows workers to remain in one location
- relative or quantitative values are desired
- there is a need to monitor a number of displays
- display is representative of the actual situation



- location of one object relative to another object is desired
- there is a need to refer to the information at a later point in time

*Good practices for displays:*

- *Ensure that displays show same positions for normal operations, allowing abnormal operations to be detected easily.*
- *Ensure that displays required for normal operation are readable to the operator 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 e.g. dials and scales, for approximate value, rate of change or comparison within limits.*

## **Types of control**

Closely linked with displays of information are control devices such as knobs, levers, on/off switches, push/pull buttons, etc. Rotary controls are useful when extensive movements are needed, and they are also suitable for accurate work. If speed is important, a reciprocating controls e.g. a lever or joystick, should be used. The proper relationship of controls and displays depends on population stereotypes. If a lever which controls a vertical scale is moved to the right, then the great majority of subjects will expect the pointer on the scale to move upward, not downward.

A major function of the worker in the workplace is to control the system. There are basically two types of control – hand controls and foot controls.

## **Hand controls**

Hand controls are preferred in the following situations:

- If the accuracy of the control is important
- If the speed on control positioning is important
- If continuous or prolonged force is not necessary

## Foot controls

Foot controls are recommended in the following cases:

- When continuous or non-precise control is required
- Where moderate to large forces are required
- When the 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.
- Control 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 operator's maximum strength
- The maximum force, speed, accuracy or range of the control should not exceed the limits of the least capable operator
- The normal control operation should be considerably less than the maximum capability of most operators
- Natural control movements are more efficient and less fatiguing
- For continuously operated controls over long periods, the resistance should be low
- Controls should be designed to withstand abuse
- 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 while arms and legs are used for actions which required strength.*
- *Place hand operated-controls at easily reached locations in full view, between elbow and shoulder height.*

- *Use long levers, hand wheels and leg pedals for operations requiring long durations and comparatively little precision.*
- *Avoid confusion in having clusters of control buttons/levers for different functions together; the different control functions should be differentiable by shape/texture or mode of operation, eg. levers and buttons.*
- *Show consistency in the control functions whereby the functions are positioned and designed similarly in all workstations.*
- *Follow the stereotypes, acceptable practices, codes of practice or consistency for control directions and movements, e.g. to power ON - switch Upward or Downward.*
- *For foot controls, where only light pressure is required, worker should be seated.*
- *Avoid machines with both hand and foot controls, restricting only to where foot pedal is used for ON/OFF switch only.*

## **5.5 The Physical Environment**

The physical aspects of the work environment have important implications for the safety, health, comfort, and productivity of the workers. The physical environmental factors at the workplace include temperature, lighting, noise and ventilation. They can pose a health hazard and safety risk. They can also affect the comfort, and consequently the job performance and productivity of the worker.

### **Temperature**

Hot or humid environment increases the physical demands of the work on the worker and may lead to fatigue rapidly. On the other hand, cold temperature may prevent muscles from warming up properly and increase the risk of injury.

**Chef exposed to hot environment**



The conditions in indoor environment can also have an impact on workers' comfort and well-being, and hence should be assessed and monitored. For instance, indoor temperature can be kept within a comfort range of 24 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*.

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*.

### **Lightings**

Sufficient and suitable lightings, natural or artificial, should be provided for employees for them to perform their tasks. This would 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 Lightings 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*.

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## 5.6 Work Organisation

Work organisation is an important factor to be considered in reducing MSD at the workplace. Measures such as reduction in the work-rate in paced operations, reducing the length of shift work, and provision of frequent rest-breaks are helpful especially in repetitive operations.

### Working hours

The manner of organisation of working hours (including shift work and night work) and the number of hours of work can have an adverse effect on the day-to-day life of the worker. Long working hours or inappropriate work-rest regimes can significantly affect the quality of working life, which may result in a higher work-related injury rate. 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 running of continuous process, the need to provide critical services or support etc. Shift work could be rotating, permanent, with two to four shifts a day. However, working outside the normal daylight hours would disrupt the circadian rhythms, possibly leading to sleep deprivation, digestive or heart problems. This could also have consequences on workplace safety as operators become less alert, especially in night shifts and transitional period.

*Good practices for working hours 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 to keep or limit night shift to essential jobs and tasks that must be completed at night.*
- *Schedule critical safety work activities outside of the 2am to 6am window.*
- *Keep or limit consecutive night shifts to a minimum.*
- *Avoid quick shift changeovers, such as finishing at 11pm and starting again at 7am.*
- *Adopt forward-rotating shift, such as morning to afternoon, afternoon to night rotating shifts.*
- *Allow time for communication of shift handovers.*
- *Keep schedule regular and predictable to facilitate family and social activities.*

- *Introduce job rotation.*

### **Work rates**

Work rates and performance varies among workers and within the same individual as well. Therefore, work targets should be set realistically to ensure they are within the physical and psychological capabilities of workers. For example, in production lines, conveyor belts could set the pace of work and workers could be subjected to substantial stresses to keep up.

*Good practices for work organisation:*

- *If a work cycle for a task is short, a variety of tasks which uses different muscle groups could be given to workers; this would help reduce fatigue in the overloaded muscles group.*
- *Buffer zones or stores of the assembled items to be provided in a production line so that workers can carry out tasks at their optimal pace.*

## **5.7 Office Ergonomics**

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

### **Workstation**

An office workstation comprises mainly of the work table, chair and computer. The workstation should be designed to suit all workers or at least 90% of the population, in terms of the height and reach requirements. It should allow workers to have good working postures, without restricting movements and posture changes. A workstation should also be flexible for workers to perform all their tasks and could be arranged for use to a variety of tasks.

*Good practices for workstation:*

- *Adjust the height of the working surface to suit the needs of the worker*
- *Provide sufficient knee clearance and legroom under the worktable and a footrest for shorter workers where necessary.*
- *Ensure 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 over-reaching, whereby frequently used items are placed in the accessible primary reach zone and the less frequently used items could be placed in the secondary reach zone.*
- *Use a chair which is stable, with armrests and backrest to provide back support, and easily adjustable.*

### **Work posture**

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

*Good practices for office work:*

- *Place the monitor directly in front of the worker, with additional working space on the sides if the work utilises the computer for most of the time.*
- *Ensure that the 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/sitting for long period of time. Workers are encouraged to change posture, stretch and stand up or walk around whenever they feel tired.*

### **Work environment**

Several physical aspects in the office environment can have important implications for the safety, health, comfort, and productivity of workers. Temperatures which are too high or low, insufficient lightings or poor housekeeping can result in distraction, discomfort and ill-health of the office worker. Visual discomfort can also result from glare of visual displays such as monitors, intense bright lights, or contrast from the daylight or artificial light sources.

*Good practices for the office environment:*

- *Isolate noise sources, such as photocopies and printers, where possible.*
- *Install curtains at windows and skylights, and place monitors perpendicular to the windows to reduce glare from daylight. Position monitors parallel to and in between overhead lights to reduce glare from overhead lights.*



- *Install diffusers or louvers to lights*

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 Workers**

As workers age, there would be deterioration in the physical performance capabilities (e.g. muscle strength and stamina), sensory abilities (e.g. vision and hearing), mental and social abilities.

Older people generally have a decline in strength, and reduced ability to perform physical work over time because of decreased cardiac, respiratory and muscular capacities. They are less agile and less able to deal with multiple or complex tasks. They may require longer times and more practice to acquire specific information handling and control skills. They are also less tolerant of extreme or adverse physical environment, such as light, heat and noise.

Older workers therefore require appropriate ergonomics attention to the design of workplace, equipment, tasks and jobs so that they are able to perform their tasks safely and at optimal effectiveness.

#### *Good practices for an ageing workforce*

- *Task-design (which involves the nature of the job and the design of equipment, machinery and tools) should be in accordance with ergonomics concepts to ensure that the jobs are within the physical and mental capacities of the workforce.*
- *For work tasks with high physical workload, measures could be implemented to reduce the amount of forceful exertion, such as reducing the weight of load, use of lifting equipment etc, as mentioned in Chapter 5.1.*
- *For workplace 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 55years.*

- *Appropriate sensory aids, such as magnifying glasses, higher contrast, and larger font size, could be used at workstations to enhance the working environment for older workers and reduce eyestrain and errors. Line or team-based work could be substituted with self-paced work to accommodate reduced ability to perform physical work over time.*
- *Tasks should be designed to avoid the effects of loss of balance; more space should be provided to allow gross body movements to perform the task.*
- *Task contexts should be designed so that procedures and objectives are clear and unequivocal; complex cognitive tasks should be avoided.*
- *Tasks should be designed to limit the demands on working memory or supplemented by the provision of memory aids.*

### **Functionally-limited Workers**

There is a great variety of specific causes and combinations of workers with functional limitations which can include those with hearing impairment, deafness, low vision, blindness, physical, speech and cognitive impairments.

Attention to the design of workplace, equipment, tasks and jobs may need to be undertaken so that workers (in addition to ageing workers) with functional limitations are able to perform their tasks safely and at optimal effectiveness. This can be achieved by providing the person with:

- Tools (eg prosthetics or orthotics) or assistive devices (eg wheelchairs, telecommunication devices for the hearing impaired) that can maximize the use of residual skills and abilities and compensate for missing abilities
- Training and development of new techniques and strategies that can allow the person with functional limitations to work better
- Development of more universal and accessible designs. For example, a redesign of the workplace can be considered for workers with artificial limbs.

## 6 Ergonomics Programme

An ergonomics programme is a list of planned activities for anticipating, identifying, analysing and controlling MSD hazards. The programme provides a systematic approach for the organization to manage ergonomic hazards and issues at the workplace. The establishment of the programme would allow the organisation to make better informed choices and help create a safety culture that promotes good ergonomics at work. An effective ergonomics programme will reduce injury and illness incidence and cost, improve productivity and product quality, and improve worker's well being; this will result in a net benefit to the workers, companies or organisations and eventually the society and nation as a whole.

A team should be formed to establish and implement the Ergonomics Programme. The team should have active employee participation and include appropriate management, safety and health, operation and relevant technical personnel.

There are seven key elements in an in-house 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. Control Measures
7. Evaluation and Review

Workplace with manual handling operations or workplace with MSD hazards should set up an ergonomics programme to prevent or control MSDs. The kind and extent of the programme depends on the extent of the problems in the workplace. For instance, when a work-related MSD is reported, the relevant elements of the ergonomics programme for that job should be implemented. See Checklist A for a sample checklist for an in-plant Ergonomics Programme, which could be used during the implementation of the programme.

## 6.1 Management Commitment and Policy

This is the key to the success of any health and safety efforts. Management should demonstrate leadership in developing and implementing the ergonomics programme. The management should establish the goals for the programme, communicate to all employees the programme's importance and make available resources for ergonomic improvements. There should be a policy statement to demonstrate the commitment of the company to manage ergonomic risks in the workplace and to set the direction for the programme. Management should have policies or practices that encourage employees to participate in the programme or make reports or suggestions.

### *Practical Guidance*

- ✓ *The company's safety and health policy includes ergonomics as one of the areas of concern and treats ergonomic efforts as part of the company's goal to create a safer and healthier working environment for all.*
- ✓ *Resources are allocated to train employees to become more aware of ergonomic risk factors and for the implementation of 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 management will hold them accountable for discharging those responsibilities.*
- ✓ *Management should provide assigned persons with the authority, resources, information and training necessary to meet their responsibilities.*

Efforts can be emphasized to recognize and consider ergonomics in the design stage of work processes or before work commences. Such proactive or anticipatory approach to the management of ergonomics at work prevents problems from developing in the first place. For instance, hazard identification and risk assessment prior work commencement can help to crack down on ergonomic issues like MSDs.

### *Practical Guidance*

- ✓ *Management can set a policy to take ergonomics into consideration for the design and selection process of tools, job methods, workstation layouts and materials.*

- ✓ *Managers for new work processes and procurement can be trained in ergonomic factors and principles. They should also have adequate information on MSDs, risk factors and control measures. Records of current ergonomic issues which employees are facing are useful sources of information in this regard.*
- ✓ *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 efforts of the programme to improve workplace conditions. This will enhance employee motivation and job satisfaction and also increase the likelihood of employees accepting changes in the job. An Ergonomics team can be formed, with participation from all levels of the organization, to address ergonomic issues. Employees should also be encouraged to give suggestions to improved work conditions.

### *Practical Guidance*

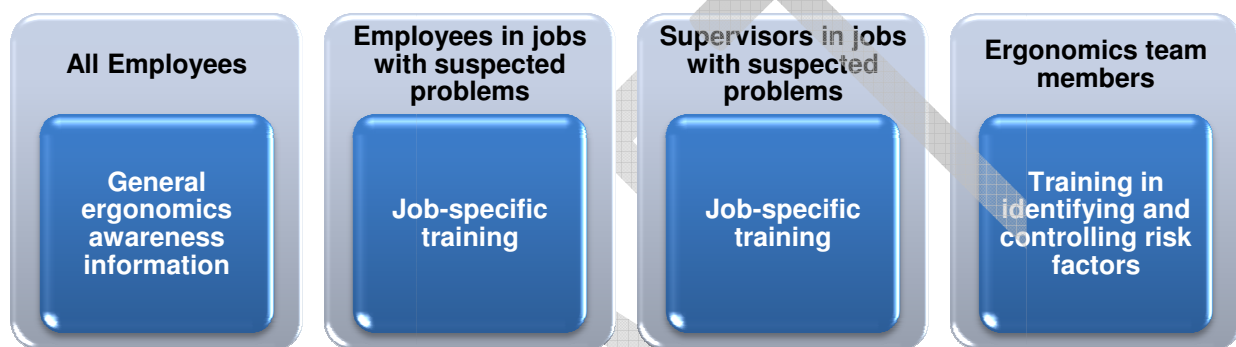
- ✓ *A dedicated team is designated to take the lead in ergonomics, with roles and responsibilities specified clearly.*
- ✓ *Employees should have a way to report signs and symptoms of work-related MSDs.*
- ✓ *Employees should have a way to report hazards associated with manual operations/material handling or any ergonomics problems at workplace.*
- ✓ *Employees should be encouraged to give suggestions or make recommendations on ways to improve manual work or operations which give excessive strain or fatigue.*
- ✓ *Employees should have access to information about the ergonomics programme.*
- ✓ *Employees should have ways to become 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 Ergonomic team should be trained in the identification of ergonomics risk factors, the risk assessment technique, the controls for ergonomics risks, as well as how to evaluate the

effectiveness of ergonomics programmes. The team could also be trained in problem-solving and team approach so that they are equipped with the correct skill sets to better manage ergonomics issues and problems within the team.

All employees, especially those in affected jobs i.e. manual handling jobs where a known MSD hazard exists, should be trained and equipped with some basic ergonomics knowledge, such as the recognition of MSDs and ache and pain symptoms associated with work tasks. They should also be briefed on the proper reporting procedures in the company for ergonomics-related injuries and issues.



#### Practical Guidance

- ✓ *Basic ergonomics knowledge would include understanding the risk factors (e.g. heavy lifting, repetitive movement, and awkward postures), common MSDs, control measures and good practices.*
- ✓ *Training focus could be placed on particular higher risk areas identified from past injury records. For instance, assembly line workers who use their hands and/or fingers in the course of their work should be trained to recognise hand and finger-related injuries like MSDs.*
- ✓ *Basic ergonomics knowledge can be included as part of the induction training programmes for new staff.*
- ✓ *Job-specific training such as proper manual handling can be implemented for targeted employees.*
- ✓ *Where mechanical aids and equipment are used, instruction on the safe and proper use should be provided as well. If adjustable tables and chairs are used, employees should be advised on the methods of adjustment and appropriate workstation layout.*

## 6.4 Hazard Identification

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

The ergonomics team should look into areas and work tasks where there could be underlying ergonomics issues. There may be some areas where there is insufficient evidence of work - related injuries and symptoms and which are less obvious to the general workforce. Where there is a lack of injury cases, there may be feedback from the employees on any body strain and stress that they are experiencing.

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

### *Practical Guidance*

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

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

- i. Conduct a hazard identification exercise together with employees who are involved in the job.

- ii. Break down the job into its various work tasks; observe employees performing the tasks to identify and evaluate job factors i.e. workplace conditions and physical work activities to determine which one are reasonably likely to be causing or contributing to the problem.
- iii. Identify risk factors for each work task. Start with a qualitative identification to find out the contributing risk factors in each task.
- iv. The risk factors can be identified from the posture, movement, load, work environment and the people doing the work. See Checklist B for a sample checklist for risk factor identification.
- v. Certain work tasks are prioritised for more detailed analysis:
  - 1) Work tasks where cases of MSD were identified based on past records
  - 2) Complaints or feedbacks from employees of excessive body discomfort like strain
  - 3) Significant or multiple risk factors identified
- vi. Further analyses of the identified work tasks are conducted to determine the safe acceptable limits for an action. This is usually conducted by professional personnel trained in ergonomic assessment.
- vii. Ratings of high or extreme risk factors, especially those occurring simultaneously in a work step or within the work task, would indicate a need for control measures.

**Prioritization** - The prioritization of work tasks for more detailed analysis is in the following order:

- 1) Work tasks where cases of MSD existed based on past records
- 2) Complaints or feedbacks from employees of excessive body discomfort like strain
- 3) Significant or multiple risk factors identified

The information obtained from injury and symptoms record would help to determine work tasks where ergonomics problems exist. Priority for job analyses and intervention should be given to areas which require immediate attention, such as those with highest rate of injuries. 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 the problem potential. Even without any medical data or symptoms from employees, preventive steps should be taken to reduce the potential risk factors. Resources could then be allocated to the work tasks accordingly to remedy the ergonomics issues.

## 6.5 Workplace Monitoring, Reporting and Medical Management

### Monitoring and Reporting

Aches and pains experienced by employees due to job tasks are tell-tale signs that there are ergonomics issues in the workplace. Information about ergonomics hazards and how to recognize and report the signs and symptoms of MSDs should be provided to all employees in those jobs. A dedicated ergonomics team can be established to proactively track the aches and pains symptoms, injuries, and other ergonomic problems that employees experienced in the workplace. Such practice to monitor ergonomics problems would encourage the promotion of awareness of ergonomics hazards and engagement of employees to report symptoms and make suggestions 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 could be established to encourage employees to report on their symptoms and injuries, particularly work-related MSDs. Employees should be encouraged to report even if the pain is acceptable to them. Early reporting of signs and symptoms would allow corrective measures to be implemented before the problems worsen.*
- ✓ *Periodic surveys could also be carried out to find out the employees' opinion on the workplace conditions and any symptoms that they could be experiencing.*
- ✓ *The records of the reports and feedbacks should be kept as a source of reference of the ergonomics issues in the workplace. Where similar types of symptoms or feedback occur, it would indicate a greater need to look into that particular area or job scope.*

## Medical Management

Whenever an employee is identified to have a work-related MSD, employer should make available prompt and effective medical management. Medical management emphasizes the prevention of impairment and disability through early detection of injuries, prompt treatment and timely recovery for the employee.

The employer can help in the early evaluation by a healthcare provider by providing education and training on the recognition of the symptoms of MSDs and reporting procedures, modifying work tasks for employees who may have functional limitations. The employer can work together with the health care provider to ensure the work tasks are suitable for employees.

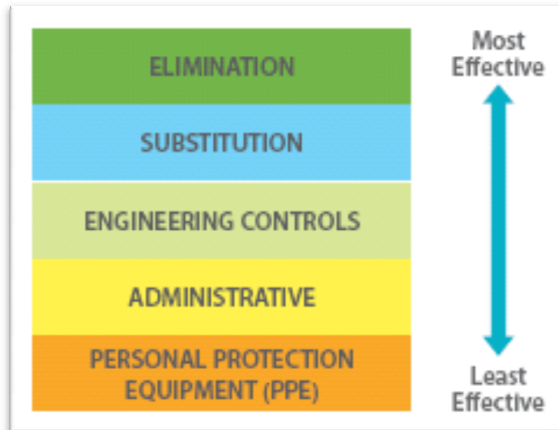
### *Practical Guidance*

- ✓ *When an employee reports signs or symptoms of a work-related MSD, employer should check out the report to determine whether medical management should be provided.*
- ✓ *Employer should provide employees with prompt access to health care providers for effective evaluation, treatment and follow-up.*
- ✓ *Employer should also provide information on work tasks and work demands to the healthcare provider for employees with reported symptoms.*
- ✓ *Employer should obtain a written opinion from the health care provider and ensure that the employee is also given access to it. 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. Employer should work with healthcare provider(s) to modify work tasks to suit employees who may have functional limitations.*

## 6.6 Control Measures

From the identified risk factors, specific measures or a series of measures could be implemented to control the 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. It is preferred for risks to be eliminated or reduced at source. These control measures should be selected based on the Hierarchy of Controls (see figure below).



The hierarchy of control measures shows the order of the effectiveness of different control measures

Elimination and substitution are the most effective solutions to eliminate MSD hazards and MSDs. Engineering controls, where feasible, are the preferred method for controlling MSD hazards. Administrative controls reduce risk through reduction of exposure time, and good work practices can be an important part of a successful ergonomics control plan. Personal protection equipment (e.g. hand gloves and knee pads) may be used as an interim control, but it should not be used as a permanent control when other controls are feasible.

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

Where solutions are obvious and the problem can be eliminated quickly, one may move directly to implementing controls without following all the steps of the control process.

Type of Control (based on Hierarchy of Controls)	Control Measures	Examples
Elimination /	Automation to eliminate	- Conveyor belts, carousels to transport

Substitution	lifting or carrying	objects
Engineering controls  - Physical changes to jobs that control exposure to MSD hazards	Use of mechanical aids and tools to eliminate or reduce exertions required	- Load elevators, scissors lift tables, hand trolleys to transport and lift objects  - Powered stackers, hoists to lift items. Vacuum lifts  - Industrial tilters, air-ball tables, rollers
	Select or redesign of work processes or tools to reduce exertions required, holding time, and improve postures	- Reduce the load and its bulkiness e.g. repackaging cartons into smaller sizes and lighter weight for easier handling
	Use of ergonomically friendly equipment  Provide user-adjustable workstations that to reduce reach and improve postures	- Ergonomically-designed pliers with bent handles  - Adjustable table, self-levelling work surface

Type of Control (based on Hierarchy of Controls)	Control Measures	Examples
Administrative  - Procedures and practices that reduce exposure to	Scheduling of tasks with sufficient rest breaks	- Short breaks between work tasks
	Job rotation / enlargement to reduce repetitive movements	- Rotate workers' tasks such as between administrative work and physically demanding work

MSD hazards by altering the way in which work is performed	Training to raise awareness and knowledge	<ul style="list-style-type: none"> <li>- Training on correct lifting posture</li> <li>- Training on proper use of work station and tools</li> </ul>
	Adjustment of work pace	<ul style="list-style-type: none"> <li>- Slower work pace to reduce frequency of exertion</li> </ul>
Personal protection equipment <ul style="list-style-type: none"> <li>- Interim control devices worn or used to protect persons from exposure to MSD hazards</li> </ul>	PPE against whole body vibration PPE against hand and arm vibration	<ul style="list-style-type: none"> <li>- Vibration isolated seat for tractor driver</li> <li>- Anti-vibration gloves for jack hammer operator</li> </ul>

## 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, or when there is a change in the work process or when new hazard or information surfaced.

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

Activity-based indicators are used to measure interim accomplishments in establishing and maintaining an ergonomics programme i.e. assess the functioning of various activities in the programme e.g. number of employees trained, number of hazards identified.

Outcome-based indicators are used to assess interventions that have been put into place, and quantify long-term success of the programme e.g. number of hazards controlled, number of lost workdays.

Base line 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 are employed to evaluate the effectiveness of control measures in reducing ergonomic risks.*
- ✓ *The following questions could be asked:*
  - *Has the control measure reduced the physical discomfort caused to the worker?*
  - *Is the worker trained in safe work procedures that encompass those control measures to mitigate ergonomics risk factors? - Do workers embrace and use the control measures implemented?*

#### **Records keeping**

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

- Employees' reports and management's responses
- Results of job hazard analysis
- Plans for controlling MSD hazards and ergonomics problems
- Medical management records
- Evaluation of programme

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## Checklist A – Sample Checklist for In-plant 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 resources dedicated to train employees to improve their knowledge on ergonomic risk factors and to implement ergonomic improvements?		
	c) Are ergonomics principles recognized and considered in the design and selection process of new tools, job methods, workstation layouts and materials?		
2	Employees Involvement		
	a) Are employees involved in efforts of the programme to improve workplace conditions?		
	b) Is there a committee formed, with employees from all levels of the organization, to address ergonomic issues, such as designating a dedicated team to take the lead in ergonomics, with roles and responsibilities specified clearly?		
	c) Are employees encouraged to give relevant suggestions on jobs which give excessive strain or fatigue and ways to improve on them?		
3	Training and Education		
	a) Are all employees educated on general ergonomics awareness?		
	b) Are all employees familiar with the procedures for reporting of ergonomic problems?		
	c) Is there job-specific training such as 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	<b>Hazard Identification</b>		
	a) Does the Ergonomics team conduct regular inspections to identify areas of concern?		
	b) Does the Ergonomic team directly observe the work processes and tasks of the 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 where cases of MSDs existed given priority for detailed analysis and implementation of control measures?		
	f) Are work tasks with significant or multiple risk factors identified and prioritized for detailed analysis and implementation of control measures?		
	g) Are employee feedback and suggestions taken into account during all phases of the assessment?		
5	<b>Workplace Monitoring, Reporting and Medical Management of MSDs</b>		
	a) Are there simple procedures in place for employees to report, suggest and feedback on their symptoms and injuries, particularly work-related MSDs, and other ergonomics issues in the workplace?		
	b) Are there periodic surveys conducted to find out ergonomic issues, symptoms or injuries at the workplace that employees are aware of?		

	c) Are records kept such as injury, staff suggestions, feedback, and ache and pain symptoms?		
	d) Does the employer work with the healthcare provider(s) to tailor work tasks for employees who may have functional limitations?		
6	<b>Control Measures</b>		
	a) Are control measures implemented to eliminate or minimize the ergonomic risks where possible?		
	b) Is elimination or engineering control method being considered first before using other risk control methods?		
	c) Are administrative control methods used where engineering method is not practicable?		
7	<b>Evaluation and Review</b>		
	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 B – Sample Checklist for Risk Factor Identification

Work Location: \_\_\_\_\_ Checked by: \_\_\_\_\_

Task Description: \_\_\_\_\_ Designation/ Signature: \_\_\_\_\_

Task Duration per Workday: \_\_\_\_\_ Date: \_\_\_\_\_

If your answer is 'Yes' to any of the following questions, it may indicate the need for action or control 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 large pushing/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 have an adequate grip of 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 whereby the hands are stretched			

	below the thighs?			
2	Is there frequent or prolonged reaching for items/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 sideway 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 e.g. standing, sitting maintained for a long period of time without any rest break in between?			
<b>Standing work</b>		<b>YES</b>	<b>NO</b>	<b>Remarks</b>
1	Do employees have to stand in a fixed location for more than 4 hours a day?			
2	Are there insufficient task variations such that there is no opportunity to change work posture, move around, or alternate between sitting and standing?			
3	Are employees who are obese, pregnant or have 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 prolonged period of time?			
3	Are loads moved or carried manually over long distances?			
4	Do employees complain or feedback that there is insufficient rest or recovery period between tasks?			
5	Is physically demanding work done continuously by the same employee without rotation?			
Hand Tools		YES	NO	Remarks
1	Does the hand-held tool require excessive force and/or exposure to excessive vibration during use?			
2	Does the tool slip out of the hand easily during use and/or is unevenly balanced?			
3	Does using the tool require excessive bending/twisting of the wrist?			
4	Does the 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 the workers?			
The physical environment		YES	NO	Remarks
1	Is the work environment found to be particularly hot or cold?			
2	Is the floor surface where employees work on uneven or slippery?			
3	Is the work area cluttered or cramped such that access and movement of employees are restricted?			
4	Are unstable or unsuitable stepping aids such as stools used to access high places?			
Individual factors		YES	NO	Remarks
1	Is the employee new to the work scope 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 is caused or made worse by their work?			
4	Have any employees been prevented from carrying out their normal activities because			

	of body aches, pain, discomfort or numbness?			
Others		YES	NO	Remarks
1	Does the employee's clothing or personal protective equipment interfere with performing manual handling work?			
2	Have the employees not been trained in manual handling techniques such as proper lifting and carrying?			
3	Are there complainTs of body aches, pain, discomfort or numbness from the employees which they feel is caused or made worse by their work?			
4	Have any of the employees been prevented from carrying out their normal activities because of the body aches, pain, discomfort or numbness?			

## Checklist C– Sample Checklist for Good Practices in the Office Environment

<b>Work Surface</b>		<b>YES</b>	<b>NO</b>
1	Can the height of the work table be adjusted?		
2	Is there sufficient knee clearance 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 accommodates the use of a mouse?		
<b>Chair</b>		<b>YES</b>	<b>NO</b>
1	Can the height of the chair be adjusted?		
2	Can the back rest of the chair recline slightly (100 to 120 degrees)?		
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 height be adjusted?		
6	Does the chair have five legs with castors and is able to swivel?		
7	Are all the chair adjustments easy to access and operate?		
8	Is a footrest provided if needed?		



<b>Monitor</b>		YES	NO
1	Is the monitor placed such that the top of the monitor is at or slightly below the eye level?		
2	Is the monitor located at about an arm's length in front?		
3	Can the monitor be adjusted e.g. tilt forwards and backwards, rotated and so on?		
4	Is the monitor free from glare and flicker?		
<b>Input devices</b>		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 the input devices, e.g. keyboard and mouse?		
4	Is the wrist supported by the table surface or keyboard and mouse pads?		
<b>Work environment</b>		YES	NO
1	Is sufficient lighting provided for the task?		
2	Are employees shielded from direct and reflected glare e.g. light from the monitor screen or sun?		
3	Is the work environment free from disturbing noise e.g. from equipment or machines that will affect the concentration of employees?		
4	Are noisy equipment or machines isolated or enclosed?		
5	Is the temperature of the work environment comfortable for employees?		

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.

## 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/carry objects weighing 25-50kg?

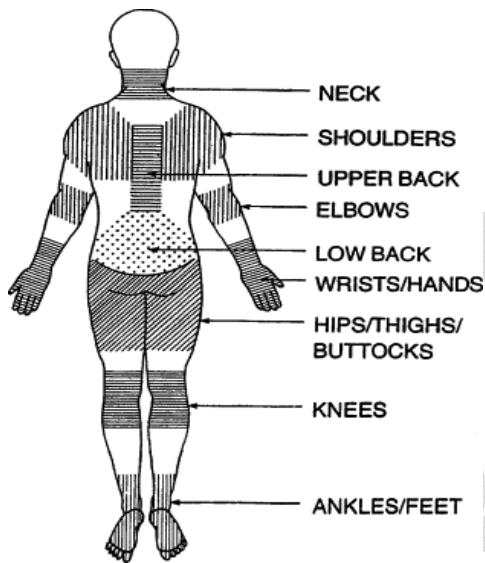
Almost daily

- At least once a week
  - At least once a month
  - Almost never
5. How often do you lift/carry objects weighting more than 50kg?
- Almost daily
  - At least once a week
  - At least once a month
  - Almost never
6. How often do roll, push 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"/> |
| Carrying 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 that bothers you and complete the following on a separate page for each area that bothers you.



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

<input type="checkbox"/>	Aching	<input type="checkbox"/>	Numbness	<input type="checkbox"/>	Weakness
<input type="checkbox"/>	Burning	<input type="checkbox"/>	Pain	<input type="checkbox"/>	Others: (please list: _____ _____ )
<input type="checkbox"/>	Cramping	<input type="checkbox"/>	Swelling		
<input type="checkbox"/>	Loss of colour	<input type="checkbox"/>	Tingling		

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

Please comment on what you think would improve your symptoms.

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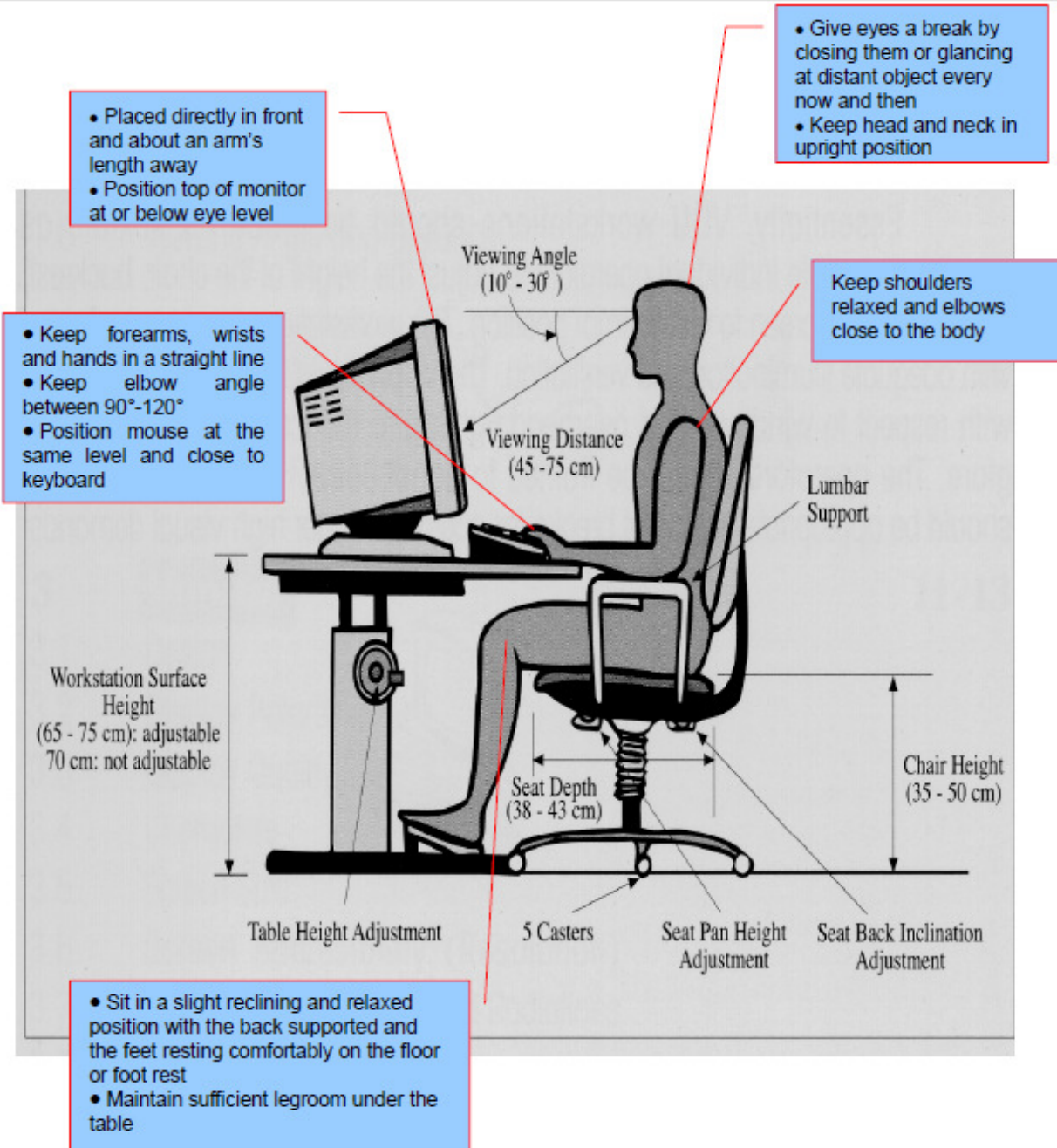
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## Annex A – Proper Steps and Postures for Lifting and Carrying

<p><b>Step 1</b></p> <p>Place one foot on one the side of the object and the other foot behind the load.</p>	<ul style="list-style-type: none"> <li>• Before you lift, check the weight of the load and clear the path of any obstruction.</li> <li>• Place one foot at the side of the load and one foot behind the load.</li> </ul>
<p><b>Step 2</b></p> <p>Grasp the object firmly and hold the object as close as possible to the body.</p>	<ul style="list-style-type: none"> <li>• Bend your knees and keep your back straight.</li> <li>• Grasp the object firmly and hold the object as close as possible to the body.</li> <li>• Distribute your body weight equally to both feet.</li> </ul>
<p><b>Step 3</b></p> <p>Lift the object by pushing up on your legs.</p>	<ul style="list-style-type: none"> <li>• Lift the object by pushing up on your legs.</li> <li>• Keep the back as straight as possible.</li> <li>• Avoid jerking to lift the object higher.</li> </ul>
<p><b>Step 4</b></p> <p>Make sure you have a firm grip on the object before moving off.</p>	<ul style="list-style-type: none"> <li>• Make sure you have a form grip on the object before moving off.</li> <li>• Hold the object close to the body.</li> <li>• Ensure that the object does not block your vision.</li> </ul>

## Annex B – Recommended Workstation Design and Work Posture



*Adapted from SS514: 2005 Code of Practice for Office Ergonomics*