

DEPARTMENT OF OCCUPATIONAL  
SAFETY AND HEALTH  
MINISTRY OF HUMAN RESOURCES

# Guidelines for Manual Handling at Workplace 2018



# Preface

Consistently high and increasing numbers of occupational accidents and diseases continue to stem from lack of attention to ergonomics in the workplace. To date, the application of ergonomic principles has only reached a limited number of workplaces despite its great potential for improving working conditions and productivity. Much more focus has been placed on research and high technology than on practical action in the places where most people work. As a result, the gaps remain large in applying ergonomics to workplaces as shown in occupational related accidents and diseases reports. *Guidelines for Manual Handling at Workplace* has been developed with the objective to provide practical and informative solutions to ergonomic problems arising in the workplace.

These Guidelines are intended to assist employer, employee, occupational safety and health practitioner and others in identifying and recognizing the risk involving manual handling tasks as well as to provide information on how to choose the effective options to reduce the risks.

It is our hope that these Guidelines will help the users to prevent injury, illness and pain suffering in the workplaces, to improve business performance and productivity, to reduce the compensation claims and to provide a safe workplace for everyone.

Thank you.

**Director General**  
**Department of Occupational Safety and Health**  
**Ministry of Human Resources**  
**Malaysia**  
**2018**

# Acknowledgement

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## Main committee

Name	Organization
Mohammad Fadzil bin Abdul Manap (Chairman)	DOSH
Husdin bin Che Amat	DOSH
Shabanon binti Mohd Sharif	DOSH
Nor Maizura binti Yusoff	DOSH
Noor Azurah binti Haji Abdul Rahman	DOSH
Fauziah binti Kamaruddin	DOSH
Dr. Muhd Zafran bin Shamsudin	DOSH
Noor Fazira binti Ab. Aziz	DOSH
Mohd Hafizul bin Adnan	DOSH
Iskandar Zulkarnain bin Rahmat	DOSH
Raemy bin Md Zein	NIOSH
Ismail bin Abdul Rahman	NIOSH
Roseni bin Abdul Aziz	NIOSH

## Technical Committee

Name	Organization
Raemy bin Md Zein (Chairman)	NIOSH
Ismail bin Abdul Rahman	NIOSH
Roseni bin Abdul Aziz	NIOSH
Zulkifli bin Marsidi	SEMA
Lee Min Ho	SEMA
Zulhilmi bin Zakaria	SEMA
Dr Ng Yee Guan	HFEM
T. Hari Krishnan	HFEM
Assoc. Prof. Dr. Shamsul Bahri bin Mohd Tamrin	HFEM

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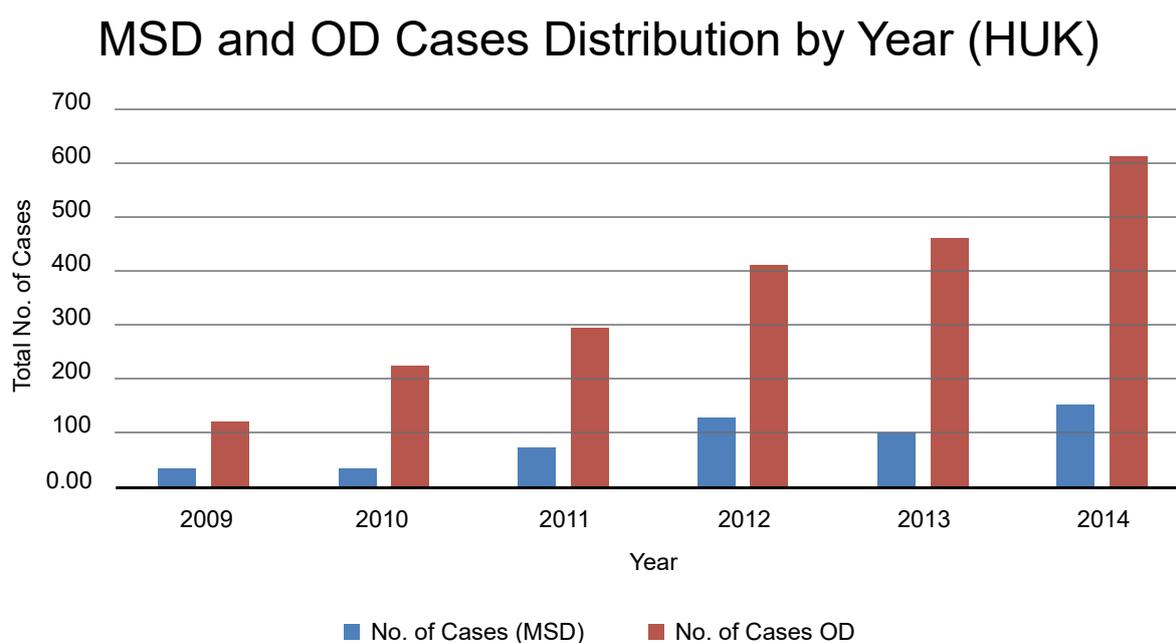
# Glossary

AGV	Automatic Guided Vehicle
DOSH	Department of Occupational Safety and Health
ERA	Ergonomics Risk Assessment
FMA	Factories and Machinery Act 1967
HFEM	Human Factors and Ergonomics Society Malaysia
HUK	<i>Hilang Upaya Kekal</i> (Permanent Disability)
IEA	International Ergonomics Association
ISO	International Organization for Standardization
LCA	Low Cost Automation
LCIA	Low Cost Intelligent Automation
MSDs	Musculoskeletal Disorders
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Act 1994
OD	Occupational Disease
PPE	Personal Protective Equipment
SEMA	Samsung Electronics Malaysia Sdn. Bhd
SOCSSO	Social Security Organization
WRMSDs	Work Related Musculoskeletal Disorders

# 1.0 INTRODUCTION

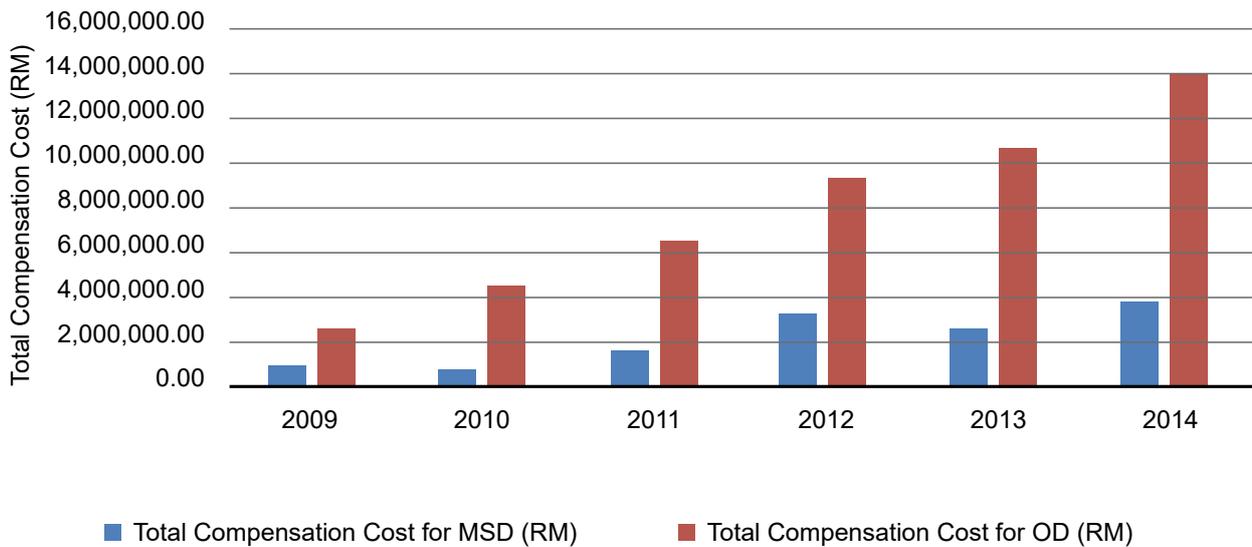
Manual handling activities involve the transporting or supporting of a load, which include lifting, lowering, pushing, pulling, carrying, restraining or holding manually using human energy and forces. These activities contribute to 40% of reported musculoskeletal disorders (MSDs) cases in Malaysia. MSDs often involve strains and sprains mainly to the lower back, shoulder, and upper limbs. They can result in protracted pain, disability, medical treatment and financial stress for those afflicted with them. Often, employers find themselves paying the bill, either directly or through employee's compensation insurance, at the same time they must cope with the loss of the full capacity of their employees.

According to Social Security Organization (SOCSCO), number of MSDs cases related to manual handling activities increase from 2009 to 2014 (Refer **Figure 1.1**). This contributes to the increase of total compensation cost to the employees (Refer **Figure 1.2**).



**Figure 1.1: Trends of MSD and OD cases reported to SOCSCO from 2009 to 2014**

## MSD and OD Total Compensation Cost Distribution by Year (HUK)



**Figure 1.2: Trends of MSD and OD compensations from SOCSO from 2009 to 2014**

These Guidelines are prepared by the Department of Occupational Safety and Health (DOSH), for the guidance to recognize manual handling tasks and choose an effective option for reducing their risks.

It provides general guidance for employers and employees on the identification, assessment and control of ergonomic risks factors associated with the manual handling task in order to reduce the likelihood of employees of getting manual handling related injuries and disorders.

### 1.1 Purpose

The objective of these Guidelines is to promote comprehensive and practical preventive strategies that improve the working environment in the workplace. The Guidelines provide specific information on the assessment and control of manual handling at the workplace in compliance with related legislation to ensure, so far as practicable, the safety, health and welfare at work of all employees.

## 1.2 Scope and Application

These Guidelines apply to all manual handling activities in the workplaces under Schedule 1, Occupational Safety and Health Act 1994 (OSHA 1994) as shown in **Table 1.1**;

**Table 1.1: List of industries in Schedule 1, OSHA 1994**

No	Workplace
1	Manufacturing
2	Mining and Quarrying
3	Construction
4	Agriculture, Forestry and Fishing
5	Utilities: a. Electricity; b. Gas; c. Water; and d. Sanitary Services
6	Transport, Storage and Communication
7	Wholesale and Retail Trades
8	Hotels and Restaurants
9	Finance, Insurance, Real Estate and Business Services
10	Public Service and Statutory Authorities

## 2.0 ERGONOMICS AND MANUAL HANDLING

### 2.1 Ergonomics

According to International Ergonomics Association (IEA), ergonomics is defined as:

“The scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance”

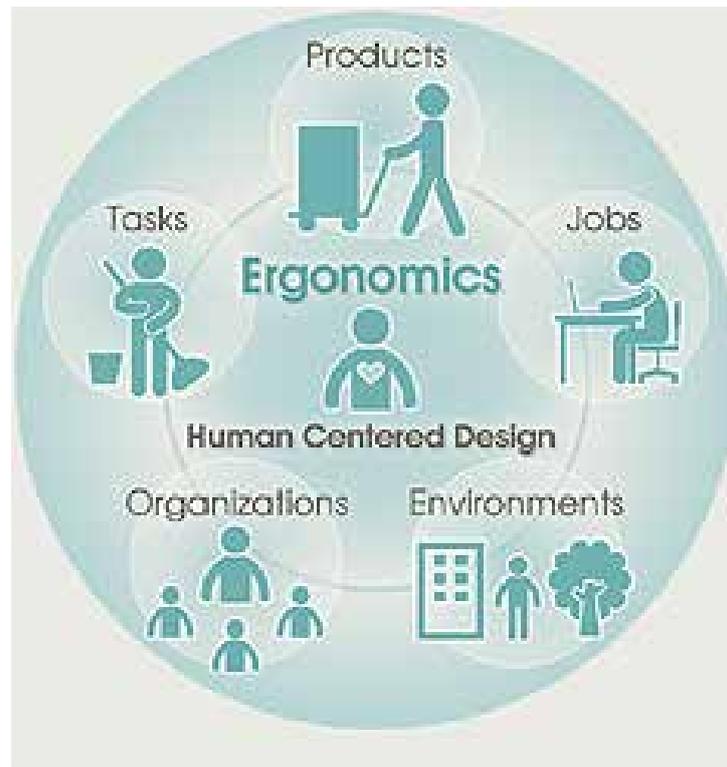
(IEA, 2015)

#### 2.1.1 Objectives of Ergonomics

Nowadays, many employees suffer from work related disorders and injuries due to their work conditions and its incompatibility with their needs, abilities and limitations. This situation affects their safety, health and welfare, as well as, that of organizations and societies.

One of the steps that can be implemented by the industries is by implementing ergonomics principles at the workplaces within organization, jobs, products, task and environment as shown in **Figure 2.1**. By applying these principles, industries may obtain an effective match between the employee and work system in order to optimize:

- a. **Efficiency:** by rearranging work tools and equipment, or reduce the motion needed to complete the task the employee can work with more movement efficiency and reduce the cycle time, ultimately increasing work productivity
- b. **Quality:** ergonomics minimizes the mental fatigue of the employee, reducing chances of human error through lapses or misjudgement
- c. **Safety:** human error, whether intentionally or not, may cause serious safety violation and incidents
- d. **Health:** overexertion may cause physical fatigue that can be causes of chronic ergonomics related symptoms
- e. **Work Comfort:** work within the employee’s capabilities and limitation enhance the employees’ comfort, allowing the employee to work at longer duration with less undue fatigue



**Figure 2.1: Principles of Ergonomics**

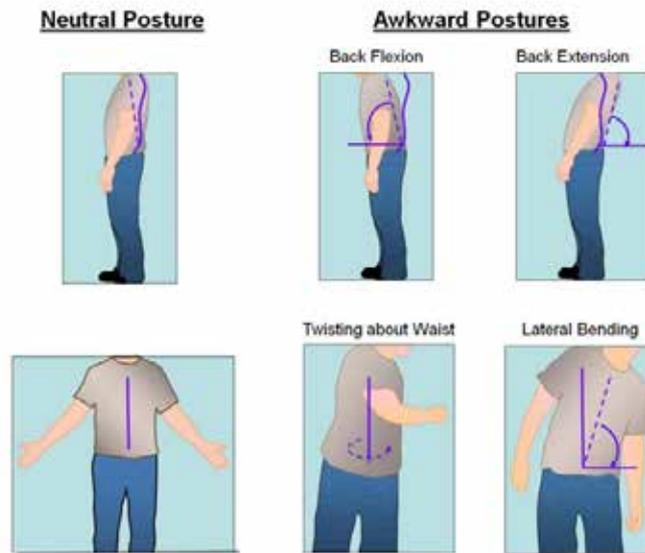
### 2.1.2 Ergonomics Risk Factors in Manual Handling Activities

Ergonomics risk factors are aspects of jobs or tasks that put biomechanical stress to the body of the individuals and may cause the onset of ergonomics related disorders or injuries.

Typical ergonomics risk factors in manual handling activities are as follows:

#### 2.1.2.1 Awkward Posture

Awkward postures refer to positions of the body (limbs, joints, back) that deviate significantly from the neutral position while job tasks are being performed. When employees are performing tasks that involve long reaches they are exposed to extreme awkward postures; that is, the positions of their shoulders, elbows and/or back deviate significantly from a more neutral position. Repeatedly performing tasks in such positions poses increased stress on the joints and/or spinal discs. Furthermore, the muscles do not work as efficiently in awkward postures, and the muscles must exert more physical effort to accomplish the task. This increased force contributes to muscle-tendon fatigue and strain. For example, the shoulder may deviate at least 90 degrees from its neutral position when reaching across a conveyor to grasp an object. Examples of awkward postures are bending, twisting and overreaching postures. **Figure 2.2** shows example of neutral posture versus awkward posture.



**Figure 2.2: Neutral vs awkward posture**

### 2.1.2.2 Forceful Exertion

Force refers to the amount of physical effort that is required to accomplish a task or motion. Tasks or motions that require application of higher force place higher mechanical loads on muscles, tendons, ligaments, and joints. Tasks involving high forces may cause muscles to fatigue more quickly. High forces also may lead to irritation, inflammation, strains and tears of muscles, tendons and other tissues.

The force required to complete movement will increase if other risk factors are involved. For example, more physical effort may be needed to perform tasks if speed of motion increases, vibration is present, or when tasks also involve awkward postures.

Examples of forceful exertion are shown in **Figure 2.3** such as lifting heavy objects on and off, delivering heavy packages, pushing a heavy cart, or moving a pallet.



**Figure 2.3 : Examples of forceful exertion**

### 2.1.2.3 Repetitive Motion

Many work tasks and cycles are repetitive in nature, and are frequently controlled by hourly or daily production targets and work processes.

High task repetition, when combined with other risks factors such as high force and/or awkward postures, can contribute to the formation of work related MSDs. A job is considered highly repetitive if the cycle time is 30 seconds or less. Examples of repetitive activities are repetitive hand movements during assembly tasks as **Figure 2.4**.



**Figure 2.4: Example of repetitive activity in electronics industry**

### 2.1.2.4 Static and Sustained Posture

Static postures involve little or no movement. The body circulatory system provides energy and removes waste. Since blood flow through muscles also depends on movement, static postures elevate the risk of discomfort and work related MSDs. Even neutral postures can result in discomfort if one posture or position is maintained for a prolonged period of time. Tasks that involve static postures quickly lead to discomfort, especially if combined with exposure to other risk factors, such as awkward postures or forceful exertions. Holding the same position for a period of time is known as sustained postures. It creates fatigue and discomfort and can interfere with work. Prolonged standing and seating such as **Figure 2.5** are examples of static postures.



**Figure 2.5: Static posture in standing and seating**

#### **2.1.2.5 Contact Stress**

Contact stress can occur either internally or externally. Internal stress occurs when a tendon, nerve, or blood vessel is stretched or bent around a bone or tendon. External contact stress occurs when part of the body rubs against a component of the tools, equipment, loads or workstation, such as contact of hands and loads during lifting as in **Figure 2.6**, the chair seat pan or edge of the desk. Both internal and external contact stress may occur simultaneously or independently. Nerves may be irritated or blood vessels constricted as a result.



**Figure 2.6: Contact stress between hands and loads during lifting**

### 2.1.2.6 Vibration

Vibration may affect tendons, muscles, joints and nerves. Vibration to a specific body part can decrease tactile sensitivity and result in unnecessary increases in muscle contraction, which may lead to fatigue or injury of that part. Localized vibration from machines and hand tools as in **Figure 2.7** may damage the nerves and blood vessels of the hands and arms. Whole-body vibration, experienced by people who operate heavy equipment such as truck and bus drivers, increases the risk of lower back pain and damage to the spinal discs. The body's response depends on the duration, frequency and amplitude of the vibration.



**Figure 2.7: Vibrating tools**

### 2.1.2.7 Environmental Factor

Environmental factor has considerable effect on human performance and may lead to poor work enthusiasm including productivity. Examples of environmental factors are extreme temperatures, lighting and noise.

#### (a) Extreme Temperatures

Extreme temperature may affect body temperature of the employee causing variety of symptoms. Exposures to hot environment as in **Figure 2.8** may lead to high body temperature because the body cannot transfer heat effectively or because of excessive the external heat gain. Heat stress is the overall heat load to which an employee may be exposed from the combined contributions of metabolic heat, environmental factors (i.e. air temperature, humidity, air movement, and radiant heat), and clothing requirements. Heat stress occurs when the body's means of controlling its internal temperature start to fail. It is generated externally from environmental temperature and internally from human metabolism. Excessive heat can cause heat stroke, a condition that can be life threatening or result in irreversible damage. Less serious conditions associated

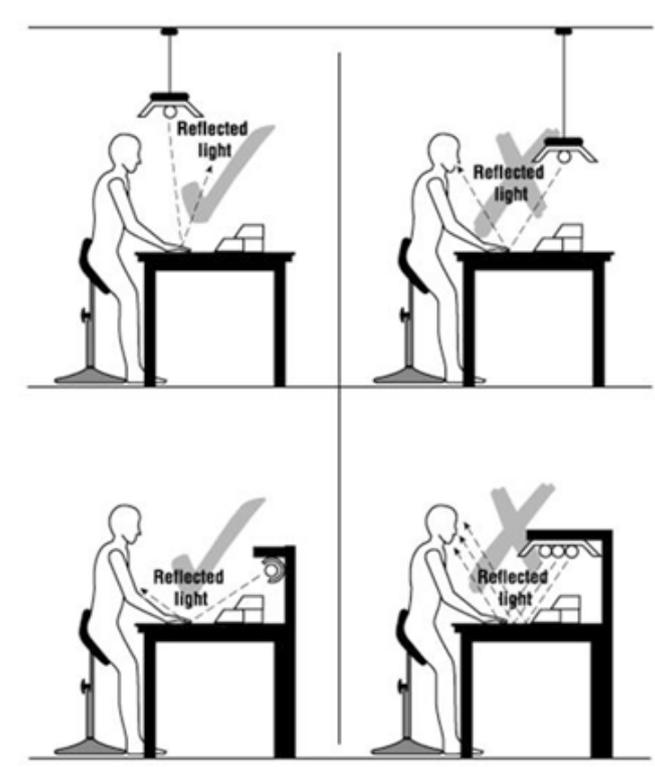
with excessive heat include heat exhaustion, heat cramps, and heat-related disorders (e.g., dehydration, electrolyte imbalance, loss of physical/mental work capacity).



**Figure 2.8: Hot environment in the foundry**

**(b) Lighting**

Appropriate lighting and elimination of glare in the work area as shown in **Figure 2.9** allows for adequate depth perception and contrast by the employee when handling material such as when lifting and carrying objects. Improper lighting can be a contributing factor to a musculoskeletal injury. For example, poor lighting could cause the employee to misjudge weight and object shape, resulting in inappropriate or poor lifting techniques.



**Figure 2.9: Poor lighting and elimination of glare**

### (c) Noise

Noise is unwanted sound. In the industrial setting, it may be continuous or intermittent and present in various forms (bang of a rifle, the clatter of a pneumatic wrench, whirl of an electric motor). Exposure to excessive noise can lead to temporary and permanent deafness, tinnitus, or speech misperception. The increase of noise level and the duration of exposure may raise the risk of hearing disorders. Sound level below permissible exposure limit, in the other hand may become a source of annoyance and may interfere with the ability of some people to concentrate.

## 2.2 Manual Handling

Manual handling activity is identified as one of the main causes of back injury. Manual handling can be defined as any activity requiring the use of force exerted by a person in **lifting, lowering, pushing, pulling, carrying, holding** or **restraining** a person, animal or any objects. In a simple way it can be described as moving anything by using human energy.

### 2.2.1 Lifting and Lowering Task

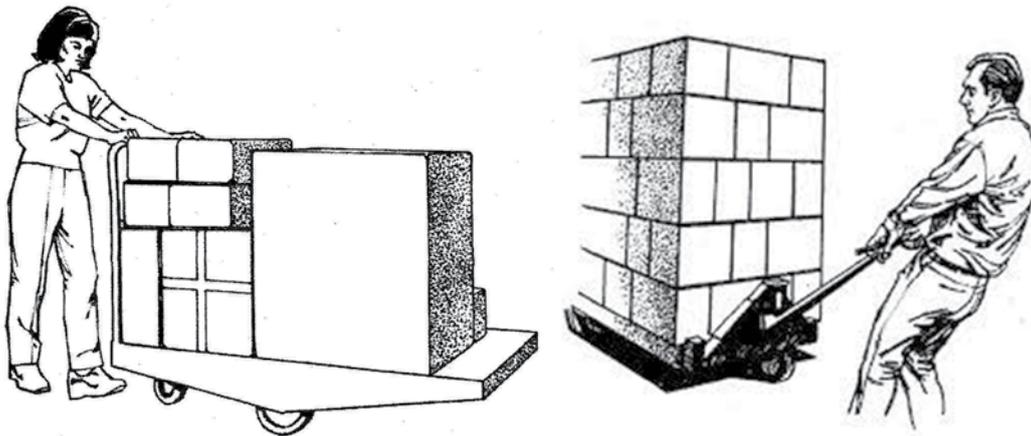
An operation concerned with the lifting or lowering of a load is considered as one of the manual handling activities. A 'load' is the item or items being lifted, which includes a person, animal or any object. Lifting practices that involve the factors of asymmetry (person's postures, load and location), limited headroom height, and restriction to access are commonly encountered in industries such as warehousing, maintenance, storage department and others. The combination of high load, poor body movement and frequency of doing the same tasks cause a high internal load on the structure of human body and increase the risk of injury and pain. **Figure 2.10** show the correct and incorrect technique when doing lifting activities.



**Figure 2.10: Correct lifting vs incorrect lifting technique**

## 2.2.2 Pushing and Pulling Task

In industry, various techniques of pushing and pulling as **Figure 2.11** is used by the employee to avoid manual lifting and carrying in a wide range of activities such as using a trolley or pallet jack, sliding a packaging box in the line, opening and closing a door, operating a machine and tools, arrange a storage material and much more. Since these actions are commonly found during working, they also contribute to the cause of many injuries in industries especially in overexertion injuries (e.g. back, shoulder pains).



**Figure 2.11: Various pushing and pulling techniques in industries**

## 2.2.3 Carrying Task

Basically carrying task is simply to move or to take objects or loads from one place to another. The example of carrying task is carrying the toolbox to the work site such as **Figure 2.12**. For a safer carrying operation, many factors need to be considered such as the load weight, carrying distance, postural constraint, grip on the load, floor surface, hand distance from lower back, environment factors and other individual risk factors.



**Figure 2.12: Carrying task**

### 2.2.4 Holding and Restraining Task

Holding and restraining task is the task where someone needs to hold and restrain the objects in a certain amount of time while maintaining the same posture. Holding task does not necessarily involve holding a heavy load. Even holding a relatively light load for an extended period of time or involving other factors such as vibration, may give adverse impact on employees. **Figure 2.13** shows the example of employees who work in the assembly line to install screws in products which require them to hold power screw driver that hangs on top of their work area also have a tendency to have adverse health effects such as neck and shoulder pains and discomfort.



**Figure 2.13: Holding and restraining task in assembly line**

## 2.3 Work Related Injuries Due to Manual Handling

Manual handling relates to the moving of items either by lifting, lowering, carrying, pushing or pulling manually and identified as one of the main causes of MSDs. The term 'musculoskeletal disorders' covers any injury, damage or disorder of the joints or other tissues in the musculoskeletal systems (muscles, bones, tendons, ligaments and joints). Other than manual handling, there are evidences that heavy manual labour, awkward postures and recent or existing injury may contribute to the development of MSDs. Manual handling injuries may also cover other non-musculoskeletal injuries such as cut, bruises, piles, hernia *etc.*

### 2.3.1 Acute Injuries

Acute injuries are injuries that happen immediately upon incident or in a relatively short time. An example of acute injuries or incidents that may happen during manual handling is muscle/skeletal damage due to slip, trip and fall while carrying loads as in **Figure 2.14** Other examples are:

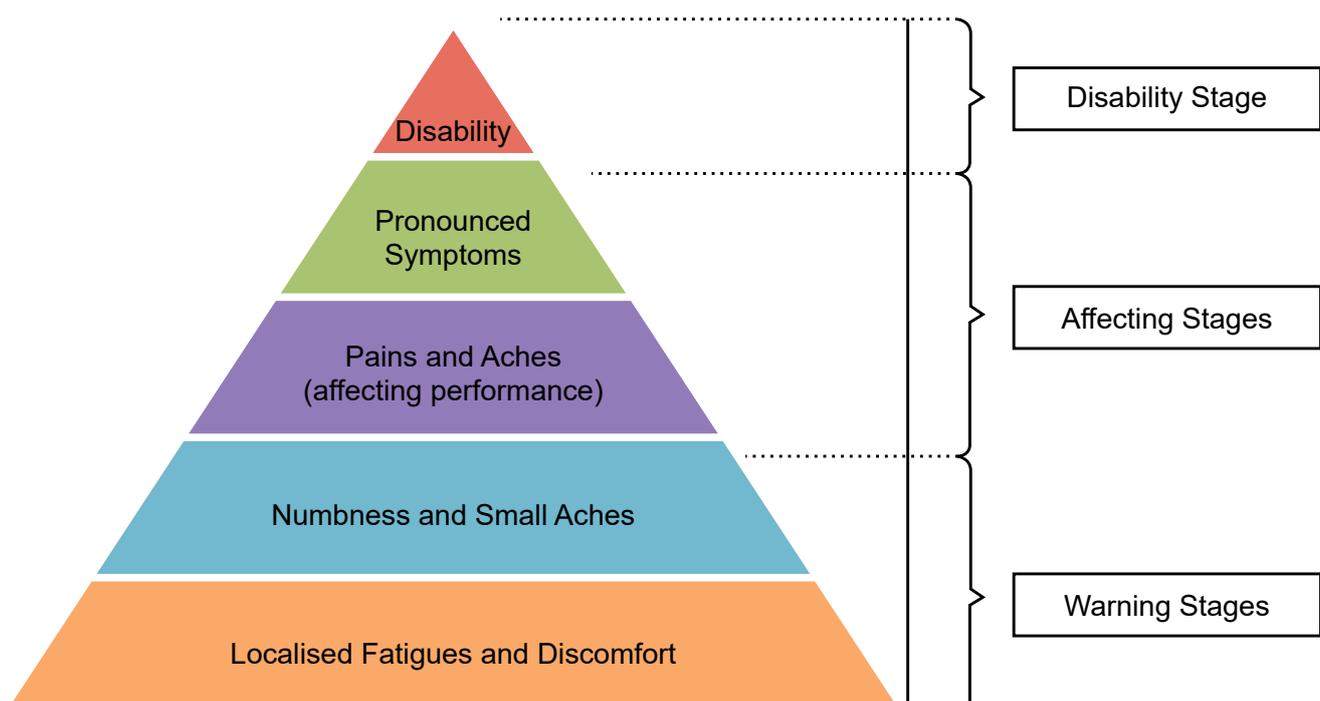
- Acute muscle/tendon/ligament tear due to over exertion
- Cut and bruises due to contact with sharp edges or pinch point
- Crush injuries due to crushed incidents by load during lifting
- Contusion/musculoskeletal damage due to hit by material handling equipment



**Figure 2.14: Acute musculoskeletal injuries due to slip, trip and fall**

### 2.3.2 Chronic Injuries

Chronic injuries are injuries/disorders that happen after prolonged exposure to the hazards, in this case improper manual handling activities. Typically, this type of injuries has been happening after working for several years before the onset of symptoms starts appearing. Since the effects are quite generic and non-specific, the employees might not realise they are having the problems until the issue become serious or irreversible. It can be divided into several stages as shown in **Figure 2.15**.



**Figure 2.15: Stages of chronic MSDs injuries**

At first, the employees might feel fatigue and discomfort in certain parts of their body (i.e. back, neck, arms, calves, etc). These symptoms normally perceived as 'normal' by both the employees and their superior. However, recognizing these localised fatigues and discomfort symptoms are very useful for early intervention in manual handling related injuries since this localised symptoms usually signal areas where the ergonomics risks exist.

Next the employees might feel occasional numbness and minor aches such as tingling sensations, 'pins and needles', stiffness, burning sensation et cetera. The employees might be seen doing something such as self-massage and stretching to reduce the pain, but normally have yet to seek medical advice or taking medication to tackle the issues.

If the exposure to hazards is not controlled the employees may start having pains and soreness that may require visits to registered medical practitioners, taking medications or time off/leave for the pains. In short, in these stages, productivity and performance of the employees will be compromised.

At later stages, these symptoms become more pronounced until it became confirmed MSDs and disability.

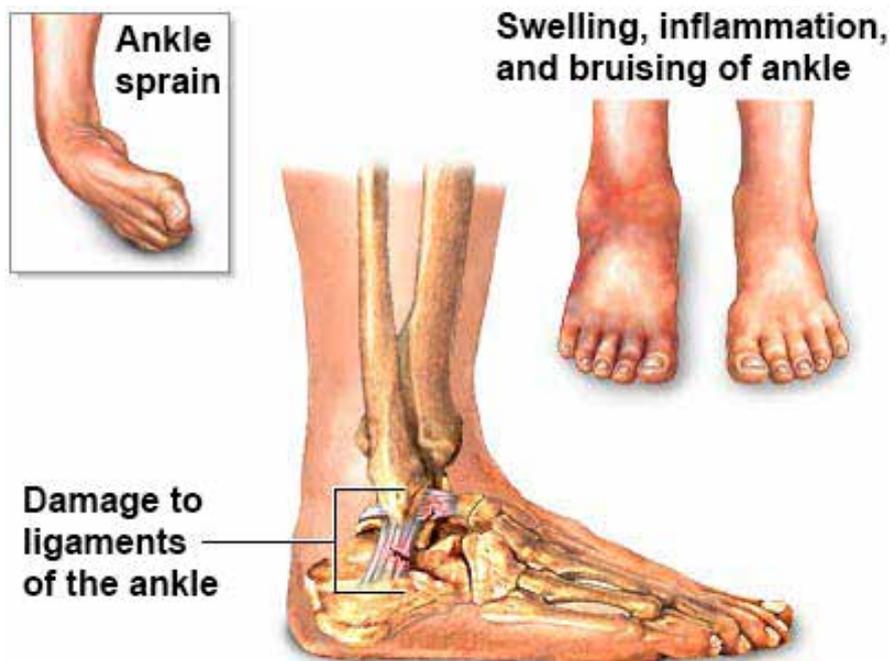
Examples of chronic disorders due to manual handling activities are as follows:

- Chronic muscle sprain and ligament strain
- Spine disorders
- Intervertebral discs disorders
- Neural (Nerve) disorders
- Hernia and piles

### 2.3.2.1 Chronic Muscle Strain and Ligament Sprain

A strain is an injury to a muscle in which the muscle fibres and its connective tendons tear as a result of overstretching. This is different from a muscle spasm which is a sudden, involuntary contraction of a muscle or a group of muscles and most commonly refers to a muscle cramp which is often accompanied by a sudden burst of pain, but is usually harmless and ceases after a few minutes.

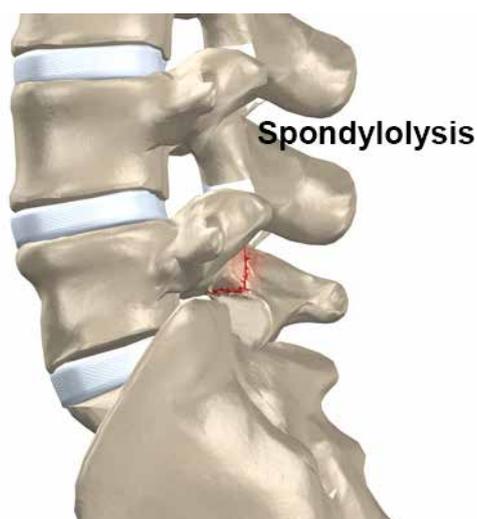
Typical symptoms of a strain include localized stiffness, discoloration and swelling around the strained muscle as in **Figure 2.16**. The equivalent injury to the ligaments is called a sprain. Chronic strain and sprain injury can happen due to prolonged exposure to trauma such as load handlings.



**Figure 2.16: Chronic muscle strain and ligament sprain**

### 2.3.2.2 Spine Disorders

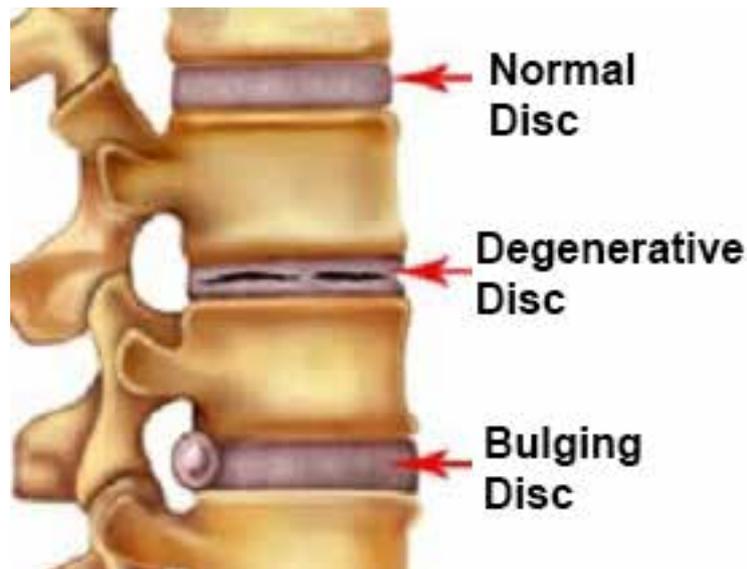
Spine disorders such as spondylolysis as in **Figure 2.17**, bone spur and fractured vertebra can happen due to increased pressure onto the vertebral column during repetitive load handling. Spondylolysis is a degenerative defect that weakens the bones that make up the spinal column. This defect can lead to small stress fractures (breaks) in the vertebrae and they may slip out of place. Bone spurs on the other hand are bony projections that develop along the edges of bones.



**Figure 2.17: Spondylolysis spine**

### 2.3.2.3 Disc Disorders

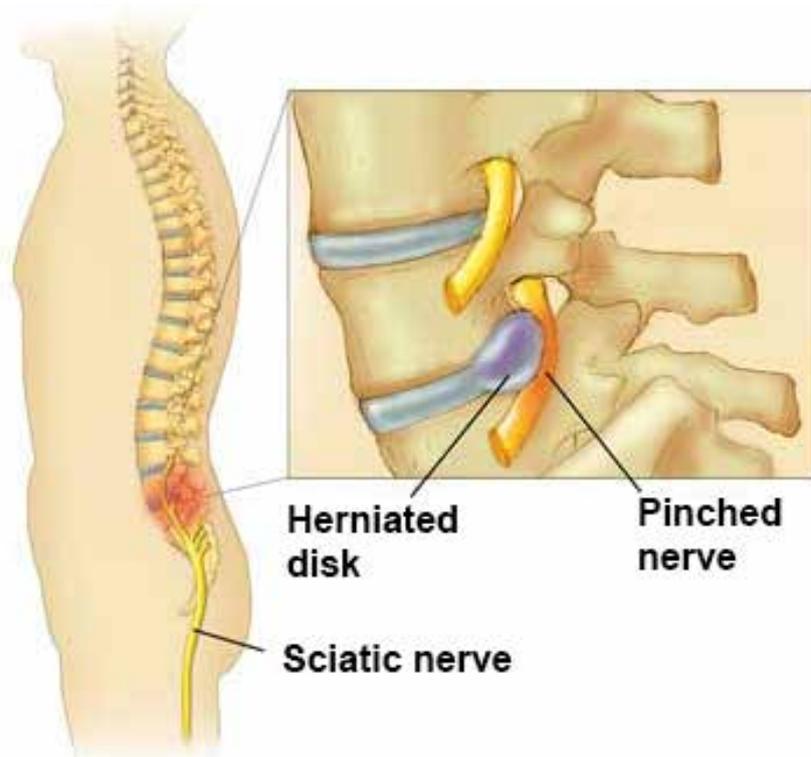
Prolapsed intervertebral discs, also known as herniated disc or slipped disc occurs when the intervertebral discs become bulged and may compress the nerve, causing pains and discomfort. This happens due to increased pressure of the discs (due to work with heavy lifting or prolonged awkward, static postures) that causes damage and tear on the outer 'wall' of the discs and allowing the soft, inner portion of the disc to bulge out beyond the damaged outer ring. **Figure 2.18** shows the condition of prolapsed intervertebral disc for normal disc, degenerative disc and bulging disc.



**Figure 2.18: Prolapsed intervertebral disc**

### 2.3.2.4 Nerve Disorders

Pinched nerve or compressed nerve may happen when too much pressure is applied to a nerve by surrounding tissues, such as bones, cartilage, muscles or tendons. As in **Figure 2.19** this pressure disrupts the nerve's function, causing pain, tingling, numbness or weakness. Sciatica (compression of sciatic nerves at pelvic area) is an example of compressed nerve disorders due to degenerative herniated intervertebral discs.



**Figure 2.19: Nerve disorder**

#### **2.3.2.5 Piles and Hernia**

Piles, also known as haemorrhoids, are swellings in the interiors of the short, muscular tube which connects the anus and the rectum. They usually occur in the anal canal, in the areas commonly called pads or cushions. They can be described as skin covered inflamed blood vessels, mostly in the lower rectal and anal region. It occurs when one of the pads or cushions slips down, because the surrounding tissue is unable to hold it up properly. As this happens, the veins in the pad swell up with blood. The main reason for the occurrence of piles is excessive pressure on the blood vessels of the lower rectal and anal region due to various reasons such as lifting heavy weights, prolonged standing and seating, obesity, or chronic constipation.

Hernia, on the other hand, is a medical condition when an organ or part of it protrudes out of a cavity or weakened connective tissues. This happens when the body is put under stressful conditions -which increase the internal pressure such as lifting heavy objects, obesity, etc. Hernia usually occurs in the abdominal region and the groin. A small-sized hernia usually shows no symptoms but a large-sized one will be painful and show various symptoms.

# 3.0 LEGAL AND STANDARD REQUIREMENTS

## 3.1 Overview of OSHA 1994 Requirements

The OSHA 1994 aims to secure the safety, health and welfare of persons at work and protect others in relation to the activities or persons at work. The objectives of this Act are:

- To secure the safety, health and welfare of persons at work
- To protect the person (other than the person at work) at place of work
- To promote the occupational environment adaptable to the person's physiological and psychological needs
- To provide the means towards a legislation system based on regulation and industry codes of practice in combination with the provisions of the Act.

The third objective of the Act intends to promote a suitable work environment that fulfills the needs of persons at work. It is intended to fit the process and the workstation to the physiological and psychological needs of employees. The work environment should be conducive to human physiology, e.g. working in hot environment would require appropriate rest-work regime; trolley to assist carrying of heavy weights above individuals capacity. It should also meet the psychological needs of employees, e.g. employee should not be overwork; an appropriate level of stressor that maximize productivity but not resulting an employee who is stressed.

Section 15(1) OSHA 1994 stipulates that "it shall be the duty of every employer and every self-employed person to ensure, so far as is practicable, the safety, health and welfare at work of all his employees". In addition, section 15(2)(b) indicate that making of arrangements for ensuring, so far as is practicable, safety and absence of risks to health in connection with the use or operation, handling, storage and transport of plant and substances.

## 3.2 Overview of FMA 1967 Requirements

FMA 1967 is an act to provide for the control of factories to matters related to safety, health and welfare of person therein, the registration of machinery and matters connected therewith.

Requirement related to manual handling and lifting of weights is stated in section 12, FMA 1967 that stipulated "no person shall be employed to lift, move or carry any load so heavy as to be likely to cause bodily injury to him."

### 3.3 Overview of ISO Standard Requirements

International Organization for Standardization (ISO) documents related to manual handling are as below:

#### **ISO 11228-1:2003 Ergonomics – Manual Handling - Part 1: Lifting and Carrying.**

ISO 11228-1:2003 specifies recommended limits for manual lifting and carrying while taking into account, respectively, the intensity, the frequency and the duration of the task.

It is designed to provide guidance on the assessment of several task variables, allowing the health risks for the working population to be evaluated. It applies to manual handling of objects with a mass of 3 kg or more, moderate walking speed, i.e. 0.5 m/s to 1.0 m/s on a horizontal level surface and does not include holding of objects (without walking), pushing or pulling of objects, lifting with one hand, manual handling while seated, and lifting by two or more people.

#### **ISO 11228-2:2007 Ergonomics - Manual handling - Part 2: Pushing and Pulling.**

ISO 11228-2:2007 gives the recommended limits for whole-body pushing and pulling. It provides guidance on the assessment of risk factors considered important to manual pushing and pulling, allowing the health risks for the working population to be evaluated.

The recommendations apply to the healthy adult working population and provide reasonable protection to the majority of this population. These standards are based on experimental studies of push-pull tasks and associated levels of musculoskeletal loading, discomfort/pain, and endurance/fatigue.

It is restricted to the following: whole-body force exertions (i.e. while standing/walking); actions performed by one person; forces applied by two hands; forces used to move or restrain an object; forces applied in a smooth and controlled way; forces applied without the use of external support(s); forces applied on objects located in front of the operator; forces applied in an upright position (not sitting). It is intended to provide information for designers, employers, employees and others involved in the design or redesign of work, tasks, products and work organization.

## **ISO 11228-3:2007 Ergonomics - Manual handling - Part 3: Handling of Low Loads at High Frequency.**

ISO 11228-3:2007 establishes ergonomic recommendations for repetitive work tasks involving the manual handling of low loads at high frequency. It provides guidance on the identification and assessment of risk factors commonly associated with handling low loads at high frequency, thereby allowing evaluation of the related health risks to the working population.

The recommendations apply to the adult working population and are intended to give reasonable protection for nearly all healthy adults. Those recommendations concerning health risks and control measures are mainly based on experimental studies regarding musculoskeletal loading, discomfort/pain and endurance/fatigue related to methods of working. ISO 11228-3:2007 is intended to provide information for all those involved in the design or redesign of work, jobs and products.

## 4.0 ROLES AND RESPONSIBILITIES

### 4.1 Employers and Employees

Under the OSHA 1994, employers, employees and the self-employed are required to meet certain standards on safety, health and welfare.

Employers should carry out the duties to ensure the safety, health and welfare of employees as stated below:

- provide or maintain equipment and systems of work that are safe and without risks to health;
- ensure the equipment and substances are used, stored and transported safely and without risks to health;
- provide information, instructions, trainings and supervision to ensure the safety and health of employees;
- maintain the safety of the workplace by ensuring no obstructions to entrances and exits; and
- ensure the safety and health of visitors to the workplace.

Employees must comply with the safety, health and welfare as follows:

- cooperate with employers to maintain the requirement level of safety and health; and
- take reasonable care of the safety and health of themselves and others.

### 4.2 OSH Committee/Supervisors

Section 30, OSHA 1994 makes it compulsory for employers who have 40 or more employees to establish a safety and health committee at their workplace or as directed by the Director General of DOSH.

The functions of the occupational safety and health committee at the workplace are to:

- Assist in the development of safety and health rules and regulations, and a safe work system;
- Review the effectiveness of the workplace safety and health programs;
- Carry out studies to identify the trend of accident, near-miss accidents, dangerous situations, substance poisoning or work-related diseases that occur at the workplace, and to report to the employer of any unsafe or unhealthy conditions or practices together with the recommendations for corrective actions; and
- Review the safety and health policy at the workplace and make recommendations to the

employer for any revision of such policies.

The committee shall inspect the workplace at least once in every three months and discuss the findings as soon as possible. Recommendations for corrective actions in the presence of risks which may harm the safety and health of employees should be made known to the employer. Additionally, the roles and responsibilities of employers, safety and health committees and employees towards ergonomics programme implementation at workplaces are stated as below:

■ **Employers:**

- ▶ To express commitment for ergonomics programme implementation
- ▶ Areas that need to be addressed:
  - Management leadership and employees involvements
  - Workplace audit/analysis
  - Accident/incident analysis and employees complaints
  - Hazard prevention and control
  - Medical managements
  - Training
- ▶ Resource allocation (financial, human resource, time)

■ **Safety and health committee and supervisory:**

- ▶ Develop the system
- ▶ Extend ergonomics/OSH information to the employees
- ▶ First line enforcers at work
- ▶ Motivate the employees to adopt ergonomics/OSH as a culture
- ▶ Deliver the suggestion/issues raised by the employees to the management

■ **Employees**

- ▶ Report any ergonomic problems or unsafe working condition/work procedures
- ▶ Early reporting of signs and symptoms of ergonomics related injuries/disorders (i.e. MSDs)

# 5.0 MANUAL HANDLING RISK IDENTIFICATION AND ASSESSMENT

This chapter provides a means for ergonomics risk identification and assessment within manual handling activities in the workplace. It provides initial manual handling risk assessment to filter manual handling activities and to identify the high risk manual handling activities for the prevention of WRMSDs.

Once the manual handling hazards have been identified, only then the exposure to the risk, potentially leading to MSDs, can be properly assessed or quantified. This is a crucial step as it outlines the focus of improvement or intervention during recommendation or planning stage.

## 5.1 Hazard Identification

### 5.1.1 Observation/Walkthrough survey

Typically, observation is conducted during the walk through survey or physical inspection to quickly provide an overview of hazards of each task in a workplace. In this case, the observation should be focused on the presence of ergonomics hazard within the manual handling tasks.

However, observation alone may not be adequate in a certain work situation. Sometimes, the limitation of observation may be due to the duration or frequency of the manual handling tasks being performed and the outcome can be confounded by the presence of an observer or being biased by inexperienced or perception of the observer.

### 5.1.2 Interview

The interview is a useful method to gather responses from the employees who are performing manual handling tasks. The interview can account for missing information during observation/walk through survey. There are 2 types of interview; informal and structured interview.

Informal interview collects various information typically using a combination of open and close ended questions without limitation to which responses received are often difficult to quantify or analyze. A structured interview, on the other hand, provides the standardized questions formatted to extract the exact information or responses as questions are typically framed in close ended answer.

### 5.1.3 Document Review

Another method of identifying ergonomics hazard is through reviewing existing documents such as standard operating procedures, manuals or guidelines, accidents, near-misses, medical records and complaints related to musculoskeletal injuries. In reviewing these records, the existence of ergonomics hazard in relation to manual handling activities should be identified for further investigation.

## 5.2 Musculoskeletal Pain/Discomfort Survey

Prior to carrying out manual handling risk assessment, the current status of musculoskeletal health is one of the valuable input or as an indicator to trigger the need for intervention or work improvement and in prioritizing limited resources.

There are many ways to implement musculoskeletal pain/discomfort survey questionnaire. For example, questionnaire survey for manual handling tasks can be implemented specifically in the form of electronic forms using email and software or paper and pencil forms.

An example of Self Assessment Musculoskeletal Pain/Discomfort Survey Form is shown in **Appendix 1**. For further information of this form, please refer to *Guidelines on Ergonomics Risk Assessment at Workplace 2017* (Part 2.1).

## 5.3 Risks Assessment of Manual Handling Tasks

In conducting manual handling risk assessments, various information such as gender, hand height, the weight of lifting objects, carrying distance, lifting or lowering distance, frequency, obstruction along the pathway, safety issues, lighting, the physiological and psychological condition of manual handling employees are required.

In order to get a more precise and accurate information, it is pertinent that the manual handling risk assessments are being conducted in consultation with the employees or operators performing the manual handling tasks as they understand the tasks better based on their experiences and understanding of limitations during manual handling.

There are currently no single standardized or agreed method for risk assessment of manual handling activities. This is primarily due to the absence of dose-response epidemiological evidence of the risk factors contributing to the development of MSDs.

Additionally, it is challenging to develop a single risk assessment method which addresses all of the ergonomic risk factors simultaneously and in the correct degree or priority. This is further complicated by the highly dynamic nature of the manual handling tasks being assessed.

As such, this section provides a recommended method based on Health and Safety Executive United Kingdom (HSE UK) Manual Handling Operations Regulations 1992. These Guidelines provide a risk assessment method for the following manual handling activities:

- Lifting and lowering;
- Repetitive lifting and lowering;
- Lifting and lowering with twisted body posture;
- Pushing and pulling;
- Handling in a seated position; and
- Carrying task

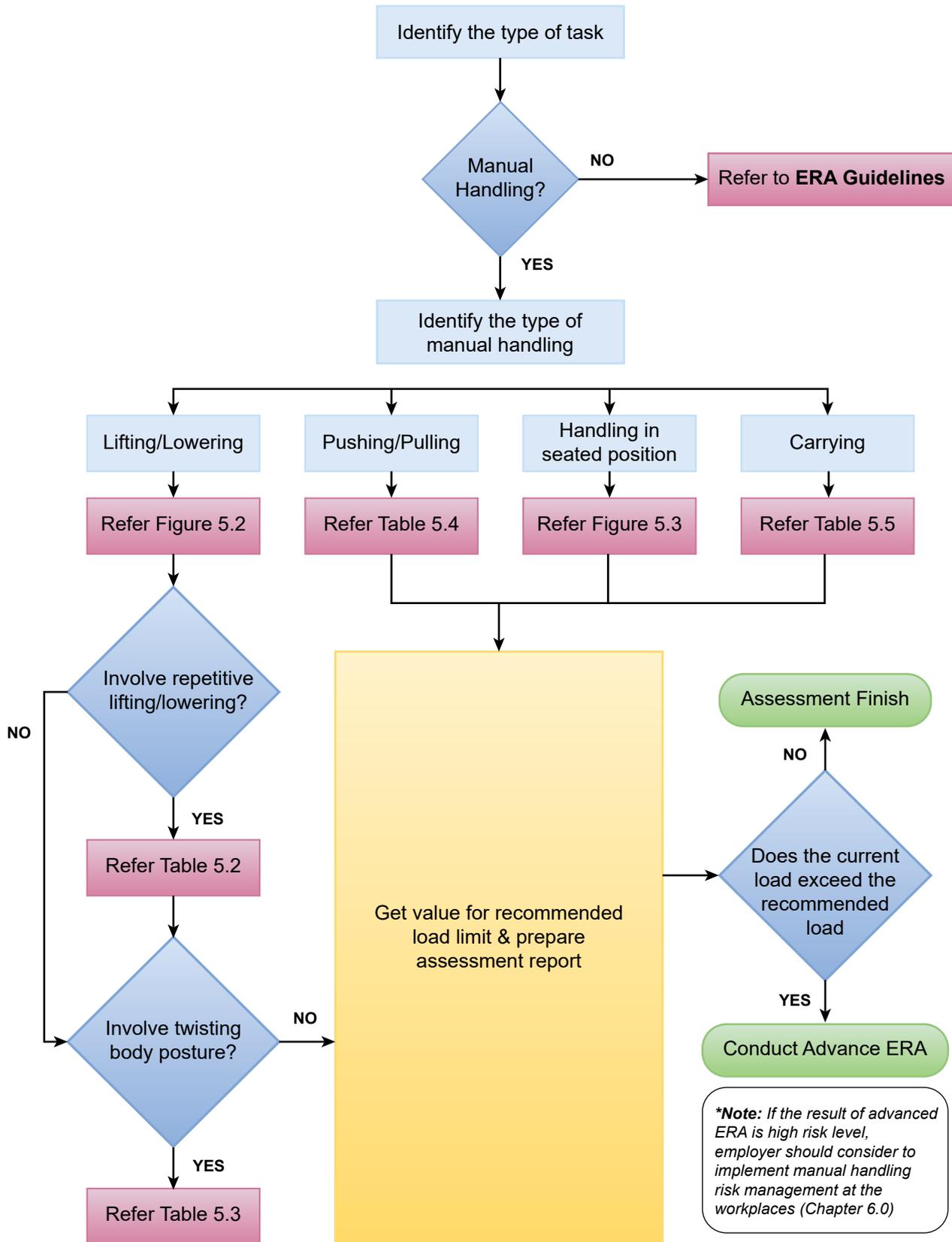
### **5.3.1 Initial Manual Handling Risk Assessment**

The initial manual handling risk assessment provides a quick and simple method for determining the necessity of advanced manual handling assessment. It provides recommended weight value for manual handling activities and helps employers to identify high risk manual handling activities.

If the task is within the recommended load limit the organisation normally does not need to do any other form of risk assessment unless you have individual employees who may be at significant risk, for example pregnant workers, young workers, those new to the job, or those with a significant health problem or a recent injury.

The initial risk assessment methods are based partly on data in published scientific literature and partly on practical experience of assessing risks from manual handling. They are pragmatic, tried and tested and set out approximate boundaries that will provide a reasonable level of protection to around 95% of working men and women. However, these values must not be regarded them as either safe weight limits or the maximum weight limit for manual handling operations. Because there are many factors that influence risk, there is no weight threshold where manual handling operations change from 'safe' to 'unsafe'. Even operations lying within the boundaries of the filters should be avoided or made less demanding wherever it is reasonably practicable to do so. Even for a minority of fit, well-trained individuals working under favourable conditions, operations which exceed the filter values by more than a factor of about two may represent a serious risk of injury. Always make these operations high priority for carrying out full risk assessments and implementing appropriate risk reduction measures.

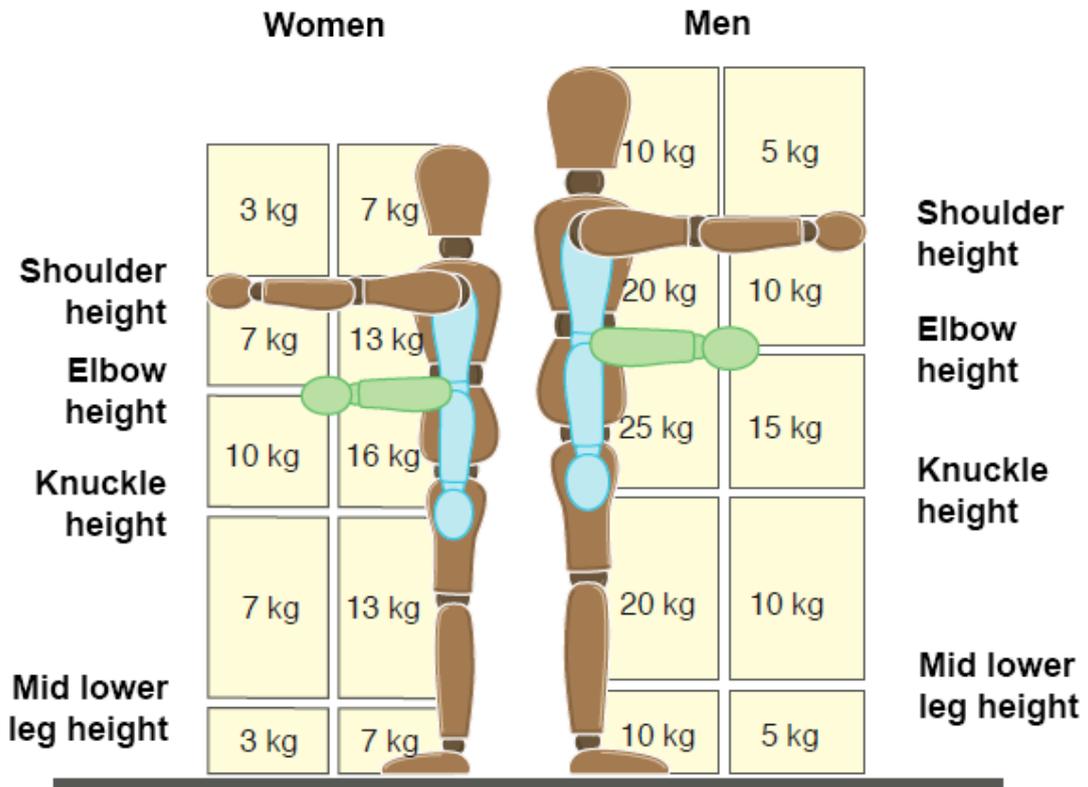
Process overview of initial manual handling risk assessment is illustrated in **Figure 5.1**. A summary or consolidated checklists of Initial Manual Handling Risk Assessment is as provided in **Appendix 2**.



**Figure 5.1: Process overview of initial manual handling risk assessment**

### 5.3.1.1 Lifting and Lowering

For lifting and lowering operation, the recommended weight is shown in **Figure 5.2**. Use **Table 5.1** to assist the assessment.



**Figure 5.2: Recommended weight**

**Table 5.1: Recommended weight limit for lifting and lowering**

Working height (where force is applied)	Recommended weight (male or female)	Current weight handled	Exceed limit?	
			Yes	No
Between floor to mid-lower leg				
Between mid-lower leg to knuckle				
Between knuckle height and elbow				
Between elbow and shoulder				
Above the shoulder				

**Guide to use Table 5.1**

- Step 1: Determine the gender of the employee.
- Step 2: Determine the working height of the employee.
- Step 3: Determine the proximity of the handling during forceful exertion (further away or close to the body).
- Step 4: Key in the recommended weight based on **Figure 5.2**.
- Step 5: Determine the current weight handled.
- Step 6: Compare if the limit is exceeded based on the current weight handled.

**Note:** If the lifter’s hands enter more than one box during the operation, then the smallest weight figure applies. An intermediate weight can be chosen if the hands are close to a boundary between boxes.

**5.3.1.2 Repetitive Lifting and Lowering**

The basic guideline figures for lifting and lowering in **Figure 5.2** are for relatively infrequent operations – up to approximately 30 operations per hour or one lift every two minutes. The guideline figures will have to be reduced if the operation is repeated more often.

If the manual handling task involves repetitive lifting and lowering, reduce the recommended weight as shown in **Table 5.2** with reference to **Figure 5.2**.

**Table 5.2: Recommended weight for lifting/lowering with repetitive operation**

If employee repeats operations	Weight limit* should be reduced by
Once or twice per minute	30%
Five to eight times per minute	50%
More than 12 times per minute	80%

\*Weight limit based on **Figure 5.2**

Example:

A male employee is carrying a weight between knuckle and elbow height close to his body. Based on **Figure 5.2**, the recommended weight is 25 kg. After observing the employee's frequency of lifting per minute, it was found that the average lifting frequency was between 7 to 8 times per minute. Therefore, the initial recommended weight need to be reduced by 50%, making the recommended weight is up to 12.5 kg only. If the employee was found to carry more than recommended weight, then an advanced ERA should be conducted.

### 5.3.1.3 Lifting and Lowering with Twisted Body Posture

If the manual handling task involves lifting and lowering with twisted body posture (if applicable), reduce the recommended weight as shown in **Table 5.3**, with reference to **Figure 5.2**.

**Table 5.3: Recommended weight for lifting/lowering with twisted body posture**

If employee twists body from forward facing to the side	Weight limit* should be reduced by
45 degrees	10%
90 degrees	20%

\*Weight limit based on **Figure 5.2**

Example:

A male employee is carrying a weight between knuckle and elbow height close to his body. Based on **Figure 5.2**, the recommended weight is 25 kg.

The employee needs to twist his body to the right side in order to place the weight on a shelf above. Based on observation, it was found that the degree of twisting was approximately 45 degrees. Thus, the recommended weight need to be reduced 10% of recommended weight in **Figure 5.2** (10% of 25kg). Therefore, the final recommended weight is  $25\text{kg} - 2.5 \text{ kg} = 22.5 \text{ kg}$ .

In addition, the employee was also observed to lift on average 5 to 8 times per minute, thus, the recommended weight should be reduced by 50% of recommended weight in **Figure 5.2** (50% of 25kg), which is 12.5 kg.

Therefore, the final recommended weight is:

$25\text{kg}$  (value from **Figure 5.2**) – 2.5 kg (reduction from twisting posture) – 12.5kg (reduction from repetition) = 10 kg

If the employee was found to carry more than recommended weight, then an advanced ERA should be conducted.

#### 5.3.1.4 Pushing and Pulling

For activities involving pushing or pulling, **Table 5.4** is applied with the following considerations:

- a) Force is applied with the hands;
- b) Hands are between knuckle and shoulder height;
- c) Distance for pushing or pulling is less than 20 m;

- d) Load is being supported on wheels;
- e) Pulling or pushing is using a well-maintained handling aid, that is, the wheels are properly aligned and in good condition.

If any of the above conditions (item (a) through (e)) are not met, advanced ERA is recommended for the pushing and/or pulling tasks.

**Table 5.4:** Recommended load weight based on type of activity for pushing and pulling

Activity	Recommended Weight	
	Male	Female
Stopping or starting a load	approximately 1000 kg load on the smooth level surface using well-maintained handling aid (or 200N pushing force measured using force dynamometer)	approximately 750 kg load on the smooth level surface using well-maintained handling aid (or 150N pushing force measured using force dynamometer)
Keeping the load in motion	approximately 100 kg load on the uneven level surface using well-maintained handling aid (or 100N pushing force measured using force dynamometer)	approximately 70 kg load on the uneven level surface using well-maintained handling aid (or 70N pushing force measured using force dynamometer)

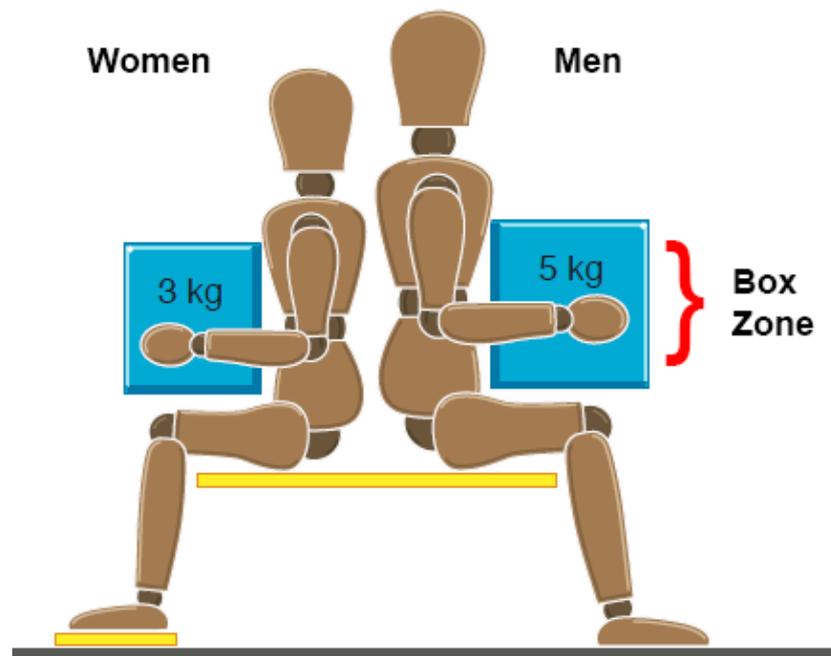
Example:

The amount of force that needs to be applied in order to move a load over a flat, level surface using a well-maintained handling aid is at least 2% of the load weight. On an uneven surface, the force needed to start the load moving could increase to 10% of the load weight, although this could be offset by using a handling aid with larger wheels. However, when there is a high slope and/or a ramp, it is recommended that the weight is reduced by 10%.

### 5.3.1.5 Handling in Seated Position

For handling of load in a seated position, an advanced ERA should be performed when:

- a) The load is beyond the recommended weight limit for male and female as indicated in **Figure 5.3**; OR
- b) The load is beyond the 'box zone' as indicated in **Figure 5.3**.



**Figure 5.3: Recommended weight limit for seated position**

### 5.3.1.6 Carrying task

When the task involves carrying load following lifting, several factors must be considered as follows:

#### a) Floor surface

- i) The floor surface is dry but in poor condition, worn or uneven
- ii) Contaminated/wet or steep sloping floor or unstable surface or unsuitable footwear

#### b) Environmental factor

Observe the work environment and score if the carrying operation takes place: in extremes of temperature; with strong air movements; or in extreme lighting conditions (dark, bright or poor contrast).

#### c) Carry distance

Observe the task and estimate the total distance that the load is carried. An acceptable distance should be within 2 to 10 meters. More than 10 meters considered as exceeding the limit.

#### d) Obstacles en route

Observe the route. If the operator has to carry a load up a steep slope, up steps, through closed doors or around tripping hazards, or if the task involves carrying the load up ladders or if the task involves more than one of the risk factors (e.g. a steep slope and then up ladders), an advanced ERA should be conducted.

Summary for carrying activities is shown in **Table 5.5**.

**Table 5.5: Summary for carrying activity**

Factor	Condition	Outcome
Floor Surface	Dry and clean floor in good condition	Acceptable
	Dry floor but in poor condition, worn or uneven	Conduct advanced ERA
	Contaminated/wet or steep sloping floor or unstable surface or unsuitable footwear	
Other environmental factors	No factors present	Acceptable
	One factor present (i.e. poor lighting condition)	Conduct advanced ERA
	Two or more factors present (i.e. poor lighting condition and strong air movements)	ERA
Carry distance	2 m—10 m	Acceptable
	More than 10 m	Conduct advanced ERA
Obstacles en route	No obstacles and carry route is flat	Acceptable
	Steep slope or up steps or through closed doors or trip hazards or using ladders	Conduct advanced ERA

An advanced ERA for manual handling activity with carrying operation should be conducted if the outcome from any of the factors above is not acceptable.

**Table 5.6** summarise the findings of initial risk assessment. Forceful exertion findings in any of the manual handling activities in **Table 5.6** which is, indicated with “YES” requires an advanced ERA.

**Table 5.6: Summary table for a single manual handling activities**

Activity	Recommended Weight Limit	Exceed limit?	
		Yes	No
Lifting and lowering only	based on <b>Figure 5.2</b> and <b>Table 5.1</b>		
Repetitive lifting and lowering	based on <b>Figure 5.2</b> and <b>Table 5.2</b>		
Twisted body posture while lifting and lowering	based on <b>Figure 5.2</b> and <b>Table 5.3</b>		
Repetitive lifting and lowering with twisted body posture	based on <b>Figure 5.2</b> , <b>Table 5.2</b> and <b>Table 5.3</b>		
Pushing and pulling	based on <b>Table 5.4</b>		
Handling in seated position	based on <b>Figure 5.3</b>		
Carrying task	based on <b>Table 5.5</b>		

### 5.3.2 Advanced ERA

There is no such thing as a completely 'safe' manual handling operation. But working within the following guidelines will cut the risk and reduce the need for a more detailed assessment. If it shows the manual handling is within the guideline figures (bear in mind the reduced limits for twisting and frequent lifts) you do not need to do any more in most cases. But you will need to make a more detailed assessment if:

- the conditions given for using the guidelines (e.g. the load can be readily grasped with both hands) are not met;
- the person doing the lifting has reduced capacity, e.g. through ill health or pregnancy;
- the handling operation must take place with the hands beyond the boxes in the diagram;
- there are extra risk factors like uneven floors or constricted spaces;
- the employee can't push or pull the load with their hands between knuckle and shoulder height;
- the load has to be moved for more than about 20 m without a break; or
- the guideline figures in above guidelines are likely to be exceeded.

For Advanced ERA or existing/combine ergonomics risk factors, refer to *Guidelines on Ergonomics Risk Assessment at Workplace 2017*.

# 6.0 MANUAL HANDLING RISK MANAGEMENT

This chapter provides a means for ergonomics risk management for manual handling activities in the workplace. It provides general principles in controlling manual handling related hazards through systematic approaches of the ergonomics management programme, engineering approaches, administrative approaches and personal protective equipment (PPE).

## 6.1 Ergonomics Management Programme

The ergonomics management programme is defined as:

“A structured programme established to systematically manage the ergonomics issues and its implementation at the workplaces”

The programme look at systematic approaches to managing ergonomics in the workplace by addressing the 3 elements of leadership elements, organizational elements and operational elements and its sub-elements (**Figure 6.1**). Often, the ergonomics management programme started due to various reasons as follows:

- High incident of MSDs
- The high cost of managing incidents
- Prolonged return to work
- Intention to increase production
- To address complaints/feedback from employees
- To address legislatives/standards requirements
- Intention to increase work/product quality

# ELEMENTS OF WORLD-CLASS ERGONOMICS

## Leadership Elements

- Strong Demonstrated Management Commitment
- Written Ergonomics Policies and Guidelines
- High Standards of Performance
- Promote Early Reporting of Injuries

## Organizational Elements

- Supportive Engineering/Safety Personnel
- Ergonomics as a Line Organization Responsibility
- Integrated Organization for Ergonomics

## Operational Elements

- Ergonomics Risk Identification & Assessment
- Hazard Prevention and Controls
- Medical Management & Evaluation
- Continuous Ergonomics Training and Development
- Programme Review and Evaluation

Figure 6.1: Ergonomics Management Programme Elements

### 6.1.1 Leadership Elements

#### 6.1.1.1 Strong Demonstrated Management Commitment

Management commitment is a key and controlling factor in determining whether the ergonomics hazards control programme will be successful. Management commitment can be expressed through:

- Demonstrated management commitment
- Integrate ergonomics protection principles in production processes
- Assign and communicate the responsibility for the various aspects of the ergonomics programme so that all managers, supervisors, and employees involved know what is expected from them
- Provide adequate authority and resources
- Ensure that each manager, supervisor, and employee responsible for the ergonomics programme in the workplace is accountable for carrying out those responsibilities

#### 6.1.1.2 Written Ergonomics Policies, Guidelines and Procedures

The organisation might want to establish related policies/guidelines/procedures regarding ergonomics at the workplaces. The written policies/guidelines/procedures should be:

- Endorsed and advocated by the highest level of management
- Outlines the employer's goals and plans
- Suitable for the size and complexity of the workplace operations
- Communicated to all personnel
- Establish clear goals, and objectives to meet those goals
- Include the earliest feasible implementation dates for completion of each programme element

#### **6.1.1.3 High Standards of Performance**

Ergonomics activities, target and goals should be geared at high standards of performance.

#### **6.1.1.4 Promote Early Reporting of Symptoms**

Management should encourage early reporting of symptoms by:

- Establishing methods for symptoms reporting (i.e. musculoskeletal pain/discomfort survey; see **Appendix 1**)
- Establishing methods for trend analysis
- Establishing methods for case management

## 6.1.2 Organizational Elements

### 6.1.2.1 Supportive Engineering/Safety Personnel

The safety/engineering personnel must be equipped with enough resources, knowledge and skills to implement ergonomics programme at the workplace. Resources needed such as trainings, detailed instruction to ergo leaders, bring in outside experts until in-house expertise can be developed need to be committed by the top management. Other than that, the management need to commit resources to implement ergonomics improvement as needed, provide time/allowances for employees expected to handle task with ergonomics concern, furnish information to all expected to handle task with ergonomics concern and provide evaluative method to track the results of ergonomics process improvements.

### 6.1.2.2 Ergonomics as a Line Responsibility

Ergonomics risk identification and management is spread across the board by empowering the employees to play a role in ergonomics management. The role and functions of top management, supervisory and employees should be clearly defined.

The employee involvement in ergonomics programme can be encouraged throughout the implementation of ergonomics programme, making decisions that affect employee safety and health, giving prompt and accurate reporting of signs and symptoms of MSDs and giving complaint or suggestion related to ergonomics.

Furthermore, employee involvements can be through safety and health committee that receive information on ergonomics problem areas, analyze them, and make recommendations for corrective action. Some organization even have designated ergonomics teams/ergonomics focal person with the required skills to identify and analyze jobs for ergonomics stress and recommend solutions.

### 6.1.2.3 Integrated Organisation for Ergonomics

Since ergonomics itself is multidisciplinary, the teams in charge of ergonomics programmes at work ideally should be represented by various departments as follows:

▶ Engineering	▶ Medical
▶ Manufacturing Engineering	▶ Materials
▶ Maintenance	▶ Quality
▶ Management	▶ Production
▶ Human Resources	▶ Safety and Health

## **6.1.3 Operational Elements**

### **6.1.3.1 Ergonomics Risk Identification and Assessment**

Ergonomics risk such as heavy load handling, repetitive task, work in awkward positions, extreme environments and others should be identified. The organization should establish procedures to identify ergonomics risk and assess the level of risk regarding ergonomics.

### **6.1.3.2 Hazard Prevention and Control**

Once ergonomics hazard is identified through the systematic worksite analysis discussed above, the next step is to design measures to prevent or control these hazards.

Ergonomics hazard are prevented primarily by effective design of the workstation, tools, and job. To be effective, an employer's programme should use appropriate engineering and work practice controls, PPE and administrative controls to correct or control ergonomics hazard, including those identified in the following paragraphs:

#### **1. Engineering controls**

Engineering approaches, where feasible, are the preferred method of control. The focus of an ergonomics programme is to make the job fit the person, not to force the person to fit the job. This can be accomplished by designing or modifying the workstation, work methods, and tools to eliminate excessive exertion and awkward postures and to reduce repetitive motion.

#### **2. Administrative controls**

Administrative controls deal with how the work is designed and structured. Examples of administrative controls are proper maintenance and housekeeping programs, job enlargement and rotation, work scheduling, giving sufficient breaks, proper work practice and training programs.

### 3. Personal protective equipment

PPE can be provided as part of the mechanism of risk controls. The PPE supplied should have proper selection, evaluation, distribution and storage mechanism. Selection of PPE, from an ergonomics point of view should consider its proper fitting to the user and comfort of usage.

#### 6.1.3.3 Medical Management

Proper medical management is necessary both to eliminate or materially reduce the risk of development of MSDs signs and symptoms through early identification and treatment and to prevent future problems through the development of information sources.

Thus, an effective medical management programme for MSDs is essential to the success of any employer's ergonomics programme. In an effective programme, health care practitioners will be part of the ergonomics team, interacting and exchanging information routinely in order to prevent and properly treat MSDs. Each work shift should have access to health care services in order to facilitate treatment, surveillance activities, and recording of information.

The medical management programme should address the following issues: injury and illness recordkeeping; early recognition and reporting; systematic evaluation and referral; treatment; return to work programme; systematic monitoring and adequate staffing and facilities.

Recommendations for medical management of MSDs are evolving rapidly, and health care practitioners should monitor developments on the subject.

#### 6.1.3.4 Training and Education

A training programme should include all affected employees, engineers and maintenance personnel, managers and to some extent the health care practitioners.

The programme should be designed and implemented by qualified persons and presented in language and at a level of understanding appropriate for the individuals being trained. The training programme should be evaluated on its effectiveness on a timely basis. **Table 6.1** shows the effective training programmed that can be done by organization.

**Table 6.1: Structure of effective training programme**

Who	What	When
<ul style="list-style-type: none"> <li>• Management</li> </ul>	<ul style="list-style-type: none"> <li>• Benefit of ergonomics</li> <li>• Programme elements</li> </ul>	<ul style="list-style-type: none"> <li>• Beginning of programme</li> <li>• Periodic progress reports</li> </ul>
<ul style="list-style-type: none"> <li>• Supervisors</li> <li>• Safety and health committee</li> <li>• Ergonomics coordinators</li> </ul>	<ul style="list-style-type: none"> <li>• Ergonomics risk identification and assessment</li> <li>• Basic problem solving</li> <li>• Handling reports of discomfort or injury</li> <li>• Purchasing requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Beginning of programme</li> <li>• Periodic refresher and advanced courses</li> </ul>
<ul style="list-style-type: none"> <li>• Employees</li> </ul>	<ul style="list-style-type: none"> <li>• Types of MSDs and their symptoms</li> <li>• Importance of early reporting</li> <li>• Risk factors for MSDs</li> <li>• Workstation adjustment</li> <li>• Proper posture, work habits and exercises</li> </ul>	<ul style="list-style-type: none"> <li>• Beginning of programme</li> <li>• New employee orientation</li> <li>• Periodic refresher course</li> </ul>
<ul style="list-style-type: none"> <li>• Purchasing personnel</li> <li>• Facilities and engineering personnel</li> </ul>	<ul style="list-style-type: none"> <li>• Ergonomics design features</li> <li>• Proper workstation set-up</li> </ul>	<ul style="list-style-type: none"> <li>• Beginning of programme</li> <li>• When changing furniture or facilities</li> </ul>
<ul style="list-style-type: none"> <li>• Healthcare practitioners</li> </ul>	<ul style="list-style-type: none"> <li>• Job tasks and physical demands</li> <li>• Available light duty work</li> </ul>	<ul style="list-style-type: none"> <li>• Beginning of programme</li> </ul>

### 6.1.3.5 Regular Programme Review and Evaluation

Regular programme review and evaluation should be conducted continually. The organization may conduct a review and evaluation through:

- Analysis of trends in injury/illness rates
- Employee surveys
- Before and after surveys/evaluations of job/worksites changes
- Review of results of workplace evaluations
- Up-to-date records or logs of job improvements implemented

## 6.2 Engineering Approach

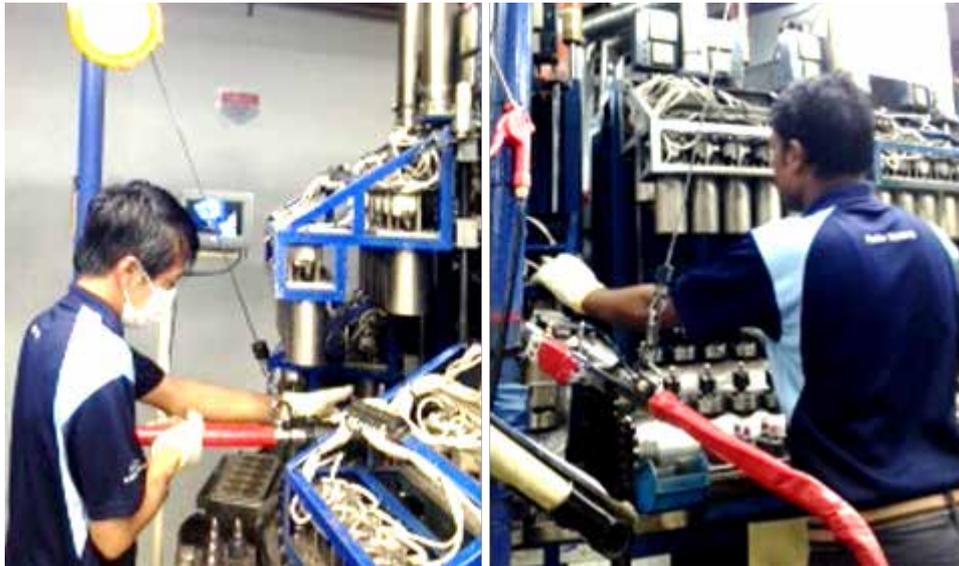
Engineering approach is the most common method to reduce or eliminate work related MSDs and can also give an immediate effect on controlling ergonomic risk factors, stress and fatigues. Some generic examples of the ergonomic engineering approach (related to manual handling in the industry) may include:

- Modifying tools
- Redesigning the workstation
- Using powered equipment
- Applying automation

### 6.2.1 Modifying Tools

The modification of the hand tools may improve the handling performance. Modification of the hand tools can be determined by certain parameters which are weight, shape, length and handling. Examples of modification of hand tools are as follows:

- i. The weight of the tool can be reduced by using a balancer. **Figure 6.2** shows example of a spring balancer equipped with jib crane is used to move up and down hand-tools, and reduce manual handling effort for employees.
- ii. Changing the pistol grip to linear grip can improve the handle shape.
- iii. Extending the hoses, wires, nozzles or handle to increase their length and improve the hand tool movement.
- iv. An appropriate method of handling tools can be done by improving the handles, therefore fixing correct angles between the arms and objects.



**Figure 6.2: A spring balancer equipped with jib crane is used to move up and down hand-tools, and reduce manual handling effort for employees**

### **6.2.2 Redesign the Workstation**

Based on the ergonomics principle of fitting the machine or tasks to employees (or human), the design of the workstation has to take into account factors such as size, shape and layout between employees and workstation to eliminate ergonomics risk factors which are listed below:

- Static or awkward posture
- Repetitive motion
- Forceful exertion

Example of engineering approach that can be implemented in redesign workstation are:

- Turntable – for multi-direction process
- Ball bearing/flow track – for reducing operation forces (pushing and pulling) as illustrated in **Figure 6.3**
- Tilting – for direction involved degree of point
- Auto clamping lifter and hydraulic cylinder lifter - for reducing operation forces (lifting and lowering) as in **Figure 6.4**



**Figure 6.3: An assembly line embedded with roller tracks and ball bearings allows heavy objects to be turned and repositioned**



**Figure 6.4: Auto-clamping lifter used to lift up/down and turn products (Left) and a hydraulic-cylinder lifter allows products to be lowered and pushed into transferring conveyor by means of a foot-switch (Right).**

### 6.2.3 Powered Equipment

Powered-equipment is an industrial machine powered by actuating medium, such as electricity and fossil fuels that can raise, lower and move heavy objects in workplaces. Implementation of power equipment must be combined with employee trainings, maintenance programme and compliance with safety precaution. Examples of these include:

1. Forklift
2. Hoist
3. Vacuum Tube Lifting System
4. Auto Leveller
5. Battery-operated Dolly
6. Automatic guided vehicle (AGV) as illustrated in **Figure 6.5**



**Figure 6.5: A powered-reach truck is used to move and lift materials short/long distances (Left). A tugging AGV used for pulling trolleys loaded with heavy objects between workstations (Right)**

### 6.2.4 Applying Automation

Automation is the application of making work processes, apparatus and systems by mechanical or electrical devices so that tasks can be eliminated or are less repetitive. The greatest advantages of using automation system are saving of time, energy, labour and improving the quality and accuracy of process and products.

Low Cost Automation (LCA) or Low Cost Intelligent Automation (LCIA) is used for offering an inexpensive but effective automation system and available for applying to existing equipment, tools, workstation and others at low cost. An example of the components and materials for LCA/LCIA are hydraulic cylinder, electronic sensors, electric motors and other low-cost materials (including in-plant recycled materials). Further information can be referred to the engineering approach case studies in **Appendix 3**.

### 6.3 Administrative Approach

Administrative approach are changes in work procedures, such as written policies, rules, supervision, schedule, and training with the goal of reducing the duration, frequency and severity of exposure to hazardous situations.

#### 6.3.1 Work Practice

Providing safe and effective procedures for completing work tasks can reduce MSDs risk. In addition, employees should be trained in the proper work technique and encouraged to accept their responsibilities for MSDs prevention. Some of the tasks can be done through team lifting. Some methods of safe lifting technique are shown in **Appendix 4**.

#### 6.3.2 Training and Education

Providing training to employees can enhance the knowledge and skill on ergonomics issue such as proper manual handling technique, identify manual handling risk factor, symptoms identification and reporting, ergonomics self-improvement and control initiatives such as stretching and strengthening techniques and others. These activities are meant to guide employees with the knowledge on how to prevent MSDs.

#### 6.3.3 Employees Selection and Job Assignment

Purpose of selection is to identify and assign the right employee for the right job. The management should screen the employees in order to identify the employees with following condition:

- Suffering from previous musculoskeletal problems
- Low fitness individuals
- Current health problems
- Undergo certain medical treatment

The management may also define standards for employee's selection and assign the employees to more suitable work/job.

### 6.3.4 Strengthening Exercise

Conditioning through flexibility and strengthening back exercises not only facilitates the back avoid injury, or belittle the severity of harm if the spine is traumatized, it likewise can help ease the annoyance of many back conditions. Many back exercises can help tone up the spinal column with the holding muscles, ligaments, and tendons. Some of the back strengthening exercises can be referred in **Appendix 5**.

### 6.3.5 Job Redesign

Sometimes it is not the nature of job that needs a makeover, but the responsibilities and roles of employee that do. Job redesign is an effort where job responsibilities and tasks are reviewed, and possibly re-allocated among employee. In doing so, the manager essentially prevents an employee from losing motivation and interest in their work as well as can reduce the risk taken by the employee while doing the job. Job rotation and job enlargement is one of the ways to redesign an employee's job.

### 6.3.6 Job Rotation and Job Enlargement

Job rotation is one of the job redesign strategy that assigns employees to an alternate job on a temporary base. Job rotation is useful and motivating in several ways. Foremost, it offers employees with something new to learn and act beyond their normal job does. Second, it provides employees with a broader perspective on how the system functions as a whole. Third, it increases the employee's understanding of what his or her co-employees do, which leads to a higher level of respect for what others get along. In the end, it provides an employee the chance to acquire additional skills, which increases their value to the system. Essentially, job rotation is great at adding variety and encouraging respect among equals, while sparking new interest in the establishment.

Job enlargement is an increase in job tasks and responsibilities to make a more challenging position. It is a horizontal expansion, which means that the tasks added are at the same level as those in the current position. Job task enlargement is a means to reduce duration, frequency and severity of MSD risk factors. Employees can rotate between workstations and tasks to avoid drawn out periods of performing a single project, thereby reducing fatigue that can lead to MSDs.

**Figure 6.6** shows the combination of job rotation and job enlargement where the employee rotates their job to do the different task, but in the same level as their current position.



**Figure 6.6: Combination of Job Rotation and Job Enlargement**

### 6.3.7 Consider the Work-Rest Ratio

Rather than being exposed to risk for extended periods of time during the course of a job, employees should, wherever possible, be permitted to distribute the workload evenly over the day and incorporate work-rest cycle. For example, the employers must ensure that repetitive or demanding task performed by employees incorporate opportunities for relaxation or recovery breaks (e.g. allow brief pauses to relax muscles; change work tasks; change postures or techniques).

### 6.3.8 Provide Enough Welfare Facilities

Employee welfare is a comprehensive term, including various services and facilities provided to the employee for their betterment. Employee welfare means anything done for the comfort and improvement, intellectual or social of the employee. In related to the employee health, the employer should consider for providing basic things such as:

- Toilet and hand soap, with soap and towel or a hand dryer
- Drinking water
- A place to store clothing (for changing if special clothing is worn)
- Proper rest and dining area

In order to have a good facility for healthy working environment in the facilities provided, the following conditions should be considered:

- Adequate ventilation; fresh air, clean air drawn from outside or ventilation system
- Suitable lighting for work being carried out
- Enough space and suitable workstation

### **6.3.9 Workstation Redesign**

Workstation redesign is used to assess how tasks or the entire job is organised within the work environment, and then ensure these are well-matched to the attributes of the employee. Workstation redesign having a more pragmatic approach and addressing those adjustments that may be required for workstations, tools, and body positions to allow the employee works more effectively. Besides, workstation redesign allows employees to see how the work methods, layout and handling procedures link together as well as the interaction between people and machines.

### **6.3.10 Maintenance and Housekeeping Programmes**

Proper housekeeping and a preventive maintenance programme are critically important in preventing injuries, illnesses, and even fatalities.

Effective housekeeping includes keeping work areas neat and orderly, maintaining floors from slip and trip hazards, removing waste materials, including fire hazards and having a good workplace layout, aisle markings, adequate storage facilities and maintenance.

Preventive maintenance is predetermined work performed to a schedule with the aim of preventing the wear and tear or sudden failure of equipment components. This helps to protect assets and prolong the useful life of production equipment, improve system reliability, decrease cost of replacement and system downtime as well as reduce the risk of injuries.

### **6.3.11 Recordkeeping**

All the records such as self-assessment forms, complaint records or related medical records, walk through inspection and initial finding, investigation report, assessment report, corrective action report and training records shall be kept in accordance with set guidelines, regulations or standards. All records that are generated under these Guidelines should be

kept for a period of not less than five years, except assessment report and investigation report, which should be kept for a period of not less than thirty years.

## 6.4 Personal Protective Equipment

This section provides PPE selection guide specifically for performing manual handling task/activities. PPE should be selected with ergonomic concern in mind. Appropriate PPE should be provided in a variety of sizes, accommodate the physical requirements of employees and the job, also not contribute to extreme postures and excessive forces.

### 6.4.1 General Principle for PPE

All PPE clothing and equipment should be of safe design and construction, and should be maintained in a clean and reliable fashion. Employers should take the fit and comfort of PPE into consideration when selecting appropriate items for their workplace. The following factors need to be considered when selecting PPE in the manual handling task and activities:

#### a) Proper Fit

PPE that fits well and is comfortable to wear will encourage employee use of PPE. If PPE does not fit properly, it can make the difference between being safely covered or dangerously exposed. It may not provide the level of protection desired and may discourage employee use. For example, gloves that are too thick or that fit improperly can reduce blood circulation and sensory feedback, contribute to slippage, and require excessive grip strength.

#### b) Protection Against Extreme Heat/Cold

The correct selection of protective equipment against hazards associated with hot/cold working places requires the determination of the relation between the intensity of the workplace-related hazards and the performance level of PPE. Proper gloves and body coverall selection is necessary when handling a hot/cold objects or when do the manual handling activities in a hot/cold environment.

#### c) Ergonomics Stressor Consideration

The types of PPE that may be selected for use in manual handling activities (e.g., arm guards) should not increase ergonomic stressors. When choosing PPE, it is important to consider the task or type of job that the person needs to do. **Table 6.2** gives the guidance on how to select the right PPE for the job performed.

**Table 6.2: Appropriate PPE recommended to minimize the risk for certain body part.**

Risk	Body Part	PPE
Contact with hard object such as tools, machinery or product during manual handling operation	Hands	Padded gloves
	Elbow/ forearm	Elbow pads
	Knees	Knee pads
Handling object – lifting or lowering, pushing or pulling, gripping, carrying	Hands	Gloves that fit and grip well
Vibration	Hands	Well-fitting anti vibration gloves
Slips, Trips and Falls	Feet	Anti-slip, proper fitting footwear
Cold Environment	Body	Warm clothing
	Hands	Warm gloves that fit and grip well
Hot Environment	Body	Cold Jacket Silver apron

#### **d) Purchasing consideration**

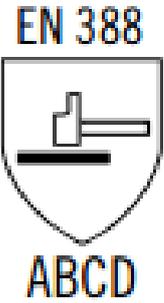
A consultation from PPE supplier or opinion from the safety and health representative should need to be considered first before purchase any PPE that shall be used by the employee.

#### **e) Training**

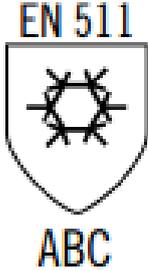
When the employee need to use the PPE, he or she need to be trained to use PPE correctly to avoid risk of injury, ill-health or, under extreme circumstances, death.

## 6.4.2 Protective Gloves

When doing the manual handling works, there is always the risk of getting the hands injured and employers must ensure that employees wear appropriate protection.

	<p><b>Mechanical Protection</b></p> <p>The variety of potential occupational hand injuries makes selection of the right pair of gloves become more challenging. It is essential that employees use gloves specifically designed for the hazards and tasks found in their workplace because gloves designed for one function may not be suitable for a different function even though they may appear to be an appropriate protective device.</p>
---	--

Performance Levels	0	1	2	3	4	5
a. Abrasion Resistance Cycles	<100	100	500	2,000	8,000	-
b. Blade Cut Resistance (index)	<1.2	1.2	2.5	5.0	10.0	20
c. Tear Resistance (newton)	<10	10	25	50	75	-
d. Puncture Resistance (newton)	<20	20	60	100	150	-

	<p><b>Cold Protection</b></p> <p>This standard applies to any gloves that protect the hands against convective and contact cold down to -50°C. Protection against cold is expressed by an icon followed by a series of three performance levels relating to specific protective qualities.</p>
---	--

Performance Levels	1	2	3	4	5
a. Convective cold Thermal insulation ITR m <sup>2</sup> .°C/W	I<0.10	0.10<I <0.25	0.15<I <0.22	0.22<I <0.30	0.30<
b. Contact cold Thermal resistance R in m <sup>2</sup> .°C/W	R<0.025	0.025<R <0.050	0.050<R <0.100	0.100<R <0.150	0.150<R
c. Water penetration test	Fail	Pass	-	-	-
d. Puncture Resistance (newton)	20	60	100	150	-

	<p><b>Heat Protection</b></p> <p>This standard specifies thermal performance for protective gloves against heat and/or fire. The nature and degree of protection is shown by an icon followed by a series of six performance levels, relating to specific protective qualities.</p>
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Performance Levels	1	2	3	4
a. Resistance to flammability (seconds)	<20s no requirement	<10s <120s	<3s <25s	<2s <5s
b. Contact heat (contact temperature & threshold temperature)	100 °C >15s	250 °C >15s	350 °C >15s	500 °C >15s
c. Convective heat (heat transfer delay)	>4s	>7s	>10s	>18s
d. Radiant heat (heat transfer delay)	>5s	>30s	>90s	>150s
e. Small drops molten metal (# drops)	>5	>15	>25	>35
f. Large quantity molten metal (mass)	30g	60g	120g	200g

### 6.4.3 Elbow Pad

The function of elbow pad is to support the employee's elbow, including possibly a significant portion of the upper body weight of the employee and assists in steadying the employee's hands. The elbow pad may include a recess or a through hole for receiving and maintaining a preferred position of the employee's elbow during performing the work. The pad relieves contact stress, pain and discomfort when performing manual handling jobs. **Figure 6.7** show some example of elbow pad that commonly used in industry.



**Figure 6.7: Example of elbow pad**

#### **6.4.4 Knee Pad**

Knee pads are an essential part of an employee's gear and offer a level of protection from sharp impact. Knee pad also allows the employee to slide and rotate on soft and hard surface more easily. Floor work such as shown in **Figure 6.8** should always be done with a good set of knee pads as the jobs will be made more comfortable. Knee pads reduce impact, evenly distribute pressure and move with the wearer. Moreover, knee pad is most useful in reducing pain from the prolonged pressure of kneeling while they don't feel bulky or feel cumbersome. Besides, knee pad also offers less protection from striking blows. Knee pads come in many varieties and it is important to understand which one to use in each situation.



**Figure 6.8: Example of the work that is need to use knee pad**

### 6.4.5 Back Support/Braces/Splints

Generally, braces, splints, back belts, and other similar devices as shown in **Figure 6.9** are not considered as PPE. Currently, the result of the several studies that have been conducted in identifying the effectiveness of the back belt is still inadequate to conclude that using a back support will reduce the injuries of the employee during manual handling.

Back support is not recommended to be used by the employees unless they get advices and being supervised by the treating physician due to:

- i. There are lacks of scientific evidence that proving the effectiveness of the back support.
- ii. The uses of the back support tend to limit the mobility of the employee, reduce the flexibility of muscle and may contribute to the back injury.
- iii. By having a back support, it can create a false sense of security to the employee and because of that there is a probability that the employee may attempt to lift more weight than they would have without back support.

However, if the management decide to supply the back support to the employees, the employee must be trained on the proper usage of the back support, use it only during heavy manual handling activities and use in conjunction with good manual handling practices



**Figure 6.9: Example of back support/braces/splint**

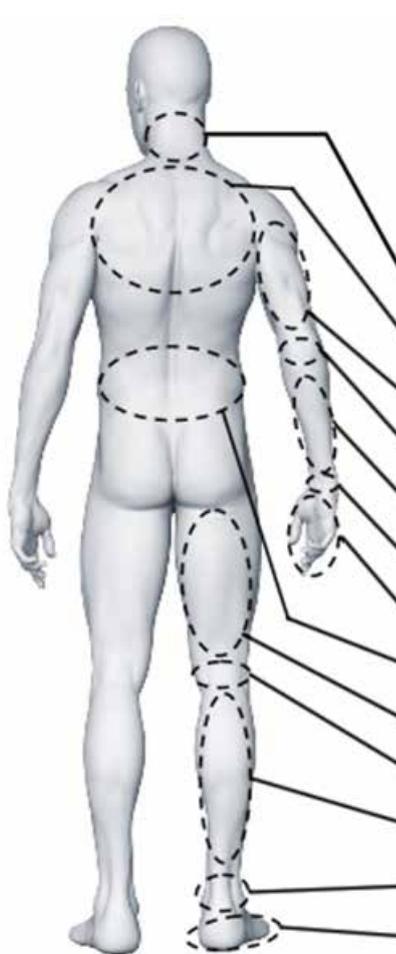
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## APPENDIX 1: SELF ASSESSMENT MUSCULOSKELETAL PAIN / DISCOMFORT SURVEY FORM (Refer to Part 5.2)

### Instruction:

1. Tick (✓) on any body parts (Column A) if you feel discomfort/pain during your work in the last 12 months
2. For those body parts you were feeling pain/discomfort, tick (✓) (Column B) if in your opinion, the pain is due to your work.



Body Parts	A		B	
	I have pain/ discomfort in the following body parts.		I think the pain/ discomfort comes from work.	
Neck				
Upper back				
Upper arm	L	R	L	R
Elbow	L	R	L	R
Lower arm	L	R	L	R
Wrist	L	R	L	R
Hand	L	R	L	R
Lower back				
Thigh	L	R	L	R
Knee	L	R	L	R
Calf	L	R	L	R
Ankle	L	R	L	R
Feet	L	R	L	R

Name : \_\_\_\_\_ Staff ID No. : \_\_\_\_\_  
 Department : \_\_\_\_\_ Job Task : \_\_\_\_\_  
 Contact No. : \_\_\_\_\_  
 Date : \_\_\_\_\_

*(Do not write anything in the below section. To be filled by trained person only)*

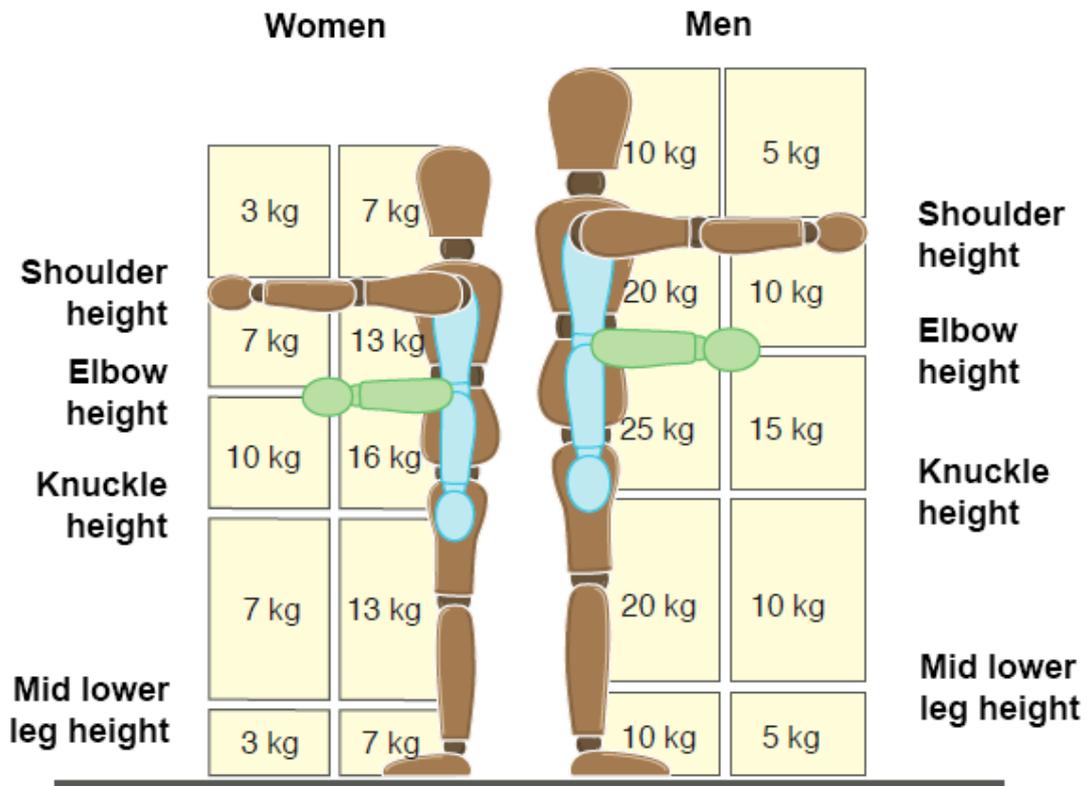
Is/Are the symptom(s) work related?      Yes       No

Comments : \_\_\_\_\_  
 \_\_\_\_\_

Name : \_\_\_\_\_ Date : \_\_\_\_\_

**APPENDIX 2: INITIAL MANUAL HANDLING RISK ASSESSMENT CHECKLISTS**  
 (Refer to Part 5.3.1)

**1. Lifting and Lowering**



**Figure 5.2: Recommended weight**

Working height (where force is applied)	Recommended weight (male or female)	Current weight handled	Exceed limit?	
			Yes	No
Between floor to mid-lower leg				
Between mid-lower leg to knuckle				
Between knuckle height and elbow				
Between elbow and shoulder				
Above the shoulder				

## 2. Repetitive Lifting and Lowering

If employee repeats operations	Weight limit* should be reduced by
Once or twice per minutes	30%
Five to eight times per minute	50%
More than 12 times per minute	80%

\*Weight limit based on *Figure 5.2*

## 3. Lifting and Lowering with Twisted Body Posture

If employee twists body from forward facing to the side	Weight limit* should be reduced by
45 degrees	10%
90 degrees	20%

\*Weight limit based on *Figure 5.2*

## 4. Pushing and Pulling

Activity	Recommended Weight	
	Male	Female
Stopping or starting a load	approximately 1000 kg load on the smooth level surface using well-maintained handling aid (or 200N pushing force measured using force dynamometer)	approximately 750 kg load on the smooth level surface using well-maintained handling aid (or 150N pushing force measured using force dynamometer)
Keeping the load in motion	approximately 100 kg load on the uneven level surface using well-maintained handling aid (or 100N pushing force measured using force dynamometer)	approximately 70 kg load on the uneven level surface using well-maintained handling aid (or 70N pushing force measured using force dynamometer)

## 5. Handling in Seated Position

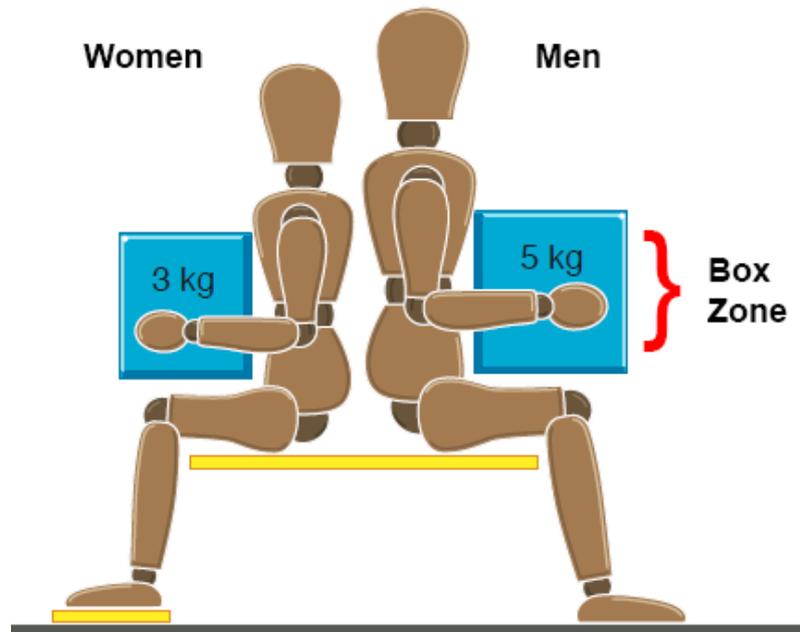


Figure 5.3: Recommended weight limit for seated position

## 6. Carrying task

Factor	Condition	Outcome
Floor Surface	Dry and clean floor in good condition	Acceptable
	Dry floor but in poor condition, worn or uneven	Conduct advanced ERA
	Contaminated/wet or steep sloping floor or unstable surface or unsuitable footwear	
Other environmental factors	No factors present	Acceptable
	One factor present (i.e. poor lighting condition)	Conduct advanced ERA
	Two or more factors present (i.e. poor lighting condition and strong air movements)	
Carry distance	2 m—10 m	Acceptable
	More than 10 m	Conduct advanced ERA
Obstacles en route	No obstacles and carry route is flat	Acceptable
	Steep slope or up steps or through closed doors or trip hazards or using ladders	Conduct advanced ERA

### Summary table for a single manual handling activities

Activity	Recommended Weight Limit	Exceed limit?	
		Yes	No
Lifting and lowering only	based on <b>Figure 5.2</b> and <b>Table 5.1</b>		
Repetitive lifting and lowering	based on <b>Figure 5.2</b> and <b>Table 5.2</b>		
Twisted body posture while lifting and lowering	based on <b>Figure 5.2</b> and <b>Table 5.3</b>		
Repetitive lifting and lowering with twisted body posture	based on <b>Figure 5.2</b> , <b>Table 5.2</b> and <b>Table 5.3</b>		
Pushing and pulling	based on <b>Table 5.4</b>		
Handling in seated position	based on <b>Figure 5.3</b>		
Carrying task	based on <b>Table 5.5</b>		

## APPENDIX 3: CASE STUDIES (Refer to Part 6.2.4)

Case #1	Ergonomics Solution to Carrying Loads
Ergonomics Issue:	The employee had to perform awkward motions and bending when the boxes were nearly empty
Improvement Measure:	Storage lifter with two pulleys
Description:	The storage lifter, suspended to wires supported with two pulleys, is used for raising the boxes on the shelf to comfortable posture

### Description:



### Task Description

#### Before

The employee had to bend down to carry styrofoam boxes to the worktable.

#### After

The modified storage rack can raise each box to waist height as well as reduce awkward postures of the low back such as bending forward when unloading the boxes.

#### Ergonomics/Operational Effects:

- Reduce the stress and fatigue on arms, shoulders, low back and knees from repetitive bending to pick up the boxes

#### Notes:

- The storage rack was made with recycled materials, i.e., used pipes, iron scraps from the press factory and other in-house using inexpensive materials

<b>Case #2</b>	<b>Ergonomics Solution to Screw-driving Task (Overreaching Postures)</b>
Ergonomics Issue:	Overreaching
Improvement Measure:	Platform to raise the height of the employee
Description:	The platform is designed to raise the height of the employee, thereby reducing the awkward postures of the shoulders and elbows

<b>Description:</b>	
	
<b>Task Description</b>	
<p><b>Before</b></p> <p>Extend reach occurred when the employee tightened up the screws on the surface of the outer panel.</p>	<p><b>After</b></p> <p>The platform (30 cm in height) allows the employee to work in a neutral posture by reducing repetitive reaching to manipulate the air screw driver.</p>
<p><b>Ergonomics/Operational Effects:</b></p> <ul style="list-style-type: none"> <li>• Reduce awkward postures and fatigue of shoulders, back, elbow and wrist (extended reaching and bending)</li> <li>• May reduce cycle time</li> </ul>	
<p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>• Should be implemented in locations where shorter employees work with raised arms and upper torso</li> <li>• May apply administrative controls such as job rotations on a daily, weekly or monthly basis (including by shift)</li> </ul>	

<b>Case #3</b>	<b>Ergonomics Solution to Long Distance of Travel While Carrying Parts</b>
Ergonomics Issue:	Repetitive motion
Improvement Measure:	The Mini Wagon Rail System
Description:	The use of mini wagon rail eliminated the long distance of carrying the component box between workstations

**Description:**



**Task Description**

**Before**

To provide the components and collect the empty box, the employee was required to manually carry 3kg weighted metallic container at ten-minute interval by walking about 30 meters from workstation to workstation.

**After**

The mini wagon rail, which is about 16 meters long, is installed on the existing furnace facility for transporting the diode components.

With a gentle hand push, the container is to be sent and received between workstations.

**Ergonomics/Operational Effects:**

- Eliminate the long distance travel to carry the metallic container which causes the fatigue and stress on the muscles/joints of lower limbs (e.g., knees, ankles and calves)

**Notes:**

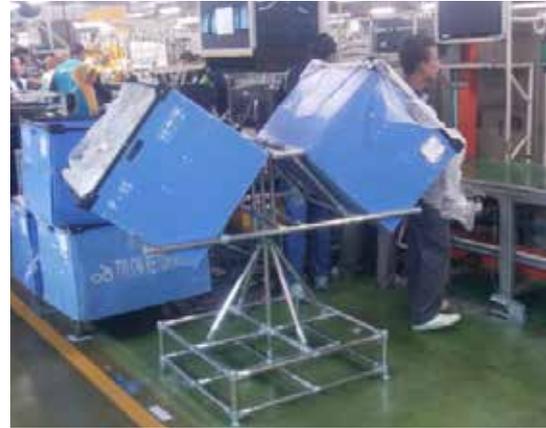
- The rail and wheels require regular maintenance for safety, longevity and proper function of the mini wagon system

<b>Case #4</b>	<b>Ergonomics Solution to Awkward Postures to Pick Up Components</b>
Ergonomics Issue:	Awkward posture
Improvement Measure:	Tilting Flow Rack with Dual Direction
Description:	This tilting flow rack is used for lowering the part boxes loaded with components to the comfort level that the employee prefers

<b>Description:</b>	
	
<b>Task Description</b>	
<p><b>Before</b></p> <p>The employee had to frequently pull his elbow away from the body to pick up parts by rubbing his hand and forearm against part boxes.</p>	<p><b>After</b></p> <p>The tilting flow rack was modified to manually adjust the height of the shelves at a downward angle; the tilting rack helps the employee to keep his wrist and arm in a neutral posture and minimize contact stress.</p>
<p><b>Ergonomics/Operational Effects:</b></p> <ul style="list-style-type: none"> <li>• Reduce the stress/fatigue on the shoulder, lower back and arms (including the reduction of contact stress on the wrist and forearm)</li> </ul>	
<p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>• The number of flow-shelves can be increased by locations, processes and other work conditions (including the size of the shelves)</li> <li>• May attach swivel casters to the tilting rack so employees can move it around workstations</li> </ul>	

<b>Case #5</b>	<b>Ergonomics Solution to Reaching Forward to Pick Up Parts/Move Bins</b>
Ergonomics Issue:	Repetitive motion and overreaching
Improvement Measure:	Carousel-typed Storage Rack
Description:	The rack is a multi-storage aid system consisting of a rotating circular shelving unit, which is divided into three compartments. This rotatable rack is used to eliminate bending far forward and extended reaching

**Description:**



**Task Description**

**Before**

The employee reached down into the part box to pick up the injection parts – repetitively moving parts from the thigh height to the assembly point at waist height.

**After**

This 360 degree rotating storage rack was designed to allow part boxes to be stored at waist height, and each part box is at a downward angle so that the employee can pick up parts in a comfortable posture.

**Ergonomics/Operational Effects:**

- Reduce the amount of reaching down to pick up parts, bending by the employee, and forward reach distance, i.e., reduction of physical exertion of arms and back
- Minimize the frequency and degree of stooping to move up/down the part boxes

**Notes:**

- The number of shelves on the rack can vary with work tasks and part sizes (e.g., double, three and four compartments)

<b>Case #6</b>	<b>Ergonomics Solution to Repetitive Motions (Moving, Overreaching)</b>
Ergonomics Issue:	Repetitive motion and overreaching
Improvement Measure:	Ferris Wheel-typed Storage Rack
Description:	The Ferris Wheel-shaped rack is a component feeding system consisting of a rotating upright structure with multiple shelves. This rack enables the employee to steadily pick up parts in a neutral posture, and therefore minimizes above-shoulder reaching and awkward postures

<b>Description:</b>	
	
<b>Task Description</b>	
<p><b>Before</b></p> <p>In order to pick up components, the employee repetitively leaned forward and reached his arm above the shoulder.</p> <p>Also, the employee often moved the part bins from the floor to a chest height stand.</p>	<p><b>After</b></p> <p>The rotating mechanism allows the employee to keep a more neutral posture for easy access to components and storage bins.</p>
<p><b>Ergonomics/Operational Effects:</b></p> <ul style="list-style-type: none"> <li>• Reduce the fatigue/stress on elbows and wrist</li> <li>• Reduce the amount to transport and reload the bin boxes in the workstation</li> <li>• Eliminate the above-shoulder reaching required to pick up the parts</li> </ul>	
<p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>• Suitable for limited floor space</li> <li>• Make sure whether a floor surface to install the rack is horizontally balanced; the imbalance between the surface and the rack can lead to the falling down while rotating the storage rack</li> </ul>	

<b>Case #7</b>	<b>Ergonomics Solution to Handling Tools against Excessive Pulling Tension</b>
Ergonomics Issue:	Excessive force
Improvement Measure:	Multi-direction Rail System (Pulley)
Description:	This is a combined mechanism of handing balancer and overhead rail for manipulating an air screwdriver from front to back and side to side. Unlike handing balancers used for lifting up and lowering screwdrivers, it could be manually driven through the overhead rail on all sides, i.e., absorbing the strong reaction of the balance spring

**Description:**



**Task Description**

**Before**

The moving/space range of tightening up screws was limited to only up-and-down movement. Forceful pushing occurred when doing the screw-driving task in the assembly lines. Over a period of time the forceful motion caused fatigues and injuries to shoulder, wrist, elbow and waist.

**After**

The air screwdriver which is connected in the spring balancer can be easily moved along the overhead rails, hence enabling the employee to smoothly move from one location to another.

**Ergonomics/Operational Effects:**

- Reduces stress on the employee's hand, wrist, shoulder and elbow
- Eliminate the repetitive motion of picking up and laying down the screw driver
- Prevent potential injuries of dropping the screw driver

**Notes:**

- Recommend to lubricate the overhead rails from time to time with chain grease, and minimize the accumulated foreign substance with a clean and dry rag

<b>Case #8</b>	<b>Ergonomics Solution to Prolonged Standing at Work</b>
Ergonomics Issue:	Prolonged standing
Improvement Measure:	Ergonomics Chair for Standing Work Process
Description:	Under the condition of the similar physical characteristics (e.g., height, weight and job skills), the ergo chair was designed to be specifically suitable for the employees' body sizes in the PCB assembly line. The in-house made chairs allow each employee to keep comfortable postures on the seat and get closer to the worktable, thereby eliminating the prolonged standing position

**Description:**



**Task Description**

**Before**

The assembly-line employees stood for long periods on the same spot and thus could not have chances to move around and have a seat at the workstation.

Those prolonged-standing work positions caused back/shoulder ache, neck stiffness and painful feet or legs.

**After**

With back support, footrest and stable design, this in-house made chair can prevent the employees from fatigue from long period of standing on the floor.

**Ergonomics/Operational Effects:**

- Reduce swelling of the legs, muscular fatigues and low back pains

**Notes:**

- Normal chair or stool with adjustment mechanism can be appropriate for the employees' neutral body postures and reduce fatigues during the standing tasks

<b>Case #9</b>	<b>Ergonomics Solution to Loading/Unloading Part Bins</b>
Ergonomics Issue	Overreaching and awkward posture
Improvement Measure:	Ladder-typed Lifter
Description:	The ladder-typed lifter is a mechanical device used for lifting and lowering part boxes from multi-compartment storage rack by means of electrical motor. This in-house designed device can reduce employees' stress and fatigue of loading/unloading heavy part boxes

**Description:**



**Task Description**

**Before**

Above-shoulder reaching, reaching forward and awkward postures occurred when employees moved part boxes from floor or waist level to storage rack and conversely.

High forces were required to lift, lower and carry the part boxes.

**After**

The ladder lifter, which is the 214 cm in length and 306 cm in height, can allow heavy boxes to move up and down with the direction control switch located on the control panel.

**Ergonomics/Operational Effects:**

- Reduces the frequency for lumbar pains and lower back injury

**Notes:**

- Employees will require training on manipulating the ladder lifter (e.g., safety manual for working at high place and processes of changing battery)

<b>Case #10</b>	<b>Ergonomics Solution to Carrying Trolley with Part Bins</b>
Ergonomics Issue	Repetitive motion
Improvement Measure:	A Tugger Automated Guided Vehicle
Description:	The mobile robot following magnetic guide tapes on the floor is used for carrying the PCB part trolley, resulting in time, manpower and space savings within the PCB assembly line

**Description:**



**Task Description**

**Before**  
 To provide the PCB components, the employee repetitively had to carry the trolley from the warehouse to assembly lines: the trolley was transported more than 50 meters (8 cycles per hour, 400 meters in total)  
  
 Handling the component trolley, especially when walking a long distance, increased not only fatigue on the operators' muscles and joints of lower limb, but also high risk of injuries.

**After**  
 The wheeled trolley loaded with PCB parts is moved along the magnetic guide tape by the tugger AGV, and this automatic unmanned transporting system eliminates the need for manually transporting the trolley.

- Ergonomics/Operational Effects:**
- Eliminate the manual force needed to push/pull wheeled trolley for a long period
  - Eliminate fatigue on the operators' muscle and joints of lower/upper limb
  - Optimize manpower for the process (2 employees at day/night shift)

- Notes:**
- Employees should receive training to learn how to control and use the AGV system

## APPENDIX 4: PROPER BODY MECHANICS FOR MANUAL HANDLING

(Refer to Part 6.3.1)

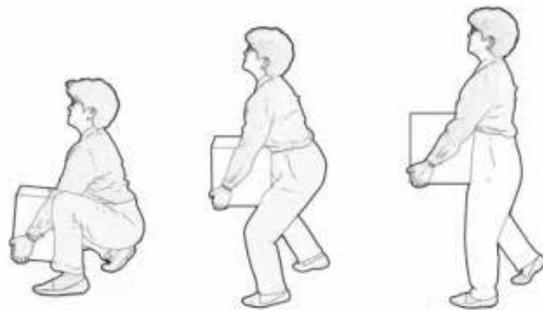
### Introduction

The following pages contain examples of different types of lifts, push and also pull. They may seem obvious and many know these techniques already, but fail to use them. This may be because performing a task using proper posture and body mechanics is usually slower than working in a less safe manner. Consequently, we must remember that:

- Any time saved by taking a risky short cut is quickly lost if an injury results
- Back injuries can develop slowly over time
- Performing an activity incorrectly may not hurt, however this doesn't mean that we are not damaging the body tissues

### Basic Diagonal Lift

This lift is the most common method of good lifting technique. Use the basic lift for objects small enough to straddle where you have enough room to use a wide stance.



1. Get close to the object
2. Stand with a wide stance; put one foot forward and to the side of the object
3. Keep your back straight, push your buttocks out, and use your legs and hips to lower yourself down to the object
4. Move the load as close to you as possible
5. If the box has handles, grasp the handles firmly
6. Put the hand (that is on the same side of your body as the forward foot) on the side of the object furthest from you
7. Put the other hand on the side of the object closest to you. Your hands should be on opposite corners of the object
8. Grasp the object firmly with both hands
9. Prepare for the lift: look forward
10. Lift upwards following your head and shoulders. Hold the load close to your body. Lift by extending your legs with you back straight, buttocks out, and breathe out as you lift

If you are doing this lift correctly, your head will lift up first, followed by your straight back. If your hips come up first and you must bend you back as you straighten up, you are doing this lift incorrectly.

### Power Lift

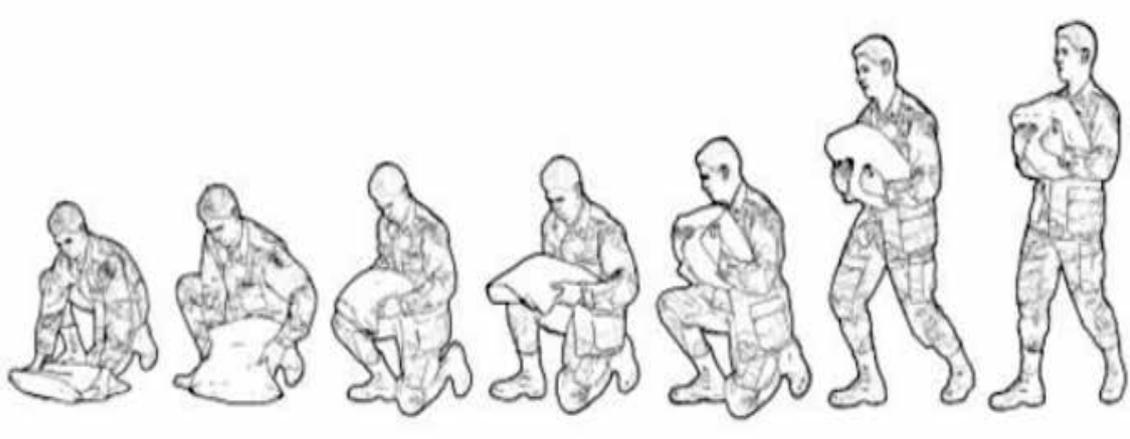
Use the power lift for objects too large for you to straddle. This lift is very similar to the basic lift. In the power lift, the object shifts your centre of gravity forward, and you must push your buttocks out to compensate (Professional weight lifters lift using this position).



1. Put one foot in front of the other using a wide stance
2. Keep your back straight, push your buttocks out and use your legs and hips to lower yourself down to the object
3. Move the load as close to your body as possible
4. Grasp the object firmly with both hands
5. Prepare for the lift; look forward
6. Lift upwards following your head and shoulders. Hold the load close to your body. Lift by extending your legs with your back straight, your buttocks out (exaggerate this position), and breathe out as you lift

## Tripod Lift

Use the tripod lift for objects with uneven weight distribution (e.g. Equipment or bags of material). This lift is recommended for people with decreased arm strength. It is not recommended for those with bad knees.



1. Put one foot next to the object. Keep your back straight, push your buttocks out and slowly lower yourself down onto one knee. For support as you lower yourself down, put one hand on a stool or your thigh for support
2. Position the object close to the knee on the ground
3. Grasp the object firmly with both hands
4. Slide the object from the knee on the ground to mid-thigh. Keep your head forward, back straight, buttocks out, and lift the object onto the opposite thigh
5. Put both forearms under the object (with palms facing upward) and hug the object to your stomach and chest
6. Prepare for the lift; look forward
7. Lift upwards following your head and shoulders. Hold the load close to your body. Lift by extending your legs with your back straight, buttocks out, and breathe out as you lift

## Partial Squat Lift

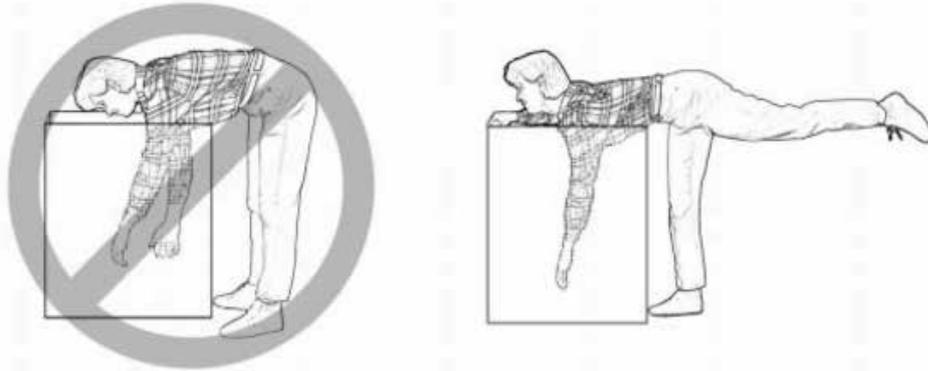
Use the partial squat lift for small, light objects with handles close to knee height.



1. Stand with the object close to your side
2. Place your feet at shoulder width apart, with one foot slightly ahead of the other
3. Place one hand on a fixed surface (such as a table or stool) or on your thigh
4. Keep your back straight, push your buttocks out and slowly lower yourself down to reach the object's handles
5. Prepare for the lift; grasp the object and look forward
6. For support as you lift, push down on the fixed surface (or on your thigh)
7. Lift upwards following your head and shoulders. Lift by extending your legs with your back straight, your buttocks out, and breathe out as you lift

## Golfer's Lift

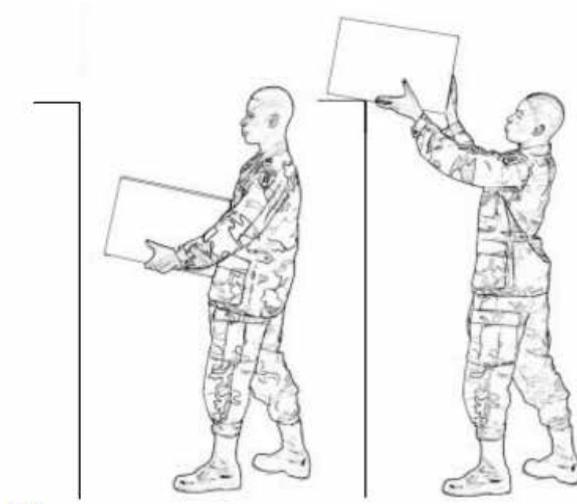
Use the golfer's lift for small light objects in deep bins and to pick small objects off the floor. Recommended for people with knee problems or decreased leg strength.



1. Place hand near the edge of a fixed surface (such as the edge of a table or bin). This hand will support your upper body during the lift
2. Keep your back straight and raise one leg straight out behind you as you lean down to pick up the object. The weight of your leg will counterbalance the weight of your upper body
3. Grasp the object firmly
4. Prepare for the lift; look forward. Keep your leg raised as you initiate the lift
5. To lift, push down on the fixed surface as you lower your leg. Keep your back straight and breathe out as you lift

## Overhead Lift

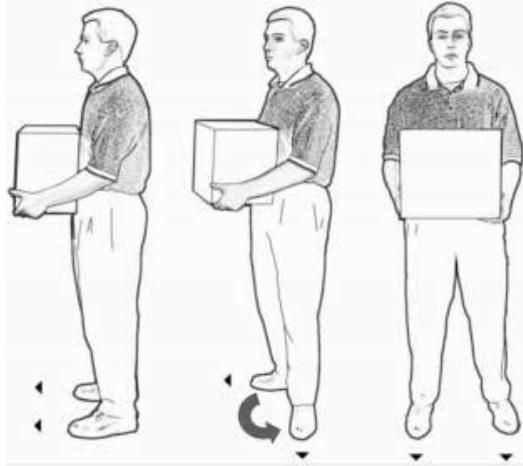
Use the overhead lift to place objects on an overhead shelf. This lift begins with an object in your hands. Be careful! Overhead lifts put you at an increased risk of muscle strain. It can be difficult to maintain balance during the lift. If possible, overhead lifts should be avoided unless necessary. Remember to take proper precautions when lifting overhead.



1. Hold the object close to your body
2. Keep feet shoulder width apart, one foot slightly ahead of the other
3. Prepare for the lift; look forward
4. Raise the object to shelf height using the arm and shoulder muscles. Keep the object close to your body and breathe out as you lift
5. As you reach the shelf, slowly shift your weight from you back foot to your forward foot. Keep your back straight
6. When the load reaches the edge of the shelf, push the object onto the shelf

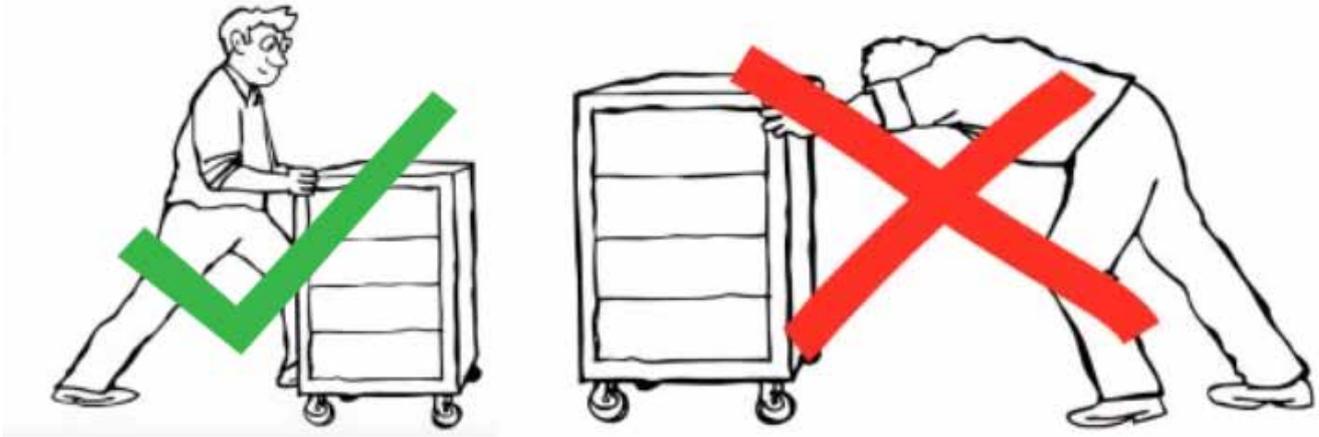
## Pivot Technique

When you must lift an object and then turn to carry it away, it is common to twist the body. Twisting while lifting can cause serious damage to the tissues of the back. Use the pivot technique to avoid twisting while lifting.



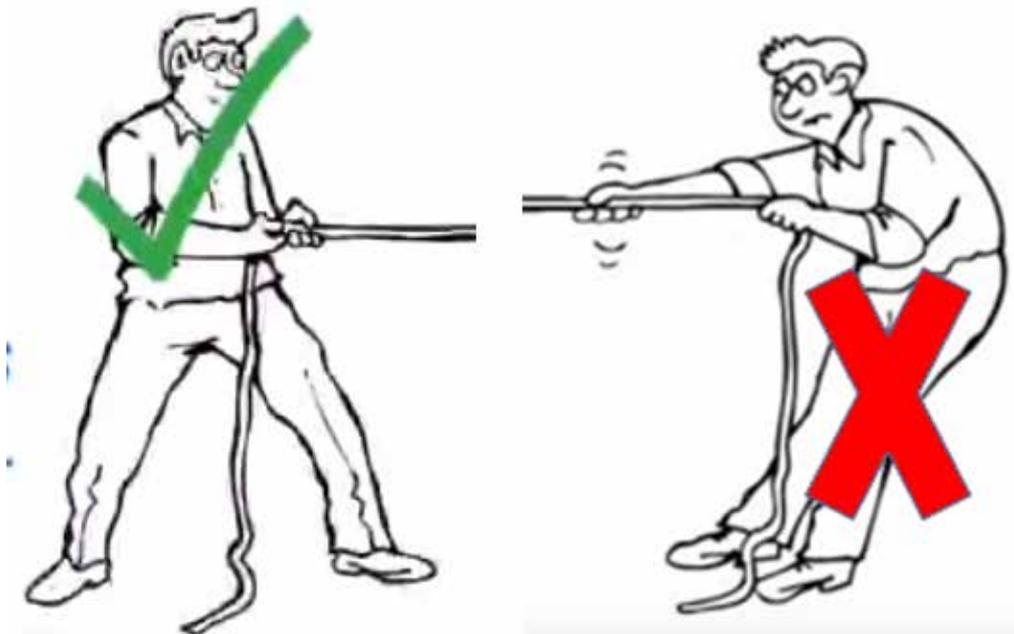
1. Lift the load using any of the previous techniques
2. Hold the load very close to your body at waist level
3. Turn the leading foot 90 degrees toward the direction you want to turn
4. Bring the lagging foot next to the leading foot. Do not twist your body

## Pushing Technique



1. It is safer to push rather than pull
2. Keep your back straight and bend your knees
3. Do not twist at your hips to push, but rather keep your core tight and use your legs and body weight to move the object
4. Face the load squarely rather than at the top or bottom of the object

## Pulling Technique



1. Keep your feet hip-width apart
2. When bending forward to pull, drop your hips and bend your knees. Concentrate on keeping your core muscles tight to decrease pressure on your back
3. Always face the object you are pulling. Take small, backward steps once you start to move

## APPENDIX 5: BACK STRENGTHENING EXERCISE

(Refer to Part 6.3.4)

### Exercise 1: Jumping Jack

- Step 1:** Stand on a soft surface such as a padded gymnastics mat or carpeted floor to reduce the impact of your landings.
- Step 2:** Stand with your feet about shoulder width apart and your hands at your sides.



- Step 3:** Simultaneously raise your arms above your head and jump up just enough to spread your feet out wide.
- Step 4:** Without pausing, quickly reverse the movement and repeat.



## Exercise 2: Front Arm Raise

**Step 1:** Hold a dumbbell at front position.



**Step 2:** Then, keeping your arms fully extended and your torso stationary, lift the dumbbells out to your front and up until they are at shoulder level. Exhale as you do so.



### Exercise 3: Dumbbell Side

- Step 1:** Stand with your back straight, feet shoulder width apart, while holding a dumbbell in each hand with a neutral grip.
- Step 2:** Hold your arms fully extended by your side, with your palms facing in to your body.
- Step 3:** Keep your elbows close to your sides. This is the start position.



- Step 4:** Left and right side for lateral posture.



## Exercise 4: Dumbbell Lateral Raise

- Step 1.** Stand with your back straight, feet shoulder width apart, while holding a dumbbell in each hand with a neutral grip.
- Step 2:** Hold your arms fully extended by your side, with your palms facing in to your body.
- Step 3:** Keep your elbows close to your sides. This is the start position.



- Step 4:** Keeping your arms fully extended and your torso stationary, lift the dumbbells out to your sides and up until they are at shoulder level. Exhale as you do so.
- Step 5:** Hold for a count of one while squeezing your shoulder muscles.
- Step 6:** Return to the start position in a smooth controlled movement inhaling as you do so.



## Exercise 5: Torso Twist

**Step 1:** Stand with your legs about a foot apart. Lift your arms out to your sides and bend them at the elbows so that your fists are next to your ears.



**Step 2:** Lift your right knee to left elbow as you twist your torso. Do it for left knee to right elbow too.



## Exercise 6: Plank

**Step 1:** Start by getting into a press up position.



**Step 2:** Bend your elbows and rest your weight on your forearms and not on your hands. Your body should form a straight line from shoulders to ankles. Engage your core by sucking your belly button into your spine. Hold this position for the prescribed time.



## Exercise 7: Side Plank

**Step 1:** Lie on your right side, in a straight line from head to feet, resting on your forearm. Your elbow should be directly under your shoulder.



**Step 2:** With your abdominals gently contracted, lift your hips off the floor, maintaining the line. Keep your hips square and your neck in line with your spine. Hold 20 to 40 seconds and lower.



## Exercise 8: Leg Lift/ Raises

- Step 1:** Lie flat on the floor (on a mat) places your arms out to the side on the floor with your palms facing down.
- Step 2:** Make sure that your head, legs and bottom are all in contact with the floor.
- Step 3:** Engage your stomach muscles and grasp the sides.



- Step 4:** Slowly lift your legs to a 90-degree angle, keeping your legs straight and not bending at the knees.



- Step 5:** Move to left and right lateral position.





**Department of Occupational Safety and Health**

Level 5 (Main Counter), Block D4, Complex D,  
Federal Government Administrative Centre,  
62530 Wilayah Persekutuan Putrajaya

**Tel** : +603 8886 5343  
**Fax** : +603 8889 2443  
**Emel** : projkkp@mohr.gov.my

[www.dosh.gov.my](http://www.dosh.gov.my)

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