EFG TRAINING SERVICES PRIVATE LTD

WORKPLACE SAFETY AND HEALTH MANAGEMENT IN CHEMICAL, PROCESS, PHARMACEUTICAL AND LABORATORIES (SUPERVISE WORKPLACE SAFETY AND HEALTH IN PROCESS PLANT)

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LEARNERS GUIDE

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INTRODUCTION

Learners will be taught on the practical approach in using various tools, tactics, tips and know-how, contextualised to the needs of different sectors, including building and engineering construction services. Learners will also acquire a deeper skill set as they learn how to match these skills to different situations and have the knowledge and expertise at their disposal.

Workplace Safety and Health Management in Chemical, Process, Pharmaceutical Industries and Laboratories is one of the skills that comes under all process sectors for competency level 3.

COURSE OVERVIEW

Competency Elements (CE) and Underpinning Knowledge (UK)

Content	Sub-topic
CE1: Comply with workplace safety and health legislations, guidelines and codes of practice and provide inputs for *risk assessment *The Risk Assessment/Management process should consider the management of infectious disease outbreak, employees' health (including mental well-being) and terrorist threats. Training Provider should take reference from the 3rd revision of the Code of Practice on Risk Management. 1.1. Identify and comply with legislations and regulations relevant to oil / petrochemical industry when carrying out duties and responsibilities of a supervisor 1.2. Perform the roles and responsibilities of the supervisors to ensure workplace safety and health 1.3. Conduct job safety analysis for a job or task 1.4. Identify safety and health hazards associated with the job or task 1.5. Evaluate level of risks involved in identified hazards 1.6. Develop ways to eliminate / mitigate hazards identified in accordance with risk management regulations 1.7. Co-ordinate measures to control risks according to organisation's procedures 1.8. Complete a risk assessment form 1.9. Communicate risks to stakeholders according to organisation's procedures	• Legal requirements of Workplace Safety and Health Act (WSHA) - Guiding principles of WSHA - Stakeholders under WSHA and their legal obligations - General penalties for offences • Key subsidiary legislations, regulations and codes of practice • Roles and duties of an oil/petrochemical supervisor in safety and health • WSH (Risk Management) Regulations 2006 • Risk management process • Methods to identify hazards • Technique to evaluate risks
CE2: Identify hazards and control measures 2.1 Anticipate and identify types of hazards that are likely to occur in the workplace 2.2 Assess hazards identified to determine their consequences and risks involved 2.3 Identify gaps or shortfalls in workplace conditions and practices against existing control measures in according with organizational procedures 2.4 Identify control measures to minimize safety risks arising from hazards 2.5 Monitor the implementation of control measures in accordance with organizational procedures	General Safety and Health • Safe means of access and egress • Hazards of working at height • Measures to prevent falls • Safe use of scaffolds and ladders • Housekeeping practices Fire and Explosion Prevention • Chemistry of fire – Fire Triangle • Types of combustible materials (Fuel) • Sources of ignition (Heat) • Classification of fires • Methods to extinguish fire • Types of Explosions Safe Work Practices in Confined Space • Confined space and its implications

Content	Sub-topic
CE2: Identify hazards and control measures Cont'd	•• Hazards in confined space • General control strategies General control strategies • Importance of ventilation systems in confined space • Procedures to carry out atmospheric testing • Duties of key personnel in performing atmospheric testing Mechanical and Electrical Hazards • Types of mechanical hazards and controls • Danger of electricity • Methods to control electrical hazards • Ways to protect against electrical danger • Importance of procedural control (Lock Out and Tag Out) • Causes of electric fire • Methods to prevent electric fire • Applying engineering control to prevent electrical hazards Health Hazards • Principles of occupational health • Types of health hazards • Chemical hazards and routes of entry • Evaluation of chemical hazards • Managing chemical hazards • Noise hazards and their effect on hearing • Controlling noise hazards • Heat exposure and symptoms of heat stress related illness • Prevention of heat stress • Ergonomic hazards • Controlling ergonomic hazards • Hazards in special operations • Safety Data Sheets (SDS), its function and importance • Hazards of asbestos • Controlling exposure to asbestos Legislations and regulations • WSH (General Provision) Regulations 2006 • WSH (Scaffolds) Regulations • Salient points of Code of practice 88: Part 1
CE3: Comply with safety and health management system 3.1 Identify the structure of Occupational Safety and Health Management System (OSHMS) 3.2 Recognise the core elements of Occupational Safety and Health Management System (OSHMS) 3.3 Check to ensure compliance of OSHMS 3.4 Communicate to relevant stakeholders the requirement of OSHMS according to organization procedure.	• WSH (Safety Management System) Regulations and the obligations of stakeholders • Elements of Process Safety Management System • Occupational Safety and Health Management System (OSHMS) - Elements of OSHMS and its sub-elements - General requirements of OSHMS - Implementation and the operations of OSHMS

Content	Sub-topic
CE4: Implement permit-to-work system 4.1 Identify circumstances that require PTW 4.2 Determine types of PTW required 4.3 Assist in preparing and submitting a PTW 4.4 Ensure compliance to PTW according to legal and organization requirements	• Permit-to-work system (PTW), and its purpose • Circumstances that require PTW • Types of PTW • Responsibility and authority of permit signatories • Competencies of permit signatories • PTW process • Guidelines for issuing permit • Essential features of a PTW • General preparatory work • Types of workplace hazards • Purpose and procedure for Lock Out Tag Out (LOTO)
CE5: Conduct safety and health inspection 5.1 Carry out safety and health inspection according to legislations and organisation's guidelines and procedures 5.2 Document observations / findings of inspection using relevant inspection checklists 5.3 Take appropriate follow-up actions to monitor deficiencies identified	• Objectives and purpose of safety and health inspection • Types of safety and health inspection • Roles and responsibilities of stakeholders in safety and health inspection • Safety and health inspection procedures • Purpose and importance of using inspection checklists • ABC hazard rating system • Follow-up actions and their purposes
CE6: Conduct incident investigation 6.1 Gather information and facts about incident 6.2 Analyse information and facts to determine root causes of incidents 6.3 Preparing recommendations for the consideration of management 6.4 Report findings according to relevant legislations and guidelines 6.5 Maintain proper documentation of incident investigation	▪ Accident causation theories and their applications ▪ Purpose of incident investigation ▪ Incident investigation process and procedures ▪ Techniques of incident report writing

CE 1: Comply with workplace safety and health legislation, guidelines and code of practice and provide inputs for risk assessment

1.1. Identify and comply with legislations and regulations relevant to oil / petrochemical industry when carrying out duties and responsibilities of a supervisor

About the Workplace Safety & Health Act

The Workplace Safety and Health Act is an essential part of the Workplace Safety and Health framework. The Act has four key features:

a. It places the responsibility for workplace safety on all stakeholders along lines of control at the workplace
b. It focuses on Workplace Safety & Health systems and outcomes, rather than merely on compliance
c. It facilitates effective enforcement through the issuance of remedial orders
d. To prevent accidents at the source, it issues higher penalties for non-compliance and risky behaviour.

What the Act covers:

1. Workplaces covered by Workplace Safety & Health Act
2. Responsibilities of Stakeholders
3. Hazardous Substances
4. Machinery & equipment

1) Workplaces covered by the Act

The Workplace Safety & Health Act covers all factories and workplaces of various risk levels and industries.

A factory is any premise which any of the following is carried out:

- the making of any article or part of any article;
- the altering, repairing, ornamenting, finishing, cleaning or washing of any article;
- the breaking up or demolition of any article;
- the adapting for sale of any article.

Specifically, the following premise types are considered factories:

Heavy Industries

a. Any yard, including any dock, wharf, jetty, quay and the area within its boundaries, where the construction, reconstruction, repair, refitting, finishing or breaking up of ships is carried out. This includes the waters next to any such yard where similar shipbuilding activities are carried out by the occupier of that yard or by others on his behalf.
b. Any premises where the construction, reconstruction or repair of locomotives, aircraft, vehicles or other plant used for transport is carried on as a part of a transport undertaking or other industrial or commercial undertaking. These premises are not used for the purpose of housing locomotives, aircraft or vehicles where only cleaning, washing, running repairs or minor adjustments are carried out.
c. Any premises where building operations or any work of engineering construction are carried on.

Light Industries

a. Any premises in which the business of hooking, plaiting, lapping, making up or packing of yarn or cloth is carried out.
b. Any premises where the making, adaptation or repair of dresses, scenery or props is carried on as part of the production of films, tapes or discs for public broadcaster screening or to the presentation of theatrical performances for trade or gain. These premises are not a stage or dressing-room of a theatre in which only occasional adaptations or repairs are made.
c. Any premises where the business of making or mending nets is carried on as part of the fishing industry.
d. Any premises where the production of cinematographic films is carried on for trade or gain. These premises are not a stage or a dressing-room of any actor connected with the production of any cinematographic film.
e. Any premises where the printing by letter press, offset, lithography, photogravure, rotogravure, or other similar process, or the binding of such printed materials is carried on for trade or gain or as part of another business.
f. Any premises where mechanical power is used in connection with the making or repair of any article incidentally to any business carried on by way of trade or for purpose of gain.

Ancillary Industries

a. Any premises where the sorting of articles is carried on before the actual work is carried out in any other factory whether that other factory is situated within or outside Singapore
b. Any premises where the washing or filling of bottles or containers or packing of articles is carried on in connection with the work of any other factory, whether that other factory is situated within or outside Singapore
c. Any laundry as a part of another business or in connection with any public institution
d. Any premises where articles are made or prepared as part of any building operations or any works of engineering construction
e. Any premises where mechanical power is used in connection with the sorting, packing, handling or storing of articles carried on for trade or gain or as part of another business.

Storage facilities

a. Any premises which are used for the storage of gas, including liquefied gas, in a container having a storage capacity of not less than 140 cubic metres.
b. Any premises which are used for the bulk storage of toxic or flammable liquid in a container (excluding liquefied gas), that is not an underground container and that has a storage capacity of not less than 5,000 cubic metres.

Utilities

a. Any premises where work is carried out for or in connection with generating electrical energy for supply for trade or gain
b. Any premises where mechanical power is used for supplying water or in connection with a water supply
c. Any sewage works where mechanical power is used and any pumping station used in connection with these works

Other workplaces subject to Workplace Safety & Health Act include:

a. Any premises within an airport where any checking, inspecting, cleaning, loading, unloading or refuelling of an aircraft is carried out by persons other than the crew of aircraft.
b. Any ship in a harbour where any of the following is carried out:

    - scaling, scuffing, or cleaning of boilers, including combustion chambers or smoke boxes, in the ship;
    - cleaning of any tanks, bilges or holds in the ship;

- construction, reconstruction, repair, fitting, furnishing or breaking up.

c. Any dock, wharf or quay where loading, unloading or bunkering of a ship is carried out by persons other than the crew of the ship.
d. Any premises delineated as a railway area under the Rapid Transit Systems Act (Cap. 263A) and where any inspection, testing or maintenance of any railway is carried out.
e. Any premises, other than domestic premises, in which a steam boiler, steam receiver or air receiver is used.
f. Any laboratory or other premises where the testing, examination or analysis of any article is carried out.
g. Any ship where any survey or inspection of the ship or its contents is carried out by any person other than by the crew of the ship.
h. Any tunnel, bridge or viaduct where any survey or inspection of the tunnel, bridge or viaduct is carried out.
i. Any hotel, lodging house, dormitory, service apartment, chalet, camping site or other premises where the provision of short-stay accommodation is carried out by way of trade or for purposes of gain.
j. Any restaurant, bar, canteen or other premises where food or drinks are sold or catered for consumption within those premises or elsewhere.
k. Any hospital, hospice, nursing home or medical or dental clinic or other premises providing nursing and rehabilitation services.
l. Any veterinary centre providing any of the following services:
   (a) diagnosis of disease in, and injuries to, animals or birds, including tests performed for diagnostic purposes;
   (b) the treatment, vaccination or inoculation of animals or birds.
m. Any premises where landscaping or garden maintenance is carried out.
n. Any premises where the collection, purification or distribution of water is carried out.
o. Any premises where the disposal or treatment of sewage or refuse is carried out.
p. Any premises where the recycling of metal or non-metal waste or scrap is carried out.
q. Any premises where:
   (a) freight forwarding, packing or crating services;
   (b) cargo surveying services;
   (c) container services; or
   (d) crane services

   are carried out by way of trade or for purposes of gain or incidentally to another business so carried out.

2) Responsibilities of stakeholders

The Workplace Safety & Health Act defines the responsibilities for the following stakeholder groups:

If you are an employer or principal

You must, as far as reasonably practicable, protect the safety and health of employees or workers working under your direct control, as well as all who may be affected by their work. Your responsibilities include:

- conducting risk assessments to remove or control risks to workers at the workplace
- maintaining safe work facilities and arrangements for the workers at work
- ensuring safety in machinery, equipment, plant, articles, substances and work processes at the workplace;
- developing and implementing control measures for dealing with emergencies;
- providing workers with adequate instruction, information, training and supervision.

If you are an occupier

You must, as far as reasonably practicable, ensure that the workplace, all entrances to and exits from the workplace, and all machinery, equipment, plants, articles and substances within are safe and without risk to the health of any person within those premises, even if the person is not one of your employees.

As an occupier, you may also be responsible for the common areas used by your employees and contractors. Occupier of the common area is responsible for the following:

- electric generators and motors located in the common area
- hoists and lifts, lifting gear, lifting appliances and lifting machines located in the common area
- means of entry into or exit from the common area
- any machinery or plant located in the common area

If you are a manufacturer or supplier

You must ensure that any machinery, equipment or substances you provide is safe for use. You are required to:

- provide proper information on the safe use of the machinery, equipment or hazardous substance

- ensure that the machinery, equipment or hazardous substance is safe for use
- ensure that the machinery, equipment or hazardous substance has been tested and examined so that it is safe for use

If you are an installer or erector of machinery

You must ensure, as far as reasonably practicable, that all machinery and equipment erected, installed or modified is safe and without health risks when properly used.

If you are an employee

- You must follow the safe working procedures and principles introduced at the workplace.
- You must not engage in any unsafe act that may endanger yourself or others working around you.
- You must use, in proper manner, any personal protective equipment, devices, equipments or other means provided to secure your safety, health and welfare while working. You must not tamper or misuse such items provided.

If you are self-employed

Even though you are self-employed, you are still required to take measures, as far as reasonably practicable, to ensure the safety and health of others, such as members of the public.

3) Hazardous substances

The following are classified as hazardous substances under the Workplace Safety and Health Act:

1. Carcinogens
2. Corrosive substances
3. Explosives
4. Flammable substances
5. Gases under pressure
6. Irritants
7. Mutagens
8. Organic peroxides
9. Oxidising substances
10. Pyrophoric substances
11. Self-heating substances
12. Self-reactive substances
13. Sensitizers
14. Substances hazardous to aquatic environment.
15. Substances which in contact with water, or emit flammable gases
16. Teratogens
17. Toxic substances

4) Machinery & equipment

Manufacturers and suppliers of the following machinery & equipment have the duty to ensure they are safe for use:

1. Scaffolds and any materials or components used to erect them
2. Lifting equipment
3. Forklifts
4. Power presses
5. Bar-benders
6. Equipment or piping intended for operation under pressure, including all statutory pressure vessels
7. Equipment or piping intended to contain corrosive, toxic or flammable substances
8. Welding equipment, including any accessory, apparatus or fitting necessary to enable its use
9. Materials or components used for the construction of support structures
10. Explosive powered tools
11. Equipment used for abrasive blasting, including any accessory, apparatus or fitting necessary to enable its use and operation

Enforcement

The Commissioner for Workplace Safety and Health, assisted by Deputy Commissioners and appointed (gazetted) inspectors, ensures that workplaces comply with safety and health regulations by taking the following actions:

Workplace Inspections

Inspectors are empowered to enter, inspect and examine any workplace at any time to ensure workplace safety.

- An inspector may inspect, examine and make copies of any workplace documents.
- An inspector may take samples of any material or substance found in, or being discharged from, any workplace for the purpose of analysis or test.
- An inspector may take photographs and video recordings to record the conditions and the processes carried out in the workplace.
- He may take into custody any article in the workplace for the purpose of an investigation or inquiry under the Act.

Investigations

The Commissioner may order an investigation into any workplace accident or incident. In the course of investigations, the inspector may inspect the accident scene and workplace, and interview and record statements of persons. The persons interviewed are bound to state the truth and assist in the investigations.

Suspension of Certificates

When necessary, the Commissioner may suspend any certificate. Examples of certificates issued under the Act include Certificates of Factory Registration and certificates of test / thorough visual examination of lifting equipment.

Remedial Orders & Stop Work Orders

Once issued a Remedial Order by the Commissioner, an employer, occupier or any other person is required to remove any workplace risk or to comply with a safe work practice, take required measures to remedy any danger so as to enable the work or process in the workplace to be carried on with due regards to the safety, health and welfare of the persons at work.

The Commissioner may also issue a Stop Work Order, which requires the specified work to cease until measures have been taken to ensure that the work can be carried out safely. An SWO is used in instances where severe lapses in safety and health conditions cause immediate danger to the persons at work.

Failure to comply with either a Remedial Order or Stop Work Order is considered an offence.

Composition Fines

Composition fines are offered for offences at the Commissioner's discretion. Offences may be compounded to a sum not more than half the maximum fine prescribed for the offence or $5,000, whichever is lower. Prosecution action may be taken if payment is not received within a specified period.

Prosecution

The Commissioner may prosecute any offender for violations under the Act. If you are charged with an offence under the Act, it is your duty to show to the courts that:

- You complied with the Act and/or its relevant subsidiary legislation
- You complied with the relevant approved code of practice or guidelines
- Where there was no specific legislation or guidelines, you took reasonable precautions and exercised due diligence

Liabilities & Penalties

The Workplace Safety and Health Act states a general maximum penalty for offences. The penalties are shown in the tables below.

Failure to comply With Remedial Orders or Stop Work Orders

Offence	Maximum fine	Maximum Imprisonment	Conditions
Failure to comply with Remedial Work Order	$50,000	12 months	Either or both
	Additional fine of $5,000 for each day of continued offence		
Failure to comply with Stop Work Order	$500,000	12 months	Either or both
	Additional fine of $20,000 for each day of continued offence		

General Penalties (for offences where no penalty is expressly provided by WSHA)

Offender Category	Maximum fine		Maximum Imprisonment	Conditions
	1st conviction*	**2nd & subsequent conviction****		
Individual persons	$200,000	$400,000	2 years	Either or both
Corporate body	$500,000	$1 million		
Persons at work who misused or failed to use protective equipment provided	$1,000	$2,000		

* 1st conviction for an offence that causes the death of another person
** 2nd & subsequent conviction of same offence that causes the death of another person

Consultation & Training

A number of safety and health professionals have been approved or accredited to assist with ensuring workplace safety. They include workplace safety and health officers, workplace safety and health auditors, authorised examiners and accredited training providers.

Requirements on the engagement of safety and health officers and auditors are stipulated in the subsidiary legislations:

- WSH (Workplace Safety and Health Officers) Regulations, 2007 and
- WSH (Safety and Health Management System and Auditing) Regulations, 2009

Workplace Safety and Health (First-Aid) Regulations:

The life of an injured employee may depend on proper first-aid given within the first few minutes of an accident. Besides saving lives, first-aid treatment is important in preventing further injury and pain. In the new framework for occupational safety and health in Singapore, the Workplace Safety and Health Act replaces the Factories Act with effect from 1 March 2006. This Workplace Safety and Health (First-Aid) Regulations is one of the subsidiary legislations under the new Act.

The Regulations will apply in the following workplaces.
1. Any premises which is a factory.
2. Any premises within an airport where any checking, inspecting, cleaning, loading, unloading or refueling of an aircraft is carried out by persons other than by the crew of the aircraft.
3. Any ship in a harbour where any of the following is carried out:
a. scaling, scurfing or cleaning of boilers, including combustion chambers and smoke boxes, in the ship;
b. cleaning of any tank, bilges or holds in the ship;
c. construction, re-construction, repair, fitting, furnishing or breaking up.
4. Any laboratory or other premises where the testing, examination or analysis of any article is carried out.

If you are an employer or occupier of the workplace, you are responsible for the following:

- provision and maintenance of first-aid box,
- appointment and training of first-aiders,
- provision and maintenance of first-aid room,
- provision of suitable facility for quick drenching of body or flushing of eyes where toxic or corrosive substances are used.

When deciding on the number of equipment, first-aiders, and facilities for your workplace, you should consider the following factors:

- type of industry, the nature and specific hazards of the work,
- number of employees, number of work shifts,
- physical layout of the workplace,
- known occurrences of accidents or illnesses,
- location of the workplace in relation to the nearest medical clinic or hospital,
- work during holidays.
- first-aiders on sick leave.

Contents of First-Aid Box

First-aid boxes should not contain materials other than those required for first-aid treatment.

It is essential that first-aid boxes be checked frequently to make sure they are fully equipped and all items are usable. Used or expired items should be replaced as soon as possible.

Provision of First-Aid Boxes

Every workplace shall be provided with a sufficient number of first-aid boxes. Where a workplace is located in a building, each floor of the building shall be provided with a sufficient number of first-aid boxes.

Every first-aid box provided in a workplace should be

- be adequately equipped;
- be properly maintained;
- be checked frequently to ensure that it is adequately equipped and that all the items in it are usable;
- be clearly identified as a first-aid box;
- be placed in a location that is well-lit and accessible; and
- be under the charge of a person appointed by the occupier of the workplace.

Accessibility of First-Aid Boxes

The first-aid box should be labeled clearly and placed in an unmistakably identified, well-illuminated and easily accessible location. The first-aid box must be made of sturdy material and be portable so that it can be quickly taken to the site of an accident.

Where the factory covers a large area, an adequate number of first-aid boxes should be provided and well distributed throughout the premises. Employees should be informed of the location of all the first-aid boxes.

A first-aid room is to be provided where there are more than 500 employees.

Design of First-Aid Room

The room should be large enough to hold a couch, and still have space for people to move about. It should be well lit and ventilated and have provision for emergency lighting. It should also be clearly identified as a first-aid room by means of a sign.

Location of First-Aid Room

When choosing a site for a first-aid room, bear in mind the following factors:

- proximity to toilets,
- proximity to lifts and main passageways which are wide enough to allow a stretcher,

- wheelchair or carrying chair through,
- accessibility to work area,
- accessibility to car park, so as to facilitate transfer of injured persons to an ambulance.

Workplace where toxic or corrosive substances are handled:

If the workplace has exposure to toxic or corrosive substances, the Commissioner of Workplace Safety and Health may require the provision of suitable facilities for emergency treatment, such as emergency showers for quick drenching and eye wash for flushing the eyes. These facilities for emergency use should be located within the work area and be properly maintained.

Some chemicals handled in the factory may not be commonly used. Hence, instructions on the handling of employees injured by such chemicals may need to be written down in Safety Data Sheets (SDS) for easy reference in the event of an accident. If a chemical has an antidote eg. amyl nitrite for cyanide poisoning, the antidote should be available. Instructions on the administration of the antidote should be clearly written down. Copies of the SDS should be located near the first-aid boxes so that they can be referred to quickly and easily.

Number to Be Appointed

Ratio Of First-Aiders To The Number Of Employees

Type of workplace	No. of employees	No. of first-aiders
All factories and workplaces covered under the Regulations	26 – 100	1
	More than 100	one for every 100 persons employed or less

Shift Work

If there is a shift work schedule, there must be a sufficient number of first-aiders corresponding to the number of employees working on that shift to provide adequate coverage for each shift.

Availability of First-Aiders

The names and where the first-aiders normally work must be displayed on a notice in a prominent location in the workplace.

Responsibilities of first aiders:

1. Management of Casualty

The first-aider should be aware of the specific hazards (eg, hazardous substances, dangerous goods, machinery or equipment) in the workplace and be able to render first-aid for these specific hazards.

In the management of an injured employee, the first-aider should take the following steps.

- Assess the situation without endangering his own life.
- Identify the injuries.
- Give immediate first-aid treatment, keeping in mind that a casualty may have more than one injury and that some casualties will require more urgent attention than others.
- Arrange without delay for the injured employee(s) to be sent to a doctor, hospital or home, according to the seriousness of his condition.
- Provide information to an attending doctor on the nature of the incident and the first-aid treatment rendered.

The first-aider's responsibility ends when the casualty is handed over to the care of a doctor, nurse or other appropriate person.

2. Maintenance of Treatment Record

The first-aider must record the treatment given and keep the record in a designated place.

3. Maintenance of First-Aid Facilities

The first-aider is responsible for maintaining the first-aid box. He should ensure that only first-aid equipment is kept inside the box. The first-aider should periodically check the first-aid box to ensure that the contents of the box are regularly replenished. In workplaces with Occupational Health Nurses, the supervision of first-aiders and the responsibility for the maintenance of first-aid facilities may be taken over by the nurse.

Availability of first-aid

Employees should be informed of the type and location of the first-aid facilities and the procedures to be followed when first-aid is required. This should take place as part of the initial training or induction of the employee and when there is a significant change in personnel, workplace, or nature or type of duties performed. All employees should also be advised and made aware of the first-aid requirements of the specific hazards in the workplace.

Training of first aiders

An employer or occupier should select suitable persons for first-aid training. Persons who are suitable are those who:

- are mature and responsible,
- can remain calm in an emergency,
- can leave their work immediately to respond to an emergency,
- are physically fit.

The employer or occupier should maintain a written record of all the first-aiders, and record the dates they obtained their first-aid certificates and the dates on which they received retraining.

Refresher Training

A person is considered a trained first-aider if he successfully completes a first-aid course approved by the Ministry of Manpower. First-aid certificates are valid for 3 years only. Thereafter, the first-aider has to undergo a refresher course and be issued with a new certificate.

WSH Competency Standards

Developing Competencies through Training

Employers are required to ensure that employees of all levels i.e. workers, supervisors, managers, and WSH Personnel possess basic Workplace Safety and Health (WSH) competencies.

WSH competencies enable employees to:

- Recognise potentially hazardous situations;
- Know their responsibilities under the WSH Act; and
- Know their roles in creating safe work conditions.

Such competencies can be developed through formal courses or on-the-job training. More information about the competency standards and training courses are available below:

Competency Standards

The Ministry of Manpower (MOM), the Workplace Safety and Health Council (WSHC) and the Singapore Workforce Development Agency (WDA), have developed a set of generic competency standards for employees of all levels.

Generic Competency Standards

The module on generic competency standards, under WDA's Employability Skills System (ESS), is part of the Workforce Skills Qualifications (WSQ) System.

The generic competency standards for employees of various levels are as follows:

Operations Level

Employees should be able to:

- Follow safe work practices and risk control procedures
- Participate in workplace safety and health management activities
- Follow workplace emergency response procedures

Supervisory Level

Supervisors should be able to:

- Interpret workplace safety and health policies, procedures and programmes
- Educate workers on workplace safety and health policies, procedures and programmes
- Implement and control workplace safety and health management programmes
- Implement workplace risk management programmes
- Maintain workplace risk control measures

Managerial Level

Managers should be able to:

- Identify responsibilities under Workplace Safety & Health Act
- Establish and maintain workplace safety and health framework
- Establish and evaluate workplace safety and health system, policies, procedures and programmes
- Establish workplace risk management procedures
- Manage workplace risk control measures

Training Courses & Records

Find out more about the safety and health-related training courses, test fees for construction safety and shipyard safety courses and how to check for workers' training records.

Certification & Registration

Before people and businesses undertake high risk activities in the workplace, they may be required to obtain a licence or certificate of competency, or register with the Ministry of Manpower.

Organisations need to appoint authorised officers to perform electronic transactions on its behalf.

MOM provides the following licensing and renewal services:

- Factory Notification & Registration
- Licensing for Equipment
- Licensing for Equipment Operators
- Licensing for Safety Professionals
- Licensing for Service Providers
- Nomination of eService Account Administrator and eService User

Factory Notification & Registration

Factory Notification

Factory owners are required to either notify or register their premises with MOM before operations begin. Factories with lower risk activities require only a one-time notification to MOM before commencing operations. This notification is inclusive of a Risk Management (RM) Declaration with the Commissioner for WSH.

Factory owners are required to either notify or register their premises with MOM before operations begin. Factories with higher-risk activities are required to register with MOM before beginning operations, subject to renewals if they fall under certain categories.

Licensing of Equipment

Lifting Equipment

Lifting equipment such as cranes, lifts, hoists, and any cage or work platform used for carrying persons must be registered with the Occupational Safety and Health Division. Registration can only be conducted by an MOM Authorised Examiner.

Pressure Vessels

Pressure vessels must be registered with the Occupational Safety and Health Division. They must be examined on a periodic basis by an Authorised Examiner.

Licensing of Equipment Operators

Crane Contractors

Under the Workplace Safety and Health (Operation of Cranes) Regulations, no person shall install, repair, alter or dismantle a mobile crane or tower crane unless he is an approved crane contractor in writing by the Commissioner.

Crane Operators

Crane operators must pass relevant courses conducted by the Accredited Training Provider (ATP) before they can be licensed to operate a crane. The licence is renewable every two years.

Crane Erectors

Approved crane erectors are required in the installation, alteration and dismantling of cranes. Contractors must deploy teams comprising approved crane erectors and sufficient crane assistants to set up and dismantle cranes safely.

Internal Combustion Engine (ICE) Driver (1st Class, 2nd Class)

Individuals must be certified by MOM before they can operate an Internal Combustion Engine (ICE) Driver. To qualify as a 2nd Class ICE Driver, applicant must have at least 2 years relevant working experience as ICE Driver in charge of an internal combustion engine, as well as pass an oral examination conducted by MOM. To be a 1st Class ICE Driver, applicants must have at least 18 months relevant working experience after obtaining the 2nd Class certificate.

Internal Combustion Engine (ICE) Engineer (1st Grade, 2nd Grade)

To be certified as a 2nd Grade ICE Engineer, applicants must have at least 12 months relevant experience in operational charge or as an assistant in operational charge of Internal Combustion Engines. They have to attend and pass the interview by the Board of Examiners. After 12 months of obtaining his 2nd Grade ICE Engineer certificate, an individual may apply to become a 1st Grade ICE Engineer.

Steam Boiler Attendant (1st Class, 2nd Class)

Applicant must have at least 2 years relevant working experience assisting in operational charge of a steam engine/steam boiler or hold a valid equivalent Certificate of Competency (COC) issued by a recognised authority. Holders of the 2nd Class certificate may apply to become a 1st Class boiler attendant after 18 months' relevant working experience.

Steam Engineer (1st Grade, 2nd Grade)

Applicants to become a 2nd Grade Steam Engineer must have at least 12 months relevant working experience assisting in operational charge of a steam engine or steam boiler. Applicants without the Engineering Knowledge II (2nd Grade) certificate awarded by Singapore Polytechnic has to attend and pass the interview by the Board of Examiners. Steam Engineers who have 12 months' relevant working experience after obtaining their 2nd Grade certificate can apply for a 1st Grade certificate.

Licensing for Safety Professionals

Authorised Examiner (Lifting equipment)

Authorised Examiners must be Registered Professional Engineers in the relevant field with a valid Practising Certificate. They must have at least 5 years of relevant experience in the design, commissioning, operation, maintenance and inspection or any related experience in the lifting equipment applied for. They must be also familiar with the relevant codes and standards on the inspection criteria related to the lifting equipment applied for.

Authorised Examiner (Pressure vessel)

To be an Authorised Examiner of Pressure Vessels, applicants must be a registered Professional Engineer in the relevant field with a valid Practising Certificate issued by Professional Engineers Board, Singapore. They should have at least 5 years relevant experience in design, commissioning, operation, maintenance and inspection or any related experience of the pressure vessels applied for. Applicant must be familiar with the relevant codes and standards on the inspection criteria of the pressure vessels applied for.

Designated Workplace Doctor

Designated factory doctors must be registered medical practitioners with the Singapore Medical Council. They must also hold relevant approved Postgraduate Occupational Health Qualifications.

Workplace Safety & Health Professional

Workplace Safety & Health (WSH) Professionals must hold one of the prescribed WSH-related qualifications, and have at least 2 years' relevant working experience (documentary proof from employer is required).

Licensing for Service Providers

Crane Contractors

Under the Workplace Safety and Health (Operation of Cranes) Regulations, no person shall install, repair, alter or dismantle a mobile crane or tower crane unless he is an approved crane contractor in writing by the Commissioner.

Risk Consultant

Risk Consultants assist the company to train staff on risk assessment and guides them through risk assessment of work processes and the implementation of risk control measures. They play a critical role in ensuring that capability in risk assessment is heightened, and a risk management system is established within the company

Scaffold Contractor

Only approved scaffold contractors are allowed to erect, install, re-position, altered or dismantle scaffolds (other than tower and trestle scaffolds or any scaffold with a height less than 4m).

Accredited Training Provider (ATP)

Training providers are required to submit course/teaching materials and examination questions/answers for accreditation by MOM. Individuals are not eligible to apply for approval to be accredited as an Accredited Training Provider (ATP).

Inspection Agency (Pressure vessels & Lifting equipment)

Third Party Inspection Agencies for Lifting Equipment and Pressure Vessels must be approved by MOM.

Workplace Safety & Health auditing organisation

Audits of safety and health management systems must be carried out in accordance to the relevant legislation and guidelines set out for each industry. To ensure that workplace safety and health audits are carried out in an acceptable manner, all approved workplace safety and health auditing organisations and auditors are required to adhere to MOM's guidelines

Approved Codes of Practice Made Under Section 40B(3) of the Workplace Safety and Health Act

In accordance with section 40B (3) of the Workplace Safety and Health Act 2006, the Workplace Safety and Health Council has approved Codes of Practice for the purpose of providing practical guidance on safety and health to the industry. The Approved Codes of Practice (ACOP) is intended to be used as a yardstick to assess whether reasonable practicable measures have been taken in regards to the upkeep of safety and health standards at the workplace.

	Approved Codes of Practice	Year Published
1.	Code of Practice for Working Safely at Height	2011
2.	Code of Practice on WSH Risk Management	2012
3.	Code of Practice on Safe Lifting Operations in the Workplaces	2011
4.	SS 98: Specification for Industrial safety helmets	2005
5.	SS 280: Specification for Metal scaffoldings, Part 1: Frame scaffoldings	2006
6.	SS 280: Specification for Metal scaffoldings, Part 2: Modular scaffoldings	2009
7.	SS 311: Specification for Steel tubes and fittings used in tubular scaffolding	2005
8.	SS 473: Specification for Personal eye-protectors, Part 1: General requirements	2011
9.	SS 473: Specification for Personal eye-protectors, Part 2: Selection, use and maintenance	2011
10.	SS 497: Code of Practice for Design, safe use and maintenance of gantry cranes, overhead travelling cranes and monorail hoists	2011
11.	SS 508: Specification for Graphical symbols - Safety colours and safety signs, Part 1: Design principles for safety signs in workplaces and public areas	2004
12.	SS 508: Specification for Graphical symbols - Safety colours and safety signs, Part 3: Safety signs used in workplaces and public areas	2004
13.	SS 510: Code of Practice for Safety in welding and cutting (and other operations involving the use of heat) (Formerly CP 50)	2005
14.	SS 511: Code of Practice for Diving at work	2010
15.	SS 513: Specification for Personal protective equipment - Footwear, Part 1: Safety footwear	2005
16.	SS 513: Specification for Personal protective equipment - Footwear, Part 2: Test methods for footwear	2005
17.	SS 514: Code of Practice for Office ergonomics	2005
18.	SS 528: Specification for Personal fall-arrest systems, Part 1: Full-body harnesses	2006
19.	SS 528: Specification for Personal fall-arrest systems, Part 2: Lanyards and energy absorbers	2006

20.	SS 528: Specification for Personal fall-arrest systems, Part 3: Self-retracting lifelines	2006
21.	SS 528: Specification for Personal fall-arrest systems, Part 4: Vertical rails and vertical lifelines incorporating a Sliding - type fall arrester	2006
22.	SS 528: Specification for Personal fall-arrest systems, Part 5: Connectors with self-closing and self-locking gates	2006
23.	SS 528: Specification for Personal fall-arrest systems, Part 6: System performance tests	2006
24.	SS 531: Code of Practice for Lighting of work places, Part 1: Indoor	2006
25.	SS 531: Code of Practice for Lighting of work places, Part 2: Outdoor	2008
26.	SS 531: Code of Practice for Lighting of work places, Part 3: Lighting requirements for safety and security of outdoor work places	2008
27.	SS 532: Code of Practice for The storage of flammable liquids	2007
28.	SS 536: Code of Practice for The safe use of mobile cranes (Formerly CP 37)	2008
29.	SS 537: Code of Practice for Safe use of machinery, Part 1: General requirements	2008
30.	SS 537: Code of Practice for Safe use of machinery, Part 2: Woodworking machinery	2009
31.	SS 541: Restraint belts Amendment 1 (2012)	2008
32.	SS 548: Code of Practice for Selection, use, and maintenance of respiratory protective devices (Formerly CP 74)	2009
33.	SS 549: Code of Practice for Selection, use, care and maintenance of hearing protectors (Formerly CP 76)	2009
34.	SS 550: Code of Practice for Installation, operation and maintenance of electric passenger and goods lifts (Formerly CP 2)	2009
35.	SS 553: Code of Practice for Air-conditioning and mechanical ventilation in buildings (Formerly CP 13)	2009
36.	SS 554: Code of Practice for Indoor air quality for air-conditioned buildings	2009
37.	SS 557: Code of Practice for Demolition (Formerly CP 11)	2010
38.	SS 559: Code of Practice for Safe use of tower cranes (Formerly CP 62)	2010
39.	SS 562: Code of Practice for Safety in trenches, pits and other excavated areas	2010
40.	SS 567: 2011 Code of Practice for Factory layout - Safety, health and welfare considerations (Formerly CP 27)	2011
41.	SS 568: 2011 Code of Practice for Confined spaces (Formerly CP 84)	2011
42.	SS 569: Code of Practice for Manual handling (Formerly CP 92)	2011
43.	SS 570: Specification for Personal protective equipment for protection against falls from a height — Single point anchor devices and flexible horizontal lifeline systems	2011
44.	SS 571: Code of Practice for Energy lockout and tagout (Formerly CP 91)	2011
45.	SS 573: Code of Practice for The safe use of powered	2012

	counterbalanced forklifts (Formerly CP 101)	
46.	SS 586: Specification for Hazard communication for hazardous chemicals and dangerous goods, Part 1: Transport and storage of dangerous goods	2008
47.	SS 586: Specification for Hazard communication for hazardous chemicals and dangerous goods, Part 2: Globally harmonised system of classification and labelling of chemicals - Singapore's adaptations	2008
48.	SS 586: Specification for Hazard communication for hazardous chemicals and dangerous goods, Part 3: Preparation of safety data sheets (SDS)	2008
49.	CP 5: Code of Practice for Electrical installations Amendment 1 (2008)	1998
50.	CP 14: Code of Practice for Scaffolds	1996
51.	CP 20: Code of Practice for Suspended scaffolds	1999
52.	CP 23: Code of Practice for Formwork 2000	
53.	CP 63: Code of Practice for The lifting of persons in work platforms suspended from cranes 1996 (2005)	1996
54.	CP 79: Code of Practice for Safety management system for construction worksites	1999
55.	CP 88: Code of Practice for Temporary electrical installations, Part 1: Construction and building sites 2001	2001
56.	CP 88: Code of Practice for Temporary electrical installations, Part 3: Shipbuilding and ship-repairing yards	2001

1.1. Perform the roles and responsibilities of the supervisors to ensure workplace safety and health

Roles and responsibilities of supervisors in the Oil/Petrochemical Industry

Introduction

Supervisors have a general legal duty to take every precaution reasonable in the circumstances to protect workers as delegated by the employers.

Responsibilities of a supervisory personnel / employer include:

- Ensuring that worker uses suitable and adequate personal protective equipment, and handles appropriate and non-faulty tools/equipment
- Advising workers of potential and actual hazards and control measures
- Taking every reasonable precaution in the circumstances for the protection of workers.
- Implementing and monitoring safe work conditions
- Implementing safe work practices and monitoring for compliance

Supervisors must:

- Be knowledgeable about potential or actual health and safety hazards in the workplace and advise workers about these hazards.
- Ensure that equipment, materials and personal protective devices provided to workers are maintained in good condition.
- Ensure that workers follow safe work procedures and use personal protective equipment, PPE required by the company and by any applicable act and regulations.
- Must provide information, instruction and supervision to a worker to protect the health or safety of the worker.
- Ensure that an up-to-date inventory of hazardous substances in the workplace is maintained.
- Ensure that all hazardous materials present in the workplace are identified and labelled in the manner prescribed by regulations.
- Ensure that safety data sheets are readily available for all hazardous materials present in the workplace.
- Ensure that workers exposed to hazardous substance receive and participate in prescribed instruction and training.
- Ensure all workplace injury and incident, including near misses are promptly reported and prompt medical attention is provided.

Supervisor's other role include:

A. Planning

With the given human and physical resources, he has to ensure that his workers carry out their work efficiently and safely through goal setting. Goal setting means

- have written plan and personal performance goals which have been agreed upon by him and his superior
- work with his team regularly to help them set SMART goals that support their workplace development
- break down his goals into shorter-term goals
- review the progress of his goals regularly
- have a method for measuring and keeping track of his goal achievement
- always be prepared for emergency or crisis management
- develop strong business relationships with the people on my team as well as with suppliers and customers

B. Leading

To provide leadership and collaborative direction to his workers; supervisor must have the following positive characters:

- a clear understanding of the Company's goals and objectives
- understand how his role fits into the goals of the Company i.e. a clear understanding of his priorities
- a clear vision of the objectives of his work area
- communicate the Company and area goals to the people under his supervision (his team) on a regular basis
- feel that the people in the Company are their most important assets
- believe that he treat others as he would like to be treated myself
- consciously work at setting an example of effective leadership
- always actively working on developing a positive self-image
- always be enthusiastic to do better
- accept personal responsibility when he make a mistake
- develop himself to inspire, motivate, coach, delegate, discipline, plan and team-build
- plan his work in advance and not procrastinate or leave things to the last minute
- ensure that his meetings always has a clear agenda and start and finish on time
- know his team well enough to understand what is important to them

- believe in the abilities of people on his team and communicate his confidence in them
- always share credit for success
- be accountable for his workers' performance
- listen to the ideas of others
- listen to understand the other person's perspective before giving his view
- always wait until others have finished talking, don't interrupt
- speak calmly to people, not raising voice, regardless of the issue at hand

C. Checking

Without having a clear idea of what is acceptable and what is not acceptable, he is not likely to achieve whatever job related goals he has set for himself in the following areas. Without checking the activities carried out by his workers at the ground, he would not be able to accomplish the following:

- Keeping cost within budget
- Keeping Safety and Health under control (Engineering as well as administrative)
- Keeping equipment in serviceable condition
- Delivering goals on time
- Minimizing materials wastage
- Ensuring procedures (especially safe and health related) are followed by his workers
- Maximizing productivity among his workers
- Ensure quality of work meets standards (including Safety and Health)
- Ensure his workers are provided with the necessary training e.g. WSH related

D. Reviewing

A good supervisor has to walk the talk, meaning he has to

- review the progress of his goals regularly
- inform others, in advance, when he cannot meet targets
- intervene whenever he spots negative deviation from his goal
- be open and give prompt and constructive criticism
- recognize and celebrate the successes of those in his team, when he spots positive variances
- give frequent feedback to the people in his team to encourage their development and the achievement of their goals and objectives

- set new goals for himself and his team
- ensure that the members of his team know on a regular basis the status of the Company's overall goal achievement
- enquire or encourage his people to express their concerns
- support training opportunity for his people so that they can develop their skills necessary to do their job well

New Ways of Supervising

Over the years, the role of a supervisor has changed significantly from being a top down, autocratic order-giver to a team leader, coach and motivator.

- from ordering to asking; and consulting.
- from telling to listening and asking questions.
- from policing to coaching.
- from each person for himself to teamwork.
- from fear to mutual respect.
- from doing everything himself to delegate work to others
- from always be around to ensure that everything is okay to his site runs smoothly even when he is not there

This change has come about, not because people are becoming "soft-hearted," but because it is now very clear that people are more productive if they are happy, motivated and upbeat. This takes place in an employee-friendly environment. The change is one of enlightened self-interest on the part of managers who decide what training is appropriate for their supervisors. They know that happy employees are productive employees.

Risk Management

Introduction

Risk assessment is the process of identifying safety and health hazards associated with work, assessing the level of risks involved, and prioritising measures to control hazards and reduce risks.

Here, risk management (RM) is an important instrument in improving workplace safety and health by identifying, evaluating and controlling risks at workplaces. Risk management not only involves risk assessment for any work activity or trade, it also includes the control and monitoring of such risks, as well as communicating these risks effectively. While the concept of risk management has been around under the Safety and Health Management System, it received greater prominence and was mandated under the new WSH framework to foster a proactive accident prevention culture.

Under the Workplace Safety and Health (Risk Management) Regulations, employers, self-employed persons and principals (including contractors and sub-contractors) have the responsibility of identifying safety and health hazards at the workplace and taking appropriate actions to eliminate the hazards or reduce the risks associated with the hazards.

Objectives and Benefits

Accidents are costly, often resulting in human suffering as well as losses to companies that include loss of production time, costs of repairing damaged equipment and poor staff

morale. A proactive endeavour in managing workplace safety and health is more desirable as it is effective in reducing risks, preventing accidents and eliminating unsafe work conditions.

Companies that take greater ownership of safety outcomes and actively involve themselves in setting safety, standards will reap the benefits of lower accident rates, higher productivity, better staff morale and corporate image. The key to determining, this is having effective risk management in the workplace.

1.3 Conduct job safety analysis for a job or task

Job Safety Analysis (JSA)
A structured process for assessing, communicating and controlling of risks associated with the tasks or jobs.

JSA is a process

- for documenting each work activity in sequential steps,
- Identify the hazards in every step and
- Recommend precautionary actions to control and / or eliminate the hazards,
- So as to protect personnel while working near/at the equipment

Prerequisites for developing JSA

Must be familiar with

– In-house safety rules and regulations
– Permit-to-Work system
– Logout Tagout (LOTO) procedure
– Job scope,
– P&ID, and
– PPE

JSA – Definition

Job/Task = A sequence of separate steps or activities that when put together will accomplish a work goal.

Procedure = Step-by-step description of how to carry out the task from start to completion.

The 4 Basic Steps of JSA

1. Select / decide on the job to be analyzed

2. Breakdown the job into successive steps
3. Identify the hazards and potential accidents
4. Develop ways to eliminate hazards and potential accidents

Step 1 – Select the job to Analyze, Based on:

- Frequency of past accidents
- Frequency of disabling injuries
- Severity of potential accidents
- New job
- Introduction or addition of new equipment

Step 2 – Breakdown the job into successive steps:

- Step by step in sequence i.e. step 1 followed by step 2 and so on…
- Step should describe what is being done & NOT why it is being done.

Two Common Errors:

- Breakdown too detailed, become too complicated / confusing
- Breakdown too general, likely to omit hazards associated with the missing steps

Example: To prepare a system for spade work

- Too Detailed
  - Trace lines and system
  - Identify valves to be isolated
  - Prepare tags for Logout and Tagout
  - Prepare Lockout and Tagout List
  - Prepare spade list
  - Tag and isolate valves
  - Tag and open vent valves
  - Tag and open drain valves

- Too General:
  - Close valves and depressurized system

- Not too Detailed and not too General
  - Identify valves to be isolated
  - Prepare Lockout / Tagout and Spade list
  - Isolate system
  - Depressurize system to sewer

Step 3 – Identify hazards and Potential accidents

- Identify all hazards of each step while task is being performed, e.g.
  - chemical,
  - physical,
  - biological,
  - ergonomics hazards etc.
  - Are there any manual handling required?
  - Any excessive force required?
  - Is there adequate illumination?
  - Are there hazards material involved?
  - Are there moving parts?

- Consider also are there Hidden hazard for each step of the job, such as
  - Presence of energy sources? (mechanical, electrical, thermal or pressure)
  - Are there hazardous airborne contaminants present?
  - Is there potential for fire or explosion?

Hints:

- Observe with specific purpose of mind that what can go wrong and what is the consequence or accident;
- Checklist maybe used;
- While analysing , do not attempt to introduce solutions

Step 4 – Develop ways to eliminate hazards and potential accidents

- In developing ways to eliminate hazards and potential accidents, one needs to consider whether the risk must be controlled or is the risk acceptable?
- If Hazard is considered High Risk, it is not acceptable. Additional Control Measures must be put in place.

The Hierarchy of Control Measures

1. Elimination
2. Substitution
3. Engineering Control
4. Administrative Control
5. Use of PPE

Methods to Develop JSA

- Observation Method
- Discussion Method
- Recall–and–Check Method

Observation Method

The JSA is conducted by actual visualization of the job process.

Advantage:

- Simulate ideas & creativity
  - About hazards, potential accidents prevention
- Helps the supervisor to learn more about the job
- Encourage exchange of ideas
  - Opportunity to discuss work with the one performing the work

Discussion Method

Supervisor carrying out the job with the workers, discuss and develop the JSA

- Discussion among employees and contractors who are familiar with the job

Advantages:

- Pooling of their knowledge, experience and ideas
- Discussion improves acceptance – Buy in
- Discussion need not wait for the job being performed

Disadvantage

- May faced difficulty getting everyone for the meeting

Recall–and–Check Method

- Individually carried out by the supervisor based on his knowledge and verified with others.

Advantage:

- No need to wait for others to turn up for meeting to discuss
- No need to wait for job to be perform to observe. Sometime job is carried out infrequently.
- This method may be adopted if other two methods cannot be implemented in practice

What is Risk Management?

Risk Management involves:

1. Risk assessment of any work activity;
2. Control and monitoring of such risks; and
3. Communicating these risks to all persons involved.

Every workplace should conduct risk assessments for all routine and non-routine operations carried out under various environmental situations, e.g., weather and soil conditions. Routine operations include activities such as preparatory and troubleshooting work activities. Non-routine operations include commissioning, repair and maintenance of plants.

Different methods of risk assessments may be adopted, but all methods should include the 3 basic steps of Hazard Identification, Risk Evaluation and Risk Control. The selection of control measures must be based on the principles of Hierarchy of Control.

Risk Assessment Team

Risk assessment should be conducted by a multidisciplinary team who have a thorough knowledge of the work to be undertaken. Team members should include management staff, process or facility engineers, technical personnel, supervisors, production operators, maintenance staff and safety personnel if available. The risk assessment team should include contractors/suppliers personnel who are involved with the work, whenever necessary.

The team leader should have undergone training in risk assessment. Alternatively, a safety consultant trained and has experience in job safety analysis and risk management could be engaged to assist in the conduct of risk assessment.

Roles and Responsibilities

Risk management duties are imposed on every employer, self-employed person and principal (including contractor and sub-contractor). These parties must take all reasonably practicable measures to ensure that the workplace is safe to every person within its premises.

The Employer should:

1. Designate, assign, appoint or engage a competent person leading a team of personnel (including contractors) associated with the process or activity to conduct risk assessments;
2. Ensure that the risk control measures are implemented without undue delay after the completion of risk assessment;
3. Inform all persons working at the workplace of the risks, and the means to minimise or, where possible, eliminate the risks;
4. Provide a risk assessment register to record the findings of risk assessment;

5. Endorse and approve the risk assessments conducted;
6. Keep risk assessment records for inspection for at least three years from the date of the assessment; and submit the records to the Commissioner for Workplace Safety and Health if the Commissioner so requires;
7. Review and update the risk assessment at least once every three years or whenever there is a significant change in the work, or after an incident involving the work process;
8. Ensure that all employees are aware of the risk assessment for the work activity they carry out;
9. Develop and implement safe work procedures (SWPs) for work which poses safety or health risks to workers; and
10. Keep a written description of SWPs and produce this to the inspector for inspection when requested.

The Team Leader should:

1. Have adequate knowledge of the risk assessment method;
2. Recommend appropriate risk control measures to reduce or eliminate the risks identified;
3. Prepare a record of the risk assessment for the employer after completion of the assessment; and
4. Assist management in monitoring the effectiveness of risk control measures after their implementation.

Employees should:

1. Participate in the risk assessment or assist in conducting the risk assessment;
2. Adhere to SWPs established to reduce any safety and health risks in the workplace; and
3. Inform their supervisors of any shortcomings in the SWPs or risk control measures.

Contractors and Suppliers

Whenever necessary, contractors and suppliers should work with the risk assessment team to identify hazards, evaluate and control the risks that machinery, equipment or hazardous substances may pose. Contractors and suppliers must provide information of any machinery, equipment or hazardous substances to their customers who may require the information to conduct risk assessment in their workplaces. For example, contractors and suppliers should provide operation manuals, maintenance manuals, safety data sheets, etc.

Where contractors and suppliers undertake work for their customers, they must take all reasonably practicable measures to eliminate or reduce the risk that may be posed by their machinery, equipment or hazardous substances as much as reasonably practicable.

Risk Management Process

Unless the workplace or worksite is not ready, the risk assessment team should visit the workplace or worksite to ensure that all work areas are covered, including routine and non-routine operations. Routine operations include activities such as preparatory and troubleshooting work activities. Non-routine operations include commissioning, repair and maintenance of plants. The team should also consider various environmental situations, e.g., weather and soil conditions, where these operations are carried out.

Other methods of risk assessments may be adopted, but all methods should include the 3 basic steps of:

1. Hazard Identification
2. Risk Evaluation
3. Risk control

and the selection of control measures must be based on the **principles of Hierarchy of Control**.

The outcome of the risk assessment conducted, regardless of the method used, should be effective risk control measures.

1 Preparation

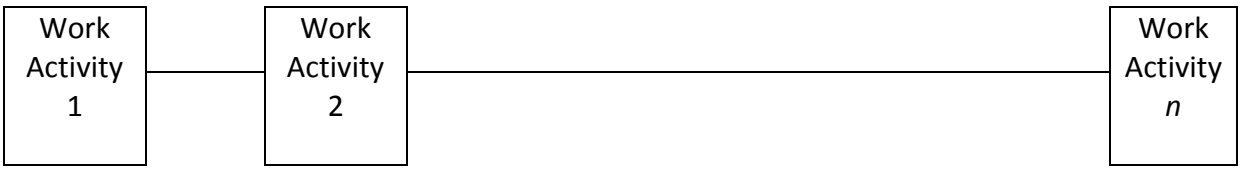
Prior to conducting a risk assessment, the following information should be obtained as far as possible:

- Plant layout plan
- Process flowchart
- List of work activities in the process†
- List of chemicals, machinery and / or tools used
- Records of past incidents and accidents
- Relevant legislation, codes of practice or specifications
- Observations and interviews
- Inspection records
- Details of existing risk controls
- Health and safety audit reports
- Feedback from staff, clients, suppliers or other stakeholders
- Safe work procedures (SWPs)

- Other information such as safety data sheets (SDSs), manufacturer's instruction
- manual
- Copies of any relevant previous risk assessments

Based on the work process, the steps of each work activity will be listed out in sequence. Each step of the process is referred to as a work activity.

† The work process is divided into sequential steps, which are referred to as work activities.



A work process broken down into *n* work activities

This starts off the risk assessment process.

1.4 Identify safety and health hazards associated with the job or task

Based on the information gathered on the process, hazards can be identified for each work activity. Hazard identification is perhaps the most important step in risk assessment because hazards can only be controlled if they are identified. Hazard identification involves identifying the hazards associated with each work activity and the type of potential accidents/incidents that can result from the hazards. Hazard identification is then repeated for all work activities of the process.

The aim is to spot hazards, brainstorm on all the possible types of accidents, incidents and/or ill-health that can occur due to the hazard(s), and identify potential victims or persons-at-risk.

To aid hazard identification, workplace safety and health hazards can be identified by considering:

- Method of work *e.g. repeated tasks and unsafe work practices*
- Electrical and mechanical hazards
- Manual material handling *e.g. lifting, pulling and pushing*
- Chemicals *e.g. corrosive substances*
- Machinery *e.g. unguarded machines*
- Temporary structures *e.g. scaffolds*
- Environmental conditions, *e.g. slippery surfaces, lighting, unstable soil conditions*
- Layout and location of equipment

Possible types of accidents, incidents and ill health include *(but not limited to)*:•

• Person falling from height	• Noise induced deafness
• Object falling from height	• Dermatitis
• Slips or falls on the level	• Collapse of structure
• Electrocution	• Fire and explosion
• Asphyxiation	• Struck by or against object
• Drowning	• Soft tissue damage (sprains, strains)

Potential victims or persons-at-risk include:

- Persons directly involved in the operation
- Visitors of the workplace
- Persons not directly involved in the operation
- Members of the public

3 Risk Evaluation

Risk evaluation is the process of estimating the risk levels of the identified hazards and if the risks can be accepted. This is used as a basis for prioritising actions to control identified hazards and thereby, minimising safety and health risks.

Risk evaluation consists of:

a. Identifying existing risk control measures;
b. Assessing potential severity of identified hazards;
c. Determining likelihood of occurrence of accidents, incidents and/or ill health arising from identified hazards; and
d. Assessing risk levels based on the severity and likelihood.

(a) Identifying existing risk control measures

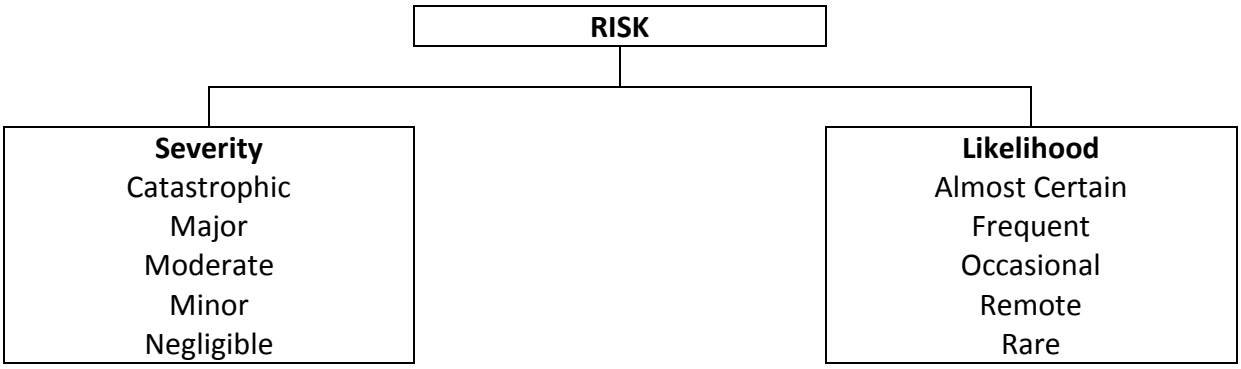
The presence of existing control measures should first be identified for each work activity of the process. By considering the effectiveness of the existing controls and the consequences that can occur should these controls fail; the risk of the activity can be assessed.

Examples of risk control measures include engineering controls, SWPs and personal protective equipment (PPE).

1.5 Evaluate level of risks involved in identified hazards

Risk has 2 parts:

I. Expected **SEVERITY** of the hazard; and
II. **LIKELIHOOD** of the occurrence of the accident / incident or ill health; taking into account the existing risk controls.



(b) Assessing potential severity of identified hazards

Severity is the degree or extent of injury or harm caused by accidents/incidents arising from workplace hazards. Severity is classified into 5 categories: (See *Table 1*).

Table 1 – Severity categories and description

Level	Severity	Description
5	Catastrophic	Fatality, fatal diseases or multiple major injuries
4	Major	Series injuries or life threatening occupational disease (includes amputations, major fractures, multiple injuries, occupational cancer, acute poisoning).
3	Moderate	Injury requiring medical treatment or ill health leading to disability (includes lacerations, burns, sprains, minor fractures, dermatitis, deafness, work related upper limb disorders).
2	Minor	Injury or ill health requiring first aid only (includes minor cuts or bruises, irritation, ill-health with temporary discomfort).
1	Negligible	Not likely to cause injury or ill health

As the severity of the hazard refers to the intrinsic or inherent nature of the adverse effect (e.g. cancer, amputation or fatal injury) that may result from the hazard, it does not depend on the controls in place. Therefore, in assigning the severity level, the existing controls should not be taken into account.

(c) Determining likelihood of occurrence of accidents, incidents and/or ill health arising from identified hazards

LIKELIHOOD of occurrence of an accident, incident or ill health is also classified into 5 categories: (See *Table 2*).

Table 2 – Likelihood categories and description

Level	Likelihood	Description
1	Rare	Not expected to occur but still possible
2	Remote	Not likely to occur under normal circumstances
3	Occasional	Possible or known to occur
4	Frequent	Common occurrence
5	Almost Certain	Continual or repeating experience

To minimise the subjectivity of estimating likelihood, in addition to looking at existing controls, the following sources of information should be considered:

- Past incident and accident records
- Industry practice and experience
- Relevant published literature

(d) Assessing risk levels based on the severity and likelihood

Once severity and likelihood have been established, the risk level is determined using a 5 X 5 risk matrix. The risk level may be classified as **low**, **medium** or **high** and depends on the combination of severity and likelihood (See *Table 3*).

To determine the risk level, select the appropriate row for Severity and the appropriate column for Likelihood; the cell where they intersect indicates the Risk Level.

Table 3 – Risk matrix to determine risk level

Likelihood / Severity	Rare (1)	Remote (2)	Occasional (3)	Frequent (4)	Almost Certain (5)

Catastrophic (5)	Medium Risk (5)	Medium Risk (10)	High Risk (15)	High Risk (20)	High Risk (25)
Major (4)	Medium Risk (4)	Medium Risk (8)	Medium Risk (12)	High Risk (16)	High Risk (20)
Moderate (3)	Low Risk (3)	Medium Risk (6)	Medium Risk (9)	Medium Risk (12)	High Risk (15)
Minor (2)	Low Risk (2)	Medium Risk (4)	Medium Risk (6)	Medium Risk (8)	Medium Risk (10)
Negligible (1)	Low Risk (1)	Low Risk (2)	Low Risk (3)	Medium Risk (4)	Medium Risk (5)

Risk Score	**Type of Risk**
1 – 3	**Low Risk**
4 – 12	**Medium Risk**
15 – 25	**High Risk**

1.7	Co-ordinate measures to control risks according to organisation's procedures

4 Risk Control

Based on the risk level determined in the risk evaluation step, risk controls should be selected to reduce the risk level to an acceptable level. This can be done by reducing the Severity and/or Likelihood.

As indicated in the risk matrix in *Table 3*, when the risk level is **High**, effective and practicable risk controls must be implemented to reduce **High Risk** to at least **Medium Risk**.

Table 4 shows the acceptability of risk and recommended actions for different risk levels, which can be used to guide the selection of risk controls.

Table 4 – Acceptability of risk and recommended actions

Risk level	Risk Acceptability	Recommended actions
Low Risk	Acceptable	No additional risk control measures may be needed. However, frequent review may be needed to ensure that the risk level assigned is accurate and does not increase over time.
Medium Risk	Moderately acceptable	A careful evaluation of the hazards should be carried out to ensure that the risk level is reduced to as low as is practicable within a defined time period. Interim risk control measures, such as administrative controls, may be implemented. Management attention is required.
High Risk	Not acceptable	High Risk level must be reduced to at least Medium Risk before work commences. There should not be any interim risk control measures and risk control measures should not be overly dependent on personal protective equipment or appliances. If need be, the hazard should be eliminated before work commences. Immediate management intervention is required before work commences.

It is essential for risks to be eliminated or reduced "at source". If a risk cannot be controlled completely by engineering measures, it is necessary to protect the employees by administrative control or personal protection.

The control of hazards and reduction of risks can be accomplished by following the **Hierarchy of Control Measures** (*Figure 2*). These control measures are not usually mutually exclusive e.g. engineering controls can be implemented together with administrative controls like training and SWPs.

1.6 Develop ways to eliminate / mitigate hazards identified in accordance with risk management regulations

ELIMINATION

Elimination of hazards refers to the total removal of the hazards and hence effectively making all the identified possible accidents, incidents and ill health impossible. This is a permanent solution and should be attempted in the first instance. If the hazard is eliminated, the risk associated of the hazard will be eliminated.

SUBSTITUTION

This involves replacing the hazard by one that presents a lower risk. *E.g. Asbestos can be substituted with non-asbestos materials.*

ENGINEERING CONTROLS

Engineering controls are physical means that limit the hazard. These include structural changes to the work environment or work processes, erecting a barrier to interrupt the transmission path between the worker and the hazard. *E.g. Isolation or containment of hazards, machine guarding, manual handling devices/equipment etc.*

ADMINISTRATIVE CONTROLS

These reduce or eliminate exposure to a hazard by adherence to procedures or instructions. Documentation should emphasise all the steps to be taken and the controls to be used in carrying out the activity safely. *E.g. Permit-to-work systems, scheduling of incompatible works etc.*

PERSONAL PROTECTIVE EQUIPMENT (PPE)

This should be used only as a last resort, after all other control measures have been considered, or as a short term contingency during emergency / maintenance / repair or as an additional protective measure. The success of this control depends critically on the protective equipment being chosen correctly, fitted correctly, worn at all times and maintained properly. Eg : Safety boots, helmet, glasses etc.

Safe Work Procedures (SWPs)

Arising from the risk assessment, SWPs for work which may pose safety and health risks should be established and implemented. The SWPs should include the safety precautions to be taken in the course of work and during an emergency, as well as the provision of PPE.

Residual Risks

Residual risks are the remaining risks after implementation of risk controls. The risk assessment team should ensure that residual risks are acceptable and manageable; and highlight the residual risks of each of the controls.

For example, if the risk control involves the use of safety harnesses and lanyards (a type of PPE), one of the residual risks is that the workers may not anchor the lanyards to protect themselves. In this case, the risk assessment team may highlight training (administrative control) as a further measure to ensure that residual risks are further minimised.

Once all the risk controls are selected and their residual risks highlighted, the risk assessment team needs to identify the action officers and follow-up dates. In this way, the specific action officers to implement the controls can be clearly identified, and the follow-up dates will help to ensure timeliness in implementation.

5 Record Keeping

A written description of the risk assessment must be kept for reference for 3 years.
The Risk Assessment Form can be used for record keeping, training and reviewing.
All risk assessment records should be concise and kept in a register.

The records should include the following information:

1) Names and designations of risk assessment team members
2) Inventory of work activities by process or location, associated with machinery,
3) equipment and chemicals
4) Hazards identification for each work activity, and possible types of accident or
5) incident
6) Existing risk control measures
7) Risk level for each hazard
8) Recommendations on additional risk controls required
9) Persons involved in implementing the measures on risk reduction
10) Signatures, date and designations of the persons conducting risk assessment
11) Signature, date and designation of management approving or endorsing the
12) Assessment

6 Implementation & Review

The results of risk assessment must be approved and endorsed by the top management. The employer should as far as is practicable, implement the recommended risk control measures as soon as possible.

An action plan should be prepared to implement the measures. The plan should include a time line of implementation and responsibilities of persons implementing the safety and health control measures. The plan should be monitored regularly until all the measures are implemented.

Regular review of the risk assessment plan is critical. While employers are required to review their plans **every three years**, a review should take place whenever:
1) New information on safety and health risks surfaces;
2) There are changes to the area of work and / or
3) After any accident / incident.

The risk assessment team should undertake the same 3 steps (hazard identification, risk evaluation and risk control) when conducting a risk assessment review. Regular auditing is required to ensure that risk control measures have been implemented and are functioning effectively.

1.9 Communicate risks to stakeholders according to organisation's procedures

COMMUNICATION

Throughout the risk management process, communication amongst stakeholders at every step is essential.

Communication:

- Engages and involves people to contribute to the risk management process
- Provides clarity on the risks, processes, control measures, perceptions etc.
- Helps stakeholders to make informed decisions
- Enables stakeholders to know the risks they face and the appropriate control measures to implement to reduce the risks.

GLOSSARY

Contractor
A person engaged by another person (referred to as principal) otherwise than under a contract of service –
a) to supply any labour for gain or reward; or
b) to do any work for gain or reward,
in connection with any trade, business, profession or undertaking carried on by the other person.

Hazard
Anything or any source or situation with the potential to cause harm or injury. Hazards may be classified as:
• Chemical, e.g. acids, alkalis, solvents;
• Biological, e.g. bacteria, fungi and viruses;
• Electrical, e.g. frayed wires;
• Ergonomic, e.g. repetitive work, awkward postures, prolonged standing;
• Mechanical, e.g. damaged equipment, forklifts, cranes, power presses;
• Physical, e.g. excessive noise, heat, radiation;

Likelihood
Probability or frequency of an event occurring

Occupational Safety & Health Management System (OSHMS)
OSHMS is part of the overall management system that facilitates the management of the safety and health risks associated with the business of the organization.
This includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the organisation's OSH policy.
(Source: SS 506: OSH Management System)

Principal
A person who, in connection with any trade, business, profession or undertaking carried on by him, engages any other person otherwise than under a contract of service –
a) to supply any labour for gain or reward; or
b) to do any work for gain or reward.

Risk
Likelihood that a hazard will cause a specific harm or injury. More specifically, it is the likelihood of accidents or ill-health occurring at work and the consequences of such occurrences.

Risk Assessment

OSH risk assessment is the process of identifying hazards, evaluating the risks, and determining the appropriate options for risk control.

Risk Management
OSH risk management involves the assessment of risks associated with any work activity or trade, control and monitoring of such risks, as well as communicating these risks.

Safe Work Procedures (SWPs)
Step-by-step procedures of doing or carrying out work safely.

Self-employed person
A person who works for gain or reward otherwise than under a contract of service, whether or not employing others.

Severity
Degree or extent of injury or harm caused by hazard, or as a result of an accident.

Subcontractor
A person engaged by any contractor or subcontractor –
a) To supply any labour for gain or reward; or
b) To do any work for gain or reward, which the contractor or subcontractor has been engaged as contractor or subcontractor.

1.8 Complete a risk assessment form

RISK ASSESSMENT FORM				
Department		**RA Leader: _____** **RA Member: _____** **_____** **_____**	**Approved by:** **Name: _____** **Designation: _____** **Signature: _____**	**RA Ref No:**
Location / Process				
Original Assessment Date		**Date: _____**	**Date: _____**	**_____**
		Last Review Date: _____	**Next Review Date: _____**	

HAZARD IDENTIFICATION				RISK EVALUATION				RISK CONTROL						
S/No	Work Activity	Hazard	Possible Injury/ III Health	Existing Risk Controls	S	L	RPN	Additional Controls	S	L	RPN	Implementation Person	Due Date	Remarks

Types of Hazards

Types of Hazards	Examples
Contact With	**Electricity, chemicals, hazardous substances, heat / cold, radiation, pressure, water, steam, protruding object.**
Struck By	**Moving / flying / falling objects**
Strike Against	**Stationary or protruding objects**
Caught In, On, or Between	**Pinch points, protruding, moving/ stationary objects**
Trip & Fall	**From height, floor level or below**
Overexertion	**Ergonomic, manual handling - Lifting, pulling, pushing**
Exposure	**Toxic gas, vapours, fumes, dust, fiber, noise / vibration, radiation, heat / cold, poor lighting, fire / explosion, biological.**

The 5 X 5 Risk Matrix with Numeric Ratings and Descriptive Ratings

Likelihood / Severity	Rare (1)	Unlikely (2)	Possible (3)	Likely (4)	Almost Certain (5)
Catastrophic (5)	Medium (5)	Medium (10)	High (15)	High (20)	High (25)
Major (4)	Medium (4)	Medium (8)	Medium (12)	High (16)	High (20)
Moderate (3)	Low (3)	Medium (6)	Medium (9)	Medium (12)	High (15)
Minor (2)	Low (2)	Medium (4)	Medium (6)	Medium (8)	Medium (10)
Insignificant (1)	Low (1)	Low (2)	Low (3)	Medium (4)	Medium (5)

Risk Score	Type of Risk
1 – 3	Low Risk
4 – 14	Medium Risk
15 – 25	High Risk

Severity Rating:

Risk Level	Severity	Description
5	Catastrophic	Fatality, fatal diseases or multiple major injuries.

4	Major	Serious injuries or life-threatening occupational disease (includes amputations, major fractures, multiple injuries, occupational cancer, acute poisoning).
3	Moderate	Injury requiring medical treatment or ill-health leading to disability (includes lacerations, burns, sprains, minor fractures, dermatitis, deafness, work-related upper limb disorders).
2	Minor	Injury or ill-health requiring first-aid only (includes minor cuts and bruises, irritation, ill- health with temporary discomfort).
1	Negligible	Not likely to cause injury or ill-health.

Likelihood Rating:

Level	Likelihood	Description
1	Rare	Not expected to occur but still possible.
2	Remote	Not likely to occur under normal circumstances.
3	Occasional	Possible or known to occur.
4	Frequent	Common occurrence.
5	Almost Certain	Continual or repeating experience.

Recommended action for risk levels:

Risk level	Risk Acceptability	Recommended Actions
Low Risk	Acceptable	• No additional risk control measures may be needed. • Frequent review and monitoring of hazards are required to ensure that the risk level assigned is

		accurate and does not increase over time.
Medium Risk	Tolerable	• A careful evaluation of the hazards should be carried out to ensure that the risk level is reduced to as low as reasonably practicable (ALARP) within a defined time period. • Interim risk control measures, such as administrative controls or PPE, may be implemented while longer term measures are being established. • Management attention is required.
High Risk	Not acceptable	• High Risk level must be reduced to at least medium Risk before work commences. • There should not be any interim risk control measures. Risk control measures should not be overly dependent on PPE or appliances. • If practicable, the hazard should be eliminated before work commences. • Management review is required before work commences.

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COMPETENCY ELEMENT 2
Identify hazards and control measures

2.1	Anticipate and identify types of hazards that are likely to occur in the workplace
2.2	Assess hazards identified to determine their consequences and risks involved
2.3	Identify gaps or shortfalls in workplace conditions and practices against existing control measures in according with organizational procedures
2.4	Identify control measures to minimize safety risks arising from hazards
2.5	Monitor the implementation of control measures in accordance with organizational procedures

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General Safety and Health

Introduction

Under the Workplace Safety and Health Act, employers or principals have to protect the safety and health of their employees or workers working under their direct control.

WSH (General Provisions) Regulations 2006

Specifically stipulates the following legal requirements for prevention of falls:

Regulation 23 —

(1) All openings in floors of a workplace shall be securely covered or fenced unless the nature of the work renders such covering or fencing impracticable.

(2) A substantial handrail shall be provided and maintained for every staircase in a workplace or which affords a means of exit from the workplace
  (a) if the staircase has an open side, shall be on that side; and
  (b) if the staircase has 2 open sides, shall be on both sides.

(3) Any open side of a staircase in a workplace shall be provided and maintained with a lower rail or other effective means.

(4) Every teagle opening or similar doorway used for hoisting or lowering goods or materials in a workplace, whether by mechanical power or otherwise, shall be —
  (a) securely fenced; and
  (b) provided with a secure handhold on each side of the opening or doorway.

(5) Any fencing referred to in paragraph (4) shall —
  (a) be properly maintained; and
  (b) except when goods or materials are being hoisted or lowered at the opening or doorway, be kept in position.

(6) It shall be the duty of the occupier of a workplace to comply the above regulations.

(7) Any person who has to work at a place from which he would be liable to fall —
  (a) a distance of more than 2 metres; or
  (b) into any substance which is likely to cause drowning or asphyxiation, shall be provided with a secure foothold and handhold at the place so far as is reasonably practicable for ensuring his safety.

(8) Where it is not reasonably practicable to provide a secure foothold or handhold, other suitable means such as a safety harness or safety belt shall be provided for ensuring the safety of every person working at such places.

(9) Where a safety harness or safety belt is provided
  (a) there shall be sufficient and secured anchorage, by means of a life line or otherwise for the safety harness or safety belt; and
  (b) the anchorage shall not be lower than the level of the working position of the person wearing the safety harness or safety belt.

(10) It shall be the duty of the employer of the person referred to in paragraph (7) to comply with the requirements of paragraphs (7), (8) and (9).

(11) It shall be the duty of the employer of a person who is exposed to the risk of falling into water and of drowning to provide —
  (a) equipment and means of rescuing and resuscitating drowning persons; and
  (b) suitable life jackets or other equipment for keeping such persons afloat in the event that they fall into the water.

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(12) No person shall require, permit or direct any person to work at a place from which he would be liable to fall —
  (a) a distance of more than 2 metres; or
  (b) into any substance which is likely to cause drowning or asphyxiation, unless the requirements of paragraphs (7), (8) and (9) have been complied with.

(13) Any person who contravenes the requirement referred in paragraph (12) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $20,000 or to imprisonment for a term not exceeding 2 years or to both.

Safe means of access and egress

Occupier or employer have to ensure that the workplace is safe and without risks to the health of any person within those premises, even if the person is not one. This legal obligation is extended to the provision and maintenance of safe means of access to and egress from all the places where employees and others have need to resort to in the course of their work.

Access and egress means the means of entry or exit to a workplace. It includes footpaths, corridors, doorways, ladders, steps etc.

Means of access and egress have to be suitably constructed, kept free from obstruction and to be well maintained. Safe access and egress is a basic safety measure for any business. When carrying out general and specific risk assessments, this must always be considered.

The main points to include are;

- Routes into/out of the premises
- Lighting
- Vehicle movements
- Floor surfaces, taking into account likely spillages, trip hazards and foot wear.
- Access and egress for disabled persons
- Areas where falls can occur from edges, into pits, tanks, excavations, etc. and from access steps, stairs and the like.
- Emergency egress arrangements
- Maintenance arrangements, including contractors especially contract cleaners.

Hazards of working at height

(1) Fall from height
(2) Struck by object that falls from height
(3) Drowning if fall into pit or sea

Examples of work practices that can cause person falling from height:

- Work being done on or near fragile surfaces such as skylights, badly rusted corrugated iron or fibreglass roofs, with no guarding, safety mesh, catch platforms, or alternative fall protection measures in place.
- Boom-type elevating work platforms such as cherry pickers, travel towers, boom lifts etc being used with no secure line and safety harness in place connecting the worker to the basket to reduce the risk of a fall from the basket.

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- Maintenance work such as gutter clearing, painting or roof restoration being done from a roof when there is no guarding or fall protection measures used.
- Work being done from the bucket on a front end loader or tractor or from a pallet lifted by a fork-lift.
- No guarding, railing or signage around holes, pits or shafts.
- Unsecured, loose or incomplete scaffolds or railing in a place near to where workers are working or likely to work in the near future.
- Truck tarps being fitted by climbing across a load with no fall prevention measures being used.
- Working from the top of livestock carriers without any fall prevention measures such as guard rails.
- Where ropes, harnesses and lanyards are being used for fall protection, the equipment is not checked regularly and before use. The equipment shows evidence of either rust, decay, cracks, knots, frays or a combination of these. The equipment used in the system is not designed for the job. Anchorage points used are inadequate in terms of location, strength and with no regard for effect of a fall, e.g. no regard for the pendulum effect if someone falls.
- Ladders are being set up on slippery or uneven surfaces and not secured to prevent them slipping forwards, backwards or sideways.

Safety in ladders

FIXED LADDERS are often permanently attached to a structure, building, or equipment. They may be the only means of access to roofs, pits, silos, towers, stacks, tanks, elevated tanks, and other difficult access areas where installation of stairs is not feasible.
A fixed ladder may consist of individual rungs, each of which is attached to the structure, or steps or rungs in side rails (or stiles) of wood or metal and attached in full length sections to the structure.

The major hazard in the use of fixed ladders is falls. Other hazards include splinters and slivers from rungs or railings, and slips resulting in sprains, strains and bruises. The problems associated with fixed ladders can be considerably reduced, if not eliminated, by proper design, construction, installation, maintenance, and the use of safety devices.

Although ladders occupy little space, they are generally not suitable for access to regular working areas, or where articles have to be carried. Only one person should use a ladder at a time.

The following general points should be observed with the construction of fixed ladders:

- All ladders should be made of sound materials suitable for the purpose for which the ladder is to be used.
- Metal is preferable to wood.
- Materials used for ladders installed in areas in which corrosive conditions may exist require careful consideration. This also applies to fixing brackets and the method of attachment.
- In most circumstances dissimilar metals should not be used together (e.g. an aluminium ladder on a steel tank). Where dissimilar metals are used the joints should be protected from electrolytic action.
- Fixed ladders should be permanently fastened at the top, bottom and intermediate points.

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- All ladders, other than the individual rung type, should have parallel sides or stiles and, as these may be used as a climbing aid, they should afford an adequate gripping surface, free from sharp edges, splinters or burrs.
- A fixed ladder should never be installed in such a position that persons working or walking beneath are in danger when it is being climbed.
- All ladders should be adequately lit.
- Ladders should not be installed near existing electrical installations and new electrical installations should not be sited near fixed ladders.
- Where the area at the base of the ladder is likely to be muddy or greasy some means should be provided for cleaning the soles of the worker's boots before he or she commences climbing. This may be boot scrapers, or material fixed to the bottom rungs which will absorb the moisture and grease.
- Where fixed ladders are accessible to the public, the bottom 2 m should be protected by fencing, locked gates, or the section made portable so that the public cannot gain access to the ladder.

PORTABLE LADDERS are used in many situations to gain access where permanent or fixed access is not practicable or possible. Portable ladders used incorrectly or in a defective condition present a serious hazard and cause many injuries each year. Because of the variety of portable ladders and their various uses it is not possible to fully cover their correct design, maintenance and use in this guide.

All portable ladders should be properly designed and constructed of suitable materials.

All ladders should be inspected on a regular basis and well maintained. Ladders which are defective should be removed from service until repaired or, if this is not possible, they should be destroyed.

Ladders awaiting repair should be suitably labelled. Prior to use they should be checked for:

- defective rungs;
- warping, cracking or splintering of stiles;
- faulty nails, screws, bolts and fittings;
- faulty feet; or
- broken ropes or fittings.

To test rungs, tap each one with the handle of a hammer—a dull sound indicates a defective rung and the ladder should not be used.

Safe Use of Portable Ladders

- Never use a ladder which is not long enough.
- Always stand ladders on a firm and level base.
- Step ladders should be properly spread to ensure stability.
- Always secure a ladder at the top and bottom.
- If this is not possible or practicable, have a second person footing or holding the ladder

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- When ascending or descending always face the ladder and use both hands and never overreach sideways from a ladder.
- Set the ladder at the correct angle of 1 unit out at the base for every 4 units of vertical height. The ladder should project at least 1 m above any platform or landing.
- Work should be carried out from a rung or step no higher than 1 m below the top of a ladder and the ladder should be positioned so that it is not necessary to lean out excessively to carry out the work. A basic rule is that the buckle of the user's belt should always be within the line of the stiles.
- Always ensure all loose items are removed from the top of a ladder before moving it.
- A metal ladder is not to be used near electricity and should be labelled "not to be used for electrical work".
- Never use a ladder in a horizontal position or as a support. The steps or rungs of ladders should not be used as work benches.
- Do not place ladders on unstable bases to obtain additional height.
- Do not alter ladders in any manner, i.e. shortening legs.
- Do not use a step ladder in the folded position.
- Only one person should use a ladder at any one time.
- When not in use, a ladder should be stored in a readily accessible position where it is
- protected from:
  - mechanical damage;
  - moisture;
  - chemicals;
  - excessive heat; or
  - any other harmful influence.
- Ladders should not be left lying around or standing where they can fall, be hit or trip up any person.
- A ladder stored horizontally should be adequately supported at several points over its length to prevent it from sagging. The support points should be covered with a soft material.

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WSH (Scaffolds) Regulations 2011
Definitions.

"approved scaffold contractor" means any firm or company which is the holder of a valid certificate of approval;
"base plate", in relation to a metal scaffold, means a plate for distributing the load from a standard;
"bay", in relation to a scaffold, means the portion of the scaffold between vertical supports (whether standards or supports from which that portion is suspended) which are adjacent longitudinally;
"brace" or "bracing" means a member incorporated in a scaffold for stability;
"building under construction" means a building in respect of which building operations are carried on;
"certificate of approval" means the certificate of approval issued to an approved scaffold contractor by the Commissioner under regulation 58(1);
"climber" means a lifting equipment through which a suspension wire rope, the lower end of which is not anchored, passes and which is controlled either by friction grips or by turns of the rope around drums within the equipment;
"frame or modular scaffold" means a scaffold manufactured in such a way that the geometry of the scaffold is pre-determined and the relative spacings of the principal members are fixed;
"guard-rail" means a horizontal rail secured to uprights and erected along an open or exposed side of any structure to prevent persons from falling;
"hanging scaffold" means a scaffold suspended by means of lifting gear, ropes, chains or rigid members and not provided with means of raising or lowering by a lifting appliance or similar device;
"independent tied scaffold" means a scaffold, the work platform of which is supported from the base by 2 or more rows of standards and which, apart from the necessary ties, stands completely free of any building, ship or other structure;
"ledger" means a member which spans horizontally and ties a scaffold longitudinally, and which acts as a support for putlogs or transoms;
"lift", in relation to any scaffold, means

(a) the vertical distance between
    (i) the base of a scaffold and its first ledger; or
    (ii) any 2 consecutive ledgers; or
(b) any level at which a platform is constructed;

"outrigger" means a structure which projects beyond the facade of any building, ship or other structure with the inner end being anchored, and includes a cantilever or other support;
"professional engineer" means a person registered as a professional engineer under the Professional Engineers Act (Cap. 253);
"putlog" means a horizontal member on which the board, plank or decking of a work platform is laid;
"recognised testing body" means a testing body acceptable to the Commissioner;
"responsible person", in relation to any workplace in which a person carries out or is to carry out any work involving the construction, erection, installation, re-positioning, alteration, maintenance, repair or dismantling of a scaffold, means

(a) his employer; or
(b) the principal under whose direction he carries out or is to carry out any such work;

"reveal tie" means the assembly of a tie tube and a fitting used for tightening a tube between 2 opposing surfaces;

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"right angle coupler" means a coupler, other than a swivel or putlog coupler, used for connecting tubes at right angles;
"scaffold" means any temporary structure

(a) on or from which any person performs work in any workplace; or
(b) which enables any person to obtain access to or which enables any material to be taken to any place at which such work is performed,

and includes any suspended scaffold, hanging scaffold, tubular scaffold, trestle scaffold, work platform, gangway, run, ladder or step-ladder (other than an independent ladder or step-ladder which does not form part of such a structure) together with any guard-rail, toe-board or other safeguards and all fixings, but does not include a lifting appliance, a lifting machine or a structure used merely to support such an appliance or such a machine or to support other plant or equipment;
"scaffold erector" means a person who is involved in the construction, erection, installation, re-positioning, alteration, maintenance, repair or dismantling of a scaffold in a workplace;
"scaffold supervisor" means a person appointed as a scaffold supervisor by the responsible person under regulation 6;
"sole plate" means a member used to distribute the load from the base plate or the standard of a scaffold to the supporting surface;
"standard" means a member used as a vertical support or column in the construction of a scaffold which transmits a load to the ground or any other solid construction;
"suspended scaffold" means a scaffold suspended by means of ropes or chains and capable of being raised or lowered, but does not include a boatswain's chair or other similar appliance;
"swivel coupler" means a coupler used to connect 2 tubes at any angle other than a right angle;
"tie" means an assembly used to connect a scaffold to a rigid anchorage;
"timber scaffold" means any scaffold which uses a timber roller as any of its member or component;
"toe-board" means a member fastened above a work platform or workplace to prevent persons or materials from falling from the work platform or workplace;
"transom" means a member placed horizontally and used to tie one ledger transversely to another, or one standard to another, in an independent tied scaffold;
"trestle scaffold" means a scaffold in which the supports for the platform are any of the following which are self-supporting:

(a) split heads;
(b) folding step-ladders;
(c) tripods; or
(d) other similar movable contrivances;

"tubular scaffold" means a scaffold constructed from tubes and couplers;
"work platform" means a platform which is used to support persons or materials, and includes a working stage.

Application

These Regulations shall apply to every workplace in which any scaffold is, is being or is to be constructed, erected, installed, used, re-positioned, altered, maintained, repaired or dismantled, whether such work or use of the scaffold commences before, on or after 10th September 2011.

PART II GENERAL PROVISIONS

Only approved scaffold contractor to construct, erect, install, re-position, alter, maintain, repair or dismantle certain scaffolds

No person shall construct, erect, install, re-position, alter, maintain, repair or dismantle any scaffold, not being an excluded scaffold, in any workplace unless he is an approved scaffold contractor.

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"excluded scaffold" means —

(a) a tower scaffold;
(b) a trestle scaffold; or
(c) a scaffold (other than a suspended scaffold, hanging scaffold or a scaffold erected on cantilever or jib supports) which, when completed and excluding the handrails and their supports at the uppermost lift of the scaffold, is less than 4 metres in height.

Scaffold erectors

It shall be the duty of the responsible person to ensure that no person is involved in the construction, erection, installation, re-positioning, alteration, maintenance, repair or dismantling of a scaffold in a workplace unless he has successfully completed a training course acceptable to the Commissioner, to equip him to perform the work of a scaffold erector.

Scaffold supervisor

(1) It shall be the duty of the responsible person to appoint a scaffold supervisor before any construction, erection, installation, re-positioning, alteration, maintenance, repair or dismantling of a scaffold in a workplace.
(2) The responsible person shall not appoint any person as a scaffold supervisor unless the person is one
   (a) who has successfully completed a training course acceptable to the Commissioner, to equip him to be a scaffold supervisor; and
   (b) whom the responsible person reasonably believes is competent to perform the functions and duties of a scaffold supervisor.

Personal protective equipment for scaffold erectors

(1) It shall be the duty of the responsible person to provide to every scaffold erector involved in the construction, erection, installation, re-positioning, alteration, maintenance, repair or dismantling of any scaffold in a workplace
   (a) a safety harness attached with a shock absorbing device; and
   (b) sufficient and secured anchorage by means of an independent life line or other equally effective means.
(2) It shall be the duty of the scaffold erector who is involved in any work referred to in paragraph (1) to use the safety harness attached with a shock absorbing device provided to him.

Supervision of construction, erection, installation, re-positioning, alteration, maintenance, repair or dismantling of scaffolds

It shall be the duty of the responsible person to ensure that no scaffold is constructed, erected, installed, re-positioned, altered, maintained, repaired or dismantled in a workplace except under the immediate supervision of a scaffold supervisor.

Construction and materials

(1) It shall be the duty of the responsible person to ensure that every scaffold, and every member or component thereof, in a workplace shall be —
   (a) of sound material, good construction and adequate strength;
   (b) free from patent defects; and
   (c) suitable and safe for the purpose for which it is intended.
(2) It shall be the duty of the responsible person to ensure that every scaffold erected at a building under construction, so far as is reasonably practicable, be erected such that it precedes the construction of the uppermost permanent floor of the building by not less than one metre above that floor.
(3) Where the height of the scaffold referred to in paragraph (2) extends beyond the uppermost permanent floor by 2 metres or more, it shall be the duty of the responsible person to ensure that the scaffold shall be adequately supported to prevent its collapse.

Foundation of scaffolds

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(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (5) are complied with.
(2) Every scaffold in a workplace shall be constructed, erected or installed on structures or foundations of adequate strength.
(3) Where a scaffold in a workplace is to be founded on soil, the soil shall be adequately consolidated.
(4) In the case of a scaffold in a workplace exceeding 15 metres in height or being erected on poorly drained soil, base plates shall bear upon sole plates that are
  (a) of strength not less than 670 kgf per square metre; and
  (b) of a length suitable to distribute the load.
(5) There shall be no cavity under the sole plate immediately below any standard of a scaffold in a workplace.

Scaffolds supported by buildings, ships or other structures

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) and (3) are complied with.
(2) No part of a building, ship or other structure shall be used as support for any part of a scaffold in a workplace unless it is sufficiently stable, and of sound material and adequate strength to afford safe support.
(3) Overhanging eaves gutters shall not be used as supports for any part of a scaffold in a workplace unless they have been specially designed as walkways and are of adequate strength.

Designated access point for scaffolds

(1) It shall be the duty of the occupier of a workplace where a scaffold is constructed, erected or installed to ensure that every scaffold shall have at least one designated access point from which a person may gain access onto the scaffold.
(2) It shall be the duty of the occupier of a workplace where a scaffold is constructed, erected or installed to ensure that every designated access point is
  (a) clearly marked with a sign or label; and
  (b) made safe for use by any person.

Stairs and ladders

It shall be the duty of the responsible person to ensure that stairs or ladders
  (a) are provided to enable persons to gain access from one level of any scaffold in a workplace to another level; and
  (b) so far as is reasonably practicable, are installed within the scaffold.

Standards and ledgers

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (8) are complied with.
(2) The standards of a scaffold in a workplace shall be
  (a) plumb where practicable;
  (b) fixed sufficiently close together to secure the stability of the scaffold, having regard to all the circumstances;
  (c) in the case of a timber scaffold, spaced not more than 1.5 metres apart; and
  (d) in the case of a metal scaffold, subject to paragraph (3), spaced not more than 2.5 metres apart.
(3) No metal scaffold with standards spaced more than 2.5 metres apart shall be constructed or erected in a workplace unless it has been approved in writing by the Commissioner.

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(4) Subject to paragraph (5), a standard of a scaffold in a workplace shall be placed on an adequate and secured sole plate in order that the foot of the standard does not rest directly on the ground or supporting surface, so as to prevent any vertical displacement of the foot.
(5) Where the floor or supporting structure is of sufficient rigidity to evenly distribute the load imposed upon it by the standard without causing any vertical displacement of the standard, the provision of a sole plate under the standard shall not be necessary.
(6) The foot of a standard of any frame or modular scaffold in a workplace shall be secured to a base plate so that it does not rest directly on the ground or supporting surface.
(7) The ledgers of a metal scaffold in a workplace shall be spaced at vertical intervals of not more than 2 metres.
(8) The ledgers of a timber scaffold in a workplace shall
  (a) as far as possible, be horizontal;
  (b) be spaced at vertical intervals of not more than 1.8 metres; and
  (c) be securely fastened to the standards.

Transoms

It shall be the duty of the responsible person to ensure that transoms are located at or near the intersections of standards and ledgers of a scaffold in a workplace.

Bracing

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (8) are complied with.
(2) Every scaffold in a workplace shall be effectively braced by means of longitudinal and transverse bracing systems which shall extend from the base to the top of the scaffold.
(3) The joints in bracing members shall be lapped or spliced.
(4) Longitudinal bracing members shall be continuous and fixed at approximately 45° to the horizontal.
(5) Each lift shall be crossed by at least one longitudinal bracing member in every 10 metres length of the scaffold.
(6) Subject to paragraph (7), a transverse bracing system shall be provided at each end of the scaffold and at intervals of not more than 10 bays.
(7) A transverse bracing system need not be provided where —
  (a) vertical transverse frames are provided for the full height of the scaffold and at each pair of standards; and
  (b) the frames are type-tested by a recognised testing body in accordance with a standard or specification acceptable to the Commissioner.
(8) Every frame scaffold in a workplace shall be provided with horizontal bracings or lacings at intervals of not more than every 5 lifts.

Gear for suspension of scaffolds

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (4) are complied with.
(2) very chain, rope and lifting gear used for the suspension of a scaffold in a workplace shall be of sound material, adequate strength and suitable quality, and in good condition.
(3) Any chain, rope and metal tube used for the suspension of a scaffold in a workplace, other than a suspended scaffold, shall be —
  (a) properly and securely fastened to safe anchorage points and to the scaffold ledgers or other main supporting members;
  (b) positioned so as to ensure stability of the scaffold;
  (c) approximately vertical; and
  (d) kept taut.

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(4) Every scaffold in a workplace that is suspended by means of chains or ropes shall be secured to prevent undue horizontal movement while it is used as a work platform.

Work platforms

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (6) are complied with.

(2) Work platforms in a workplace shall be provided —

(a) at any place of work which does not afford a proper and secure foothold; and

(b) in the case of a building under construction, around the edge of the building at every uppermost permanent floor which is under construction.

(3) Notwithstanding paragraph (2)

(a) work platforms shall be provided at intervals of not less than every alternate lift of any scaffold, except a tower scaffold or a trestle scaffold, used in any premises where building operations are being carried on; and

(b) unless approval is given in writing by the Commissioner, the vertical distance between any 2 work platforms shall not exceed 4 metres.

(4) Every work platform provided under paragraph (3) shall cover the lift of a scaffold throughout its entire length.

(5) Every work platform provided under this regulation shall

(a) be closely boarded, planked or decked;

(b) be at least 500 millimeters wide; and

(c) not have any opening except to allow access to that work platform.

(6) The distance between a work platform and any building, ship or other structure shall be as narrow as is reasonably practicable and shall not exceed 300 millimetres.

Loading requirements for scaffolds

(1) It shall be the duty of the responsible person to ensure that signboards stating the maximum permissible weight of tools and materials and the maximum number of persons permissible on each bay are prominently displayed at suitable locations on the scaffold in a workplace.

(2) It shall be the duty of the occupier of the workplace to ensure that the signboards referred to in paragraph (1) are displayed at all times until the scaffold is dismantled.

(3) It shall be the duty of the occupier of a workplace in which a scaffold is constructed, erected or installed to ensure that the requirements of paragraphs (4) to (8) are complied with.

(4) Subject to regulation 45, a scaffold in a workplace shall not be overloaded and, so far as is reasonably practicable, the load thereon shall be evenly distributed.

(5) When any material is transferred to or from a scaffold in a workplace, the material shall be moved or deposited without imposing any violent shock.

(6) The maximum loading for persons and materials allowed on any work platform in any bay of a scaffold in a workplace shall be —

(a) in the case of a timber scaffold, 75 kgf per square metre; or

(b) in any other case, 220 kgf per square metre.

(7) The maximum number of persons allowed on any work platform in any bay of a timber or metal scaffold in a workplace shall be —

(a) in the case of a timber scaffold, not more than 2 persons; and

(b) in the case of a metal scaffold, not more than 4 persons.

(8) The maximum number of persons allowed in any bay of a timber or metal scaffold in a workplace shall be

(a) in the case of a timber scaffold, not more than 4 persons; and

(b) in the case of a metal scaffold, not more than 8 persons.

Design by professional engineer

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(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) and (3) are complied with.
(2) Subject to regulation 19(6) and (7), a work platform and any support thereof in a workplace shall be constructed in accordance with the design and drawings of a professional engineer where the work platform is used —
(a) to provide footing for more than 2 persons in each bay; or
(b) to support tools or materials exceeding 25 kgf in each bay.
(3) Subject to regulation 19(8)(b), where a metal scaffold is used in a workplace to support more than 4 persons in any bay, the scaffold shall be constructed in accordance with the design and drawings of a professional engineer.
(4) It shall be the duty of a professional engineer who designs any work platform or support referred to in paragraph (2) or any metal scaffold referred to in paragraph (3) to
(a) take, so far as is reasonably practicable, such measures to ensure that his design can be executed safely by any person who constructs or uses the work platform, support or metal scaffold according to his design; and
(b) provide to any person who constructs or is to construct the work platform, support or metal scaffold, all design documentation (including all relevant calculations, drawings and construction procedures) as is necessary to facilitate the proper construction of the work platform, support or metal scaffold according to his design.
(5) It shall be the duty of the occupier of the workplace in which a scaffold is erected or installed to ensure that no work platform or support referred to in paragraph (2) or metal scaffold referred to in paragraph (3) is used unless the design and drawings certified by the professional engineer are kept available at the workplace for inspection by an inspector.

Boards, planks and decking

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (4) are complied with.
(2) All boards, planks or decking used in the construction of work platforms in a workplace shall —
(a) be of uniform thickness;
(b) be capable of supporting a load of 670 kgf per square metre with due regard to the spacing of the supports; and
(c) be flushed along their lengths and effectively secured to prevent tipping or uplift.
(3) Any metal decking which forms part of a work platform in a workplace shall be provided with non-skid surfaces.
(4) Any board or plank which forms part of a work platform in a workplace shall project beyond its end support to a distance of not less than 50 millimetres and not more than 4 times the thickness of the board or plank.

Toe-boards and guard-rails

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (6) are complied with.
(2) Every side of a work platform or workplace from which a person is liable to fall more than 2 metres shall be provided with toe-boards and 2 or more guard-rails.
(3) The toe-boards and guard-rails provided under paragraph (2) shall —
(a) be of sound material, good construction and adequate strength to withstand the impact during the course of work;
(b) be placed on the inside of the uprights and secured so as to prevent any accidental displacement; and
(c) be placed so as to prevent the fall of any person or material.
(4) The uppermost guard-rail provided under paragraph (2) shall be at least one metre above the work platform or workplace for which the guard-rail is provided.

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(5) The height of toe-boards provided under paragraph (2) shall not be less than 90 millimetres.
(6) The vertical distance
(a) between any 2 adjacent guard-rails provided under paragraph (2); and
(b) between any work platform or workplace and the guard-rail immediately above it shall not exceed 600 millimetres.

Overlay and screening nets

(1) Subject to paragraph (2), it shall be the duty of the responsible person to ensure that overlay or screening nets shall be used to envelope any timber or metal scaffold in a workplace which is erected on the outside of a building.
(2) Paragraph (1) shall not apply to a tower scaffold.

Scaffolds to be free of material which endanger safety

It shall be the duty of the occupier of a workplace in which a scaffold is constructed, erected or installed to remove any material, including waste material or debris, from the scaffold which may endanger the safety of any person.

Measures against electrical hazards

It shall be the duty of
(a) the employer of any person who uses or is to use any scaffold in a workplace; or
(b) the principal under whose direction any person uses or is to any scaffold in the workplace,
to ensure that all practicable measures shall be taken to protect the person from electric shock by electrical wires or equipment when using the scaffold.

Inspection of scaffolds

(1) Subject to paragraph (4), it shall be the duty of the occupier of a workplace in which a scaffold is constructed, erected or installed to ensure that no scaffold is used unless it has been inspected by a scaffold supervisor
(a) upon completion of its construction, erection or installation, as the case may be;
(b) thereafter, at intervals of not more than 7 days immediately following the date of the last inspection by the scaffold supervisor; and
(c) after exposure to weather conditions likely to have affected its strength or stability or to have displaced any part.
(2) It shall be the duty of the scaffold supervisor to
(a) enter the results of every inspection referred to in paragraph (1) into a register containing such details as may be required by the Commissioner; and
(b) provide the register to the occupier of the workplace.
(3) Subject to paragraph (4), it shall be the duty of the occupier of the workplace in which a scaffold is constructed, erected or installed to
(a) keep the register referred to in paragraph (2) at the workplace; and
(b) produce the register for inspection upon request by an inspector.
(4) This regulation shall not apply to
(a) a trestle scaffold; or
(b) a scaffold, from no part of which a person is liable to fall more than 2 metres.

Labelling of scaffolds after inspection

(1) It shall be the duty of the scaffold supervisor who carries out the inspection of a scaffold under regulation 26 to, immediately after such inspection, display a notice or label indicating whether the scaffold is safe for use or otherwise.
(2) The notice or label referred to in paragraph (1) shall
(a) be in a form readily understood by the persons employed in the workplace; and
(b) be displayed at every designated access point.

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(3) Subject to paragraph (4), it shall be the duty of

(a) the employer of any person who uses or is to use any scaffold in a workplace to which regulation 26 applies; or

(b) the principal under whose direction any person uses or is to use any scaffold in a workplace to which regulation 26 applies,

to ensure that the person does not use the scaffold unless a notice or label is displayed at the designated access point indicating that the scaffold is safe for use.

(4) Paragraph (3) shall not apply in relation to a person who is

(a) a scaffold supervisor carrying out any inspection of a scaffold under regulation 26; or

(b) a scaffold erector carrying out the repair of a scaffold under regulation 28.

Construction, erection, maintenance, repair and dismantling of scaffolds

(1) It shall be the duty of the occupier of a workplace in which a scaffold is, or is being, constructed, erected or installed to ensure that the requirements of paragraphs (2) to (8) are complied with.

(2) No scaffold or part thereof which is partially constructed, erected, installed or dismantled shall be allowed to be used unless it is made safe.

(3) Where any scaffold referred to in paragraph (2) is unsafe for use, a prominent warning notice or signs in a form readily understood by all persons indicating that the scaffold or part thereof is not to be used shall be affixed near any point at which the scaffold or part, as the case may be, is liable to be approached for the purpose of use.

(4) Every scaffold shall be properly maintained and every part thereof shall be fixed, secured or placed in position so as to prevent, so far as is reasonably practicable, any accidental displacement.

(5) Any scaffold, and any member or component thereof, that has been damaged or weakened shall be repaired as soon as reasonably practicable.

(6) No person shall be permitted on a scaffold that is damaged or weakened except a scaffold erector who is carrying out the repair of the scaffold.

(7) All reasonably practicable measures shall be taken to ensure the safety of the persons carrying out the repairs referred to in paragraph (6).

(8) Where ties of a scaffold to a permanent structure have to be removed, the portion of the scaffold from which the ties are removed shall be dismantled unless adequate measures are taken to ensure the stability of the scaffold.

PART III METAL SCAFFOLDS

Approved metal scaffolds

It shall be the duty of the responsible person to ensure that no metal scaffold shall be erected or installed in a workplace unless

(a) it has been type-tested by a recognised testing body in accordance with a standard or specification acceptable to the Commissioner; and

(b) it complies with such conditions as the Commissioner may think fit to impose.

Design of certain metal scaffolds by professional engineer

(1) It shall be the duty of the responsible person to ensure that every metal scaffold

(a) exceeding 15 metres in height in any shipyard; or

(b) exceeding 30 metres in height in any workplace other than in a shipyard,

be erected or installed in accordance with the design and drawings of a professional engineer.

(2) It shall be the duty of a professional engineer who designs any metal scaffold referred to in paragraph (1) to

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(a) take, so far as is reasonably practicable, such measures to ensure that his design can be executed safely by any person who erects, installs or uses the scaffold according to his design; and

(b) provide to any person who erects or installs or is to erect or install the scaffold, all design documentation (including all relevant calculations, drawings and construction procedures) as is necessary to facilitate the proper erection or installation of the scaffold according to his design.

(3) It shall be the duty of the occupier of a workplace in which a metal scaffold referred to in paragraph (1) is erected or installed to ensure the scaffold is not used unless

(a) the scaffold has been examined by the professional engineer after its erection or installation, and a certificate stating that the scaffold is safe for use has been obtained from the professional engineer;

(b) the design and drawings certified by the professional engineer and the certificate referred to in sub-paragraph (a) are kept available at the workplace for inspection by an inspector; and

(c) the scaffold has been inspected by a professional engineer at least once every 3 months to ensure that it is safe for use.

(4) It shall be the duty of the professional engineer, when he discovers any defect in a metal scaffold in the course of his examination or inspection referred to in paragraph (3), to immediately inform the occupier of the workplace in which the scaffold is erected or installed.

(5) It shall be the duty of the occupier referred to in paragraph (4), upon being informed of any defect in a scaffold under that paragraph, to immediately take action to rectify the defect before the scaffold is used.

Ties for metal scaffolds

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (7) are complied with.

(2) Every alternate lift and every uppermost lift of an independent tied metal scaffold in a workplace shall be effectively tied to the building or structure by means of ties.

(3) Ties shall be located no further than one bay from the ends of the independent tied metal scaffold and thereafter, at intermediate spacing of not more than 3 bays or 7.5 metres apart, whichever is the lesser.

(4) Ties other than tie tubes and couplers shall not be used without the approval in writing of the Commissioner.

(5) Every tie under this regulation shall conform with the following:

(a) tie tubes shall be attached by right angle couplers to the outside ledger or standard or, in the case of an independent scaffold, to both the inside and outside standards as close as possible to the junction of the standards and ledgers; and

(b) the ends of the tie tubes shall be attached to the building or structure by one of the following methods:

(i) the tie tubes shall form part of a yoke constructed of tubes and couplers which passes around and bears hard against the sides of a column, pier, beam or similar structural members;

(ii) each tie tube shall pass through the wall and be secured with 2 pieces of tube of minimum length of 300 millimetres and shall be attached one on each side of, and bear hard against, the wall;

(iii) each tie tube shall be attached to a reveal tie not greater than 1.5 metres in length but reveal ties shall not be used where a horizontal diagonal plan bracing is used; or

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(iv) each tie tube shall pass through ring bolts which shall be secured by casting in or being anchored in the wall.

(6) Every tie tube shall be perpendicular to the longitudinal plane of the scaffold and, where this is not practicable, the deviation from the perpendicular shall not exceed 15°.

(7) Every tie shall be capable of withstanding a force of 1,000 kgf applied in either direction along the length of the tie.

Transoms for modular or tube-and-coupler scaffolds

It shall be the duty of the responsible person to ensure that every modular scaffold or tube-and-coupler scaffold in a workplace is provided with transverse horizontal members or transoms for each lift.

Spigots, jointpins or sleeves

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (6) are complied with.

(2) Spigots, jointpins or sleeves shall be used to connect one standard of a metal scaffold in a workplace to another standard.

(3) Where spigots, jointpins or sleeves are used to locate and connect one standard to another, such spigots, jointpins or sleeves shall

(a) permit full bearing over the whole bearing area at the ends of the standards; and

(b) have such external or internal dimensions that the maximum difference of mating diameters in any part between the spigot, jointpin or sleeve and the other standard does not exceed 1.6 millimetres.

(4) Spigots and jointpins shall engage in the ends of the standards by at least 70 millimetres.

(5) Sleeves shall cover the end of the standard by at least 70 millimetres.

(6) The standards shall be securely held if they are connected by the spigots, jointpins or sleeves.

Adjustable base plates

Where an adjustable base plate is used on a standard of a metal scaffold in a workplace and the adjustment exceeds 150 millimetres, it shall be the duty of the responsible person to ensure that the standard is tied longitudinally to the adjacent standard or standards at a height of not more than 460 millimetres above the supporting surface by right angle or swivel couplers.

Frame or modular scaffolds to be erected in one plane

It shall be the duty of the responsible person to ensure that every frame or modular scaffold in a workplace is erected such that every lift is horizontal and in one plane.

Cross brace not to be used as means of access or egress

It shall be the duty of

(a) the employer of any person who uses or is to use any frame scaffold in a workplace; or

(b) the principal under whose direction any person uses or is to use any frame scaffold in a workplace,

to ensure that no cross brace on the frame scaffold shall be used as a means of access or egress by the person.

PART V SUSPENDED SCAFFOLDS

Suspended scaffolds

(1) It shall be the duty of the responsible person to ensure that no suspended scaffold shall be erected or installed in a workplace unless

(a) the outriggers or other supports are

(i) of adequate length and strength;

(ii) properly installed and supported;

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(iii) securely fixed to a building, ship or other structure by anchor bolts or other similar means, or where such fixing is not reasonably practicable, adequately and securely anchored at the inner ends; and

(iv) subject to paragraph (2), provided with rope guards of adequate strength at the outer ends to prevent the ropes from being displaced from the outriggers;

(b) the points of suspension are at adequate horizontal distances from the building face, the hull of the ship or any other structure;

(c) the suspension ropes are

(i) of galvanised wire ropes;

(ii) of sound material, good construction and adequate strength, and free from patent defects;

(iii) securely attached to the outriggers or other supports and, if winch drums are used, to the winch drums; and

(iv) of such length that the platform is capable of being lowered to the ground or floor, and in the case of winches, that there are at least 2 turns of the rope remaining on each winch drum;

(d) the platform is

(i) at least 500 millimetres and not more than 750 millimetres in width unless measures have been taken to prevent transverse tilting of the platform; and

(ii) so arranged or secured that, at each working position, the edge of the platform is as close as practicable to the work area and the distance between the platform and the work area is not more than 460 millimetres; and

(e) boards, planks or decking used as platforms shall be capable of supporting a load of 670 kgf per square metre with due regard to the spacing of the supports.

(2) Paragraph (1)(a)(iv) shall not apply when the primary suspension wire-ropes are suspended from the outer end of the outriggers or other supports by means which preclude the displacement of the wire-rope from its point of suspension.

(3) It shall be the duty of

(a) the employer of any person who uses or is to use any suspended scaffold in a workplace; or

(b) the principal under whose direction any person uses or is to use any suspended scaffold in a workplace,

to ensure that no person shall enter or leave the cradle of a suspended scaffold unless it is at rest on the ground or at any level which affords a safe means of access or egress.

Suspended scaffolds raised or lowered by climbers, winches or powered device

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (7) and (9) are complied with.

(2) No suspended scaffold that is raised or lowered by climbers, winches or any powered device shall be erected or installed in a workplace unless

(a) the suspended scaffold has been designed and constructed in accordance with a standard or code acceptable to the Commissioner;

(b) the climbers, winches or device is properly maintained;

(c) the climbers, winches or device is opened for inspection and servicing at least once in every 12 months to ensure that the drive mechanisms are in safe working order; and

(d) records of such inspection and servicing are kept for each climber, winch and device.

(3) The outriggers or overhead supports shall be spaced not more than 3.2 metres apart measured from the longitudinal centre line of one outrigger or support to such centre line of the adjacent outrigger or support, unless the prior approval in writing of the Commissioner has been obtained.

(4) Wire ropes used to suspend the work platform shall be vertical and taut.

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(5) The climbers, winches or device shall be synchronised so that the work platform of the suspended scaffold is maintained level at all times.
(6) In the case of a suspended scaffold manufactured outside Singapore, the design of the suspended scaffold shall be certified by a professional engineer or a third-party inspection agency approved in writing by the Commissioner.
(7) Where the work platform of a suspended scaffold is supported by wire ropes, the outriggers or other overhead supports for the suspended scaffold shall be constructed in accordance with the design and drawings of a professional engineer.
(8) It shall be the duty of a professional engineer who designs any outrigger or overhead support for the suspended scaffold referred to in paragraph (7) to

(a) take, so far as is reasonably practicable, such measures to ensure that his design can be executed safely by any person who constructs or uses the outrigger or other overhead support for the suspended scaffold according to his design; and
(b) provide to any person who constructs or is to construct the outrigger or other overhead support for the suspended scaffold, all design documentation (including all relevant calculations, drawings and construction procedures) as is necessary to facilitate the proper construction of the outrigger or other overhead support for the suspended scaffold according to his design.

(9) Where a suspended scaffold has been re-positioned or shifted from one location to another within the same workplace, the suspended scaffold and its attachments shall be erected or installed in accordance with the design and drawings certified by the professional engineer.
(10) It shall be the duty of the occupier of a workplace in which a suspended scaffold is erected or installed to ensure that no suspended scaffold referred to in paragraph (7) shall be used unless the design and drawings certified by the professional engineer are kept available at the workplace for inspection by an inspector.

Safety device for suspended scaffolds

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) and (3) are complied with.
(2) Subject to paragraph (4), every suspended scaffold in a workplace that is raised or lowered by climbers, winches or a powered device shall be provided at each suspension point with a safety rope with an automatic safety device mounted on it.
(3) The safety rope with the automatic safety device referred to in paragraph (2) shall be capable of supporting the platform in the event of a failure of the primary suspension rope, winch, climber or any part of the device or mechanism used for raising or lowering the suspended scaffold.
(4) Paragraph (2) shall not apply if

(a) the platform is supported on 2 independent suspension wire ropes at or near each end such that, in the event of a failure of one suspension wire rope, the other wire rope is capable of sustaining the weight of the platform and its load and preventing it from tilting; or
(b) a system is incorporated which operates automatically to support the platform and its load in the event of a failure of the primary suspension rope.

Prohibition of overloading of suspended scaffolds

It shall be the duty of the occupier of a workplace in which a suspended scaffold is erected or installed to ensure that the suspended scaffold shall not at any time be loaded beyond the safe working load except in a test in the presence of an inspector or authorised examiner.

Suspended scaffolds counter-balanced by counter-weights

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (5) are complied with.

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(2) In relation to a scaffold in a workplace, water or other liquids, earth, clay, sand, chippings or other aggregates shall not be used as counter-weights.
(3) Every portable counter-weight shall have its weight permanently and distinctly stamped, engraved or embossed thereon.
(4) Every counter-weight shall be securely attached at the inner end of the outriggers to prevent any accidental displacement or tampering by any person.
(5) The counter-balancing weight on any outrigger shall not be less than 3 times the weight necessary to balance the load on the projecting part of the outrigger when the suspended scaffold in a workplace is fully loaded.

Prevention of sway

It shall be the duty of the responsible person to ensure that the work platform of a suspended scaffold in a workplace shall be securely fastened to the building or other structure in such a manner and at such intervals as to prevent the platform from swaying.

Age limit of operator

It shall be the duty of

(a) the employer of any person who uses or is to use any suspended scaffold in a workplace; or

(b) the principal under whose direction any person uses or is to use any suspended scaffold in a workplace,

to take, so far as is reasonably practicable, such measures as are necessary to ensure that no person below the age of 18 years operates a climber, winch, powered device or mechanism used for raising or lowering a suspended scaffold.

Personal protective equipment for users of suspended scaffolds

(1) It shall be the duty of

(a) the employer of any person who uses or is to use any suspended scaffold in a workplace; or

(b) the principal under whose direction any person uses or is to use any suspended scaffold in a workplace, to provide to the person

(i) a safety harness attached with a shock absorbing device; and

(ii) sufficient and secured anchorage by means of an independent life line or other equally effective means.

(2) It shall be the duty of the person who uses any suspended scaffold in a workplace to use the safety harness attached with a shock absorbing device provided to him.

Notice to be displayed in suspended scaffolds

(1) It shall be the duty of the responsible person to prominently display a notice in the cradle of a suspended scaffold in a workplace that is in a form readily understood by any person

(a) stating the safe working load of the suspended scaffold;

(b) stating the maximum number of persons allowed to be in the suspended scaffold; and

(c) reminding the person to attach his safety harness to a secured anchorage at all times.

(2) It shall be the duty of the occupier of the workplace to ensure that the notice referred to in paragraph (1) is displayed at all times until the suspended scaffold is dismantled.

PART VI OTHER SCAFFOLDS

Tower scaffolds

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (5) are complied with.
(2) The height of a tower scaffold erected or installed on board a ship in a shipyard shall not exceed 4 times the lesser of the base dimensions of the scaffold.

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(3) The height of a tower scaffold in a workplace, other than a tower scaffold referred to in paragraph (2), shall not exceed 8 times the lesser of the base dimensions of the scaffold.
(4) Where the height of a tower scaffold in a workplace, excluding the handrails and their supports at the uppermost lift of the scaffold, exceeds 3 times the lesser of the base dimensions of the scaffold, the scaffold shall be effectively tied to the building or a rigid structure so as to prevent toppling.
(5) Any tower scaffold which can be moved on casters shall
(a) be constructed with due regard to its stability and, if necessary, adequately weighted at the base;
(b) be used only on a firm and even surface; and
(c) be provided with a positive locking device on each caster to hold the scaffold in position.
(6) It shall be the duty of
(a) the employer of any person who uses or is to use any tower scaffold in a workplace; or
(b) the principal under whose direction any person uses or is to use any tower scaffold in a workplace,
to ensure that no more than 2 work platforms shall be used on a tower scaffold in the workplace at any one time.
(7) It shall be the duty of
(a) the employer of any person who uses or is to use any tower scaffold in a workplace; or
(b) the principal under whose direction any person uses or is to use any tower scaffold in a workplace, to ensure that —
(i) no tower scaffold is moved except by applying force at or near the base;
(ii) the casters are locked to hold the tower scaffold in position while the person is on the tower scaffold; and
(iii) no person remains on the tower scaffold when it is being moved.

Scaffolds and work platforms erected on cantilever or jib supports

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (4) are complied with.
(2) A scaffold in a workplace that is erected on cantilever or jib supports shall be adequately supported, fixed and anchored on the supports to prevent displacement.
(3) The cantilever or jib supports used to support the scaffold shall
(a) have outriggers of adequate length and cross section; and
(b) be constructed in accordance with the design and drawings of a professional engineer.
(4) Where a work platform in a workplace rests on bearers that let into a wall at one end and it does not have other support, the bearers shall
(a) pass through the wall;
(b) be of adequate strength; and
(c) be securely fastened on the other side of the wall.
(5) For the purposes of this regulation and regulation 53, “cantilever or jib support” includes any structure, including a bracket or beam, that projects beyond a fulcrum or point of attachment and that is not supported directly from the ground or floor below.

Design of cantilever or jib supports by professional engineer

(1) It shall be the duty of a professional engineer who designs a cantilever or jib support, referred to in regulation 52(3)(b), to
(a) take, so far as is reasonably practicable, such measures to ensure that his design can be executed safely by any person who constructs or uses the cantilever or jib support according to his design; and

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(b) provide to any person who constructs or is to construct the cantilever or jib support, all design documentation (including all relevant calculations, drawings and construction procedures) as is necessary to facilitate the proper construction of the cantilever or jib support according to his design.

(2) It shall be the duty of the occupier of a workplace in which a scaffold is erected on cantilever or jib supports to ensure that the scaffold is not used unless

(a) the scaffold (including the cantilever or jib support) has been examined by the professional engineer after its erection or installation, and a certificate stating that the scaffold is safe for use has been obtained from the professional engineer;

(b) the design and drawings certified by the professional engineer and the certificate referred to in sub-paragraph (a) are kept available at the workplace for inspection by an inspector; and

(c) the scaffold has been inspected by a professional engineer at least once every 3 months to ensure that it is safe for use.

(3) It shall be the duty of the professional engineer, when he discovers any defect in a scaffold in the course of his examination or inspection referred to in paragraph (2), to immediately inform the occupier of the workplace in which the scaffold is erected or installed.

(4) It shall be the duty of the occupier of the workplace referred to in paragraph (3), upon being informed of any defect in a scaffold under that paragraph, to immediately take action to rectify the defect before the scaffold is used.

Hanging scaffolds

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2) to (4) are complied with.

(2) A hanging scaffold in a workplace shall be

(a) constructed before being hung into position on a building, ship or other structure;

(b) securely anchored to the hull or any other part of the building, ship or structure to prevent lateral movement or sway;

(c) constructed so that the work platform is in a horizontal plane; and

(d) provided with safe means of access to and egress from its platform by means of stairs or ladders.

(3) For the purposes of paragraph (2)(d), stairs or ladders

(a) shall be placed in such a manner as to prevent any person from falling; and

(b) shall not rise to a vertical distance of more than 3 metres between landings.

(4) A hanging scaffold from which a person may fall more than 2 metres shall be constructed and installed in accordance with the design and drawings of a professional engineer.

(5) It shall be the duty of a professional engineer who designs a hanging scaffold referred to in paragraph (4) to

(a) take, so far as is reasonably practicable, such measures to ensure that his design can be executed safely by any person who constructs, installs or uses the hanging scaffold according to his design; and

(b) provide to any person who is constructs or installs or is to construct or install the hanging scaffold, all design documentation (including all relevant calculations, drawings and construction procedures) as is necessary to facilitate the proper construction or installation of the hanging scaffold according to his design.

(6) It shall be the duty of the occupier of a workplace in which a hanging scaffold is constructed or installed to ensure that no hanging scaffold referred to in paragraph (4) is used unless the design and drawings certified by the professional engineer are kept available at the workplace for inspection by an inspector.

Personal protective equipment for users of hanging scaffolds

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1) It shall be the duty of

(a) the employer of any person who uses or is to use any hanging scaffold in a workplace; or

(b) the principal under whose direction any person uses or is to use any hanging scaffold in a workplace, to provide to the person —

(i) a safety harness attached with a shock absorbing device; and

(ii) sufficient and secured anchorage by means of an independent life line or other equally effective means.

(2) It shall be the duty of the person who uses any hanging scaffold in a workplace to use the safety harness attached with a shock absorbing device provided to him.

Trestle scaffolds

(1) It shall be the duty of the responsible person to ensure that the requirements of paragraphs (2), (5) and (6) are complied with.

(2) Subject to paragraph (3), no trestle scaffold in a workplace shall

(a) be constructed with more than 3 tiers; or

(b) have a work platform more than 4.5 metres above the ground or floor or other surfaces upon which the scaffold is erected.

(3) Paragraph (2) shall not apply to a trestle scaffold constructed in accordance with the design and drawings of a professional engineer.

(4) It shall be the duty of a professional engineer who designs a trestle scaffold referred to in paragraph (3) to

(a) take, so far as is reasonably practicable, such measures to ensure that his design can be executed safely by any person who constructs or uses the trestle scaffold according to his design; and

(b) provide to any person who is constructs or is to construct the trestle scaffold, all design documentation (including all relevant calculations, drawings and construction procedures) as is necessary to facilitate the proper construction of the trestle scaffold according to his design.

(5) No trestle scaffold shall be erected on a scaffold platform unless

(a) the width of the platform is such as to leave sufficient clear space for the transport of materials; and

(b) the trestles or uprights are firmly attached to the platform and adequately braced to prevent displacement.

(6) No trestle scaffold shall be erected on a suspended scaffold.

(7) It shall be the duty of the occupier of a workplace in which a trestle scaffold is constructed or erected to ensure that no trestle scaffold referred to in paragraph (3) is used unless the design and drawings certified by the professional engineer are kept available at the workplace for inspection by an inspector.

PART VII APPROVED SCAFFOLD CONTRACTORS

Application for approval to be approved scaffold contractor

(1) A firm or company may apply to the Commissioner for his approval to act as an approved scaffold contractor.

(2) An application under paragraph (1) shall

(a) be accompanied by a non-refundable fee of $150;

(b) be in such form and manner as the Commissioner may require; and

(c) be accompanied by such particulars, information, statements and documents as the Commissioner may require.

Certificate of approval

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(1) On receipt of an application under regulation 57(1), the Commissioner may

(a) issue to the applicant a certificate of approval, subject to such conditions as the Commissioner may think fit to impose; or

(b) refuse to approve the application.

(2) Where the Commissioner refuses to approve the applicant to act as an approved scaffold contractor, he shall give the applicant notice in writing of the reasons for his refusal.

Production of certificate of approval

It shall be the duty of any approved scaffold contractor to produce his certificate of approval for inspection upon request by an inspector.

Suspension or cancellation of certificate

The Commissioner may suspend or cancel the certificate of approval of any approved scaffold contractor if the Commissioner is satisfied that the approved scaffold contractor

(a) has obtained the certificate of approval by means of fraud, false representation or the concealment of any material fact; or

(b) is contravening or has contravened any condition of the certificate of approval.

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Housekeeping

Why should we pay attention to housekeeping at work?

Effective housekeeping can eliminate some workplace hazards and help get a job done safely and properly. Poor housekeeping can frequently contribute to accidents by hiding hazards that cause injuries. If the sight of paper, debris, clutter and spills is accepted as normal, then other more serious health and safety hazards may be taken for granted.

Housekeeping is not just cleanliness. It includes keeping work areas neat and orderly; maintaining halls and floors free of slip and trip hazards; and removing of waste materials (e.g., paper, cardboard) and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of accident and fire prevention.

Effective housekeeping is an ongoing operation: it is not a hit-and-miss cleanup done occasionally. Periodic "panic" cleanups are costly and ineffective in reducing accidents.

What is the purpose of workplace housekeeping?

Poor housekeeping can be a cause of accidents, such as:

- tripping over loose objects on floors, stairs and platforms
- being hit by falling objects
- slipping on greasy, wet or dirty surfaces
- striking against projecting, poorly stacked items or misplaced material
- cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday. Although this effort requires a great deal of management and planning, the benefits are many.

What are some benefits of good housekeeping practices?

Effective housekeeping results in:

- reduced handling to ease the flow of materials
- fewer tripping and slipping accidents in clutter-free and spill-free work areas
- decreased fire hazards
- lower worker exposures to hazardous substances (e.g. dusts, vapours)
- better control of tools and materials, including inventory and supplies
- more efficient equipment cleanup and maintenance
- better hygienic conditions leading to improved health
- more effective use of space
- reduced property damage by improving preventive maintenance
- less janitorial work

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- improved morale
- improved productivity (tools and materials will be easy to find)

How do I plan a good housekeeping program?

A good housekeeping program plans and manages the orderly storage and movement of materials from point of entry to exit. It includes a material flow plan to ensure minimal handling. The plan also ensures that work areas are not used as storage areas by having workers move materials to and from work areas as needed. Part of the plan could include investing in extra bins and more frequent disposal.

The costs of this investment could be offset by the elimination of repeated handling of the same material and more effective use of the workers' time. Often, ineffective or insufficient storage planning results in materials being handled and stored in hazardous ways. Knowing the plant layout and the movement of materials throughout the workplace can help plan work procedures.

Worker training is an essential part of any good housekeeping program. Workers need to know how to work safely with the products they use. They also need to know how to protect other workers such as by posting signs (e.g., "Wet - Slippery Floor") and reporting any unusual conditions.

Housekeeping order is "maintained" not "achieved." Cleaning and organization must be done regularly, not just at the end of the shift. Integrating housekeeping into jobs can help ensure this is done. A good housekeeping program identifies and assigns responsibilities for the following:

- clean up during the shift
- day-to-day cleanup
- waste disposal
- removal of unused materials
- inspection to ensure cleanup is complete

Do not forget out-of-the-way places such as shelves, basements, sheds, and boiler rooms that would otherwise be overlooked. The orderly arrangement of operations, tools, equipment and supplies is an important part of a good housekeeping program.

The final addition to any housekeeping program is inspection. It is the only way to check for deficiencies in the program so that changes can be made. The documents on workplace inspection checklists provide a general guide and examples of checklists for inspecting offices and manufacturing facilities.

What are the elements of an effective housekeeping program?

Dust and Dirt Removal

In some jobs, enclosures and exhaust ventilation systems may fail to collect dust, dirt and chips adequately. Vacuum cleaners are suitable for removing light dust and dirt. Industrial models have

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special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt may accumulate.

Special-purpose vacuums are useful for removing hazardous substances. For example, vacuum cleaners fitted with HEPA (high efficiency particulate air) filters may be used to capture fine particles of asbestos or fibreglass.

Dampening (wetting) floors or using sweeping compounds before sweeping reduces the amount of airborne dust. The dust and grime that collect in places like shelves, piping, conduits, light fixtures, reflectors, windows, cupboards and lockers may require manual cleaning.

Compressed air should not be used for removing dust, dirt or chips from equipment or work surfaces.

Employee Facilities

Employee facilities need to be adequate, clean and well maintained. Lockers are necessary for storing employees' personal belongings. Washroom facilities require cleaning once or more each shift. They also need to have a good supply of soap, towels plus disinfectants, if needed.

If workers are using hazardous materials, employee facilities should provide special precautions such as showers, washing facilities and change rooms. Some facilities may require two locker rooms with showers between. Using such double locker rooms allows workers to shower off workplace contaminants and prevents them from contaminating their "street clothes" by keeping their work clothes separated from the clothing that they wear home.

Smoking, eating or drinking in the work area should be prohibited where toxic materials are handled. The eating area should be separate from the work area and should be cleaned properly each shift.

Surfaces

Floors: Poor floor conditions are a leading cause of accidents so cleaning up spilled oil and other liquids at once is important. Allowing chips, shavings and dust to accumulate can also cause accidents. Trapping chips, shavings and dust before they reach the floor or cleaning them up regularly can prevent their accumulation. Areas that cannot be cleaned continuously, such as entrance ways, should have anti-slip flooring. Keeping floors in good order also means replacing any worn, ripped, or damaged flooring that poses a tripping hazard.

Walls: Light-coloured walls reflect light while dirty or dark-coloured walls absorb light. Contrasting colours warn of physical hazards and mark obstructions such as pillars. Paint can highlight railings, guards and other safety equipment, but should never be used as a substitute for guarding. The program should outline the regulations and standards for colours.

Maintain Light Fixtures

Dirty light fixtures reduce essential light levels. Clean light fixtures can improve lighting efficiency significantly.

Aisles and Stairways

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Aisles should be wide enough to accommodate people and vehicles comfortably and safely. Aisle space allows for the movement of people, products and materials. Warning signs and mirrors can improve sight-lines in blind corners. Arranging aisles properly encourages people to use them so that they do not take shortcuts through hazardous areas.

Keeping aisles and stairways clear is important. They should not be used for temporary "overflow" or "bottleneck" storage. Stairways and aisles also require adequate lighting.

Spill Control

The best way to control spills is to stop them before they happen. Regularly cleaning and maintaining machines and equipment is one way. Another is to use drip pans and guards where possible spills might occur. When spills do occur, it is important to clean them up immediately. Absorbent materials are useful for wiping up greasy, oily or other liquid spills. Used absorbents must be disposed of properly and safely.

Tools and Equipment

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench. Tools require suitable fixtures with marked locations to provide orderly arrangement, both in the tool room and near the work bench. Returning them promptly after use reduces the chance of being misplaced or lost. Workers should regularly inspect, clean and repair all tools and take any damaged or worn tools out of service.

Maintenance

The maintenance of buildings and equipment may be the most important element of good housekeeping. Maintenance involves keeping buildings, equipment and machinery in safe, efficient working order and in good repair. This includes maintaining sanitary facilities and regularly painting and cleaning walls. Broken windows, damaged doors, defective plumbing and broken floor surfaces can make a workplace look neglected; these conditions can cause accidents and affect work practices. So it is important to replace or fix broken or damaged items as quickly as possible. A good maintenance program provides for the inspection, maintenance, upkeep and repair of tools, equipment, machines and processes.

Waste Disposal

The regular collection, grading and sorting of scrap contribute to good housekeeping practices. It also makes it possible to separate materials that can be recycled from those going to waste disposal facilities.

Allowing material to build up on the floor wastes time and energy since additional time is required for cleaning it up. Placing scrap containers near where the waste is produced encourages orderly waste disposal and makes collection easier. All waste receptacles should be clearly labelled (e.g., recyclable glass, plastic, scrap metal, etc.).

Storage

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount

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of handling is reduced, especially if less manual materials handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one metre (or about three feet) of clear space under sprinkler heads.

Stacking cartons and drums on a firm foundation and cross tying them, where necessary, reduces the chance of their movement. Stored materials should not obstruct aisles, stairs, exits, fire equipment, emergency eyewash fountains, emergency showers, or first aid stations. All storage areas should be clearly marked.

Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas that are appropriate for the different hazards that they pose. Storage of materials should meet all requirements specified in the fire codes and the regulations of environmental and occupational health and safety agencies in your jurisdiction.

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Fire and Explosion Prevention
Introduction

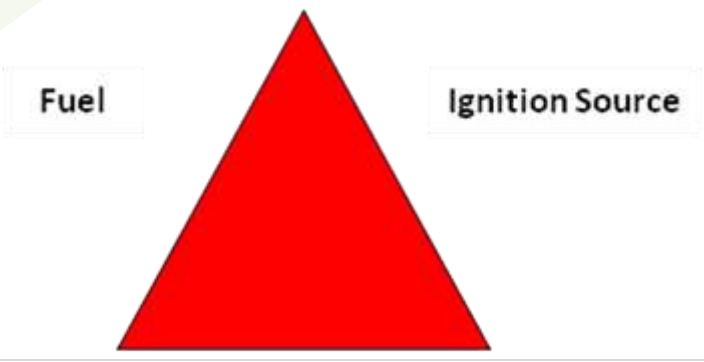
Fire or explosion at work is a hazard that can cause serious injuries, deaths and damage to property. Highly flammable substances like gasoline and solvents are the most obvious sources but less apparent substances such as food, wood and metal dusts have also been known to explode and cause major fires.

Chemistry of Fire
Fire or burning is the process of a fuel (such as solvents or gasoline) combining with oxygen to produce heat. The fuel can be in solid, liquid or vapour form, but vapour and liquid fuels are generally easier to ignite. A fire will only occur if the fuel, oxidizer and an ignition source are present. If any of these compounds is removed or not present in the right proportions, fire will not occur. Altering only one of these components sufficiently will stop the process of burning.

Most explosions in chemical plants arise from chemical reactions. This type of explosion is called chemical explosion. **Detonation and deflagration** are two kinds of chemical explosions which are propagating in nature. In a detonation, the shock wave travels at supersonic speed i.e. faster than sound. For deflagration, this speed of propagating is much lower. Pressures in a detonation wave are much higher than deflagrations. Thus detonations are more destructive than deflagrations. A deflagration may turn into a deflagration, particularly when travelling down a long pipe.

Effects of fires & explosions
Fires generate heat which can cause injury to persons. Fires can also cause explosions and generate smoke and toxic gases. Excessive smoke can hinder the escape of persons during a fire. Toxic gases, such as carbon monoxide is most frequently produced by dangerous materials. Carbon monoxide is odourless and is a chemical asphyxiant. It can overcome people during the first stage of fire.
Burning of combustible materials containing elements, such as chlorine, sulphur and nitrogen can result in the formation of irritating and toxic gases. For example, PVC and nitrogen containing polymers such as polyurethane may release hazardous concentrations of irritating hydrogen chloride and extremely toxic hydrogen cyanide upon combustion.
An explosion may give rise to blast waves which can cause damage to humans and buildings. Furthermore, if the explosion occurs in a confined space such as inside a vessel, the force of the explosion can rupture the vessel and project debris to its surroundings, creating what is often called a missile effect. Hot, toxic gases or dust may be produced by an explosion. These hazardous products can also cause serious injury to humans.

The fire triangle



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Three elements –
Fuel, oxygen and an ignition source such as heat, are all needed to be present in the correct concentration for a fire to start or an explosion occur:

1. Oxygen is present naturally in the air around us.
2. Fuel keeps a fire burning.
3. Ignition source provides energy to initiate a fire

Types of combustibles materials

Examples of Fuel	
Liquids	Gasoline, acetone, pentane, ammonia, ethylene oxide
Gases	Acetylene, propane, carbon monoxide
Solids	Rubber, plastics, wood, plastic foams, packaging, textiles, sugar dust, wood dust, flour dust

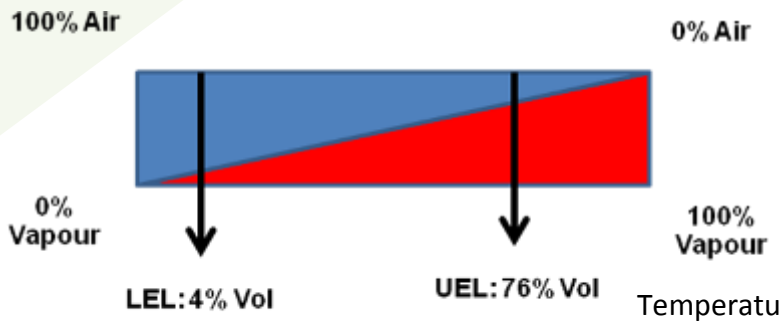
Sources of ignition

Examples of Ignition Sources
Sparks, open flames, welding arc, static electricity, heat, motor starter, cigarette ember, pilot light, hot surfaces, spontaneous ignition, and friction

Definitions

Flash Point (FP)
Minimum temperature at which a liquid gives off enough vapour to form an ignitable mixture with air.

Flammability Limits
The range of flammable vapour or gas-air mixture between the upper and lower flammable limits. The limits indicate the minimum and maximum concentrations in air of a flammable gas or vapour at which ignition can occur. Concentrations below the lower flammable limit (LFL) are too lean to burn; concentrations above the upper flammable limit (UFL) are too rich to burn.



Auto-ignition Temperature (AIT)
The lowest temperature at which a flammable gas- or vapour air mixture is capable of extracting enough energy from the environment to self-ignite.

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Flammable Liquids and gases

Compound	Flash Point (°C)	LFL (vol% in air)	UFL (vol% in air)	Auto-IgnitionTemp (°C)
Acetone	17.8	2.5%	12.8%	465
Acetylene	NA (Gas)	2.5%	100%	305
Ammonia	NA (Gas)	15%	28%	651
Benzene	-11.1	1.2%	7.8%	498
Butane	NA (Gas)	1.6%	8.4%	365
Carbon monoxide	NA (Gas)	12.5%	74%	605
Diesel	52	0.6%	6.5%	254 to 285
Ethylene oxide	-28.9	3%	100%	429
Hydrogen	NA (Gas)	4%	76%	500 to 571
LPG	NA (Gas)	1.6% (Butane)	8.4% (Butane)	-
		2.1% (Propane)	9.5% (Propane)	
Methane	NA (Gas)	5%	15%	537
Methanol	12	5.5%	44%	464
Pentane	-49	1.5%	7.8%	309
Petrol	< -21	1.3%	7.1%	250
Propane	-104	2.1%	9.5%	450
Toluene	4	1.1%	7.1%	480
Turpentine	30 to 46	0.8%	6%	220 to 255

Types of fire

A pool fire is the combustion of flammable vapour evaporating from a layer of liquid at the base of the fire. A common source is a spill of liquid or a liquid in an open container.

A flash fire is the combustion of a flammable vapour and air mixtures at less than sonic velocity, such that negligible damaging over pressure is generated.

A jet flame is the combustion of substance emerging with sufficient momentum from an orifice, as when ignition occurs on substance releasing from a flammable source under pressure.

A fire ball is a fire burning sufficiently fast for the burning mass to rise into the air as a cloud or ball. It is particularly associated with a boiling liquid expanding vapour explosion.

Types of explosions

A confined explosion is an explosion of a fuel-oxidant mixture inside a closed system such as a tank or vessel.

A vapour cloud explosion is a partially confined explosion in an open air of a cloud made up of a mixture of flammable vapour or gas with air.

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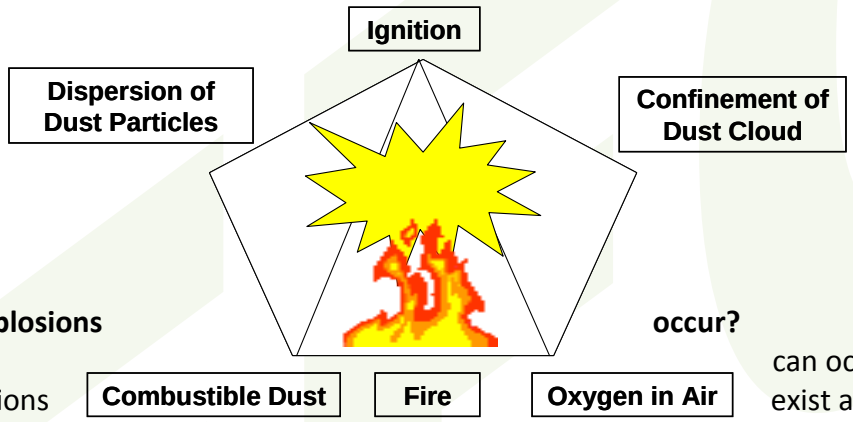
A boiling liquid expanding vapour explosion (BLEVE) is the sudden rupture of a vessel or system containing liquefied flammable gas under pressure as a result of fire impingement. The pressure burst and the flashing of the liquid to vapour creates a blast wave and potential missile damage, and immediate ignition of the expanding fuel-air mixture leads to intense combustion creating a fire ball.

A pressure burst is the rupture of a vessel or system under pressure which results in the formation of a blast wave and missiles.

A rapid phase transition is the rapid change of state of a substance which may produce a blast wave and missile as the instantaneous vaporisation of water on contact with molten metal.

Combustible Dust

Materials such as wood, food, metal dusts can cause explosions due to the dispersion of fine combustible particles, when in sufficient quantities and concentration and under favourable conditions, such as air, heat, fuel, dispersion and confined environment.



How do dust explosions occur?

A dust explosion can occur when the following conditions exist at the same time:

1. Fuel, i.e. combustible dust of sufficiently small particle size;
2. Air;
3. Dispersion of the dust into the air;
4. A confined environment (e.g. a silo); and
5. An ignition source (e.g. heat).

Examples of combustible dusts are:

- Wood dust.
- Rubber dust.
- Plastic dust and additives (e.g. polyethylene, resin dust).
- Metal dust (e.g. aluminium, chromium, iron, magnesium, zinc).
- Food and grain dust (e.g. sugar, spice, starch, flour, animal feedstock).

Implement dust control measures:

- Establish effective dust control measures to prevent and reduce the escape of dust from processing equipment to the environment, e.g. dust collecting system.
- Replace combustible dust with safer alternatives e.g. ready-to-use materials.
- Establish and implement good housekeeping practices to keep work places clean and safe, such as cleaning at regular intervals to prevent the accumulation of dust.
- Design building elements and arrange equipment to reduce dust accumulation. Use features such as smooth, easy-to-clean walls and sloped surfaces.

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Fire protection

The main aspects of fire protection are prevention and loss limitation.

Fire prevention

Effective fire prevention simply means the manipulation of the three constituents (fuel, oxidizer or oxygen, heat) so that a fire cannot start

Inerting (to reduce Oxygen)

Nearly all combustion processes require the presence of oxygen. Furthermore, the higher the oxygen concentration, the more rapidly will the burning process be. Inerting is often used to reduce the concentration of oxygen to a safe concentration. This process involves the addition of an inert gas, usually nitrogen or carbon dioxide. Sometimes, steam is also used.

Heat

Burning is an exothermic process. The very small fire started by a tiny heat source supplies to its surroundings more heat than it absorbs, thus enabling it to ignite more fuel and oxygen mixture. The combustion started will then propagate to initiate more fires. The various sources of ignition are open flames, electric sources, hot surfaces, spontaneous ignition, sparks, static electricity and friction. Ensuring that there is no contact of heat source to possible flammable fuel-oxygen mixture can prevent the occurrence of fire.

Fuel

Combustion takes place most readily between oxygen and fuel in its vapour or other finely divided state. Solids are most easily ignited when reduced to powder or vapourised by the application of heat. For liquids, some will give off dangerous quantities of flammable vapours at below room temperature. Preventing the vaporisation of a flammable chemical and its accumulation to form dangerous concentration are the two basic principles of fire prevention.

Classes of fire

Fires are classified into 4 categories which take into account the type of substance that forms the fuel and the means of extinction.

Class A: Fires involve combustion of solid materials which are usually of an organic nature such as wood, paper, plastic, and natural fibres. The most effective extinguishing agent is water either as a spray or jet. The mode of extinguishing is by cooling of the glowing embers which propagate the fire

Class B: Fires involving combustion of flammable liquid and gas, such as oil, gasoline, paint, acetone, and grease, where oxygen exclusion or a flame interrupting effect of the extinguishing agent is required

Class C: Fire involving electrical wiring and electrical equipment where dielectric non conductivity of the extinguishing agent is required.

Class D: Fires consisting metals, such as magnesium, potassium, powdered aluminium, titanium, zirconium and lithium, where a material specific extinguishing agent is required. Special dry powder e.g. graphite, talc, soda ash, limestone and dry sand must be used. The extinguishers act by smothering the fire. Normal extinguishing agent should not be used for Class D fires.

Methods of extinguishing fire

There is no fire when any one of the three elements is eliminated or removed.

- Remove air to smother fire. Fire cannot burn without oxygen.
- Remove fuel sources. E.g. prevent build-up of combustible or flammable debris will decrease the likelihood of a fire.
- Keep sparks or other ignition sources away from fuel sources.

Types of fire extinguishers

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Types of Extinguisher	Suitable Class of Fire	Remarks
Dry Chemical	Class A, B & C fires	Effective on most common types of fires. Highly corrosive and leaves a sticky residue. Not for use around delicate electrical appliances or computers.
Carbon Dioxide	Class B & C fires	Very clean no residue. Spraying range is short, therefore extinguishing agent must be applied close to fire.
Water Based Agent	Class A fire only	Inexpensive to refill and maintain. These are the most common extinguishers in use.

WSH(General Provisions) Regulations 2006

Precautions with regard to explosive or flammable dust, gas, vapour or substance

26. —(1) Where any process in a plant used in a workplace gives rise to dust, gas, vapour or substance that may escape into any place of work and the dust, gas, vapour or substance that may escape is of such a character and is to such an extent as to be liable to explode on ignition

(a) all reasonably practicable steps shall be taken to prevent such an explosion

(i) by enclosure of the plant used in the process;

(ii) by removal or prevention of accumulation of the dust, gas, vapour or substance;

(iii) by exclusion or effective enclosure of possible sources of ignition; or

(iv) by the use of suitable flame-proof equipment; and

(b) unless the plant in which the process is carried out is so constructed as to withstand the pressure likely to be produced by any such explosion, all reasonably practicable steps shall be taken to restrict the spread and effects of such an explosion by the provision of chokes, baffles and vents, or other equally effective appliances in the plant.

(2) Where any part of a plant in a workplace contains any explosive or flammable gas or vapour under pressure greater than atmospheric pressure, that part shall not be opened, unless it is positively isolated, depressurised and vented to a safe location, and where necessary, purged to remove any residual gas or vapour.

(3) No plant, tank or vessel in a workplace that contains, or has contained, any explosive or flammable substance shall be subjected to

(a) any welding, brazing or soldering operation;

(b) any cutting operation which involves the application of heat; or

(c) any operation involving the application of heat for the purpose of taking apart or removing the plant, tank or vessel or any part of it, until all reasonably practicable steps have been taken to remove the substance and any fumes, gas or vapour arising from it, or to render the substance and fumes non-explosive and non-flammable.

(4) If any plant, tank or vessel in a workplace has been subjected to any operation referred to in paragraph (3) (*a*), (*b*) or (*c*), no explosive or flammable substance shall be allowed to enter the plant, tank or vessel until the metal has cooled sufficiently to prevent any risk of igniting the substance.

(5) No plant, tank or vessel in a workplace which contains, or has contained, any explosive or flammable substance shall be subjected to any operation referred to in paragraph (3) (*a*), (*b*) or (*c*) unless such plant, tank or vessel has been inspected and a competent person has certified that

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(a) it is free from

(i) any explosive or flammable substance; and

(ii) any fumes, gas or vapour arising from any such substance; or

(b) any explosive or flammable substance, and any fumes, gas or vapour arising from any such substance, have been rendered non-explosive and non-flammable, and that it is safe for the operation to be carried out.

(6) Any certificate issued by a competent person under paragraph (5) in respect of any workplace referred to in that paragraph shall be kept available at all times for inspection by an inspector.

(7) It shall be the duty of the occupier of a workplace referred to in paragraphs (1) to (6) to comply with those paragraphs.

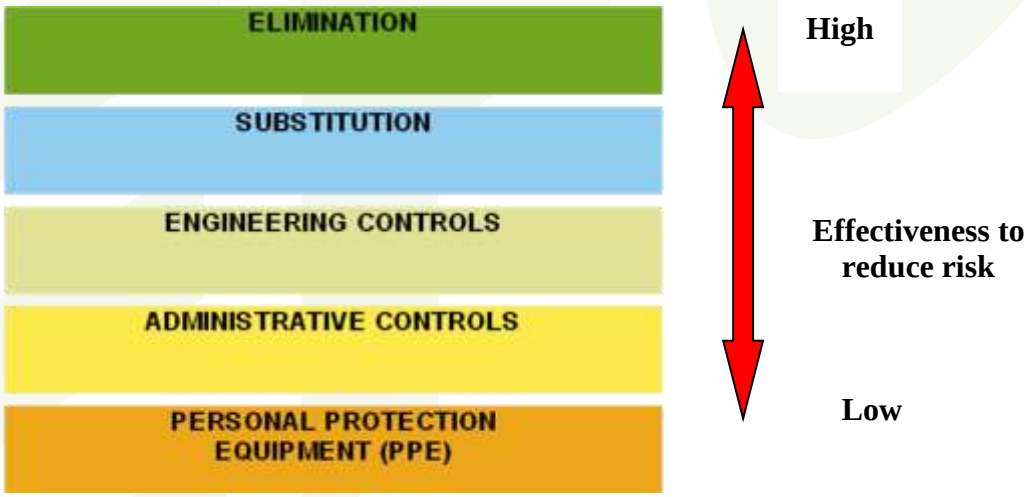
(8) It shall be the duty of a competent person to exercise all due diligence in making any inspection and certification under this regulation.

Prevent Fire/Explosions Through The Hierarchy of Control

The following are examples of control measures associated with the handling of flammable and combustible substances.

Care must be exercised when selecting the measures to ensure that they are appropriate for the setup of your facilities.

Hierarchy of control



Elimination

The first priority of control is to eliminate the risk at source. If the work or the process can be carried out without the need for the use of flammable or combustible substances, the risk of fire or explosion arising from the ignition of such substances will be eliminated.

Eliminate oxygen:

- Pipelines intended for carrying flammable substances should be purged to eliminate the presence of oxygen before use.

Eliminate fuel:

- Do not use oil or grease for lubricating valves, gauge connection or other parts of an oxygen system.

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Substitution

Substitute flammable and combustible substances with safer alternatives:

- Use water-based substances or any non-flammable process instead of solvent-based substances.
- Use high flash point* substances instead of low flash point substances.
- Replace powders with materials in paste or pellet form.
- Use safer technologies or methods of work such as brush or roller application instead of spraying.
- Flash points of substances can be found from this TA's Glossary or from Safety Data Sheets (SDSs).

Engineering Controls

Design safety into the process:

• Use spark-proof/explosion-proof, intrinsically safe or double insulated equipment.	
• Ensure that construction material for tanks, piping, containers and vessels are suitable for flammable substances.	
• Bond and ground to minimise static electricity build-up when: - Carrying nonconductive liquids through metallic pipes, vessels, containers. - Pneumatically-carried solids. - Mixing immiscible liquids.	
• Use electrical devices that are enclosed in explosion proof housings, which are designed to withstand an internal explosion and prevent the combustion from spreading beyond the enclosure.	
• Segregate flammable storage from the process areas. Dike vessels to contain and carry away spills.	

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• Install and maintain explosion vents of tanks or compartments, where appropriate. • Install and maintain pressure relief vents for pressurised equipment.	

- Fireproof vessels, pipes, structures with insulation to minimise damage due to fires.
- Design controls to fail safe. Add safeguards for safe shutdown during emergencies.
- Install ventilation and extraction systems to dilute flammable vapours with air to prevent fire/explosions.
- Apply local and/or dilution ventilation for works that cannot be carried out in the open, such as using a blower to supply fresh air to dilute the concentration of flammable substances.

Administrative Controls

		
No smoking sign	Intrinsically safe lighting	Install gas monitors to detect leaks

- Establish safe work procedures for work involving the storage, use, handling and disposal of flammable substances.
    - Instil good housekeeping practices such as regular cleaning of any contamination or spills.
    - Implement a safe storage and proper disposal system and store flammable substances away from heat or ignition sources.
    - Keep lids on containers of flammable substances when not in use.
    - Prohibit or control smoking.
    - Do not allow naked flames in areas where flammable vapour is likely to be present.
- Implement a permit-to-work (PTW) system for hot work, or work involving flammable substances, such as spray painting in confined space.
- Institute an effective preventive maintenance programme for process equipment and protective equipment such as safety valves and alarms.
- Manage changes in processes, technologies and equipment to ensure operation integrity and safety.
- Use suitable electrical installations and equipment.
- Do not overload electric circuits and promptly report signs of electrical malfunction.
- Maintain and monitor equipment to prevent any possible defects that can lead to fire or explosions.

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- Identify clearly the contents of containers, packaging, intermediate bulk containers (IBCs), portable tanks,
- multiple-element gas containers (MEGCs) and bulk containers containing flammable substances with the
- United Nations Recommendations on the Transport of Dangerous Goods (UNRTDG) flammable symbols.
- Obtain, use and disseminate information found in SDSs for flammable substances.

- Provide training on:
    - How to recognise the Globally Harmonised System of Classification and Labeling of Chemicals (GHS) pictogram for flammable substances.
    - Implementing the health and safety measures required for flammable substances, including storage,
    - safe use and emergency procedures.
    - The appropriate use and maintenance of PPE.

UNRTDG Flammable Symbols

GHS Pictogram for Flammable Substances

Personal Protective Equipment (PPE)

Suitable PPE can be used to protect persons against fires and explosions. However, PPE should not be used as the only means of protection; it should be used in conjunction with the other risk control measures mentioned earlier.

- Selection of PPE: The selection of PPE should be suitable and compatible to the work, substances used and the work environment.
- Use of PPE: Workers should be familiar with the correct way of wearing and removing PPE.

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- Maintenance of PPE: PPE should be properly maintained and stored to retain its protection efficacy.

Emergency response planning

A written emergency response plan should be established.

Keep updated information on flammable substances and processes including: • Location, types and quantities of flammable and combustible substances. • Possible accidents and emergency scenarios, with considerations to neighbouring buildings and installations. • Protocols on activation of key personnel to oversee and direct the management of accidents, inclusive of chain of command and communication protocols. • Suitable media for fire fighting, commensurate with the types of flammable substances involved and operational resources. • Recovery procedures inclusive of clean-up and decontamination operations.	
Fire protection and fire fighting systems: • Maintain fire protection and fire fighting systems (e.g. PPE, fire extinguishers). • Institute an inspection programme for emergency equipment and systems. • Install, use and maintain fixed and mobile fire fighting equipment (e.g. hydrants, fire monitors, deluge systems, sprinkler systems, water curtains etc). • Ensure good supply and drainage of fire-fighting water. • Ensure access to extinguishers, hoses, alarms, fire exits and other emergency equipment and sprinkler heads are free from obstruction.	 Deluge system

Emergency response equipment should be kept on site, made readily available and accessible.

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Fire hydrant monitor	Sprinkler system (bulb and nozzle type)	Sprinkler located on top of a tank

Training

- Train and educate employees on fire fighting, safety related operations and procedures (e.g. evacuation, location and use of emergency equipment, activation of alarms and communicator system).

Drills

- Regularly review emergency action plans to ensure its continual relevance and currency.
- Conduct emergency drills at regular intervals, involving all persons at site to thoroughly validate and test the effectiveness and robustness of the plans.

Accident case studies:

Case Study 1 Explosion of an oil drum when cut with a gas torch

The Incident A drum, which was previously used for containing waste oil, exploded when a worker was cutting it with an oxyacetylene gas torch. The worker suffered serious head injuries from the explosion and died two days after the accident.	 Damaged drum cover due to impact of the explosion
Findings • The explosion was due to the ignition of the remnant waste oil in the drum by the oxy-acetylene cutting operation. • No risk assessments were conducted for hot work.	 Scene of accident where the explosion took place

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Lessons Learnt

Before carrying out any hot work, a careful assessment of the associated risks involved should be made. In the assessment, other alternative or safer methods of work such as cold cutting technique should be considered instead of hot work.

Upon ascertaining that hot work is necessary, the oil drum should first be rendered gas-free by cleaning, purging or steaming, or inerted before hot work commences.

Additionally, safe work procedures must be established and implemented to ensure that hot work can be carried out safely without endangering the safety of workers and other workers in the vicinity of the hot work.

Damaged cutting torch due to impact of the explosion

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- http://www.mom.gov.sg/Documents/safety-health/WSH%20(Scaffolds)%20Rgs.pdf
- http://www.ccohs.ca/oshanswers/hsprograms/house.html
- http://www.mom.gov.sg/Documents/safety-health/WSH%20(General%20Provisions)%20Rgs.pdf
- http://www.mom.gov.sg/Documents/safety-health/Technical%20Advisory%20for%20Flammable%20Hazardous%20Substances.pdf
- Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl / Joseph F. Louvar. Safe Working with Flammable Substances, HSE www.hse.gov.ul/pubns/indg227.pdf
- NIOSH Pocket Guide to Chemical Hazards www.cdc.gov/niosh/npg
- ILO International Chemical Safety Cards www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/index.html
- FM Global Property Loss Prevention Data Sheets 7-0, Causes and Effects of Fires and Explosions
- FM Global Property Loss Prevention Data Sheets 7-76, Prevention and Mitigation of Combustible Dust Explosions and Fire
- Combustible Dust in Industry: Preventing and Mitigating the Effects of Fire and Explosions,
- OSHA www.osha.gov/dts/shib/shib073105.html
- Emergency Response Program, EPA www.epa.gov/OEM/docs/chem/W-Chap-08.pdf
- Fact Sheet on Personal Protective Equipment, OSHA www.osha.gov/OshDoc/data_General_Facts/ppe-factsheet.pdf
- Globally Harmonised System of Classification and Labelling of Chemicals (GHS) www.unece.org/trans/danger/publi/ghs/ghs_rev02/02files_e.html
- Workplace Safety and Health Act
- Workplace Safety and Health (General Provisions) Regulations
- Workplace Safety and Health (Risk Management) Regulations
- Workplace Safety and Health (Shipbuilding and Ship-repairing) Regulations 2008 at www.mom.gov.sg/legislation/wsh.html
- More information and guidelines on Risk Assessment www.mom.gov.sg/wsh/risk_management
- The Fire Safety Act and Fire Code www.scdf.gov.sg/Building_Professionals/Publications/index.html

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Safe Practices in Confined Space

Introduction

Working in confined spaces is more hazardous than working in other workplaces because:

- The entrances/exits of confined spaces might not allow the entrant to evacuate effectively if there is a flood or collapse of free-flowing material;
- Self-rescue by entrant is more difficult;
- Rescue of the victim is more difficult. The interior configuration of a confined space often restricts the movement of people or equipment within it;
- Natural ventilation alone is often not sufficient to maintain breathable quality air because the interior configuration of some confined spaces does not allow air movement to circulate;
- Conditions can change very quickly;
- The space outside the confined space can impact on the conditions inside the confined space and vice versa; or
- Work activities may introduce hazards not present initially.

Yet, people needs to enter a confined space for 1 of these reasons:

- Cleaning;
- Inspection;
- Maintenance and repair;
- Construction; or
- Rescue, etc.

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What is a confined space

A "confined space" is any chamber, tank, manhole, vat, silo, pit, pipe, flue or any other enclosed space, in which:

- dangerous gases, vapours or fumes are liable to be present to such an extent as to involve risk of fire or explosion, or persons being overcome thereby;
- the supply of air is inadequate, or is likely to be reduced to be inadequate, for sustaining life; or
- there is a risk of engulfment by material.

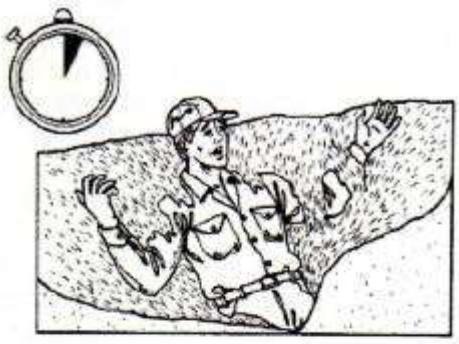

Figure 3: *Within seconds the victim may be completely engulfed.*

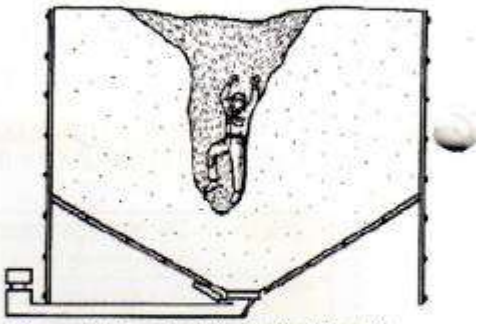

Figure 4: *As material is emptied from the bottom of a confined space, a person may be trapped in a funnel-like depression.*

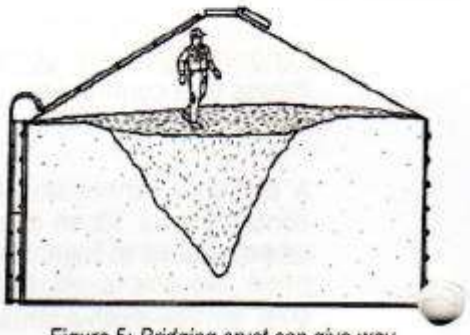

Figure 5: *Bridging crust can give way under a person's weight.*

Characteristics of Confined Space

A confined space is any enclosed or partially enclosed area that:

- is not primarily designed or intended for human occupancy;
- has a restricted entrance or exit by way of location, size or means;
- may contain a hazardous atmosphere;
- contains material that could trap or bury an entrant;
- has such a shape that an entrant could become trapped or asphyxiated; or
- can present a risk to the health and safety of anyone who enters, due to one or more of the following factors:

  i. its design, construction, location or atmosphere;

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ii. the materials or substances in it; iii. work activities being carried out in it; or iv. the mechanical, electrical, process and safety hazards present.	

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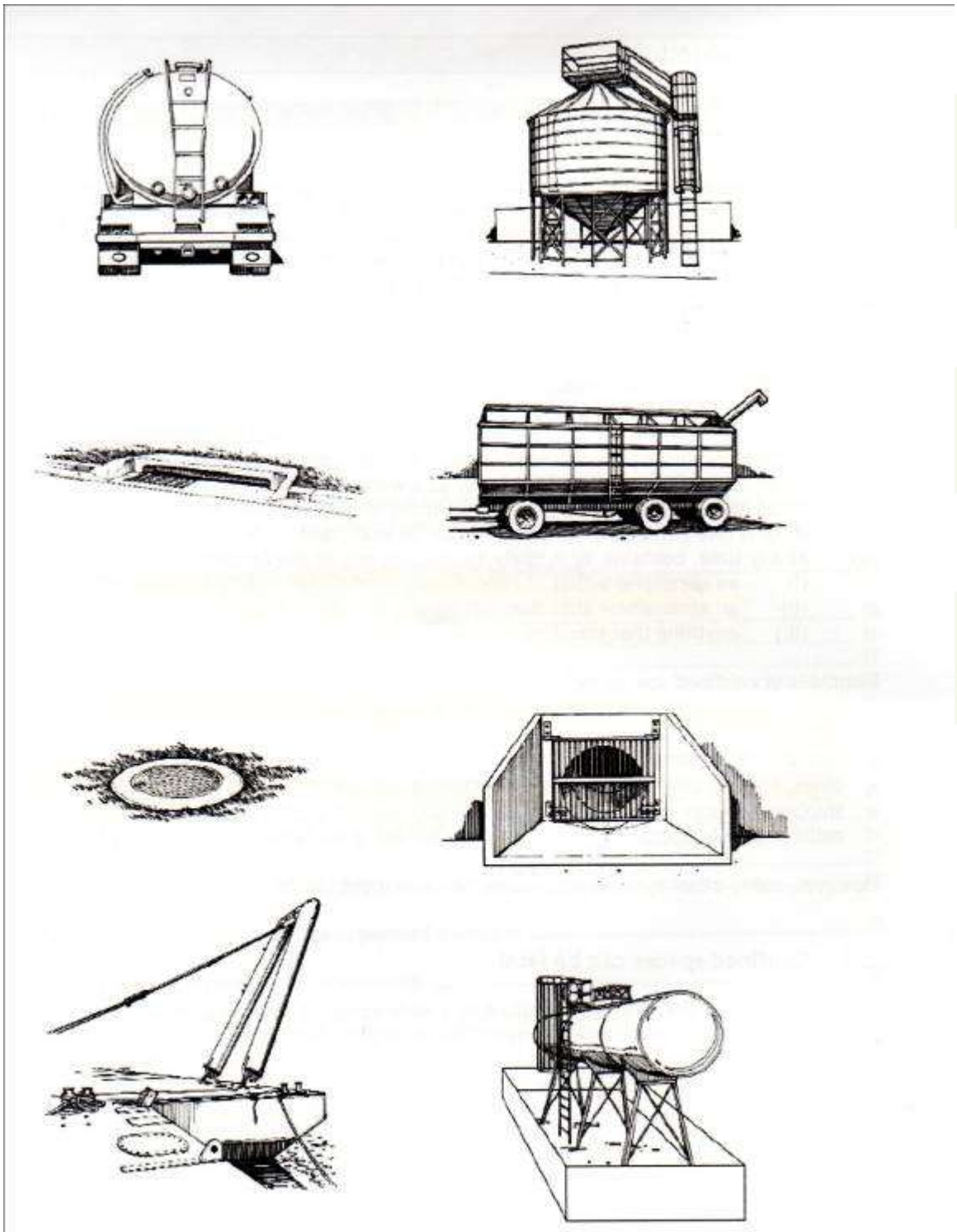

Figure 1: *Some examples of confined spaces*

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Safety Requirements for entry and working in Confined Spaces

When any person enters or carries out any work in a confined space, the Employer and/or Principal shall comply with the regulations strictly. Under the legislation, the responsible person has to ensure safe entry/working in confined spaces. These include:

- Identification/Record/Warning Signs/Information of all confined spaces at the workplace;
- Evaluation of the need for entry into the confined space;
- Safe means of access to and egress from the confined space;
- Safe practices for opening the entrance of a confined space;
- Sufficient and suitable lighting for entry into or work in a confined space;
- Adequate ventilation of the space to sustain life before entry and during work in a confined Safety and health training on working in confined spaces for workers and supervisors;
- Emergency rescue operations in confined spaces which include the establishment of a rescue
- plan and provision of rescue equipment for confined space;
- Appointment of a confined space attendant; and
- The worker is fit to work in confined space;
- Procedures and control of entry into a confined space including gas testing;

Definitions

At this point, we need to explain a few important terms before we proceed further.
A ‘‘**responsible person’’**, in relation to a person entering or working in a confined space, is:

- his employer; or
- the principal under whose direction he enters or works in the confined space.

An **“authorised manager”** is a person appointed by his employer or principal to perform the duties under regulation 9 of the Workplace Safety and Health (WSH) (Confined Spaces) Regulations.

A **“competent person”** refers to a person who has sufficient experience and training to perform the work required to be carried out.

A **“confined space safety assessor”** is a safety assessor appointed by his employer or principal to perform the duties under regulation 9(b) of the WSH (Confined Spaces) Regulations.

A **”confined space attendant”** is an attendant appointed by his employer or principal to perform the duties under regulation 22 of the WSH (Confined Spaces) Regulations.
An “e**ntrant”** is a person required to enter confined spaces to carry out work.
“**Confined space entry permit**” means a permit issued under regulation 13 of the WSH (Confined Spaces) Regulations
“Entry” refers to ingress by persons into a confined space. This occurs when a person’s head passes through an opening into the confined space.
“Hazardous atmosphere” means an atmosphere where:

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- the level of oxygen in the atmosphere is less than 19.5% or more than 23.5% by volume;
- the level of flammable gases or vapours in the atmosphere is 10% or more than its Lower Explosive Limit (LEL); or
- the levels of toxic substances in the atmosphere exceed the Permissible Exposure Levels
- (PEL) as specified in the First Schedule of the WSH (General Provisions) Regulations

Risk based Approach to Safe Working in Confined Spaces

1. Assess Need for Entry into a Confined Space

Before attempting to enter or work in a confined space, it is important to consider the possibility of using alternatives and other methods to do the job without entering the confined space. Entry into or work in a confined space should only be a last resort.

2. Identification and Evaluation of Confined Spaces

All confined spaces shall be clearly identified, documented and labeled. It includes any equipment that constitutes a confined space in the workplace. The document should contain the particulars of the types of confined spaces and their services. For the equipment record, it is important to also include its type and identification number. It is critical to identify and evaluate each confined space to determine whether it has chemical or physical hazards. It is advisable not to assume that a confined space is hazard-free. Different chemical and physical hazards may be introduced through various work activities inside the confined space.

- **Chemical Hazards** include conditions such as fumes and dust, which affect the air in the confined space and can be flammable, toxic, corrosive, or asphyxiating. The only way to identify an atmospheric hazard is to conduct gas testing from the outside of the confined space.

- **Physical Hazards** include conditions such as mechanised equipment, loose materials, excessive noise, extreme temperatures, humidity, low illumination, and access difficulty.
- It is also necessary to display warning signs at or near every access point to a confined space to warn persons of the potential hazards.

3. Control of Confined Space Hazards

It is important to follow the steps in the hierarchy of control measures to manage the identified risks:

- **Elimination**

  Eliminate all hazards in the space or control the hazards so that the entrants can accomplish their tasks and exit the space safely. For example, disconnect, Lockout & Tagout (LOTO) all electrical energy sources of equipment in the confined space to eliminate the hazards; remove remnants of sludge and remove any potential trapped products or gases through continual cleaning.

- **Substitution**

  Instead of entering a confined space to carry out an activity, consider the possibility of using alternative methods to do the job without entering. For example, using a vacuum machine and an extended hose to suck out the sludge instead of having workers enter the confined space to manually remove it.

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- **Engineering Control**

  Engineering controls are physical means that limit the hazards. These include using continuous forced ventilation with continuous monitoring of the atmosphere to ensure the ventilation is adequate in the confined space. These will help to maintain a safe atmospheric and comfortable work environment.
- **Administrative Control**

  - Establish Entry Procedures
    Before any worker enters a confined space, it is necessary to establish safe work procedures covering all phases of the entry process. It is crucial that the entry permit is duly completed and the confined space is safe for workers to enter.
  - The Entry Permit
    It is necessary for the entry permit documents to reflect acceptable entry conditions and indicate that the confined space is safe for workers to enter. It is important to display the entry permit at the entrance of the confined space.

- **Personal Protective Equipment**

  If reasonably practicable control measures are not available to mitigate the risks of working in a confined space, the use of Personal Protective Equipment (PPE) may be considered as the last line of defence.
  For example, when entering a sewer system that has deep standing water and sludge with pockets of methane and hydrogen sulfide. These hazards cannot be eliminated by ventilation alone. If entry is deemed essential, fresh air supply, respiratory protection and other control measures are absolutely necessary.

  Communication

  It is important to communicate the final outcome of the risk assessment to all workers who may be exposed to the risks during confined space entry. It is necessary for managers/supervisors to inform the workers of:
  - The confined space work activities to be carried out;
  - Associated safety and health hazards affecting them and nature of the risks involved;
  - Types of control measures implemented to protect them;
  - Their responsibilities and expectations to comply with all work requirements including:
    - ✓ Obeying general safety rules and regulations;
    - ✓ The use of personal and respiratory protective equipment;
    - ✓ Complying with safe work procedures; and
    - ✓ Instructions as required under the Permit to Work system.
  - Any changes to the work conditions and risks control measures

Periodic Risk Assessment

It is essential to review or revise the confined space risk assessment at least once every 3 years. It is also necessary to review the risk assessment when the following events happen:

- When there is significant change to work practices or procedures including implementation of additional risk control measures; or
- After an incident arising from work in confined spaces.

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Documentation

It is important to maintain duly approved records and current risk assessments. It is essential for the record to include:

- The results or findings recorded in the risk assessments;
- Risk control measures taken or to be taken within an agreed time frame; and
- Any safe work procedures.

Injuries arising from Confined Space Entry

Types of injuries relevant to confined space accidents include:

- Injuries arising from fire and explosion;
- Loss of consciousness or asphyxiation arising from harmful gases, vapours or fumes, free flowing solids or lack of oxygen;
- Drowning arising from an increase in level of liquid;
- Heat-related disorders;
- Electrocution;
- Physical contact with moving or rotating parts; and
- Falls from height.

Many hazards can exist in confined spaces. In general, hazards that can occur in non-confined spaces can also occur in confined spaces. It is important to note this point. The characteristics of a confined space usually aggravate or intensify many of these hazards.
The most dangerous hazards in confined spaces are associated with the atmosphere contained within them. The atmosphere inside different confined spaces varies depending on the type of space, the work being done inside, and what was previously contained or stored in them.
However, the most common atmospheric hazards found in confined spaces can be broadly classified into:

- Suffocation (or asphyxiation) hazards — due to oxygen deficiency;
- Fire/Explosion hazards — due to presence of flammable gases and vapours;
- Poisoning — due to presence of toxic gases, vapours or fumes.

<u>Suffocation Hazards — By Oxygen Deficiency</u>

The air in our natural environment contains 20.9 % oxygen. An environment is considered oxygen deficient when the concentration of oxygen is **less than 19.5 % by volume**.
The low oxygen level in a confined space can be caused by oxidation, rusting, bacterial growth, work such as welding, cutting or displacement by other gases such as nitrogen or carbon dioxide. In sewers, for example, the natural oxidation process of rotting materials within an enclosed space will deplete the oxygen in this atmosphere, thus resulting in an oxygen deficient environment. Reduced oxygen levels could also arise in poorly ventilated enclosed spaces such as ship holds, process plant vessels, silos, and so on.

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Fire/Explosion Hazards — By Flammable Gases and Vapours

The risk of fire or explosion in an enclosed space is extremely high whenever there is a buildup of any flammable gas and vapours. If the gas or vapours are colourless and odourless, the build-up cannot be detected unless a gas detection instrument is used.
For these gases and vapours to ignite and result in a fire or explosion, the following conditions must be met:

- A **SOURCE OF IGNITION** is present, the temperature of which is equal to or higher than the **IGNITION TEMPERATURE** of the flammable substance in question. There are many processes which can be sources of ignition. Some examples include:

  i. hot work like welding or gas cutting;
  ii. pyrophoric materials (e.g., iron sulphide);
  iii. sparks from internal combustion engines, (e.g., compressor, drilling and non-flame cutting); or
  iv. flows of certain materials like non-conductive liquids and combustible powders which can generate static charges thus providing a source of ignition of the flammable liquid or combustible powder itself.
- The concentration of the flammable substance is in the range between the **LOWER EXPLOSIVE LIMIT (LEL)** and the **UPPER EXPLOSIVE LIMIT (UEL)**. In the case of a flammable liquid, a flammable vapour/air mixture can only be generated if the temperature of the surroundings is equal or higher than the **FLASH POINT** of the liquid.
- A sufficient amount of oxygen is present.

Examples of LEL and UEL values for a few flammable substances in the oil petrochemical industry:

Substance	LEL (% Vol.)	UEL (% Vol.)	Auto Ignition Temp(°C)	Flash Point (° C)	PEL (PPM)
Benzene	1.2	7.1	498	-11.1	1
Hydrogen Sulfide	4.3	44	260	NA	10
Carbon Monoxide	12.5	74	607	NA	25
Styrene	1.1	6.1	490	31	50
Isopropyl Alcohol	2	12.0	399	11.7	400
Butane	1.8	8.4	287	-60	800
Ethanol	3.5	19	365	13	1000

Poisoning — By Toxic Gases, Vapours or Fumes

Different toxic substances may be present at the same time for different types of confined spaces. Exposure to toxic substances such as hydrogen sulphide and carbon monoxide can result in death or irreversible health effects. The effects of exposure to toxic substances include:

a) Chemical asphyxiation, a result of oxygen deficiency in our body caused by inhalation of gases or vapours. An example of a chemical asphyxiant is carbon monoxide which is released

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during combustion processes as a result of incomplete combustion. For example hot work and internal combustion engines;

b) Narcotic effects like headache, dizziness, nausea. For example, hydrocarbon vapours from spray painting or sludge removal;

c) Cancer. For example benzene and vinyl chloride monomer from cargo tanks;

d) Systemic poisoning. For example lead from welding fumes, mercury from crude oil coated onto cargo tank walls and released during cutting.

Different toxic substances produce different health effects at different concentrations. It is therefore essential to know and find out what toxic substances could be present in the confined space so that the correct gas testing equipment and their corresponding alarm concentrations on this equipment can be preset to provide a warning in response to a dangerous level. Such levels are **Permissible Exposure Levels** (PEL). The PEL is defined as the maximum airborne concentration of a toxic substance that a worker may be exposed to for 8 hours a day, 5 days a week without experiencing adverse health effects. PELs for toxic substances are established by the Ministry Of Manpower in the First Schedule of the Workplace Safety & Health (General Provisions) Regulations.

Where the PEL for a particular toxic substance is not available, other internationally established sources of occupational exposure limits that may be referred to **Threshold Limit Values** (TLV), which were established by the American Conference of Government Industrial Hygienists (ACGIH), and Permissible Exposure Limits established by the National Institute Of Safety and Health (NIOSH).

Other Confined Space Hazards

Many other hazards can occur. Like oxygen deficiency, flammable substances and toxic substances, many of these hazards have the potential to cause death or serious injury/illness. It is important to give careful consideration to these hazards when carrying out the risk assessment for working inside confined spaces. For example:

Hazard	How it can happen	What the danger is
Oxygen enrichment	• Leaking oxygen from gas cutting equipment, eg cutting torch	• Flammable materials catch fire more easily
Combustible particulates	• Flour mills → airborne flour dust • Pharmaceutical powders, eg during transfer	• Fire and Explosion
Skin contact with chemicals / absorption	• Painting, cleaning	• Skin irritation, dryness, swelling • Skin burns • Systemic effects, eg liver poisoning, blood disorders, if absorbed through skin into bloodstream
Heat	• Poor mechanical ventilation • Crowded space • Hot work	• Heat cramps, heat exhaustion, heat stroke

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	• Heat generating machinery • Thick / heavy protective clothing / equipment • Strenuous activity	
Noise	• Jack hammering • Cutting • Ventilation fan • Hydro-jetting • Grit / shot blasting	• Short term or long term hearing loss (noise induced deafness) • Poor communication → accidents
Ergonomic hazards	• Limited space • Awkward working position	• Musculoskeletal effects eg backache, muscle cramps
Poor lighting	• Insufficient artificial lighting	• Slips, trips and falls
Road traffic	• Road manhole work without proper cordoning or traffic diversion	• Injury, death
Engulfment	• Collapsing loosely packed particles • Stepping on loosely packed particles • Inadvertent opening of feed lines to confined space	• Trapped inside materials → breathing difficulty and suffocation
Entrapment	• Tapering or inwardly sloping and smooth walls eg. cyclones	• Trapped at bottom end, breathing difficulty → asphyxiation
Mechanical hazards	• Moving or rotating parts, eg belts, gears	• Injury, death
Electrical hazards	• Improper electrical wiring • Poor housekeeping of electrical cables • No provision of grounding • Wet spaces • Humid environment → decreased electrical resistance	• Electrocution → burns, death
Falling from height	• Improperly barricaded openings, eg tower trays • Scaffoldings without proper guardrails • Working at height without proper use of harness	• Severe injury, drowning, death

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Falling objects	• Limited storage and working space • Poor housekeeping practices • Inadequate securing of tools, structural materials	• Injury, death
Radiation	• Ultraviolet and infrared radiation from welding • Non destructive testing (x-ray) • Maintenance of level instrumentation using radioactive isotopes	• Skin burns, cataract, arc eye, genetic changes, cancer
Asbestos	• Removal of partition walls in ships	• Asbestosis, mesothelioma, lung cancer
Drowning	• Inadvertent opening of liquid supply lines • Falling from height to bottom	• Death
Biological hazards	• Viruses, bacteria in decomposing waste or water • Insects, rodents, snakes	• Gastrointestinal disease, hepatitis A and poisoning

Confined Space Entry Permit

A formal check is necessary to ensure that all the elements of a safe system of work are in place before persons are allowed to enter or work in confined spaces. No person shall enter or work in a confined space without a valid entry permit.

It is recommended that an entry permit clearly identifies the roles and responsibilities of persons who may authorise particular jobs and who are responsible for specifying the necessary precautions (e.g., isolation, atmospheric testing, emergency arrangements, etc).

However, the entry permit does not entitle the applicant to carry out hotwork or any other hazardous work. Separate permits-to-work (PTW) must be obtained to carry out these works. A permit-to-work system for entry into a confined space shall be established and implemented. The confined space entry permit (hereinafter referred to as entry permit) and PTW ensure that:

- The confined space work is carried out with careful consideration on safety and health of persons who are carrying out the work;
- Such persons are informed of the hazards associated with confined space work; and
- The necessary safety precautions are taken and enforced when confined space work is being carried out.

Information Required on The Entry Permit:

The entry permit shall include at least the following information:

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a) identification of the confined space;
b) location of the confined space;
c) purpose of entry;
d) entry date and time duration;
e) validity of the permit (date and time of completion/ expiration of entry/work);
f) potential hazards in the confined space:
   - atmospheric hazards
   - non-atmospheric hazards
g) control measures (how hazards will be controlled so that the space is safe to enter).
   - Isolation
   - Personal Protective Equipment (PPE)
   - other personal equipment (pocket/personal gas detector; torchlight)
   - Barricades and signboards
   - Emergency response:
     - ✓ a well-rehearsed rescue plan;
     - ✓ rescue equipment;
     - ✓ name and contact number of emergency responders.
h) name of confined space attendant;
i) provision of ventilation;
j) lighting arrangement;
   - use of flame-proof light (protected light)
k) results of the atmospheric testing of the confined space:
   - Oxygen;
   - Flammable gases;
   - Other toxic gases.
l) name and signatures of supervisor, confined space assessor, and authorized person.

Application and Issuance of Entry Permit

Having carrying out a joint risk assessment by the supervisor of work crew and the Authorised Manager; there are altogether 4 stages from application of the entry permit to completion of work:

STAGE 1 — Application of entry permit by supervisor

The supervisor shall:

a) state the measures which will be taken to ensure the safety and health of the persons who will enter or carry out work in the confined space based on the completed risk assessment;
b) inspect and prepare the pre-entry requirements for the confined space;
c) highlight the intended work to the concerned personnel; and
d) complete and forward the entry permit to the confined space assessor.

STAGE 2 – Evaluation by confined space safety assessor

The confined space safety assessor shall:

a) inspect the site/area together with the applicant;

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b) determine possible atmospheric hazards and establish appropriate sampling strategy, such as measurement method, number and location of sampling points;
c) use suitable and calibrated atmospheric gas/vapour testing instruments;
d) test the space for atmospheric hazards and record the results of the test;
e) highlight any deviation from the acceptable limits to the authorised Manager; and
f) endorse and forward the permit to the authorised manager.

STAGE 3 – Approval by authorized manager

The authorised manager shall:

a) assess whether all reasonable practicable measures have been taken to ensure the safety and health of persons who will be entering or working in the confined space;
b) evaluate the hazards and risk involved in the in the confined space work;
c) confirm that the work is properly coordinated in the safety meeting and there are no incompatible works which may pose a risk to the safety and health of persons who will be entering or working in the confined space; and
d) approve and issue the entry permit .

STAGE 4 – Notification of work completion

Upon work completion, the supervisor shall remove the display copy of the entry permit and return it to the confined space assessor for record keeping.

Display of Entry Permit

A copy of the entry permit issued by the authorised manager shall be displayed by the supervisor clearly at the entrance to the confined space so that entrants are informed of the condition of the space and the measures taken to ensure safe entry.

Review and Endorsement of Entry Permit

It is the duty of the authorised manager to review and assess the need to continue the work in the confined space on a daily basis and revoke the entry permit if he thinks fit to do so. If the work in the confined space needs to be continued after the assessment, the authorised manager shall endorse the entry permit by signing on the permit or by using other equally effective means.

Revocation of Entry Permit

If, after issuing an entry permit, the authorised manager determines that carrying out the work in the confined space is likely to pose a risk to the safety and health of persons in the confined space, he may order the work to cease immediately and revoke the entry permit.

The authorised manager shall terminate entry and cancel the permit when:

- The entry operations covered by the entry permit have been completed; or
- A condition that is not allowed under the entry permit arises in or near the permit space.

For example, the authorised manager is to revoke the entry permit when the monitoring equipment alarm sounds; indicating the deficiency of oxygen level, or 10% of LEL, or PEL of toxic gas is exceeded

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Re-certification of Confined Spaces

When a hazardous atmosphere in a confined space is detected, the supervisor or confined space safety assessor shall withdraw the entry permit. A "no entry" sign shall be clearly displayed at the entrance of the confined space. The authorised manager shall revoke the entry permit.

The supervisor, CSSA and the authorised manager shall evaluate how the hazardous atmosphere developed. Effective means shall be provided to remove the atmospheric hazards in the confined space.

Upon removal of the atmospheric hazards, the supervisor shall raise a "new" entry permit for the confined space, if entry or work in the confined space is to be continued. No person shall re-enter the confined space until the confined space has been re-certified safe for entry and a new entry permit is issued by authorised manager.

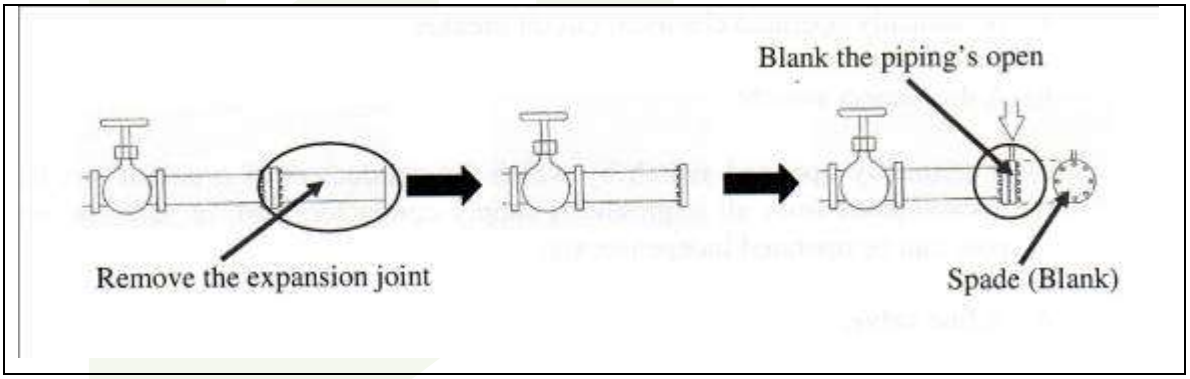
Record Keeping

Employers are required to keep records of work in confined spaces, including entry permits and test results for two years as stipulated under the WSH (Confined Space) Regulations.

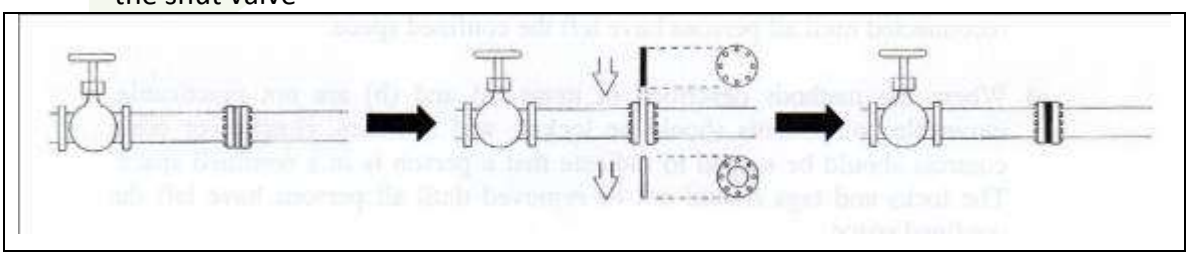
Control of Hazardous Energy

It is important to ensure that the confined space is isolated before entry. This is to prevent materials from coming into the space via pipelines or vents and to ensure that equipment inside the space does not start up while the entrant is inside. This procedure is also to protect personnel from injury owing to inadvertent re-energisation, start-up or the release of stored energy from the machines, equipment or processes during the repair or maintenance of equipment. It is acknowledged that isolation by shutting valves alone is never reliable.

Below are 3 positive isolation practices common in the Oil Petrochemical Industry.



1. Isolation by dropping a section and blanking off the live end
2. Isolation by spade after the shut valve



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3 Isolation by turning the spectacle blind after the shut valve.

Lock out and Tag out

Energy sources can come in many forms but not limited to electrical, mechanical, hydraulic, pneumatic, chemical, thermal, gravitational, ionising and non-ionising radiation. It is necessary for all mechanical, electrical equipment and all other energy sources connected to a confined space are isolated to prevent them from unintentional activation. If gases or vapors could enter the confined space, physical isolation of pipe works , valves, etc need to be locked and tagged using lockout and tagout procedures. In all cases, a check is required to ensure isolation is effective.

Example of an electrical lockout

Example of valves and piping lockout

General Requirements

Openings of Confined Spaces

Before an entrance cover is removed, any known unsafe conditions shall be eliminated. When entrance cover is removed, the opening shall be promptly guarded by a cover, or barrier. This will prevent anyone from falling through the opening. The barrier or cover shall prevent foreign objects from entering the space and protect each employee working in it. If it is in a traffic flow area, adequate barriers shall be erected to divert the traffic. It is necessary to take precautions when opening the covers to tanks and within other confined or enclosed spaces in the event the space is under pressure or hazardous materials have leaked from internal piping systems. It is important to leave at least two nuts on opposite sides of the cover in place until the cover can be cracked and any internal pressure has released.

Barricade

It is essential to use safety barriers to separate workers from hazards that cannot be reasonably eliminated by other engineering controls. Selection of suitable barriers will depend on the nature of the hazard and the size of the area or equipment to be cordoned off. The supervisor must determine if safety barriers will be needed for the confined space entry prior to any workers entering the confined space.

Warning Signs

Warning sign/s can be used to inform workers about the confined spaces. It is critical for the workers to know the location of the confined space, its hazards, the required safe work procedures and permit to enter the confined space.

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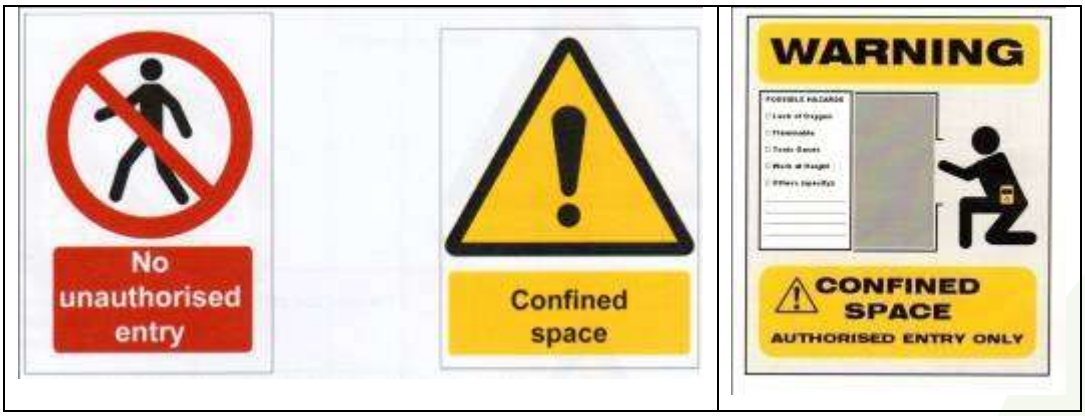

Confined Space Attendant (CSA)

CSA should be appointed where any person enters or carries out any work in a confined space. He shall remain outside the confined space to:

- Monitor persons entering and working in the confined space;
- Maintain regular contact with the persons in the confined space and when necessary assist them to evacuate should the need arise; and
- Alert the rescue personnel to activate the rescue operation in an emergency.

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Communication

An effective and reliable means of communication between entrants inside the confined space, and between entrants and attendants, is required. When choosing a means of communication, it is advisable to give careful consideration to all anticipated conditions inside the confined space (e.g. visibility, possibility of a flammable atmosphere, and noise levels) and to the personal protective equipment in use (e.g. ear muffs and breathing apparatus). The communication system used can be based on speech, hand signals, telephone, radio etc. Whatever system is used, it is important that all messages can be communicated easily, rapidly and unambiguously between relevant people. It is important to take note on the limited penetration of radio signals into buildings, vessels and below-ground structures. The advantages of having a person outside the confined space in direct voice and visual contact with the entrants are clear. This also facilitates the monitoring of entrants for the symptoms or behavioural effects of exposure to hazards.

It is important that confined space entrant(s) are informed quickly if a situation arises on the outside which could endanger the entrants, such as problems with a supplied air system or ventilation system. It is essential for the means of raising the alarm and setting in motion the emergency rescue procedures are effective and reliable. It is also necessary for the line of communications be available at all times during the work.

It is required to have an appropriate means of communication between the person working inside a confined space and the person stationed outside, whether by voice, rope tugging, tapping or by a battery-operated communication system specially designed for confined space use. Note that radio frequency/wireless devices do not work effectively in confined spaces such as tanks or sewers, where there is metal or concrete shielding between the interior of the space and the outside. Body alarm devices may be useful in a confined space where communication between workers and attendants is difficult. These are designed to sound if the wearer does not move during a specified period of time.

Lighting and electrical equipment

Adequate and suitable lighting shall be provided for entry and work in a confined space. Access and passage into a confined space shall be provided with illumination of not less than 50 lux. All portable hand-held lightings provided in confined space shall be operated at a voltage not exceeding alternative current (AC) 55 volts between the conductor and earth or direct current (DC) 110 volts. Temporary lights shall be equipped with guards to prevent accidental contact with the bulb, except that guards are not required when the construction of the reflector is such that the bulb is deeply recessed.

Temporary lights shall be equipped with heavy-duty electric cords with connections and insulation maintained in safe condition. Temporary lights may not be suspended by their electric cords unless cords and lights as designed for this means of suspension. Splices shall have insulation equal to that of a cable. Temporary lights and electrical services shall be protected by an earth leakage circuit breaker (ELCB). Working spaces, walkways, and similar locations shall be kept clear of cords so as not to create a hazard to employees. All electrical equipment shall be protected by an ELCB.

Respiratory Protective Equipment

It is recommended to use respiratory protective equipment (RPE) as a last resort when all of the other control measures in the hierarchy of control are either inadequate or impractical, or in the event of an emergency where entry is required for rescue purposes.

The Authorised Manager is advised to always aim to achieve a safe atmosphere where respiratory protective equipment would not be necessary. If this is not practicable, appropriate respiratory protective equipment should be considered depending on the likely concentration of contaminant and/or oxygen level in the confined atmosphere.

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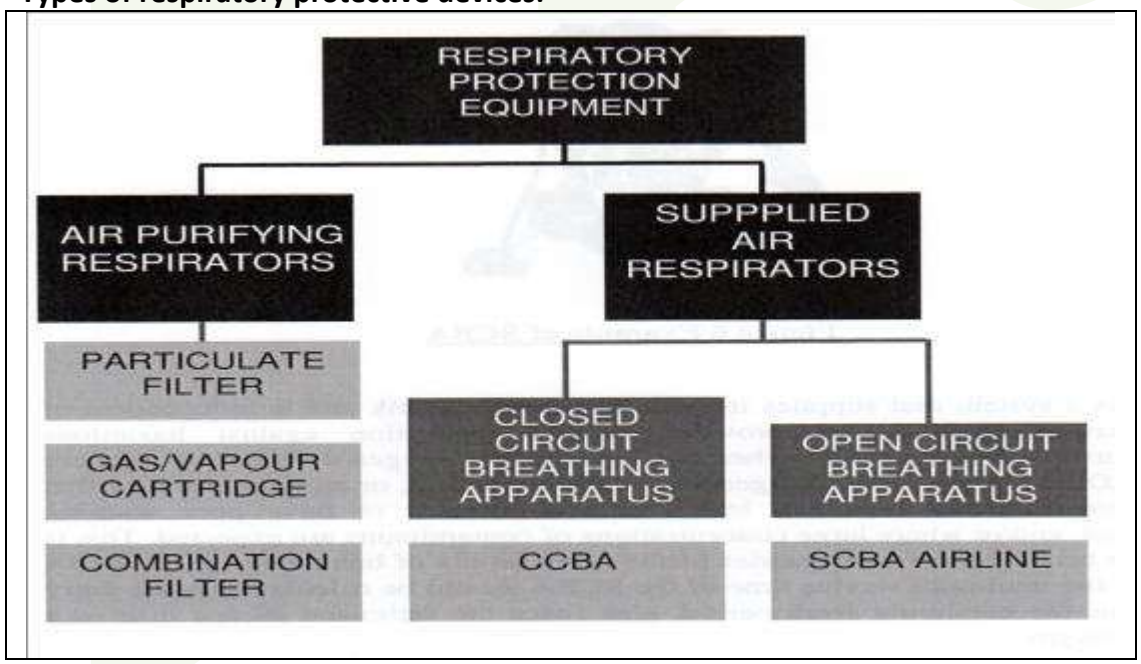
Respirators are devices that allow workers to breathe safely without inhaling harmful levels of toxic gases or particles. It is critical to have a competent person to determine the appropriate respiratory protective equipment based upon conditions and test results of the atmosphere and the work activity to be performed.

It is important that the breathing apparatus fits properly and is safe to use. Care needs to be taken in the selection of the device and in its use. It is also important not to use any damaged or defective protective devices.

Selection of respiratory protective devices is generally based on:

a) Type of air contaminants present (i.e., articles, vapors, gases);
b) Hazard of exposure (i.e., IDLH, eye irritant, Toxicity);
c) Warning properties of contaminants;
d) Level of exposure;
e) Exposure time;
f) Work activity;
g) Characteristics and limitations of the respirator equipment; and
h) Level of protection needed.

Types of respiratory protective devices:



Only Supplied Air Respirators (SCBA and Air lines) should be used in confined spaces where there is lack of Oxygen (oxygen deficiency).

SCBA is a system that supplies its own air through a hose or tank and is independent of the surrounding air. It provides reliable protection against hazardous environments. It is the choice when dealing with any oxygen deficient atmosphere that is IDLH (Immediately Dangerous to Life or Health), or any environment that is unknown or has unknown levels of

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contaminants or have poor warning properties, and/or where large concentrations of contaminants are expected. This is possible because the wearer carries his/her own supply of breathable air. If SCBA is used, the minimum service time of the SCBA should be calculated on the entry time plus the maximum work period, plus twice the estimated escape time as a safety margin.

The limitation of this system is that it is often difficult to work with, requiring special support equipment and training. In addition, because of their weight and restrictiveness, their use requires more physical effort.

Figure 5(b) – Self contained breathing apparatus (SCBA)

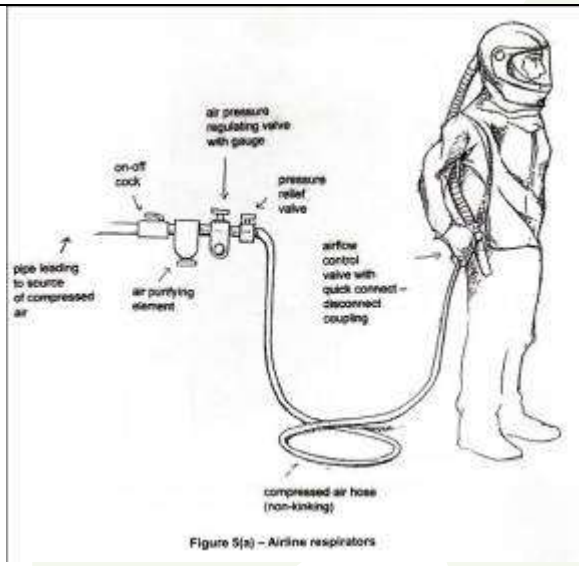

Figure 5(a) – Airline respirators

Supplied Air Respirator

An airline respirator is recommended when entry with a normal SCBA is physically restricted and/or the work duration is longer than the service time of the SCBA. Breathing air from an airline respirator normally comes from a trolley-mounted cylinder(s) positioned in safe zones in close proximity to the user, from a compressor or a combination of both. The breathing air is then supplied to the user by the breathing hose which is normally connected to a lightweight harness to provide the user with an uninterrupted air supply. When compared to more the conventional self contained breathing apparatus, this arrangement provides greater freedom of movement and less fatigue to the user.

Air purifying (cartridge) respirator

Air Purifying (Cartridge) Respirators offer no protection against oxygen deficiency.

Figure 4(c) – Full face respirator

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It is basically a filtering system that cleans the air being inhaled. Air-Purifying Respirators (APR) can remove contaminants in the air that the person breathes by filtering out particulates (e.g. dusts, metal fumes, mists, etc.). Other APRs purify air by adsorbing gases or vapors on a sorbent (adsorbing material) in a cartridge or canister. They are tight-fitting and are available in several forms:

a) half-face mask (covering the face from the nose to below the chin), or full face piece (covering the face from above the eyes to below the chin).

Respirators with a full face piece also protect the eyes from exposure to irritating chemicals. The limitation of APR is that the system depends on the surrounding air for oxygen and filters the contaminants from the person's breathing air. It is critical for the atmosphere of the confined space contain at least 19.5% oxygen. It is also required to know the approximate concentration of contaminants to ensure that the respirator's capabilities are not exceeded. The concentration of contaminants cannot exceed the "Immediately Dangerous to Life and Health" (IDLH) levels and it is necessary for the person to be fit-tested to ensure the correct size of respirator prior to use.

It is important not to use any kind of filtering respiratory protection device;

a) in oxygen deficient atmospheres (less than 19.5 vol. % O2);
b) in poorly ventilated areas or confined spaces, such as tanks, tunnels, or vessels;
c) in atmospheres where the concentrations of the toxic contaminants are unknown or are immediately dangerous to life or health (IDLH);
d) when the concentration of a contaminant is higher than the maximum permissible concentration and /or the filter class capacity.

It is also important to ensure:

- it fits properly.
- if both gases and particles are present, the combination filter is used to filter out both gases and particles

Fit testing

It is important to conduct qualitative or quantitative fit testing for all wearers of filtering respiratory protection device to ensure that the facial seal is good. It is crucial for fit testing always be performed by the manufacturer or their authorised agent.

Qualitative fit testing comprises two steps;

a) A sensitivity test with a diluted test solution (without filtering device) to check if the wearer can detect or taste the test solution.

b) The actual test will be conducted using a concentrated test solution. In the actual fit testing, the user is asked to wear the filtering device and perform the following tasks; to breathe normally, to breathe deeply, to turn his head from side to side, to move his head up and down, talking, bending over, jogging on the spot and then back to breathing normally.

If the test solution cannot be tasted after completing all the above, the qualitative fit testing is a success and the user will be given a certificate for wearing this filtering respiratory protection device. A retest will be required, if other filter respiratory devices are to be used Quantitative fit testing is normally performed with special equipment by a trained operator. With this test, no answer is required from the user. This eliminates any possibility of a subjective perception.

Other Personal Protective Equipment (PPE)

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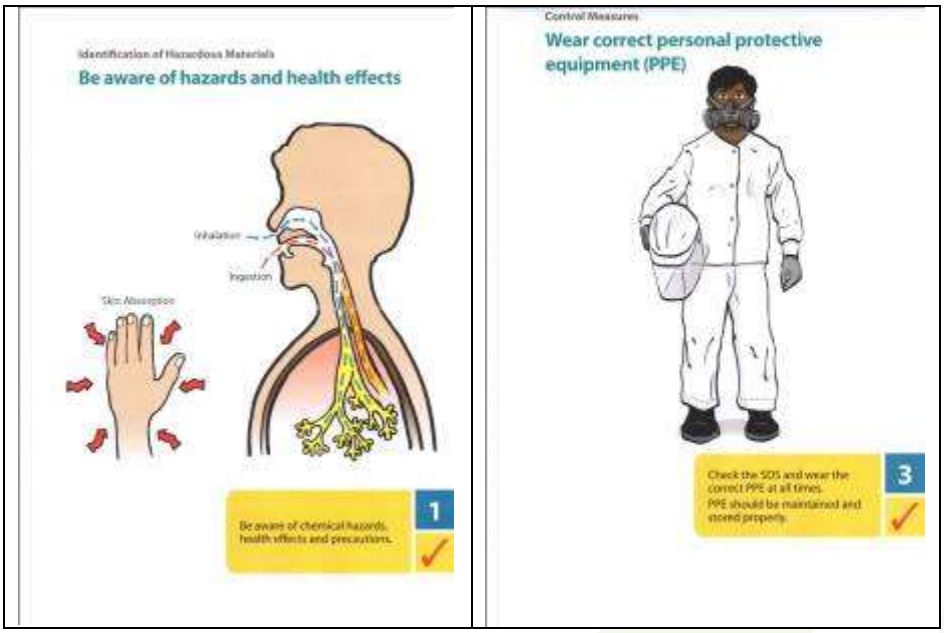

Protective Clothing

All persons entering a confined space shall wear a full-suit work clothing. It is important for the clothing materials worn to provide appropriate protection against toxic or irritating substances. If the hazards are heat or cold, protection from over-exposure to these hazards should be worn. It is necessary for such clothing to comply with applicable codes or international standards.

Head Protection

A hard hat is required when there is danger of head injury. It is important to wear a safety helmet which complies with applicable codes or international standards.

Eye and Face Protection

Eye protection is required in all confined spaces. If eye-irritating chemicals, vapours or dusts are present, it is necessary to wear a pair of appropriate safety goggles. It is critical to use eye and face protection equipment which complies with applicable codes or international standards.

Hand Protection

Gloves and protective clothing made of a suitable resistant material are to be worn to protect the hands from exposure to potential injuries. Specialty gloves may be required to protect against heat, cold, or when handling slippery material or tools. Special foot protection may be worn to protect against slippery surfaces, electricity, falling objects, chemicals, or sparks. Safety shoes are required to comply with applicable codes or international standards.

Hearing Protection

All persons are required to wear hearing protection if they are exposed to excessive noise.

Safety Harness

It is critical for safety harnesses to be worn when there is a potential of falling from height. When wearing it, exercise care that such equipment would not introduce a hazard or unnecessarily hinder free movement within a confined space. It is important to give careful consideration to the possible hazards/rescue arrangements during the selection of the type of safety harness. The safety harness is required to comply with applicable codes or international standards.

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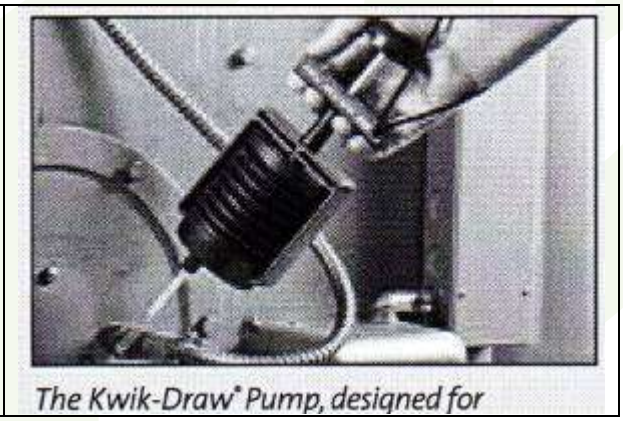
Gas Testing and Monitoring the Confined Space Atmosphere



The lack of oxygen and the presence of many toxic or flammable gases in a confined space can neither be seen, tasted nor smelt. Therefore, it is important for a confined space to be tested to ensure that the atmosphere is safe for persons to enter. It is also important to continuously monitor after entry so that the atmosphere is maintained at the acceptable/safe level.

Atmospheric testing is required for two purposes:
• To evaluate the hazards in the confined space; and
• To verify that it is safe for entry into the confined space.

No person shall enter a confined space until it is tested to be free from any gas hazards. If entry is required, the authorised entrant must be equipped with an appropriate supplied air respirator and other PPE as per defined by hazards analysis. It is important that satisfactory gas testing is carried out by a confined space safety assessor, as specified in WSH (Confined Spaces) Regulations, before entry into any confined space. Conduct the gas tests in the following sequence:

- oxygen level to be > 19.5% but < 23.5%
- presence of flammable and/or toxic gases to be < 10% LEL
- presence of toxic vapour, gas or fume to be < PEL

It is crucial to carry out the initial testing from outside the confined space by drawing the air from the atmosphere using suitable sampling devices.

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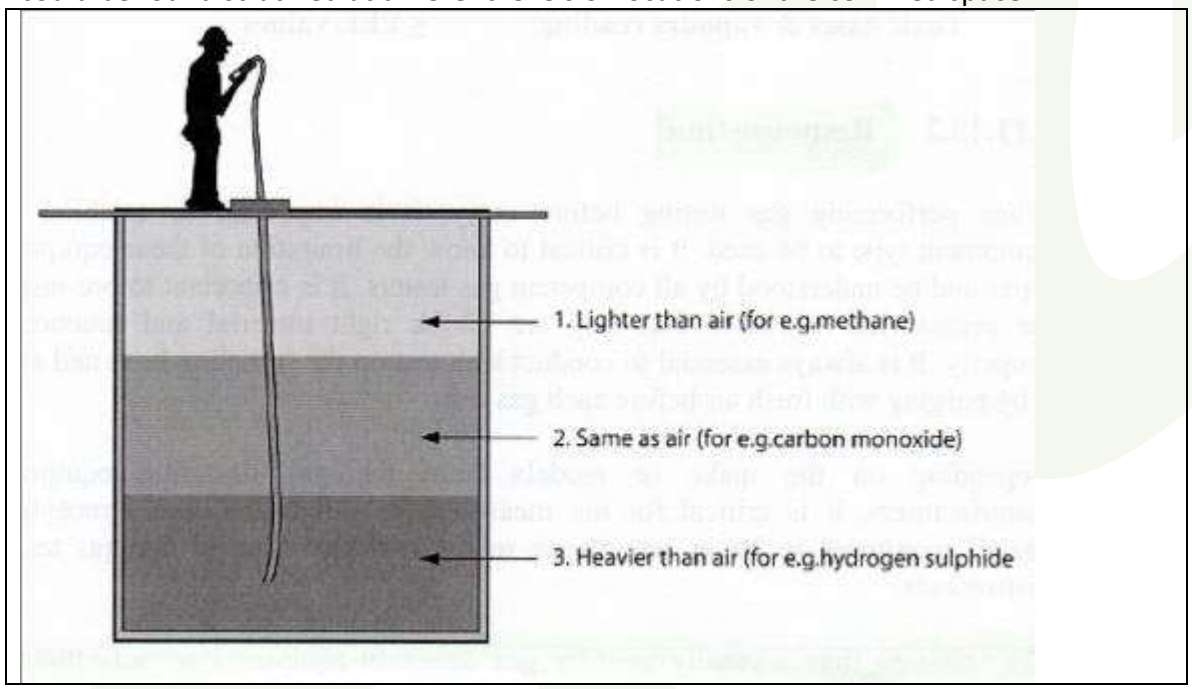
If it is absolutely necessary to conduct gas test inside the confined space, the confined space safety assessor is required to wear suitable breathing apparatus (BA) and is authorised by the authorised manager to enter. It is also necessary to record all gas testing results and attach it to the entry permit.

Different depths

When performing gas testing before entry, it is important to determine the proper equipment to be used. It is critical to know the limitations of these equipment types and understood by all competent gas testers. It is important to pre-inspect the accessories to ensure that they are of the right material and functioning properly.

It is also important that the gas testers understand and take into account the geometry of the confined space and the physical properties of the gases to be monitored. These gases could be found stratified at different levels or locations of the confined space.



Types of Testing Methods/Equipment

There are various types of portable and transportable electronic gas testing instruments for detection of the gas hazards in confined space.

Type of Gas Hazard	Example	Gas Measurement Principles				
		Catalytic Sensor	Infrared Sensor	PID Sensor	Electrochemical Sensor	Colorimetric Tubes
Toxic	Ammonia				X	X
Flammable in Inert	Propane	X (with dilution probe)	X			
Toxic & Flammable	Benzene	X		X		X
Toxic & Flammable	Carbon Monoxide	X			X	X
Oxygen deficiency	Nitrogen				X	
Toxic	Hydrogen Sulphide				X	X

Table 4 Types of gas hazard and their measurement principles

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These instruments may be available either as a single gas monitoring instrument for just one gas or contaminant, or a multi-gas monitoring instrument that will typically measure oxygen, flammable gases and toxic gases. It is recommended that an Ex approved electronic gas detection instrument that is capable of detecting OX/EX/TOX simultaneously be used. Using either diffusion or active sampling via manual or electrical pump will warn the users when concentration levels in the confined space are unsafe. It is important that training be given on the use of these instruments include instrument calibration, equipment maintenance and the proper interpretation of the instrument readings and warning alarms. When in doubt, it is advisable for the CSSA to check with the instrument manufacturers for more details.

As mentioned, not all gases can be measured with an electronic gas detection instrument. The colorimetric tubes are still a common method used by many gas testers. These tubes are impregnated with chemicals that will react in the presence of a specific gas or vapour. The reaction will produce a colour change and from the length of the colour change or the intensity of the colour change, the concentration of this gas or vapour can be determined.

Continuous Monitoring and Frequency of Tests

Even when the confined space is tested and certified safe for any person to enter, at least one person in a group working in the same vicinity shall be equipped with suitable instrument for measuring oxygen, combustible and the identified toxic contaminants.

In addition to the continuous ventilation requirement, it is essential to conduct the periodic retesting, taking the following factors into consideration:

- The possibility or likelihood of a change in the space by the potential release of the hazardous materials;
- When continuous occupation exceeds 6 hours;
- When a confined space is vacated for a significant period of time ≥ 30 min, without the space being monitored continuously;
- When the atmospheric hazards in a confined space are detected by the confined space safety assessor during periodic testing or continuous monitoring, all persons in the confined space shall vacate the confined space immediately;
- The confined space entry permit shall be cancelled immediately and “No Entry” signs must be prominently displayed at the entrance to prevent unauthorised entry;
- An evaluation shall be made to determine how the hazardous atmosphere was developed; and
- No person shall re-enter the confined space until it has been re-certified safe for entry and a new confined space entry permit is issued.

Maintenance of Equipment (General)

It is important that the gas monitoring instrument used for testing the confined space is in good working condition. It is necessary to perform proper maintenance and calibration in accordance

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with the manufacturer's guidelines. Additionally, it is necessary to keep an equipment log book/records of the results such as calibration performed, parts replacement, and so on.

Purging and Ventilation

When a confined space is known to contain hazardous contaminants, it is crucial to purge the space adequately before any entry. Subsequently, continuous ventilation should be provided to maintain a safe work environment. It is also important to note that purging and ventilation do not exclude the need for gas testing.

Purging

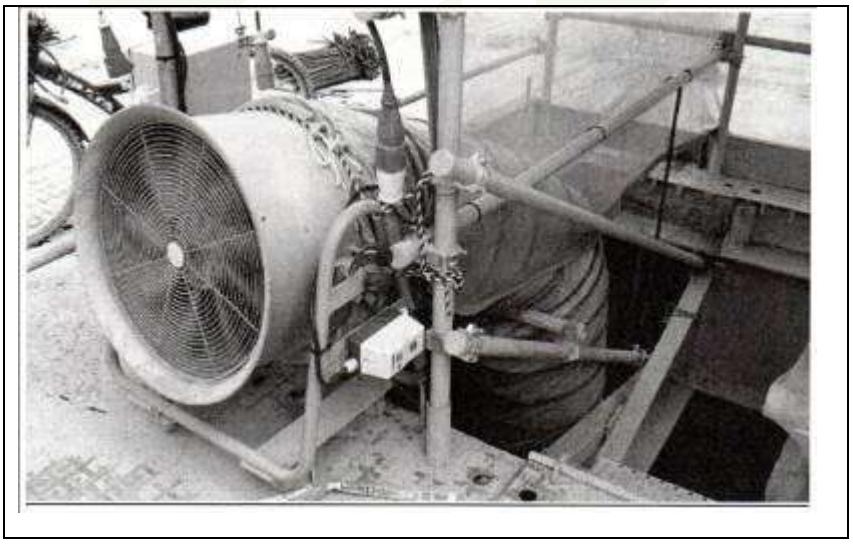
Purging of a confined space is conducted before any entry and the purpose is to remove any existing contaminants by displacing the hazardous atmosphere with another medium such as air, water, steam or inert gases. The choice of a suitable medium will depend on factors such as nature of the contaminants and their concentrations.

Inerting

Inerting is a form of purging which involves removing oxygen from the confined space by displacing it with inert gases such as nitrogen (N2) and carbon dioxide (CO2). Inerting is commonly used to remove the potential hazards of fire and explosion by reducing oxygen to a concentration that is below the level that can support combustion. When inerting, care must be taken to ensure that following the purging of the contaminants with inert gases, the space must be ventilated with fresh air to restore the atmosphere to normal atmospheric condition. Also, when purging flammable substances, the equipment used such as nozzles and pipes must be bonded to the space to prevent the build up of static charges which can cause ignition.

Ventilation

It is unsafe to enter any confined space when adequate ventilation is absent. Adequate and effective ventilation is required throughout the validity period of the entry permit. Even when the confined space has been certified safe for entry, new contaminants may be introduced from the change in conditions, or when work performed in the space such as welding releases new contaminants. As such, it is important to provide adequate and effective ventilation to always maintain the contaminants concentration level as low as possible, and the level of oxygen within safe range.



Type of Ventilation and its Uses

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Due to the unique characteristics of confined spaces, natural ventilation is usually not adequate and would require the use of mechanical ventilation. Mechanical ventilation can largely be classified into two main types:

- Forced (supplied) ventilation; and
- Local exhaust ventilation (LEV).

Factors to consider in determining the type of ventilation to use include:

- The nature of contaminants;
- The configuration of the space; and
- The expected work to be performed in the confined space.

Forced (Supplied) Ventilation

Forced or supplied ventilation introduces fresh air into the confined space through the use of a mechanical air moving devices such as a blower. The constant supply of fresh air in sufficient quantity will help to maintain the level of oxygen in the space within the safe range, as well as dilute the level of contaminants released in the confined space to an acceptable level. Forced ventilation used to dilute contaminants is usually more suitable when:

- The contaminants released are of relatively low toxicity (as a general guide, contaminants with PEL of equal or higher than 500 ppm is deemed to be slightly toxic);
- The rate of emission or release is relatively constant and is of small quantities;
- Contaminants are gases or vapours or finely suspended solids;
- The release of the contaminants is widespread; or
- There is sufficient distance between the worker and the source and allow effective dilution to take place.

It is important to ensure that the air moving device is placed where the air is drawn into the confined space from a contaminant-free source. For example, it is not appropriate to place the air moving device behind a diesel generator where the exhaust gas of the generator could be drawn into the confined space.

Local Exhaust Ventilation (LEV)

Exhaust ventilation is achieved by pulling air out of the confined space and in the process, removing the contaminants from inside the space. LEV is a specific application of exhaust ventilation where the extraction is applied directly at the contaminant source. The use of LEV should be considered when dilution ventilation is not effective due to restrictions in the confined space or when high local concentrations of contaminants may occur during work activities such as welding and chemical cleaning. In general, LEV is suitable when:

- The released contaminants are of relatively moderate to high toxicity (as a general guide, contaminants with PEL of lower than 500 ppm is deemed to be moderate to high toxicity);
- The rate of emission or release is of large quantity;
- The contaminants are fumes or solids that are difficult to remove by dilution ventilation;
- The release of the contaminants is localised; and

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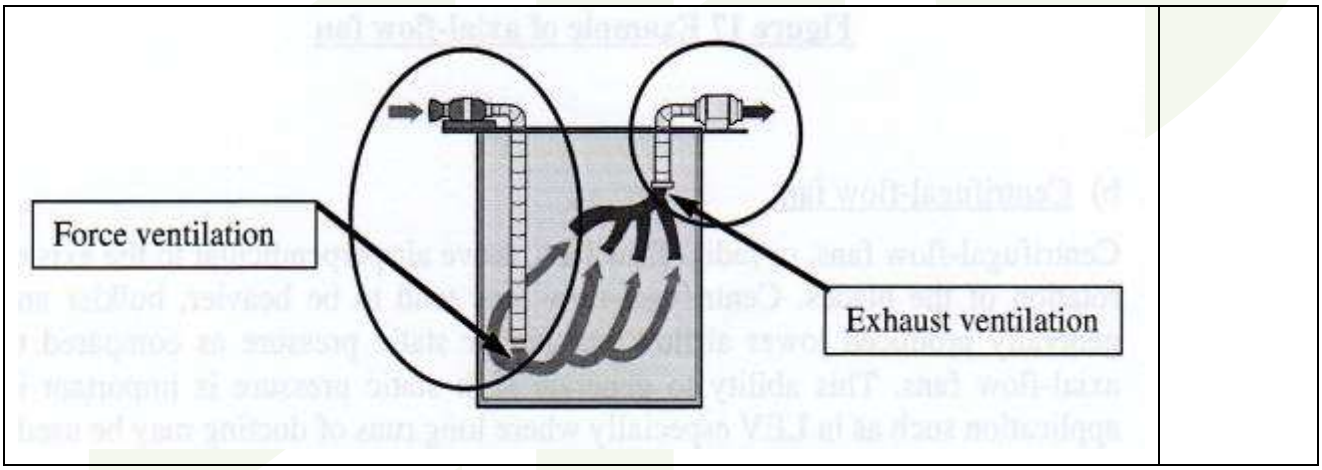
- There is insufficient distance between the worker and the source to allow effective dilution to take place.

For LEV to be effective, it is crucial to place the exhaust hood close to the contaminants' source. It is important that the exhausted air is discharged outside the confined space to avoid re-introduction into the space. In addition, it is also important that the fan capacity is adequate to pull the contaminants into the exhaust hood, move them along the duct and discharge into the atmosphere outside the space. As LEV removes air from the confined space, it creates a slight negatively pressured environment in the space. Therefore, it is important that replacement air is provided in the form of supply ventilation.

Push-pull System

A push-pull system uses a combination of both forced ventilation and exhaust ventilation. It usually provides more effective ventilation of the space than using any of the ventilation system alone, and is recommended for use whenever practicable. The push-pull system introduces fresh air into the space while removing contaminants by exhausting them.



Air Moving Devices

There are typically three types of air moving devices that are used in the mechanical ventilation of confined spaces. These are:

- Axial-flow Fans.
- Centrifugal-flow Fans
- Venturi Eductor

when flammable gases/vapours are present, the fan must have explosion-proofed construction.

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Axial Flow Fan	Centrifugal Flow Fan	Venturi Eductor

Ducting

	Ducting is used widely and extensively to channel air to and from confined spaces. There are two main types of ducting commonly used: • Flexible collapsible ducting; such as plastic material tubing. It lacks structural support and can only be used for forced ventilation • Flexible non-collapsible ducting, such ducting offers strength and flexibility. These non-collapsible ductings can be used for both forced and exhaust ventilation

Effective ventilation

Another key component of ventilation in confined space is to ensure that the ventilation systems in place are effective. As a general principle, ventilation systems should be set up with the following consideration:

a) Long confined Space;
b) Deep confined space;
c) Prevent short-circuiting;
d) Prevent re-circulation of exhaust air;
e) Remove lighter-than-air contaminants;
f) Remove heavier-than-air contaminants.

<u>Long confined space</u>

For a long confined space, fresh air is blown in at one end of the space and the contaminated air is being exhausted at the other end. If necessary, use a series of fans (do not connect them) to move air through long distances.

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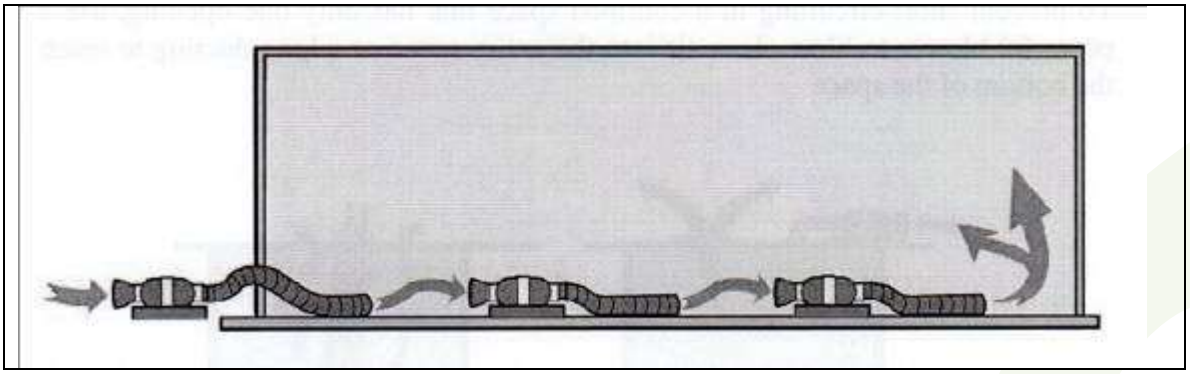
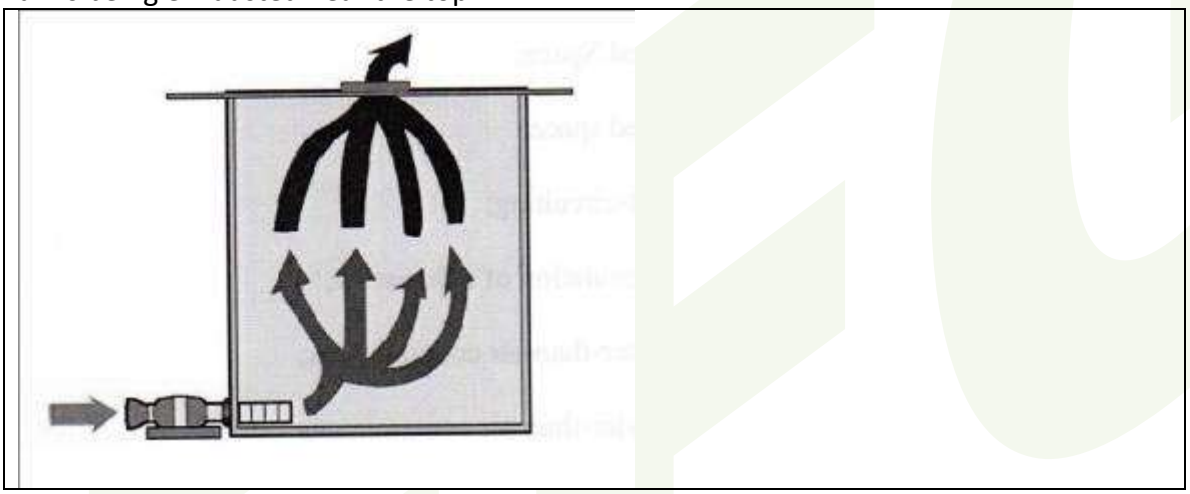


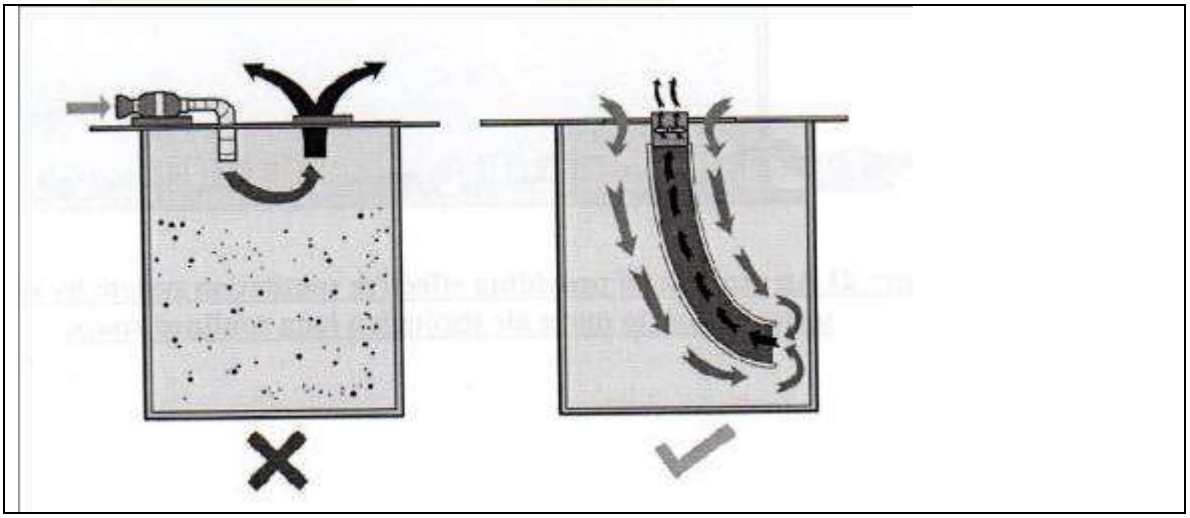
Deep confined space

For a deep confined space, the fresh air is blown into the bottom, and the contaminated air is being exhausted near the top.



Prevent short-circuiting

To prevent short-circuiting in a confined space that has only one opening, use a powerful blower to blow clean air into the entire space or a long ducting to reach the bottom of the space



Prevent re-circulation of exhaust air

To prevent re-circulation of exhaust air in a confined space, position the air intake away from any contaminated source. This includes facing away from the opening of a confined space.

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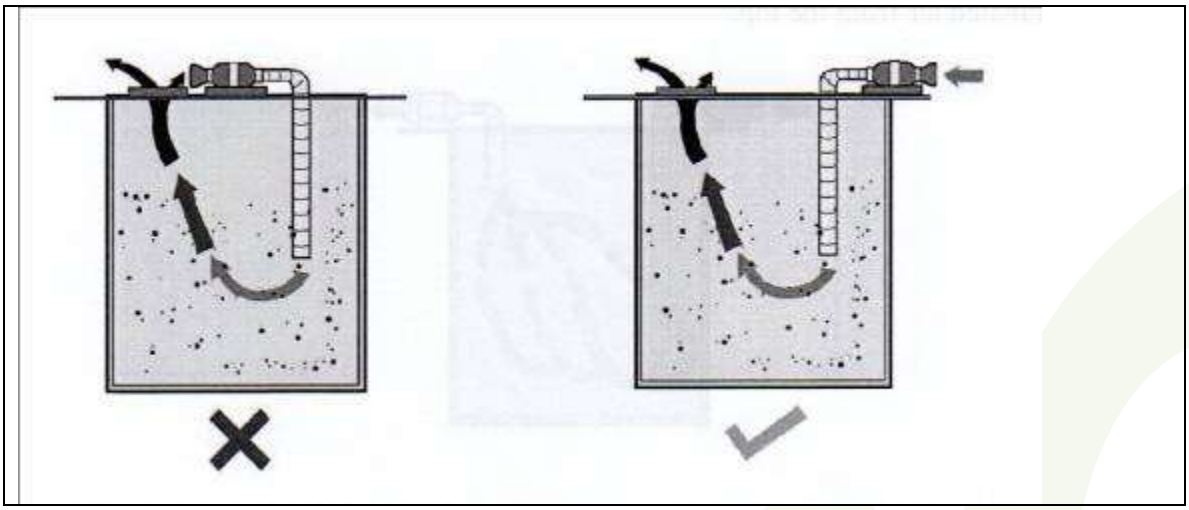
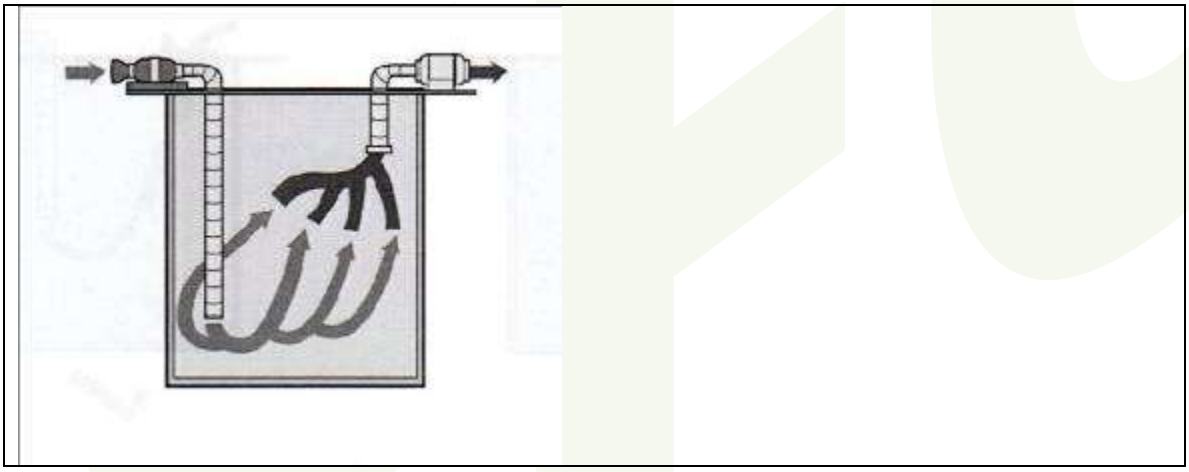


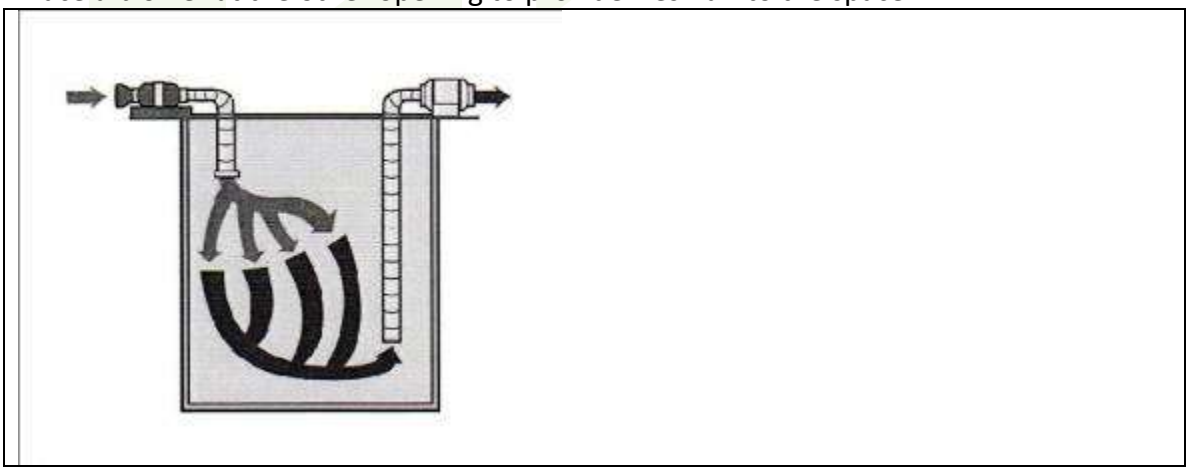
Remove lighter-than-air contaminants

To remove lighter-than-air contaminants from a confined space that has two openings at the top of the space, use a blower and duct work to introduce fresh air to the bottom of the space. Place an exhaust fan at the other opening to draw the contaminated air from the top.



Remove heavier-than-air contaminants

To remove heavier-than-air contaminants from a confined space that has two openings at the top of the space, use an exhaust fan and duct work to capture the low-lying contaminants. Place a blower at the other opening to provide fresh air to the space.



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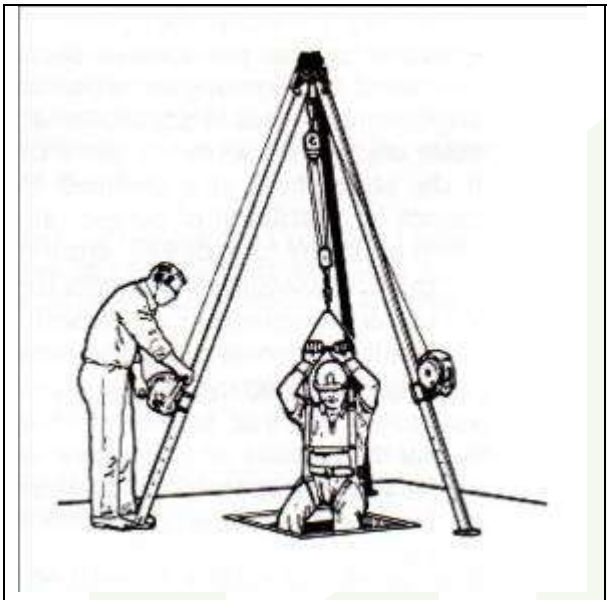
Before anyone is authorised to enter a permitted space, it is crucial to have trained emergency rescue personnel available when an entrant needs help. It is important for such personnel to reach the site promptly and know how to deal with the emergency.
In any unplanned rescue, such as when someone instinctively rushes in to help a downed co-worker, it can easily result in a double fatality or even multiple fatalities if there are more than one would-be rescuers.

It is "A MUST" to have a written and established rescue operation plan on-site that includes equipment, such as retrieval devices, breathing and resuscitating apparatus, ready for emergency use immediately. The severity of accidents can be reduced with timely alerts from attendants outside the confined space. A well-trained and fully equipped rescue team can ensure a speedy response in an emergency.

Rescue Plan



A written rescue operation plan shall be established for the purpose of rescuing persons in a confined space. The rescue operation plan shall:

a) Have names of the designated rescue personnel available;
b) Indicate the methods of rescue to retrieve persons inside a confined space;
c) Prescribe the types and availability of equipment necessary for rescue; and
d) Provide an effective means to summon the designated rescue personnel in a timely manner.

Rescue Arrangements

The risk assessment will determine what rescue arrangements are necessary. The arrangements will depend on the nature of the confined space, the risks identified and the types of emergency situations which are foreseeable. It is important to note the possible emergencies in the confined space, and any other foreseeable accident for a rescue operation.
For example, the incapacitation of a person, wholly or partially, following a fall inside a confined space.
Possible confined space rescue strategies include the following:

a) Self-rescue where the circumstances, the nature of the hazards and the control measures available allow;
b) Rescue by team members (trained rescue personnel) using non-entry methods if feasible;
c) Rescue by team members (trained rescue personnel) using a safe entry technique; and
d) Rescue using a safe entry technique by the local public emergency services subject to adequate time being available (this depends on the nature of the hazards and the response time of the emergency services).

The risk assessment shall determine the combination of confined space rescue strategies as appropriate for the particular situation.

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It is important for suitable and sufficient emergency arrangements to take account of:

a) Rescue considerations;
b) Rescue logistics;
c) Training of rescue personnel;
d) Provision of rescue equipment; and
e) Provision of materials safety data sheet

Rescue Considerations

It is advisable to always consider confined space as immediately dangerous to life and health (IDLH) unless proven otherwise. Plan and prepare emergency response and rescue procedures for all confined space entry work. These procedures must be in place before any work commences. It is important to note that a very short period, approximately four minutes, without adequate breathing can cause a worker to suffer permanent brain damage due to lack of oxygen.

Characteristics when deciding the appropriate rescue plan

It is important to consider the following characteristics when deciding the appropriate rescue plan for a confined space entry work:

a) Internal configuration:

i. Open -- there are no obstacles, barriers, or obstructions within the space. One example is a water tank;

ii. Obstruction -- the space contains some type of obstruction that a rescuer would need to manoeuvre. For example, a baffle or mixing blade. Large equipment, such as a ladder or scaffold, brought into a space for work purposes would be considered an obstruction if the positioning or size of the equipment would make rescue more difficult.

b) Elevation:

i. Elevated -- a permit space where the entrance or opening is above ground by 4 feet or more. This type of space usually requires knowledge of high angle rescue procedures because of the difficulty in packaging and transporting a patient to the ground from the space

ii. Non-elevated -- a permit space with the entrance located less than 4 feet above ground. This type of space will allow the rescue team to transport an injured employee normally.

c) Portal size:

i. Restricted -- A portal of 24 inches or less in the smallest dimension.
Portals of this size are too small to allow a rescuer to simply enter the space while using SCBA. The portal size is also too small to allow normal spinal immobilization of an injured employee;

ii. Unrestricted -- A portal of greater than 24 inches in the smallest dimension. These portals allow relatively free movement into and out of the permit space.

d) Space access:

i. Horizontal -- The portal is located on the side of the permit space. Use of retrieval lines could be difficult;

ii. Vertical -- The portal is located on the top or bottom of the permit space.

Rescuers must climb down or up of the permit space respectively to enter it. Vertical portals may require knowledge of rope techniques, or special patient packaging to safely retrieve a downed entrant.

For confined space entry, it is important for the authorised manager to designate a standby worker; one or more workers who are trained in industrial first aid and also trained in confined space emergency and rescue procedures. It is necessary for the designated standby

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worker be presented and remained at the entrance to the confined space at all times while his co-worker is in the confined space.

The authorised manager shall ensure that openings for entry and exit to a confined space are of adequate size to permit rescue of all persons who may enter a confined space. The openings are not obstructed by fittings or equipment which could impede rescue. It is important for rescuers be trained in and follow established emergency procedures and use appropriate equipment and techniques (such as lifelines, respiratory protection, and standby person).

Conducting of drill

It is important for all parties involved in a potential rescue operation understand and agree on the emergency and evacuation procedures. It is necessary to include all steps for safe rescue in the confined space entry procedures. It is also critical for rescue to be well planned and evidence to be made available that indicates drills have been frequently conducted on emergency procedures. A rescue drill in a confined space shall be held at least once in every 6 months. The record of such drill shall be kept and shall include the time, date of drill, personnel involved, a short description of the drill and the evaluation of the drill.

It is also important to note that workers who are not trained in proper rescue procedures shall not undertake or be permitted to undertake rescue operations.

Provision of Rescue Equipment

Suitable and sufficient rescue equipment is needed to carry out emergency in a timely and safe manner. It is important to list the appropriate equipment for the likely type of emergencies in the risk assessment. It is crucial to maintain the rescue equipment properly and be readily available whenever and wherever confined space work is undertaken.

For example, rescue equipment may include:

a) Full body harness with retrieval line attached;
b) Hand-cranked mechanical winch and tripod (required when entrant is five feet or more below the entrance);
c) Ladder;
d) Explosion-proof lighting;
e) Breathing Apparatus;
f) Stretcher;
g) Approved head protection; and
h) Resuscitating apparatus.

Rescue equipment will often include self-contained breathing apparatus (SCBA). Its duration in use is governed by the size and number of cylinders and its type.

Availability and maintenance

As a guide, the following recommendations are good practices:

a) equipment placed on-site locations should be checked daily;
b) equipment based in the location should be checked on a weekly basis; and
c) equipment located in storage locations should be checked monthly.

It is necessary to complete a maintenance/audit survey form while conducting maintenance checks.

It is important for the form to cover the following:

a) Date of inspection;
b) Name of person conducting inspection;

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c) Location; Inspection frequency;
d) Type;
e) Condition;
f) Remedial action required; and
g) Further action required.

It is the duty of the competent person to exercise all due diligence during such checks

Provision Of Safety Data Sheet

The safety data sheet (SDS) and other related information of a hazardous substance shall be made available to the medical facility treating the injured as a result of exposure to hazardous substances found in a confined space.

TRAINING FOR PERSONNELS INVOLVED IN CONFINED SPACE ENTRY AND WORK

It is necessary to provide training to all personnel who are directly or indirectly involved in confined space entry or work. These include confined space entrants, attendants, supervisors, rescue personnel, safety assessors and authorised managers. It is important to have the training that is consistent with their duties and responsibility. In practice, some of the duties can be performed by the same person. It is important that training is conducted by a competent trainer.

a) Entrant

A person who is required to enter confined spaces to carry out inspections or work. He is required to follow entry and work procedures when carrying out work in confined spaces. It is important for the person to understand the functions of portable gas/vapour measuring instruments used for continuous monitoring of the atmosphere in the confined space, and evacuate from the confined space when the instrument's alarm is activated.

b) Confined space attendant

A person appointed to monitor entrants entering and working in a confined space. It is important for him to maintain regular visual and/or verbal contact with the entrants in the confined space and inform them to evacuate the space should the need arises. In an emergency, he shall alert the rescue personnel to activate the rescue operation.

c) Supervisor

A person who oversees entry and work in confined spaces. He is responsible for ensuring that entrants and standby attendants adhere to entry procedures, and that rescue equipment and appointed rescue personnel are available when confined space work is to be carried out. It is essential for him to brief all entrants on the work to be performed inside the confined space before he allows them to enter the confined space.

d) Rescue Personnel

Persons who carry out any rescue work in confined spaces

e) Confined space safety assessor

A competent person appointed to test the atmosphere of confined spaces before entry, and to conduct periodic testing. When hazardous atmosphere is detected during periodic testing, he is to alert entrants inside the confined space to vacate the space immediately.

f) Authorised Manager

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A person who has overall control of all the work carried out in a confined space at a workplace. His duties include issuing and revoking entry permits, ensuring that confined spaces have been rendered as far as practicable free of hazards for safe entry and work, and that measures have been taken to eliminate or control the risk(s) identified in risk assessment conducted. It is necessary for him to review and assess the need to continue confined space work on a daily basis.

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Mechanical and Electrical Hazards
WSH (General Provisions) Regulations 2006

Prime movers

11. Subject to regulation 13, it shall be the duty of the occupier of a workplace to ensure that in every workplace where a prime mover is used, every flywheel connected to the prime mover and every moving part of the prime mover is securely fenced, whether the flywheel or prime mover is situated in the engine house or not.

Electric generator, motor, transmission machinery, etc.

12. —(1) Subject to regulation 13, it shall be the duty of the occupier of a workplace to ensure that every dangerous part (including any flywheel) of any electric generator, motor, transmission machinery or other machinery in the workplace is securely fenced unless the dangerous part of the generator, motor or machinery

(a) is in such a position or of such construction as to be safe to every person at work in the workplace as it would be if securely fenced; or

(b) is made safe for persons at work in the workplace by other effective means which will protect the persons from being injured by the dangerous part when that part is in motion or in use.

(2) It shall be the duty of the occupier of a workplace to ensure that in any room or place in the workplace where transmission machinery is used, there is provided and maintained efficient devices or appliances in that room or place by which the power can promptly be cut off from the transmission machinery.

(3) Without prejudice to the generality of paragraph (1), it shall be the duty of the occupier of a workplace to ensure that any part of a stock-bar used in a workplace which projects beyond the headstock of a lathe is securely fenced or is otherwise made safe to every person at work in the workplace.

Removal of fencing from machinery

13. —(1) Subject to paragraph (2), the fencing or other effective means referred to in regulations 11 and 12 (1) which are used to render machinery safe may be removed to such extent as is necessary when

(a) a person is carrying out in the workplace, while the part of machinery is in motion

(i) any examination of the machinery or part of the machinery; or

(ii) any lubrication or adjustment shown by such examination to be immediately necessary, being an examination, a lubrication or an adjustment which is necessary to be carried out while the part of machinery is in motion; or

(b) a person is carrying out in the workplace any lubrication or any mounting or shifting of belts in respect of any part of a transmission machinery and if

(i) the Commissioner has determined that, owing to the continuous nature of such process, the stopping of that part would seriously interfere with the carrying on of the process in the workplace; and

(ii) the lubrication or mounting or shifting of belts is carried out by such methods and in such circumstances and subject to such conditions as the Commissioner may determine.

(2) Paragraph (1) shall only apply where

(a) the relevant examination, lubrication or other operation is carried out by a person who

(i) has attained the age of 18 years;

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(ii) has been trained to carry out, and is acquainted with the dangers of moving machinery connected with the relevant examination, lubrication or other operation; and

(iii) is wearing clothing which has no loose ends and which is fastened by means having no exposed loose ends;

(b) another person, instructed as to the steps to be taken in case of an emergency, is immediately available within sight or hearing of the person carrying out the relevant examination, lubrication or other operation; and

(c) any ladder or work platform in use for the carrying out of the relevant examination, lubrication or other operation is securely fixed or lashed, or is firmly held by a person stationed at the foot of the ladder.

Electrical installation and equipment

14. —(1) It shall be the duty of the occupier of a workplace to ensure that every electrical installation and electrical equipment in the workplace

(a) is of good construction, sound material and free from defects; and

(b) is used and maintained in such manner so that it is safe to use.

(2) It shall be the duty of the occupier of a workplace to ensure that all reasonably practicable measures are taken to protect any person against the risks of electric shock arising from or in connection with the use at work of any electrical installation or equipment in the workplace.

Construction and maintenance of fencing or other safeguards

15. —(1) It shall be the duty of the occupier of a workplace to ensure that all fencing or other safeguards required to be provided for the purposes of regulations 11 and 12 are

(a) of substantial construction;

(b) properly maintained; and

(c) kept in position and properly adjusted to render the machinery safe for any person while the parts required to be fenced or safeguarded are in motion or in use.

(2) Paragraph (1) (*c*) shall not apply where

(a) the parts mentioned in that paragraph are necessarily exposed in motion for examination and for any lubrication or adjustment shown by such examination to be immediately necessary; and

(b) all the conditions specified in regulation 13 (2) are complied with.

Lock-out procedures

16. —(1) It shall be the duty of the occupier of a workplace to establish and implement lock-out procedures relating to the inspection, cleaning, repair or maintenance of any plant, machinery, equipment or electrical installation in the workplace that, if inadvertently activated or energised, is liable to cause bodily injury to any person.

(2) It shall be the duty of the occupier of a workplace to ensure that every person carrying out any inspection, cleaning, repair or maintenance of any plant, machinery, equipment or electrical installation in the workplace is fully instructed on the lock-out procedures for that work before commencing that work.

(3) In this regulation, "lock-out procedures" means a set of procedures

(a) to ensure that all energy sources to the relevant plant, machinery, equipment or electrical installation are isolated, disconnected or discharged; and

(b) to prevent any part of the plant, machinery, equipment or electrical installation from being inadvertently activated or energised.

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Identification of Mechanical hazards

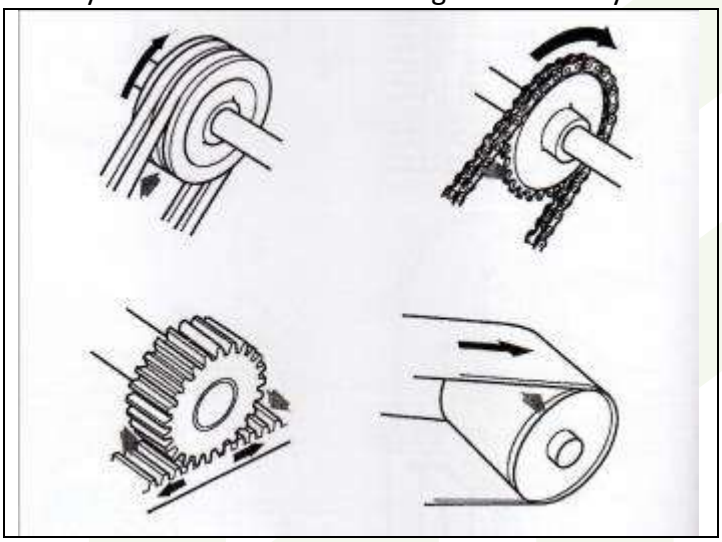
Movement of machinery parts basically consists of rotary, sliding or reciprocating motion or combination of the aforesaid movements. These movements can cause injury by entanglement, friction or abrasion, cutting, shearing, stabbing or puncture, impact, crushing or drawing a person into a position where one or more of these types of injury can occur.

Mechanical hazards may include:

a) Contact or entanglement with machinery
b) Trapping between machine and material or fixed structures
c) Contact or entanglement with material in motion
d) Struck by ejected parts of machinery
e) Struck by material ejected from machinery or pressurised system
f) Struck by compressed air or fluids from pressurised system

Entanglement

Bodily contact with the following features may lead to entanglement:



Drawing in hazards between rotating and tangentially moving surfaces

Controls for Mechanical hazards

Entanglement hazards may be reduced by

- reducing speed or distance of movement
- avoiding projections and recesses
- restricting force, torque and inertia and
- having smooth polished surfaces
- installing guards.

Friction and abrasion can also be reduced by

- reducing speed or distance of movement
- restricting force, torque and inertia and
- having surfaces as smooth as possible.
- Installing guards

Cutting hazards can be reduced by

- reducing speed or distance of movement
- restricting force, torque and inertia and
- increasing corner radii on machine parts.

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- Installing guards

Control mechanism

Control levels or knobs should be so positioned such that the operator need not have to over stretch or moved from his normal working position.

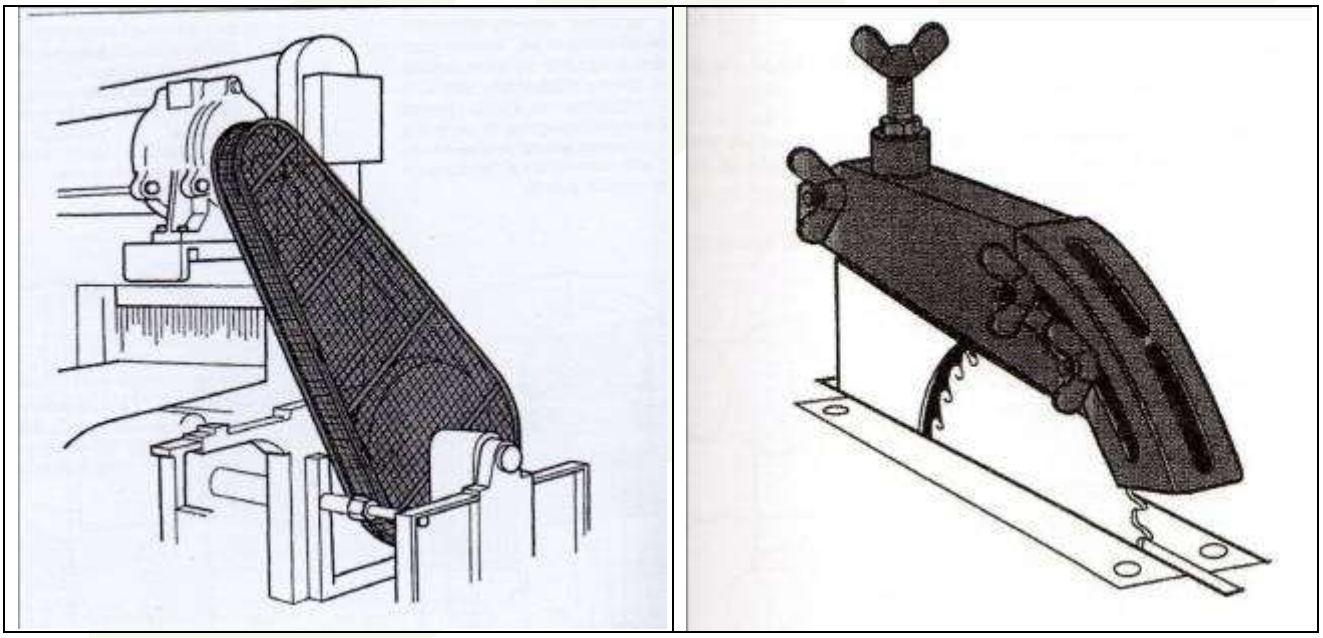
They should be clearly identifiable and readily distinguishable from each other by varying their separation, size, shape, colour or feel. They should also be clearly labelled to identify the function or consequence of use of the control. For example, the operating handle for a cross slide automatic feed should be separated from the handle of a traversing feed. Start button or pedal should be guarded against accidental operation.

The direction of movement of control should correspond with the direction of motion being controlled. A lever requiring movement towards or away from the operator should result in corresponding movement of the moving part. For example, where a handle or hand wheel controls a sliding part, clockwise rotation should direct movement away from the operator, to his right or in an upward direction.

Warning signals

Where malfunction of machinery can creates a hazardous situation, suitable warning signals should be provided. These signals should be preferably be given automatically and should be both audible and visual.

Guards



Fixed guard

Adjustable guard

Emergency stopping devices

Where these are used, they are not a substitute to effective guarding. They are however practical mechanical hazard reduction measures when guards cannot be installed on the machinery, for example on a conveyor belt.

Emergency stop buttons should be of the mushroom head type and colour RED with a yellow background. The push buttons and switches should be of the lock in type so that the machinery cannot be started again until they have been reset manually.

Emergency stop pull cords and pressure sensitive cable devices

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Such cords and cables should be located in such manner as to be clearly visible, readily accessible and so positioned that they can be operated only at the operator's normal position.

Maintenance of safeguards

There should be a regular inspection of safeguards to ensure that the requisite standard of safety is maintained. Competent personnel should carry out the inspection and testing program.

Danger of Electricity

Dangers of Electricity include a variety of hazards that include Electric Shock, Physical Burns, Neurological Damage and Ventricular fibrillation resulting in death.

Any form of energy, when not properly controlled or harnessed, can result in serious danger to those who use it. The risks inherent with electric power can generally be divided into two categories: direct and indirect. The direct danger is the damage that the power itself can do to the human body, such as stoppage of breathing or regular heartbeats, or burns. The indirect dangers of electricity include the damages that can result to the human body as a result of something caused by electric shock, such as a fall, an explosion, or a fire.

Electricity at any voltage can be dangerous and should always be approached with caution. An electric shock can occur upon contact of a human or animal body with any source of voltage high enough to cause sufficient current flow through the muscles or nerves. The minimum current a human can feel is thought to be about 1 milliampere (mA). As little as 80 milliampere, can seize the heart muscle. The current may cause tissue damage or heart fibrillation if it is sufficiently high. A fatal electric shock is referred to as electrocution.

Burns

Dangers of Electricity include physical burns. High-voltage (> 500 to 1000 V) shocks tend to cause internal burns due to the large energy (which is proportional to the duration multiplied by the square of the voltage) available from the source. Damage due to current is through tissue heating. In some cases 16 volts might be fatal to a human being when the electricity passes through organs such as the heart.

Ventricular fibrillation

A low-voltage (110 to 220 V), 50 or 60-Hz AC current travelling through the chest for a fraction of a second may induce ventricular fibrillation at currents as low as 60mA. With DC, 300 to 500 mA is required. If the current has a direct pathway to the heart (e.g., via a cardiac catheter or other kind of electrode), a much lower current of less than 1 mA, (AC or DC) can cause fibrillation. Fibrillations are usually lethal because all the heart muscle cells move independently. Above 200mA, muscle contractions are so strong that the heart muscles cannot move at all.

Neurological effects

Other Dangers of Electricity cause interference with nervous control, especially over the heart and lungs. Repeated or severe electric shock which does not lead to death has been shown to cause neuropathy.

When the current path is through the head, it appears that, with sufficient current, loss of consciousness almost always occurs swiftly.

Arc Flash

Arc flash and arc blast will always be present on the job, but proper awareness, training and the development of arc flash safety personal protection strategies can minimize the likelihood of injury and fatality.

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Electricity: The Basics

What affects the flow of electricity?

Electricity flows more easily through some materials than others. Some substances such as metals generally offer very little resistance to the flow of electric current and are called " conductors." A common but perhaps overlooked conductor is the surface or subsurface of the earth. Glass, plastic, porcelain, clay, pottery, dry wood, and similar substances generally slow or stop the flow of electricity. They are called " insulators." Even air, normally an insulator, can become a conductor, as occurs during an arc or lightning stroke.

How does water affect the flow of electricity?

Pure water is a poor conductor. But small amounts of impurities in water like salt, acid, solvents, or other materials can turn water itself and substances that generally act as insulators into conductors or better conductors. Dry wood, for example, generally slows or stops the flow of electricity. But when saturated with water, wood turns into a conductor. The same is true of human skin. Dry skin has a fairly high resistance to electric current. But when skin is moist or wet, it acts as a conductor. This means that anyone working with electricity in a damp or wet environment needs to exercise extra caution to prevent electrical hazards.

What causes shocks?

Electricity travels in closed circuits, normally through a conductor. But sometimes a person's body -- an efficient conductor of electricity -- mistakenly becomes part of the electric circuit. This can cause an electrical shock. Shocks occur when a person's body completes the current path with:

- both wires of an electric circuit;
- one wire of an energized circuit and the ground;
- a metal part that accidentally becomes energized due, for example, to a break in its insulation; or
- another "conductor" that is carrying a current.

When a person receives a shock, electricity flows between parts of the body or through the body to a ground or the earth.

What effect do shocks have on the body?

An electric shock can result in anything from a slight tingling sensation to immediate cardiac arrest. The severity depends on the following:

- the amount of current flowing through the body,
- the current's path through the body,
- the length of time the body remains in the circuit, and
- the current's frequency.

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This table shows the general relationship between the amount of current received and the reaction when current flows from the hand to the foot for just 1 second.

Effects of Electric Current in the Human Body

Current	Reaction
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6–25 milliamperes (women)	Painful shock, loss of muscular control*
9–30 milliamperes (men)	The freezing current or "let-go" range.* Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
50–150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000–4,300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death probable

* If the extensor muscles are excited by the shock, the person may be thrown away from the power source.

What kind of burns can a shock cause?

Burns are the most common shock-related injury. An electrical accident can result in an electrical burn, arc burn, thermal contact burn, or a combination of burns.

Electrical burns are among the most serious burns and require immediate medical attention. They occur when electric current flows through tissues or bone, generating heat that causes tissue damage.

Arc or flash burns result from high temperatures caused by an electric arc or explosion near the body. These burns should be treated promptly.

Thermal contact burns are caused when the skin touches hot surfaces of overheated electric conductors, conduits, or other energized equipment. Thermal burns also can be caused when clothing catches on fire, as may occur when an electric arc is produced.

In addition to shock and burn hazards, electricity poses other dangers. For example, arcs that result from short circuits can cause injury or start a fire. Extremely high-energy arcs can damage equipment, causing fragmented metal to fly in all directions. Even low-energy arcs can cause violent explosions in atmospheres that contain flammable gases, vapors, or combustible dusts.

Why do people sometimes "freeze" when they are shocked?

When a person receives an electrical shock, sometimes the electrical stimulation causes the

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muscles to contract. This " freezing" effect makes the person unable to pull free of the circuit. It is extremely dangerous because it increases the length of exposure to electricity and because the current causes blisters, which reduce the body's resistance and increases the current.

The longer the exposure, the greater the risk of serious injury. Longer exposures at even relatively low voltages can be just as dangerous as short exposures at higher voltages. Low voltage does not imply low hazard.

In addition to muscle contractions that cause " freezing," electrical shocks also can cause involuntary muscle reactions. These reactions can result in a wide range of other injuries from collisions or falls, including bruises, bone fractures, and even death.

What should you do if someone" freezes" to a live electrical contact?

If a person is "frozen" to a live electrical contact, shut off the current immediately. If this is not possible, use boards, poles, or sticks made of wood or any other non-conducting materials and safely push or pull the person away from the contact. It's important to act quickly, but remember to protect yourself as well from electrocution or shock.

How can you tell if a shock is serious?

A severe shock can cause considerably more damage than meets the eye. A victim may suffer internal hemorrhages and destruction of tissues, nerves, and muscles that aren't readily visible. Renal damage also can occur. If you or a coworker receives a shock, seek emergency medical help immediately.

What is the danger of static electricity?

Electrostatic charge is generated whenever there is friction between 2 bodies moving relative to one another.

Charge generation occurs in liquid systems on the molecular level at the interface of any 2 unlike materials, so a static charge will be generated in any moving fluid, with positive or negative charges moving from the fluid onto the bounding surface.

The causes of electrostatic charge generating include the following examples:

- Friction caused by fluid flowing in pipes
- High fluid velocities
- Fluids flowing in ungrounded pipes and hoses
- Passage of fluids through filter elements or other microporous structures
- Generated by turbulence in the liquids and by pumping elements, especially centrifugal pumps
- Fluid discharging on to the free surface of the reservoir
- When free air is present in the liquid, for example, in bearing and paper machine return lines
- Imparted into the liquid when component surfaces sliding is relative to one another

Fluid acquires a charge when it flows through a pipe or microporous structure, and when this charge is carried downstream, it’s called a streaming current

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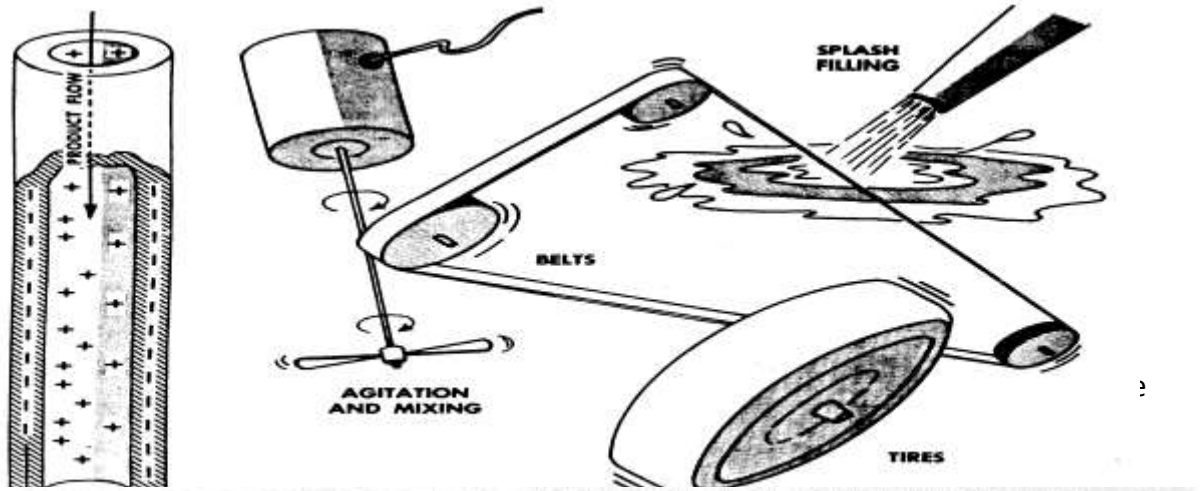
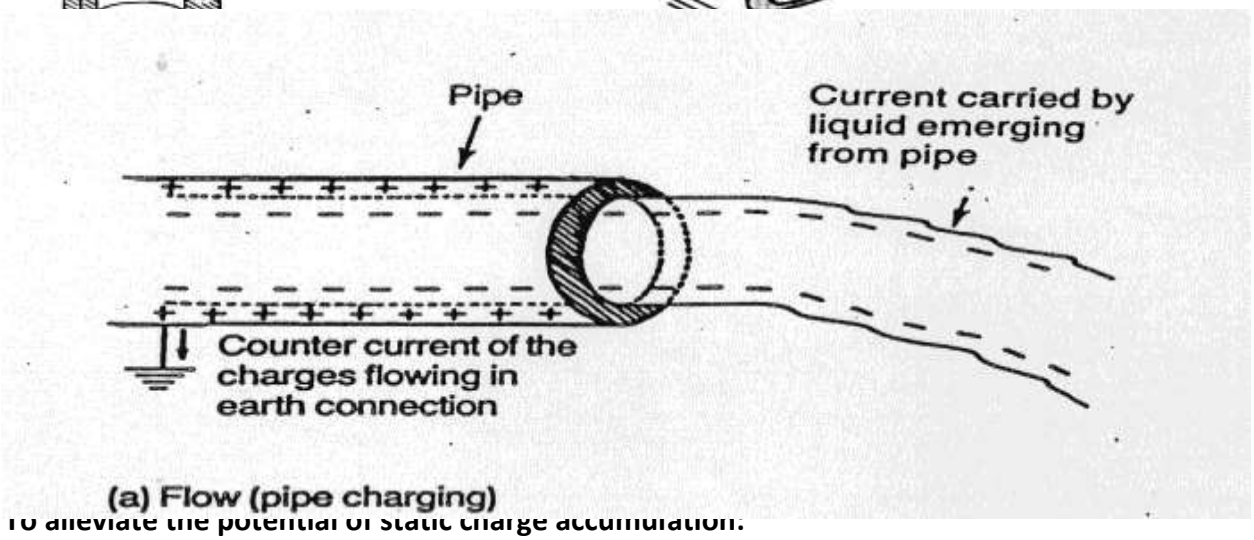
Protection Against Electrical Hazards

In pipeline flow, the streaming current will be discharged back to the pipe walls, reservoir or component surfaces, and the discharge rate is controlled by the characteristics of the fluid and its additives.
If the exterior surface is grounded, the net charge will be zero.
If not, the charge will accumulate and eventually generate an electrostatic discharge where the charge discharges to a surface at lower voltage. Resultant of a high-energy spark.

Generation of static electricity





To alleviate the potential of static charge accumulation:

- ✓ Use antistatic additive to increase the fluid conductivity, thereby accelerating the rate of charge relaxation. Antistatic additives have been successfully used in fuel systems but have

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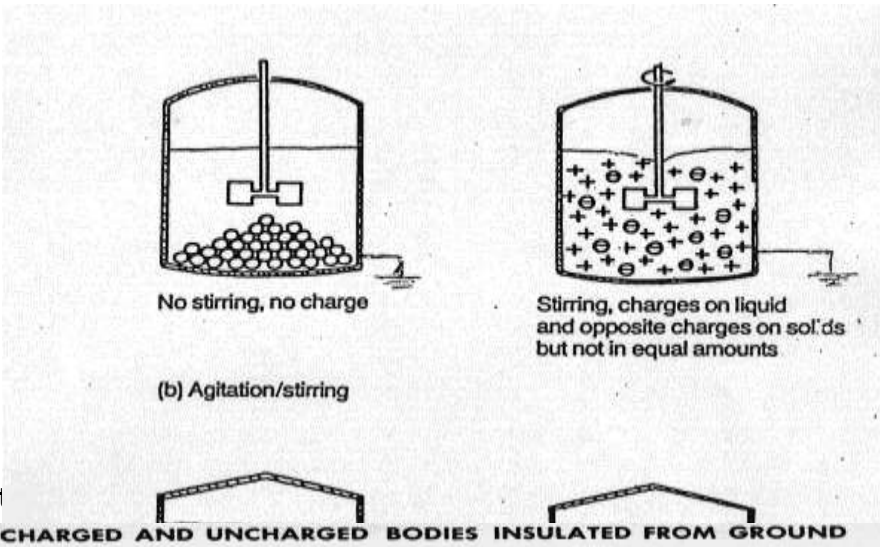
not been approved by oil manufacturers for use in hydraulic and lube systems. Additives on the market are intended for fuel systems only.

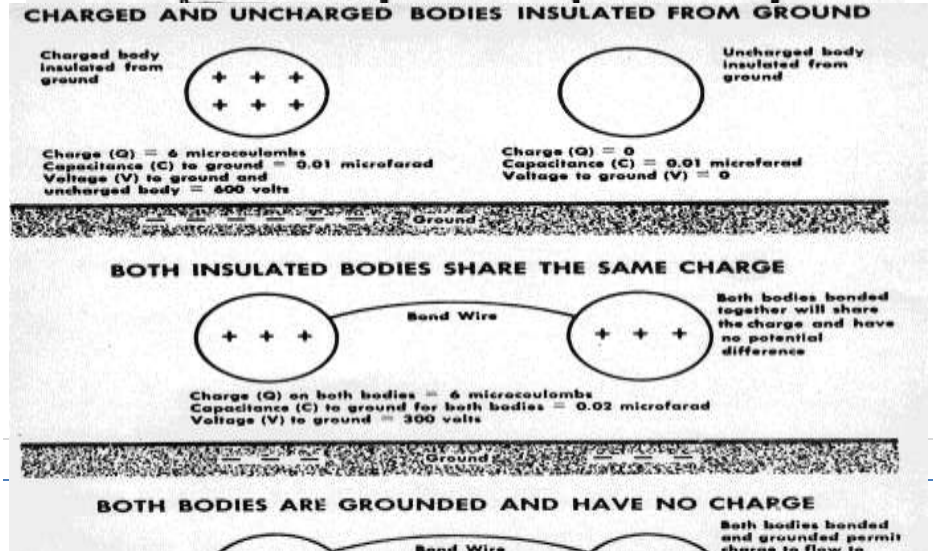
- ✓ Reduce the charge exiting the filter by adding a conductive mesh (grounding) downstream of the filter material which discharges some of the filter material's charge.
- ✓ Reduce the flow density in the filter material by increasing the filter size. This will reduce the charge generated, as it is a function of flow density, and is perhaps the easiest of these options.
- ✓ Increase the time for the charge to decay. This will necessitate an increase in the time between successive charge generators by additional piping or increase the overall system time constant using an extra reservoir. This is an effective but costly solution.

Protection against static discharge by

- Control humidity
- Antistatic additive
- Adding a conductive mesh (grounding) downstream of the filter material
- Increasing the filter size, reduce the flow density
- Increase the time for the charge to decay (Settling time)



St … between flanges



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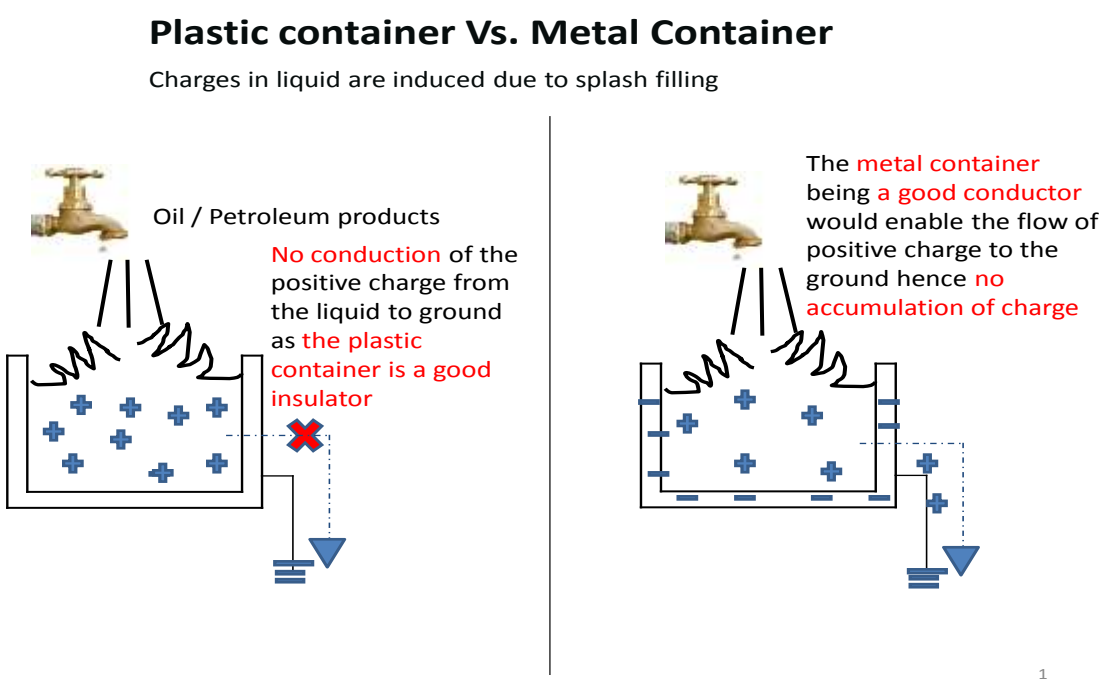

What is the best way to protect yourself against electrical hazards?

Most electrical accidents result from one of the following three factors:

- unsafe equipment or installation,
- unsafe environment, or
- unsafe work practices.

Some ways to prevent these accidents are through the use of insulation, guarding, grounding, electrical protective devices, and safe work practices.

What protection does insulation provide?

Insulators such as glass, mica, rubber, or plastic used to coat metals and other conductors help stop or reduce the flow of electrical current. This helps prevent shock, fires, and short circuits. To be effective, the insulation must be suitable for the voltage used and conditions such as temperature and other environmental factors like moisture, oil, gasoline, corrosive fumes, or other substances that could cause the insulator to fail.

How do you identify different types of insulation?

Insulation on conductors is often color coded. Insulated equipment grounding conductors usually are either solid green or green with yellow stripes. Insulation covering grounded conductors is generally white or gray. Ungrounded conductors, or "hot wires," often are black or red, although they may be any color other than green, white, or gray.

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Before connecting electrical equipment to a power source, it's a good idea to check the insulation for any exposed wires for possible defects. Insulation covering flexible cords such as extension cords is particularly vulnerable to damage.

What is guarding and what protection does it offer?

Guarding involves locating or enclosing electric equipment to make sure people don't accidentally come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where it is accessible only to authorized people qualified to work with it. Recommended locations are a room, vault, or similar enclosure; a balcony, gallery, or elevated platform; or a site elevated 8 feet (2.44 meters) or more above the floor. Sturdy, permanent screens also can serve as effective guards.

Conspicuous signs must be posted at the entrances to electrical rooms and similarly guarded locations to alert people to the electrical hazard and to forbid entry to unauthorized people. Signs may contain the word " Danger," " Warning," or " Caution," and beneath that, appropriate concise wording that alerts people to the hazard or gives an instruction, such as " Danger/High Voltage/Keep Out."

What is grounding and what protection does it offer?

"Grounding" a tool or electrical system means intentionally creating a low-resistance path that connects to the earth. This prevents the buildup of voltages that could cause an electrical accident.

Grounding is normally a secondary protective measure to protect against electric shock. It does not guarantee that you won't get a shock or be injured or killed by an electrical current. It will, however, substantially reduce the risk, especially when used in combination with other safety measures discussed in this booklet.

A *service* or *system ground* is designed primarily to protect machines, tools, and insulation against damage. One wire, called the " neutral" or " grounded" conductor, is grounded. In an ordinary low-voltage circuit, the white or gray wire is grounded at the generator or transformer and at the building's service entrance.

An *equipment ground* helps protect the equipment operator. It furnishes a second path for the current to pass through from the tool or machine to the ground. This additional ground safeguards the operator if a malfunction causes the tool's metal frame to become energized. The resulting flow of current may activate the circuit protection devices.

What are circuit protection devices and how do they work?

Circuit protection devices limit or stop the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. Well-known examples of these devices are fuses, circuit breakers, ground-fault circuit interrupters, and arc-fault circuit interrupters.

Fuses and *circuit breakers* open or break the circuit automatically when too much current flows through them. When that happens, fuses melt and circuit breakers trip the circuit open. Fuses and circuit breakers are designed to protect conductors and equipment. They prevent wires and other

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components from overheating and open the circuit when there is a risk of a ground fault.

Ground-fault circuit interrupters, or ELCBs, are used in wet locations, construction sites, and other high-risk areas. These devices interrupt the flow of electricity within as little as 1/40 of a second to prevent electrocution. ELCBs compare the amount of current going into electric equipment with the amount of current returning from it along the circuit conductors. If the difference exceeds 5 milliamperes, the device automatically shuts off the electric power.

Arc-fault devices provide protection from the effects of arc-faults by recognizing characteristics unique to arcing and by functioning to deenergize the circuit when an arc-fault is detected.

What work practices help protect you against electrical hazards?

Electrical accidents are largely preventable through safe work practices. Examples of these practices include the following:

- de-energizing electric equipment before inspection or repair,
- keeping electric tools properly maintained,
- exercising caution when working near energized lines, and
- using appropriate protective equipment.

What work practices help protect you against electrostatic hazards?
Protection against static discharge by

- Control humidity
- Antistatic additive
- Adding a conductive mesh (grounding) downstream of the filter material
- Increasing the filter size, reduce the flow density
- Increase the time for the charge to decay (Settling time)
- Increasing the filter size, reduce the flow density

How can you protect yourself against metal parts that become energized?

A break in an electric tool's or machine's insulation can cause its metal parts to become "hot" or energized, meaning that they conduct electricity. Touching these energized parts can result in an electrical shock, burn, or electrocution. The best way to protect yourself when using electrical tools or machines is to establish a low-resistance path from the device's metallic case to the ground. This requires an equipment grounding conductor, a low-resistance wire that directs unwanted current directly to the ground. A properly installed grounding conductor has a low resistance to ground and greatly reduces the amount of current that passes through your body. Cord and plug equipment with a three-prong plug is a common example of equipment incorporating this ground conductor.

Another form of protection is to use listed or labeled portable tools and appliances protected by an approved system of double insulation or its equivalent. Where such a system is employed, it must be marked distinctively to indicate that the tool or appliance uses an approved double insulation system.

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How can you prevent an accidental or unexpected equipment startup?

Proper lockout/tagout procedures protect you from the dangers of the accidental or unexpected startup of electrical equipment and are required for WSH regulations and CP 91 on Lock out and Tag out. These procedures ensure that electrical equipment is de-energized before it is repaired or inspected and protects you against electrocution or shock.

The first step before beginning any inspection or repair job is to turn the current off at the switch box and padlock the switch in the OFF position. This applies even on so-called low-voltage circuits. Securely tagging the switch or controls of the machine or equipment being locked out of service clarifies to everyone in the area which equipment or circuits are being inspected or repaired.

Only qualified electricians who have been trained in safe lockout procedures should maintain electrical equipment. No two of the locks used should match, and each key should fit just one lock. In addition, one individual lock and key should be issued to each maintenance worker authorized to lock out and tag the equipment. All employees who repair a given piece of equipment should lock out its switch with an individual lock. Only authorized workers should be permitted to remove it.

How can you protect yourself from overhead power lines?

Before working under or near overhead power lines, ensure that you maintain a safe distance to the lines and, for very high-voltage lines, ground any equipment such as cranes that can become energized. If working on power lines, ensure that the lines have been de-energized and grounded by the owner or operator of the lines. Other protective measures like guarding or insulating the lines help prevent accidental contact.

Employees unqualified to work with electricity, as well as mechanical equipment, should remain at least 10 feet (3.05 meters) away from overhead power lines. If the voltage is more than 50,000 volts, the clearance increases by 4 inches (10 centimeters) for each additional 10,000 volts.

When mechanical equipment is operated near overhead lines, employees standing on the ground should avoid contact with the equipment unless it is located outside the danger zone. When factoring the safe standoff distance, be sure to consider the equipment's maximum reach.

What protection does personal equipment offer?

Employees who work directly with electricity should use the personal protective equipment required for the jobs they perform. This equipment may include rubber insulating gloves, hoods, sleeves, matting, blankets, line hose, and industrial protective helmets designed to reduce electric shock hazard. All help reduce the risk of electrical accidents.

Why tools need to be regularly checked and inspected?

Appropriate and properly maintained tools help protect workers against electric hazards. It's important to maintain tools regularly because it prevents them from deteriorating and becoming dangerous. Check each tool before using it. If you find a defect, immediately remove it from service and tag it so no one will use it until it has been repaired or replaced.

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When using a tool to handle energized conductors, check to make sure it is designed and constructed to withstand the voltages and stresses to which it has been exposed.

What special training do employees need?

All electricians should be trained to be thoroughly familiar with the safety procedures for their particular jobs. Moreover, good judgment and common sense are integral to preventing electrical accidents. When working on electrical equipment, for example, some basic procedures to follow are to:

- de-energize the equipment,
- use lockout and tag procedures to ensure that the equipment remains de-energized,
- use insulating protective equipment, and
- maintain a safe distance from energized parts.

What's the value of a safety and health program in controlling electrical hazards?

Every good safety and health program provides measures to control electrical hazards. The measures suggested in this booklet should be helpful in establishing such a program. The responsibility for this program should be delegated to someone with a complete knowledge of electricity, electrical work practices, and the appropriate WSH standards for installation and performance.

Everyone has the right to work in a safe environment. Safety and health add value to your business and your workplace. Through cooperative efforts, employers and employees can learn to identify and eliminate or control electrical hazards.

Salient points of Code of Practice CP88 Part 1

The CP 88:2001 is the code of practice for temporary electrical installations in construction and building worksites.

Compliance with this CP is mandatory for temporary electrical installations for building operations and works of engineering construction under the WSH (Building Operations and Works of Engineering Construction) Regulations as well as the Electricity (Electrical Installations) Regulations.

Furthermore, the WSH (General Provisions) Regulations stipulates that it shall be the duty of the occupier of a worksite to ensure that every electrical installation and electrical equipment in his worksite is of good construction, sound material and free from defects; and is used and maintained in such manner so that it is safe for use. The occupier shall also take all reasonably practicable measures to protect any person against the risks of electric shock arising from or in connection with the application of any electrical installation or equipment at work.

Supply for equipment:

The following voltages shall not be exceeded:

a	Fixed plant, moveable plant fed via trailing cable, installation in site buildings such as site offices, workshops, canteens and quarters, fixed flood lighting and site lighting	400V 230V	Three-phase Single-phase
b	Portable electric hand held tools and portable hand lamps	230V	Single-phase
c	Portable electric hand tools and portable hand lamps used underground such as any shaft, tunnel, caisson or cofferdam	110V	Single-phase, centre point earthed
d	Portable electric hand tools and portable hand lamps used in	50V	Single-phase,

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	confined locations such as insides of boilers, tanks or pipes		centre point earthed

Protection for safety: control of supply

Every electrical installation on construction sites shall be adequately controlled by switchgear readily accessible to the skilled person or his authorised representative in charge of the installation and shall incorporate:

(a) Means of isolations

(b) Means of overcurrent and earth protection and

(c) Means of earth leakage protection (except extra low voltage installations)

Prohibited use of fuses for final circuits

Fuses shall not be used for protecting final circuit circuits in any part of the installation, except for those socket outlets incorporated with fuse protection.

Protection against direct contact

One or more of the following basic protective measure shall be used in accordance with the requirements in SS CP 5:

(a) Protection by insulation of live parts

(b) Protection by a barrier or an enclosure

(c) Protection by obstacles

(d) Protection by placing out of reach

Protection by Residual Current Device for final circuits

Residual current circuit breaker (RCCB) with a tripping current not exceeding 30mA and a tripping time within 0.1 sec complying with SS97 for final circuits of rating not exceeding 63A three- phase or single- phase at main voltage.

Protective earthing of metalwork

Metalwork not belonging to the installation including steel scaffolding which is liable to come into fortuitous contact and become live in event of a failure of insulation of the installation shall be effectively earthed at all times.

Portable hand lamps

Portable hand lamps supplied through flexible cords shall be of the moulded composition for the purpose and equipped with a handle. Hand lamps shall be also be equipped with substantial guard attached to the lamp holder or handle.

Electrical welding system

Every a.c. welding set must be equipped with low voltage shock preventor. The preventor shall effectively reduce the open circuit secondary voltage to a safe level not exceeding 25V.

Socket-Outlet Assembly (SOA)

One of the key recommended practices in the CP 88 is the use of socket outlet assembly (SOA). The SOA enables users to tap power supply safely at the location where work is to be carried out, thus avoiding the need to run long trailing wires for each appliance. The SOA can be metal or plastic cabinet or a portable box in which the various electrical protective devices are housed. It is typically equipped with up to 9 single-phase industrial socket outlets or up to 3 three-phase socket outlets. SOA can also have the combination of 3 single-phase socket outlets and 3 three phase socket outlets.

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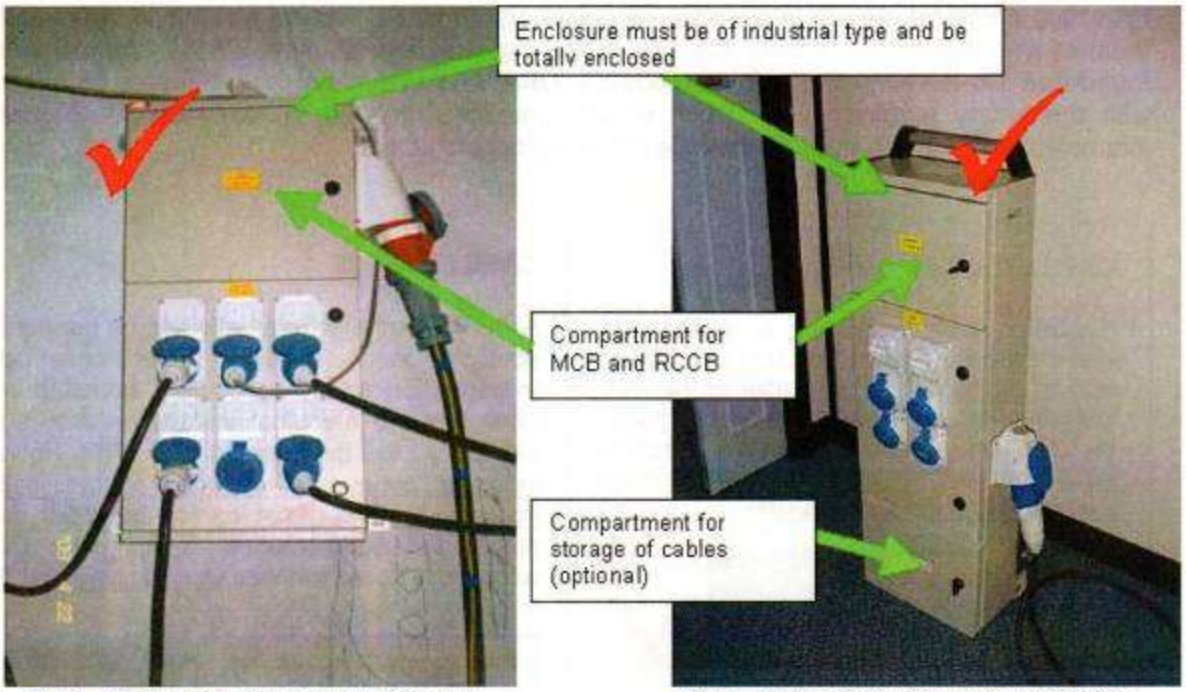

Fig. 5 – This photograph shows a typical wall mounted SOA.

Fig. 6 – This photograph shows a typical floor standing SOA

These industrial socket outlets allow for the connection of portable electrical equipment such as electrical hand tools, lamps, and water pumps, etc.
Thus it is necessary for each and every piece of portable electrical equipment to be connected up using only industrial plug. This enables the equipment to be plugged directly into the industrial socket outlet fitted on the SOA.
The SOA has to be manufactured in accordance with the requirements of CP88. It can be designed for wall mounting or fitted with castors s that it can be moved around in the worksite.
The purpose of SOA is to ensure a more systematic and safe approach in the set up of temporary electrical installations at worksite.
Providing electrical supply to portable electrical equipment on an ad-hoc basis in a haphazard manner used to be a common unsafe practice in the construction industry. Very often, it was also found that 'DIY' or do-it-yourself distribution boards (DBs) and extension socket outlets do not comply with safety requirements. Such unsafe practices had led to many electrical accidents, examples of which are illustrated by the following case studies:

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CASE STUDY #1

A worker, while positioning a water pump, was electrocuted when he came into contact with an exposed 'live' conductor at the PVC insulation taped joint of the water pump. Investigation revealed that the electrical installation was not protected by a Residual Current Circuit Breaker (**RCCB**).

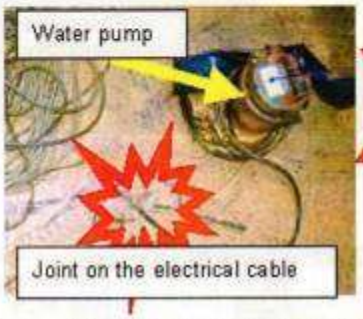

Fig. 2 – This photograph shows the water pump and the PVC insulation taped joint (joint was opened up for investigation).

Fig. 3 – This photograph shows a typical connection commonly found at worksite that caused the accident.

CASE STUDY #2

A worker was electrocuted when he handled a lit spotlight in a building under construction. Investigation into the accident revealed many faults on the electrical installation that supply electricity to the spotlight. This includes incorrect connection of wires to the isolator, improper jointing of cables and improper use of plugs and socket-outlets. To make matter worse, the deceased was working on a wet floor.

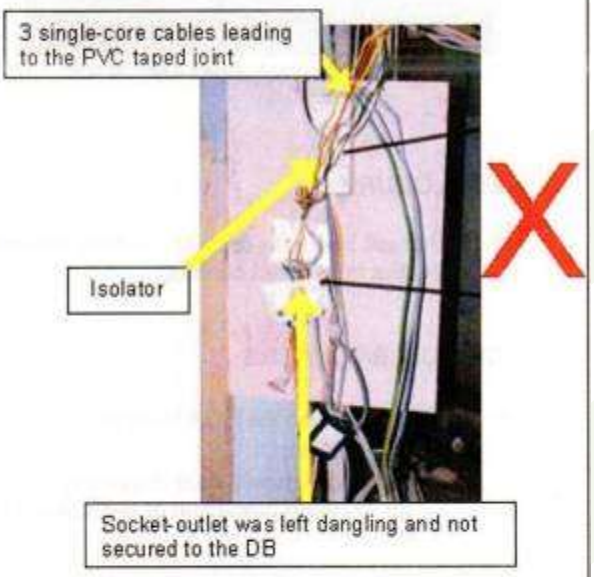

Fig. 4 – This photograph shows DB that was poorly constructed. The electrical installation was not effectively earthed. The socket-outlet was found to be defective.

The above examples show that haphazard unsafe temporary electrical installations using makeshift DB, extension socket outlets and cables can lead to accident. Such accidents could be prevented if SOAs had been used..

Key features of SOA:

- SOA must be totally enclosed with all live parts protected from direct contact.
- Socket outlets must be incorporated with Miniature Circuit Breakers (MCB) for overload protection
- Socket outlets must be incorporated with Residual Current Circuit Breaker (RCCB) for earth leakage protection.

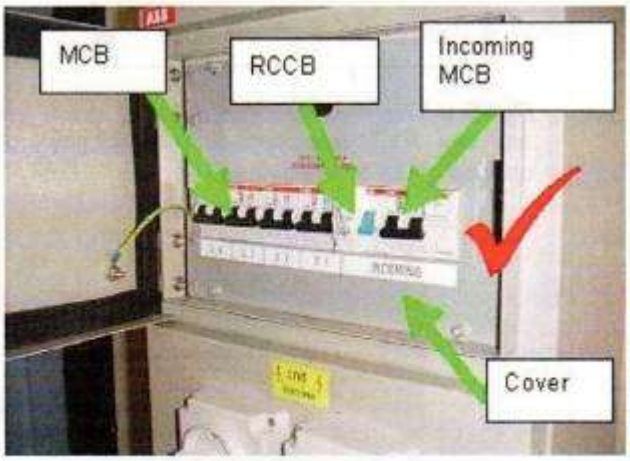

Fig. 7 – This photograph shows the circuit breaker inside the SOA.

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- All plugs, socket outlets and cable couplers likely to be exposed to the weather shall be contained in a weatherproof enclosure unless they are of the weatherproof type in compliance with IEC60309.
- All industrial plugs, socket outlets and cable couplers must be identified by different colour as given in the table below

Operating Voltage (V)	Colour	Examples
55	White	
110	Yellow	
230	Blue	
400	Red	

- Flexible cables used for portable electrical equipment such as hand held tools must not exceed 3 metres or such other length as supplied by manufacturer.
- All SOA for connection of any portable electrical equipment at worksites must be constructed in compliance with CP88: Part 1: 2001, Code of Practice for Temporary Electrical Installations for Construction and Building Sites.

• Multiple socket outlet adapter such as that shown in the figure below do not conform to any IEC standards and shall not be used. The use of such adapters can lead to overloading of the electrical circuit and electrocution.	

Inspection by Licensed Electrical Worker (LEW)

All temporary electrical installations (including SOA) have to be inspected and certified for use or operation by an appropriate class of LEW before connecting to the source of power supply. Thereafter the installation shall be inspected at least once a month by LEW. The inspection, testing and maintenance of the electrical installations must comply with the requirements of CP 88 Part1: 2001.

Procedural control (Logout and Tag out)

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The following steps shall be taken to achieve a safe energy isolation and machine (system) lockout. The recommended sequence shall be as follows:

(a) Announce the shut down. Inform all affected employees of the purpose and duration of the lockout application. This notification must be given before the lock out procedure is performed.

(b) Machine (System) shut down. The machine (system) must be shut down using the operating controls according to the shut down procedure for each individual machine (system) to avoid any additional or increased hazard. This is a safe practice as any attempt to shut down machine (system) under load risks damaging the machine (equipment).

(c) Machine (system) Isolation. All energy isolating devices that control the energy to the machine (system) must be operated to isolate the machine (system) from the energy source. The energy control procedure must also identify the location of all energy isolating devices and energy sources including secondary power supplies. This will ensure the safe and complete de-energisation of the machine (system).

(d) Lockout and tagging device application. The authorised employee is responsible for the application of proper lockout and tagging devices to the energy isolating devices of the machine (system). The authorised employee must use his own locks only and nobody is allowed to apply his locks on behalf of another individual, except for group lockout protection. The lockout devices must be sturdy and lockout the energy isolating devices in the "OFF" position. They must also be designed to prevent the operation of the energy isolating devices when they are lockout. If more than one person is working on the machine (system), every member of the crew must attach his personal lock and tag. Secure tags directly to the energy isolating devices. Each tag must be clearly visible, explaining the purpose of the lockout and warning against the hazard of operating the machine(system). It must also identify the person who affixed the tag and the date of lockout.

(e) Control of stored energy. Any residual stored energy in the machine(system) can be equally hazardous to the employee. The authorised employee must ensure that any stored energy is safely released before work begins. The following are examples of ways to control stored energy:

   a. Relieve trapped pressure downstream
   b. Discharge capacitor and install ground wire
   c. Release tension on spring or block movement of spring driven part
   d. Use block to prevent fall due to gravity and
   e. Use blank flange to block flow of hazardous materials if valve is not available

(f) Verify the energy isolation. The authorised employee must verify the isolation and de-energisation of the machine(system) before work begins. The following actions shall be accomplished after the lockout application to confirm the energy isolation:

   a. Operate the machine(system) "ON/OFF" switch both at the site and at the control panel to verify that the machine(system) is indeed not working and return all control; to the "OFF" or "NEUTRAL" position.
   b. Use appropriate instrument to verify that machine(system) is completely de-energised.

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Steps for start-up

The procedure for release of lockout is equally important after the construction, servicing and maintenance is completed. The following actions are required for safe start-up of machine (system) to ensure the safety of employees:

(a) The machine (system). Before restoring energy to the machine (system), the authorised employee must ensure that the work area is clear of all non essential items and all necessary components are operationally intact. For a complex machine (system), use a checklist to verify that all essential components are functional.

(b) Personnel. It should be ascertained that personnel are physically clear of the machine (system). Multiple personnel and energy source situations demand comprehensive measures to ensure that assigned work has been completed and all personnel have cleared the machine (system).

(c) Lockout and tagging devices removal. Inform all affected employees when the lockout devices are removed but before the machine (system) is energised. Only the authorised personnel who applied the lockout and tag are authorised to remove their own locks and tags. No other employees should attempt to remove another person's lockout.

(d) The lockout procedure should also have a provision for the removal of another person's lockout, in event that the individual is not present. This provision must ensure that the procedure taken is as safe as if the individual were present to remove his locks.

Shift or personnel changes

Specific procedure shall be followed during shift or personnel changes to ensure the continuity of lockout protection, including provision for the orderly transfer of lockout protection between outgoing and incoming employees, to minimise exposure to hazards from the unexpected energisation or start-up of the machine (system) or release of stored energy.

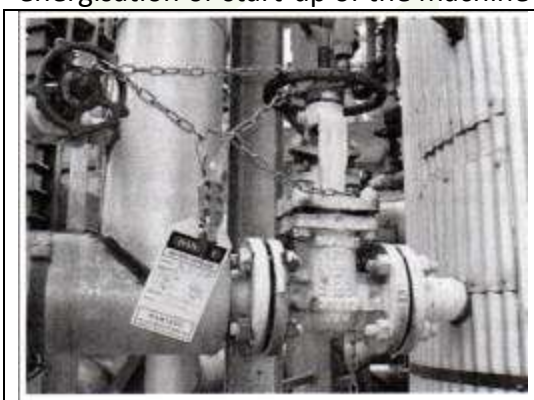

Figure 28 Example of valves and piping lockout

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Routine and repetitive minor adjustments

In the case of required repetitive minor adjustments where the machine (system) cannot be shut down and lockout or in the case of normal production operations, these activities shall be accomplished under the protection of specially designed control circuits, control interlock and safe work procedure that provide proven effective protection for the affected personnel.

Personal protection

Where live electrical current above 250V is the hazard, conductive and antistatic footwear must not be used. Where contact with electricity is likely, not only should helmets be of non-conducting material but they should also have no conductive fittings penetrating the shell.

Always wear dry hole-free **insulating** gloves to protect against or reduce electric shock. The welder should also wear rubber-soled shoes, and use an insulating layer, such as a dry board or a rubber mat, for protection on surfaces that can conduct electricity.

Rubber insulating gloves are among the most important PPE for electrical workers. Workers must avoid contact above 50 volts AC unless they are insulated with rubber gloves meeting the ASTM D120 standard (per OSHA 1910.137 (a)).

It is important to train workers to select gloves rated for their particular applications. For example, gloves may be selected that meet ASTM D120 standards for protection against circuits up to 500 volts AC (Class 00) or for protection against circuits up to 1,000 volts AC (Class 0). Similarly, gloves also are rated for use in applications where protection against higher voltages is required. Class 1 gloves can be used up to 7,500 volts AC, Class 2 up to 17,000 volts AC, Class 3 up to 26,500 volts AC, and Class 4 up to 36,000 volts AC.

Cotton glove liners may be used inside to absorb perspiration and to improve wearer comfort. Wool and thermal liners also are available for use in cold outdoor applications. Various styles of liners are offered by glove manufacturers.

Leather protector gloves should be worn over electrical insulating gloves to provide needed mechanical protection against abrasion or cuts. Even a small puncture in an electrical insulating glove will allow electrical current to reach the hand. Before purchasing a protector glove, make sure it complies with ASTM F696, which is required by OSHA. Also, it is important for the purchaser of the protector gloves to ensure there is enough clearance between the top of the protector gloves' cuffs and the top end of the beads of the rubber insulating gloves. ASTM F696 outlines specifications for the minimum clearance distances required.

All insulating gloves are recommended to be electrically tested every six months. There are several labs in the United States that perform the required testing. Glove manufacturers usually can assist with finding a test lab to meet your needs. In addition, gloves must be visually inspected before each use to check for tears, rips, and punctures. Portable glove inflators are available to simplify visual inspection.

Fire prevention

Electrical systems are designed for the various needs of the building occupant and have built in safety margins. As needs change and electrical equipment and motors are added, and as electrical components age and deteriorate, the possibility for failure increases. Over time, the inspection and maintenance of electrical systems becomes increasingly important. The following items should be checked on a regular basis.

- Electrical components damaged or subject to damage
- Electrical components subject to heat and moisture
- Circuit load • Temporary wiring used instead of permanent wiring

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- Electrical components deteriorated due to age or conditions
- Electrical components poorly installed and maintained.

Over current protection

Circuit breakers and fuses are designed to restrict the amperage to electrical wiring according to their design limitations. If the amperage capacity is not correct, excessive temperatures will break down wire insulation and start a fire. Over current protection must always match the wire size.

Hazardous locations

Special electrical components including motors, lights, or switches are required in locations where flammable gas or vapours, dust or fibrous material are present or may be present. The components are commonly referred to as explosion proof, dust ignition proof or fiber ignition proof. A qualified electrical contractor should be consulted to determine the necessary components for the application.

Preventive maintenance

Electrical systems deteriorate over time and require preventive maintenance. Wire insulation dries out, receptacles and switches become loose, and equipment accumulates dirt and oil, which can lead to overheating. A qualified electrical contractor should routinely inspect the system.

Thermal infrared imaging is becoming an increasingly popular method of identifying problem areas within an electrical system. A thermal infrared imaging camera identifies hot spots, which indicates a problem that may result in a fire if not corrected. Any abnormal condition should be investigated immediately.

General fire prevention and safety tips

- Do not plug several power cords into one outlet.
- Never break off the third prong on aplug. Replace broken three-prong plugs and make sure the third prong is properly grounded.
- Never use extension cords as permanent wiring. Use extension cords only to temporarily supply power to an area that does not have a power outlet.
- Keep power cords away from heat, water and oil. They can damage the insulation and cause a shock.
- Do not allow vehicles to pass over unprotected power cords. Cords should be put in a conduit or protected by placing planks alongside them.
- Inspect tools, power cords, and electrical fittings for damage or wear prior to each use. Repair or replace damaged equipment immediately.
- Always tape cords to walls or floors when necessary as nails and staples can damage cords causing fire and shock hazards.
- Use cords or equipment that is rated for the level of amperage or wattage that you are using.
- Always use the correct size fuse. Replacing a fuse with one of a larger size can cause excessive currents in the wiring and possibly start a fire.
- Be aware that unusually warm or hot outlets may be a sign that unsafe wiring conditions exist. Unplug any cords to these outlets and do not use until a qualified electrician has checked the wiring.

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- Always use ladders made of wood or other non-conductive materials when working with or near electricity or power lines.
- Place halogen lights away from combustible materials such as cloths or rags. Halogen lamps can become very hot and may be a fire hazard.
- Risk of electric shock is greater in areas that are wet or damp. Install ELCB as they will interrupt the electrical circuit before a current sufficient to cause death or serious injury occurs.
- Make sure that exposed receptacle boxes are made of non-conductive materials.
- Know where the breakers and boxes are located in case of an emergency.
- Label all circuit breakers and fuse boxes clearly. Each switch should be positively
- Identified as to which outlet or appliance it is for.
- Do not use outlets or cords that have exposed wiring.
- Do not use power tools with the guards removed.
- Do not block access to circuit breakers or fuse boxes.
- Do not touch a person or electrical apparatus in the event of an electrical accident. Always disconnect the current first.

Engineering control

Fuses, MCBs, RCDs, and RCBOs are all devices used to protect users and equipment from fault conditions in an electrical circuit by isolating the electrical supply. With fuses and MCBs only the live feed is isolated; with RCDs and RCBOs both the live and neutral feeds are isolated.

Fuses

A fuse is a very basic protection device which is destroyed (i.e. it 'blows') and breaks the circuit should the current exceed the rating of the fuse. Once the fuse has blown, it needs to be replaced.

In older equipment, the fuse may just be a length of appropriate fuse wire fixed between two terminals (normally screw terminals). These are becoming rarer as electrical installations are updated - the presence of such fuses usually indicates that it is about time that the installation is updated.

Modern fuses are generally incorporated within sealed ceramic cylindrical body (or cartridge) and the whole cartridge needs to be replaced.

Cartridge fuses are used in older type consumer units, fused sockets, fused plugs etc.

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Miniature Circuit Breaker (MCB)

An MCB is a modern alternative to fuses used in Consumer Units (Fuse Boxes). They are just like switched which switch off when an overload is detected in the circuit. The advantage of MCBs over fuses is that if they trip, they can be reset - they also offer a more precise tripping value.

Residual Current Device (RCD)

Modern alternatives (better) to Earth Leakage Circuit Breakers and fuses in the Consumer Unit. RCDs are tripped if they detect a small current imbalance between the Live and Neutral wires above the trip value - this is typically 30mA.

RCDs can be wired to protect a single or a number of circuits - the advantage of protecting individual circuits is that if one circuit trips, it will not shut down the whole house, just the protected circuit.

Thermal Circuit Breaker

A thermal circuit breaker is a safety device which breaks an electrical circuit if the temperature gets too high. These devices are used to prevent fires, damage due to voltage fluctuations, and other dangerous electrical situations. Many people are familiar with thermal circuit breakers because they may have them in their homes, or they may use a thermal/magnetic circuit breaker, which contains two fail safes to open a circuit in the event that a problem develops.

Circuit breakers work by detecting hazardous conditions in an electrical circuit and opening that circuit so that it cannot be completed. As long as the circuit is open, electricity cannot flow through it, and thus the opening of the circuit eliminates a hazardous situation. Once the problem which caused the breaker to open has been addressed, the breaker can be reset, closing the circuit and allowing it to work again. If the breaker is reset without addressing the problem, there is a high probability that it will trip again.

In the case of a thermal circuit breaker, the breaker is designed to detect elevations in temperature. The temperature triggers a mechanical reaction which trips the breaker, breaking the circuit. Classically this is accomplished by putting two pieces of metal with different rates of expansion together. As the metals expand in response to heat, they pull on the breaker, snapping it open. Circuit breakers are designed to be fully open or fully closed, preventing partial flows of

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electricity, and when they trip, they usually come to rest in the middle of their range of motion, so that someone can easily identify the breaker which tripped. To reset the breaker, it has to be pulled all the way off and then put back in the on position.

The mechanical action involved in opening the circuit often generates an audible snapping or popping noise. This can alert people to the fact that a thermal circuit breaker has tripped in the event that they do not notice an electrical problem. When a breaker trips, people should determine which circuit it is associated with, and check the circuit for signs of a problem. For example, running multiple electrical heaters on a single circuit can trip a thermal circuit breaker, and it may be possible to resolve the problem by unplugging the heaters and moving them to different circuits. In other cases, there may be a serious problem with the circuit which requires the attention of an electrician.

Class 1 Electrical appliance

These appliances must have their chassis connected to electrical earth (US: ground) by an earth conductor (coloured green/yellow in most countries, green in the U.S., Canada and Japan). A fault in the appliance which causes a live conductor to contact the casing will cause a current to flow in the earth conductor. This current should trip either an overcurrent device (fuse or circuit breaker (CB)) or a residual-current device (RCD) also named as residual current circuit breaker (RCCB), or (ground fault circuit interrupter (GFCI)) or also, residual current operated circuit-breaker with integral overcurrent protection (RCBO). which will cut off the supply of electricity to the appliance.

Class II –Electrical Appliance

Double insulated or class 2 electrical appliances are products that have been designed in a way so as not to require a safety connection to electrical earth (These products must NOT have a safety connection to Earth). These products are required to prevent any failure from resulting in dangerous voltage levels becoming exposed causing a shock etc. This must be done without the aid of an earthed metal casing. Ways of achieving this include double layers of insulating material or reinforced insulation protecting any live parts of the fitting. There are also strict requirements relating to the maximum insulation resistance and leakage to any functional earth or signal connections of such appliances. Products of this type are required to be labelled "Class II", "double insulated" or bear the double insulation symbol (the symbol displayed above) Follow some of the links below to view / purchase some examples of these products

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Class III –Electrical Appliance

A Class III appliance is designed to be supplied from a separated/safety extra-low voltage (SELV) power source. The voltage from a SELV supply is low enough that under normal conditions a person can safely come into contact with it without risk of electrical shock. The extra safety features built into Class I and Class II appliances are therefore not required.

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Electrical Equipment and appliances for Hazardous Atmosphere

As of July 2006, organizations in EU must follow the directives to protect employees from explosion risk in areas with an explosive atmosphere.

There are two **ATEX** directives (one for the manufacturer and one for the user of the equipment):

- the ATEX 95 *equipment* directive 94/9/EC, Equipment and protective systems intended for use in potentially explosive atmospheres;
- the ATEX 137 *workplace* directive 99/92/EC, Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

Employers must classify areas where hazardous explosive atmospheres may occur into zones. The classification given to a particular zone, and its size and location, depends on the likelihood of an explosive atmosphere occurring and its persistence if it does.

Areas classified into zones

0, 1, 2 for gas-vapor-mist and

20, 21, 22 for dust

must be protected from effective sources of ignition.

Equipment and protective systems intended to be used in zoned areas must meet the requirements of the directive.

Zone 0 and 20 require Category 1 marked equipment,

zone 1 and 21 required Category 2 marked equipment and

zone 2 and 22 required Category 3 marked equipment.

Zone 0 and 20 are the zones with the highest risk of an explosive atmosphere being present.

Equipment in use before July 2003 is allowed to be used indefinitely provided a risk assessment shows it is safe to do so.

The regulations apply to all equipment intended for use in explosive atmospheres, whether electrical or mechanical, including protective systems. There are two categories of equipment

I for mining and
II for surface industries.

Manufacturers who apply its provisions and affix the CE marking and the Ex marking are able to sell their equipment anywhere within the European union without any further requirements being applied with respect to the risks covered being applied. The directive covers a large range of

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equipment, potentially including equipment used on fixed offshore platforms, in petrochemical plants, mines, flour mills and other areas where a potentially explosive atmosphere may be present.
In very broad terms, there are three preconditions for the directive to apply: the equipment

a) must have its own effective source of ignition;

b) be intended for use in a potentially explosive atmosphere (air mixtures); and c) be under normal atmospheric conditions.

The directive also covers components essential for the safe use and safety devices directly contributing to the safe use of the equipment in scope. These latter devices may be outside the potentially explosive environment.

Manufacturers/suppliers (or importers, if the manufacturers are outside the EU) must ensure that their products meet essential health and safety requirements and undergo appropriate conformity procedures. This usually involves testing and certification by a 'third-party' certification body (known as a Notified Body e.g. Sira, Baseefa, Lloyd's, TUV) but manufacturers/suppliers can 'self-certify' Category 3 equipment (technical dossier including drawings, hazard analysis and users manual in the local language) and Category 2 non-electrical equipment but for Category 2 the technical dossier must be lodged with a notified body. Once certified, the equipment is marked by the 'CE' (meaning it complies with ATEX and all other relevant directives) and 'Ex' symbol to identify it as approved under the ATEX directive. The technical dossier must be kept for a period of 10 years.

Certification ensures that the equipment or protective system is fit for its intended purpose and that adequate information is supplied with it to ensure that it can be used safely. There are four ATEX classifications to ensure that a specific piece of equipment or protective system is appropriate and can be safely used in a particular application:

1. Industrial or Mining Application;
2. Equipment Category;
3. Atmosphere; and
4. Temperature.

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Health Hazards

Occupational Health is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations by preventing departures from health, controlling risks and the adaptation of work to people, and people to their jobs. (ILO / WHO 1950)

Principles of Occupational Health

There are thousands of potentially hazardous situations in our workplaces arising from the use of hazardous substances or regular exposure to noise, vibration, radiation, heat or cold. Consequently, no single solution will work for all of them. Nor could any attempt be made to legislate separately for health and safety in each case. Recognising the hazards, assessing the risks, and controlling those risks to an acceptable level will provide the best economic solution to achieving a healthy workplace. Occupational hygiene is really a system of workplace management which finds out just what the hazards are, evaluates the risks and subsequently controls them to a level which is considered acceptable.

There is no set formula to follow in an occupational hygiene investigation. All workplaces are different. But four basic principles apply:

- Anticipation of problems is considered a vital skill, but while this usually requires considerable experience, assistance is now provided by safety data sheets (SDSs) and abundant advice available in the literature, various databases and electronic sites.
- Recognition—knowing the hazards, the processes or identifying them through adverse health effects.
- Evaluation—measuring exposures, comparing against standards, evaluating risk.
- Control—providing contaminant or hazard control; the level of protection is based on knowledge of the toxicology or adverse effects produced by known quantitative exposures to the hazard.

Types of Workplace Hazards

The workplace health hazards are generally classified as follows:

- Chemical hazards (e.g. Ethylene Oxide)
- Biological hazards (e.g. Legionella)
- Physical Agents (e.g. Noise)
- Ergonomic Hazards (e.g. Manual Handling)
- Psycho-Social Stress

Chemical Hazards and Routes of Entry

Chemicals give rise to the greatest number of hazards to workplace health. The category ‘chemicals’ includes many naturally-occurring substances, such as minerals and cotton, as well as both simple and complex manufactured chemical products.

Chemical exposure can arise through direct use or from by-products. Exposure to chemical hazards occurs in the following ways:

- Inhalation of airborne contaminants, including:
  - dusts—silica, coal, asbestos, lead, cotton, wood, cement
  - mists—acid mists, chrome plating
  - gases—chlorine, sulphur dioxide, ethylene oxide, ozone

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– fumes—smoke, metal fumes from welding
– vapours—chlorinated and aromatic solvents, amines, ethers, alcohols

- Through skin contact, including:
  – direct absorption through skin—pesticides, phenol
  – action on eye and mucous membranes—acids, irritating effect of vapours
  – corrosive action on the skin—acids, alkalis, phenols
  – solvent defatting of skin—toluene, methylene chloride
  – photosensitising agent to skin—creosote, bitumens
  – allergenic action on skin—nickel, chromium.
- Through ingestion, for example

  – consume food contaminated with lead or mercury

Safety Data Sheets (SDS)

Chemicals are widely used in the Oil & Petrochemical industry. Many of them are corrosive, toxic or flammable. However, they can be safely handled if information on their physical, chemical and hazardous properties together with the necessary precautions to take is made available to users. The key information available on SDS includes:

1) Identification of the substance and its manufacturer
2) Composition/information of its ingredients
3) Hazard identification
4) First aid measures
5) Fire fighting measures
6) Accidental release measures
7) Handling and storage
8) Exposure control and personal protection
9) Physical and chemical properties
10) Stability and reactivity
11) Toxicological information
12) Ecological information
13) Disposal consideration
14) Transport information
15) Other information

In Singapore, suppliers and manufacturers of chemical compounds are obligated to provide users SDS. Employers are then required to make these SDS readily available to their employees. Non compliance with this regulation is an offence under the WSH Regulations.

Evaluation of Chemical Hazards

Exposure Standards

The development of exposure standards first occurred in a systematic way in the United States. The most widely known are the Threshold Limit Values (TLV) published by the American Conference of Governmental Industrial Hygienists (ACGIHR 2001; 2006). These standards provide good guidance on the acceptability (or otherwise) of exposures to hazardous substances in an imperfect working world. Many TLV exposure limits have been derived from epidemiological and clinical studies of industrial workers using a particular substance or performing a particular process.

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In addition, relevant animal studies have also provided useful information, as have some human volunteer exposure experiments. The Permissible Exposure Levels, PEL the equivalence to TLV have been adopted as the legislated occupational exposure standards in Singapore. These 3 forms of exposure standard are used in different ways in dealing with hazardous substances in the workplace:

- **PEL (Long Term)-** This value represents the average airborne concentration of a particular substance when calculated over a normal 8-hour working day, for a 5-day working week.
- **PEL (Short Term)-**This represents the exposure limit means a 15-minute TWA exposure which should not be exceeded at any time during a working day, even if the 8-hour TWA is within the PEL (Long Term) exposure standard. Exposures should not be longer than 15 minutes and should not occur more than four times per day. There should be at least 60 minutes between successive exposures. A PEL (Short Term) is only assigned to substances with a PEL (Long Term) where there is evidence either from human or animal studies that adverse health effects can be caused by short-term excessive exposures.
- **PEL (Ceiling)-**This value represents a maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes. A PEL (Ceiling) is assigned to substances such as corrosives or irritants, which can cause acute health effects after brief high level exposures.

Exposure standards are used to ensure that there is adequate control of exposure to hazardous substances in the workplace. They are not precise divisions between acceptable and unacceptable working conditions but are believed to represent concentrations to which most workers may be exposed day after day during their working lives without suffering adverse health consequences.

Air Sampling

Within the workplace, two kinds of measurements can be made for atmospheric contaminants:

- personal measurements, which are taken in the breathing zone of a worker.
- static measurements, which are taken in a fixed location such as in the middle of a room or next to a machine, and

Exposure standards are compared with the actual exposure workers are likely to receive through inhalation (which means the airborne concentration of a substance in the worker's breathing zone as determined by personal monitoring). The breathing zone is described by a hemisphere of 300 mm radius extending in front of a person's face and measured from the midpoint of an imaginary line joining the ears.

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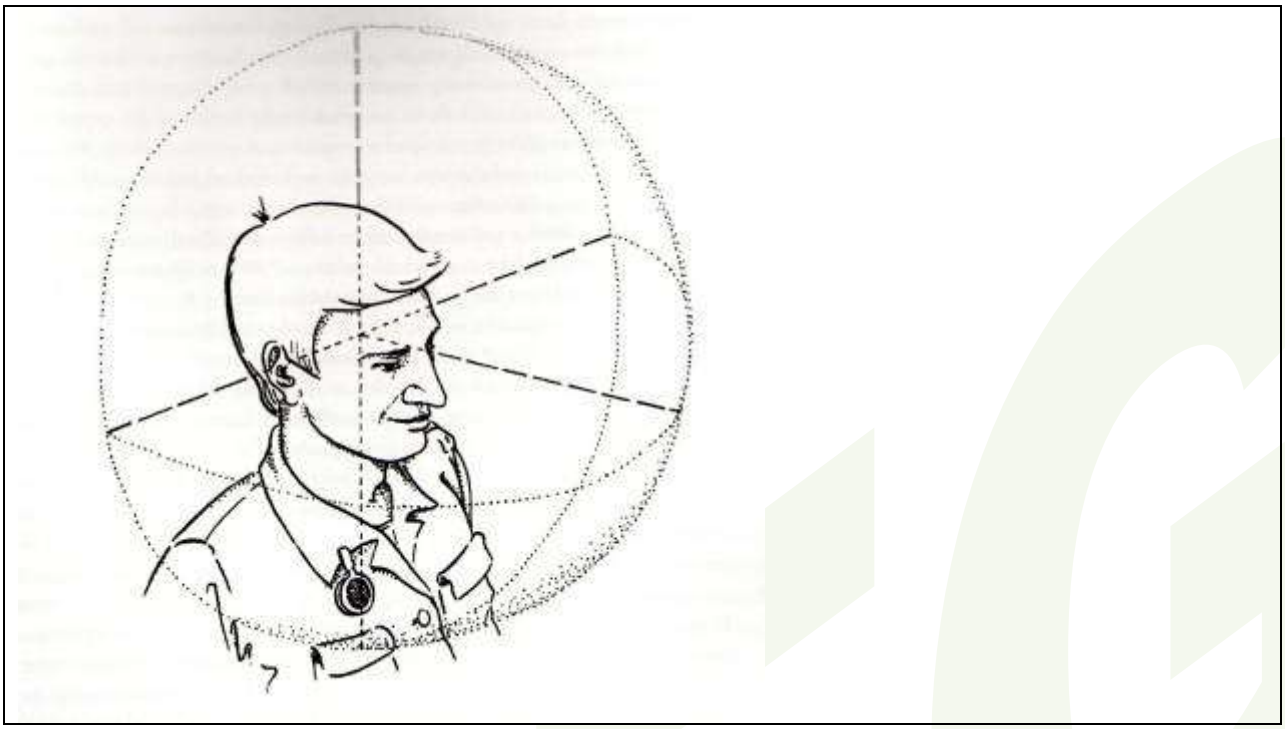

Static samples taken at a fixed point may be useful in assessing the effectiveness of control measures, or in warning of leaks or fugitive emissions from equipment, they do not provide a valid indication of actual worker exposure.

Control of Chemical Hazards

Introducing controls requires knowledge of:

- the hazard
- the degree of risk from the exposure
- routes of entry
- various practicable control strategies—that is, the Hierarchy of Controls: elimination,
- substitution, isolation, ventilation, administrative controls, personal protection
- how much control is required
- comparative effectiveness of different control procedures
- the relative costs of implementation
- maintenance and testing procedures for control procedures
- user acceptability

The choice of control recommended by the WSH practitioner will require consideration of:

- the hazard and the extent of the risk it poses
- the practicability of the various controls
- the efficacy of the different controls
- the consequences of failure of controls
- the relative costs of providing, operating and maintaining controls
- the acceptability by the workforce (if the control measures are viewed as impractical they will not be used).

The following situations are examples of best choice for workplace control:

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- replace cancer-causing chemicals rather than controlling them, unless they are essential to the workplace (e.g. potent drug treatments in a hospital)
- an expensive dust-control system would not be recommended for intermittent or infrequent exposures (e.g. a job undertaken for 3 hours every 6 months) where respiratory protection would suffice half-face respirators, which might technically provide good protection, would not be recommended for a worker permanently employed on an acid pickling line;
- control of the acid aerosol by suppression and ventilation would provide a more acceptable long-term solution
- a worker requiring access to the same acid pickling line for 5 minutes per day can be adequately protected by the appropriate half-face respirator.

Experienced WSH practitioner will find that there are always a number of possible control solutions. Some work better than others, some are less expensive, some are more acceptable, others less so.

Elimination / Substitution

Elimination of a hazard in the workplace, by removing a process or a substance completely, is the definitive way of reducing risk. In practical terms, however, the drastic step of eliminating a process central to a workplace may result in the closing down of an industry.

Substitution offers a number of ways of controlling health hazards in the workplace.
It can involve substitution of materials and/or processes.

(A) Materials

For some workplaces, it may not be possible to substitute the hazard—for example, in mining ores, or smelting metals. But substitution of one hazardous substance with a less hazardous one has been widely employed throughout history in many process industries.
Many of the developments in occupational health over the last 60 to 70 years have occurred specifically in the search for less hazardous substitutes. Other well-known examples include:

- replacement of cancer- and mesothelioma-causing asbestos fibres by safer synthetic substitutes (glass foam, rock and glass wool)
- removal of benzene (which causes leukaemia) as an industrial solvent and replacement by less hazardous aromatic solvents (e.g. xylene)
- replacement of beach and river sands, which have high quartz contents, as abrasive blasting agents, with low quartz content materials (ilmenite, zircon, copper slag)
- replacement of mercury compounds for fur carroting by less hazardous organic acid peroxide mixtures
- replacement of petroleum naphtha with carbon tetrachloride for dry-cleaning;
- carbon tetrachloride was successively replaced by perchlorethylene and then chlorofluorocarbons (with a subsequent return to perchlorethylene when CFCs became restricted as ozone-depleting substances)
- replacement of mercury retorting for gold extraction by cyaniding, and ‘carbon-in-pulp leaching

(B) Processes

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In some industrial processes, where substitution to a less hazardous material is not possible, the risk in handling hazardous materials can be reduced by a change in the process. For example:

- use a pelletised form of masterbatch instead of a dusty powder (e.g. lead stabilisers in PVC pipe production)
- use a gelled form of organic solvent which reduces the rate of vapour emissions (e.g. gelled styrene, gelled paint strippers)
- choose a manufacturing route which does not give off hazardous by-products (e.g. the unwanted by-product of dioxin in herbicide manufacture)
- choose a manufacturing route which does not require storage of large quantities of extremely hazardous intermediates (e.g. methylisocyanate in pesticide manufacture, or hydrogen cyanide in manufacture of potassium cyanide)
- change from a dry to wet process for dust control (damp sawdust), or from
- sweeping to vacuum cleaning
- lower the temperature to reduce evaporation of volatile materials.

Engineering out the hazard

A range of engineering controls is possible, including various types of containment and ventilation systems.

(A) Isolation

When use of hazardous materials is unavoidable, the next best procedure often is to engineer-out the hazard by isolation. If the worker can be isolated completely from the hazard, the risk to health is removed. Isolation may be a physical or a distance barrier. Time is also a barrier, although time may equally be considered an administrative control. The following examples illustrate the principle:

- the use of interlocked doors or barriers to prevent entry into an area while toxic substances are present
- remote storage of hazardous materials (e.g. explosives, fuel tank farms)
- separating materials that could create hazards by coming into contact with each other by accident (e.g. oxidants and fuels).

(B) Containment

Once an agent (dust, fume, vapours, noise) has escaped from the source it becomes far more difficult to control. A better strategy is to maximise the containment by engineering controls. For example:

- a whole process is totally enclosed and coupled with an exhaust extraction system
- a remotely controlled laboratory to handle radioactive isotopes
- gas-tight systems, used in chemical processing or in many sterilising or fumigation procedures.

(C) Ventilation

The engineering control of air contaminants by dilution or local exhaust ventilation in confined spaces

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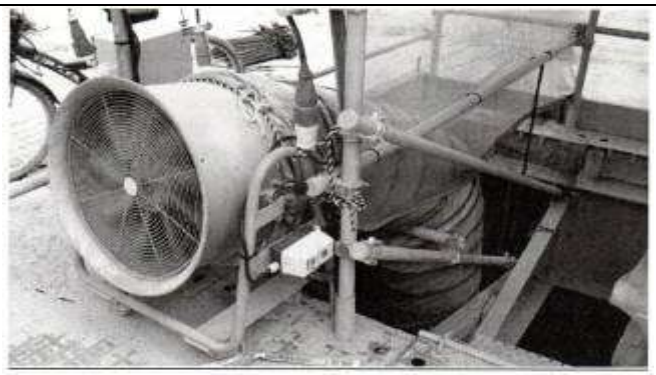

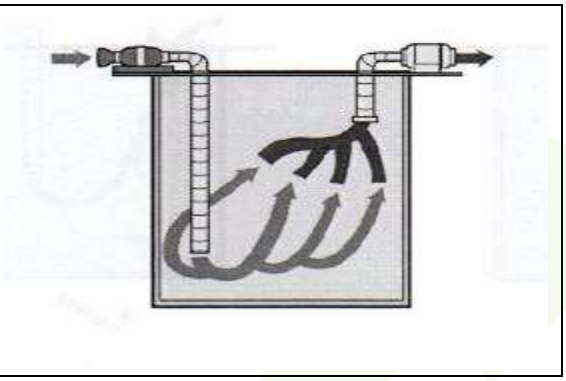

Administrative Control

(A) Education and Training

The (WSH Regulations) require training and induction of workers. Provision of information, such as the mandatory availability of a material safety data sheet, is an administrative control mechanism. Training programs should be formalised and administered throughout the length of employment. Training should always incorporate the practical aspects of a job and include some form of competency assessment. If potentially exposed workers are made fully aware of not only the consequences of overexposure but also the routes and mechanisms of exposure, they are more likely to identify other exposure situations and act to reduce exposures in new situations.

(B) Safe Work Procedure

In Singapore, the local WSH regulations require companies to develop, implement and maintain safe work procedure for handling hazardous chemicals. The written procedure is expected to cover aspects of safe storage, application, and disposal in normal or emergency situations.

(C) Worker Rotation and Removal from Exposure

For examples are:

- in the lead industry, workers may be removed if blood lead levels exceed a certain level, and remain removed from further lead exposure until blood lead levels fall to an acceptable level
- Radiation workers are restricted to a maximum radiation dose over a specified time period

Where workers have developed sensitivity to a substance, one common administrative control is to prevent any further exposure. In other instances workers may be predisposed to effects at lower thresholds than the average worker, or they may be diagnosed as showing effects due to exposure without actually being symptomatic.

Examples are:

- isocyanate-sensitised workers are prevented from any further exposure
- workers with certain genetic dysfunction should not be occupationally exposed to TNT or chemicals causing haemolytic anaemia
- pregnant workers should not be exposed to known foetal toxins (e.g. lead, ethylene glycol ethers)
- asthmatics should not work with strong irritant gases.

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Personal Protective Equipment

PPE represents the absolute last resort; beyond the PPE is the unprotected worker and inevitable exposure if the PPE is not correctly selected, maintained and used. Even though PPE is on the bottom of the hierarchy it is still widely used and accepted as a back-up and supplement for other controls. There will also be situations where higher level controls cannot be used and PPE will be the only practicable solution.
Gloves are widely used in industry for hand protection against many different materials. The selection of the correct glove type is not so straightforward and simple. For example, gloves that protect against methylated spirit solvents may not protect against turpentine. Knowledge of the chemical and permeation resistance of different glove materials is required before making a choice.

The re-use and laundering of gloves can be fraught with problems and any decision to do this should be approached with caution. Some of the problems include:

- gloves may have small holes that are not detected
- contaminants can be moved to the inside of the glove during washing
- the washing process can physically damage the glove
- the washing process may not remove any chemical that has started to migrate through the glove material.

There are many tasks where the use of respiratory protective equipment (RPE) is an established method of protection for reasons such as:

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- other control methods are far too costly or impracticable (e.g. electrical power may not be available, or ventilation controls cannot be arranged around a large open formwork metal structure)
- the task may be carried out at various locations (e.g. a pesticide applicator providing termite treatments to buildings)
- the task may involve only short-term exposures (e.g. one job lasting 2 hours per month)
- exposure may be only trivial, not requiring elaborate controls (e.g. nuisance dust exposure)
- use of materials which have very poor or no warning properties and overexposure can readily occur
- RPE is required for emergency procedures, including emergency escapes (e.g. fire fighting, escape from chemical leaks or spills)
- air-supplied RPE is mandatory for entry into oxygen-deficient or partially oxygen deficient atmospheres e.g. confined spaces
- RPE is necessary to supplement other control procedures
- air-supplied RPE is still required for abrasive blasting even when water suppression is used.

Tests for correct fitting of the RPE in use can only be conducted using the proper equipment. To test qualitatively for facial leaks, the wearer typically is subjected to an aerosol (Bitrex, saccharin) or isoamyl acetate vapour test.

The respirator user has a hood over his head and an aerosol of saccharin is aspirated into the hood. The user is asked to perform a series of exercises involving talking and head movements. Any failure of the face seal will be detected by the taste of saccharin. This method is only suitable to test face seals on respirators fitted with particulate filters, as the particles can pass through gas and vapour filters. A similar test can be conducted where organic vapour air purifying respirators are used by using isoamyl acetate vapour as the challenge agent.

The more complex quantitative face-fit tests use a particle detector and a modified respirator face piece to detect the inward leakage of an aerosol. Some tests of this type use ambient aerosols naturally occurring in the environment while others use a generated sodium chloride aerosol or oil mist. These tests require both specialist equipment and training.

Both types of tests (qualitative and quantitative) help ensure the selected respirator adequately fits the face of the wearer so that in future they will receive suitable protection. The tests should be performed at the time of issue and whenever respirator types are changed. Additionally, the tests reinforce with the respirator user the need to carefully put on the respirator each time, and can also demonstrate the effect of damaged parts or the effect of facial hair on impairing face seal. Any facial hair, particularly stubble beard growth, can interfere with the sealing of the respirator; all wearers should be clean shaven in the area of the face seal.

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Positive Seal Check Negative Seal Check

A negative pressure seal check can be done to check for leaks by blocking off the filters using the palms and inhaling. Any inward leakage can be detected. This test is not very sensitive however, as the negative pressure within the respirator face piece causes the respirator to be drawn onto the face by the external atmospheric pressure, improving the seal on the face. A similar positive pressure test can be done by exhaling while covering the filters or exhalation valve and trying to detect leakage. These checks are *not* substitutes for fit testing, but are used after donning respirators to ensure they have been put on correctly.

With the exception of disposable filter type respirators, the use of RPE in the workplace requires a constant program of inspection, maintenance and repair. Maintenance includes washing, cleaning, disinfecting where necessary, inspection for wear, checking for leaks and replacement of worn components and replacement of filter components.

Wearing RPE is not without its physiological and psychological limitations. There are a number of medical conditions, including diabetes, asthma, emphysema, skin sensitivity, a punctured eardrum or chronic airways disease, that prevent a worker from using RPE. Some workers also feel claustrophobic wearing a normal filter respirator, but may find a powered air purifying respirator (PAPR) more acceptable. Always seek expert medical advice from a source experienced in respiratory medicine if prospective wearers have problems wearing respirators.

Physical Agent

All workplaces result in exposure to physical agents which could be harmful, including heat, noise, vibration, repetitive movements, light and other radiation. Increasing mechanisation may decrease heat stress, but increases in industrialisation and greater use of high technology can be accompanied by new hazards. Health effects are caused by:

- noise—absorbed though the ear; some very low frequency (infrasound) and ultrasonic sounds are absorbed directly by the body
- vibration—received by body in contact with vibration
- light—visible, ultraviolet and infrared are received by both the eye and the skin;
- the eye is susceptible to laser energy; poor lighting may also be a workplace health hazard
- heat—absorbed by all parts of the body
- cold—cold environments experienced by whole of body; extremities in contact with cold
- pressure—extremes affect areas of body with gas spaces: lungs, teeth, sinuses, inner ear

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- electromagnetic non-ionising radiation—microwaves, radiofrequency and very low electromagnetic radiation are received directly by the body
- ionising radiation—X-rays, radioactive decay energies: α (alpha) particles, β (beta) particles and γ (gamma) rays are received directly by the body

Noise Hazards

Sound originates from a vibrating source causing variations in the atmospheric pressure which are detected by the ear and interpreted by the brain. Sound may convey useful information. When sound is unintelligible, unwanted, or may cause damage to hearing, it is referred to as 'noise'. A person gains all the information about, and identifies the uniqueness of, a sound by virtue of only three features:

- **combinations of frequencies**;
- their **relative intensities**; and
- the rate of **onset and decay** of the combinations of sounds of different frequencies.

As sound is transmitted through the elastic medium of air, the air is compressed and rarefied to form a pressure wave like the ripples on a pond when a pebble is thrown in the water. The number of pressure variations per second is called the frequency of sound and is measured in Hertz (Hz). The wavelength is the distance between two similar points on the sine wave. The velocity of sound (wavelength × frequency), depends on the mass and elasticity of the conducting medium. In air, sound propagates at about 344 m/s at 20°C. In water, sound propagates at about 1500 m/s, and through steel it propagates at about 6000 m/s. The spectrum of good human hearing ranges between about 20 and 20 000 Hz, and everyday sounds contain a wide mixture of frequencies. Speech communications rely on frequencies ranging between 100 and 5000 Hz. Audible sound pressure variations are superimposed on the atmospheric air pressure (100 000 Pa) and normally range between 20 µPa and 100 Pa.

The principal health-related effect of noise exposure is hearing loss. Excessive noise can destroy the ear's ability to hear, and the damage is not reversible. Hence, the WSH practitioner should put great emphasis on prevention. Damage to hearing depends on how loud the noise is and the length of the exposure. Noise also impairs communication, making it harder to do a job, and in the social sphere it spoils much of our enjoyment of life. Hearing normally deteriorates with age (presbycusis), and permanent hearing loss induced by noise can accelerate presbycusis and drastically affect quality of life.

- **Temporary threshold shift** in hearing occurs during or immediately after exposure to significant loud sounds. Quiet sounds can no longer be heard, and the condition may last for minutes to hours and days. This is caused by the hair cells in the hearing organ (cochlea) becoming reversibly desensitised.

- **Permanent threshold shift** results from long-term regular exposure to loud noise, particularly higher pitched noises. Noise-induced hearing loss (NIHL) is not reversible as it arises from the destruction of the hair cells in the cochlea. The human ear does not have the ability to regrow hair cells and there is no medical treatment.
- **Tinnitus** or 'ringing in the ears' sometimes accompanies NIHL. It may manifest as ringing, clicking, cicadas or continuous tones, and can be extremely distracting andeven tormenting. Tinnitus can also happen after exposure to loud noise which causes a temporary threshold

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shift, for example using a jackhammer without wearing hearing protectors, or after a rock concert.

- **Acoustic trauma** normally results from high intensity explosive- or loud impact type impulsive noise, which can destroy the hair cells and other ear mechanisms after one or relatively few exposures.

Noise dose assessment

Many workers move in their jobs from one noisy environment to another. Their total noise exposure therefore is the sum of the many different partial exposures. The personal noise dose meter (also known as dosimeter) provides an integrated noise exposure over a known period, usually the work shift. Modern noise dose meters provide data logging with computer readable output, in dose, LAeq,8h, and A-weighted noise exposure, EA,T, expressed in decibel [dB(A)].

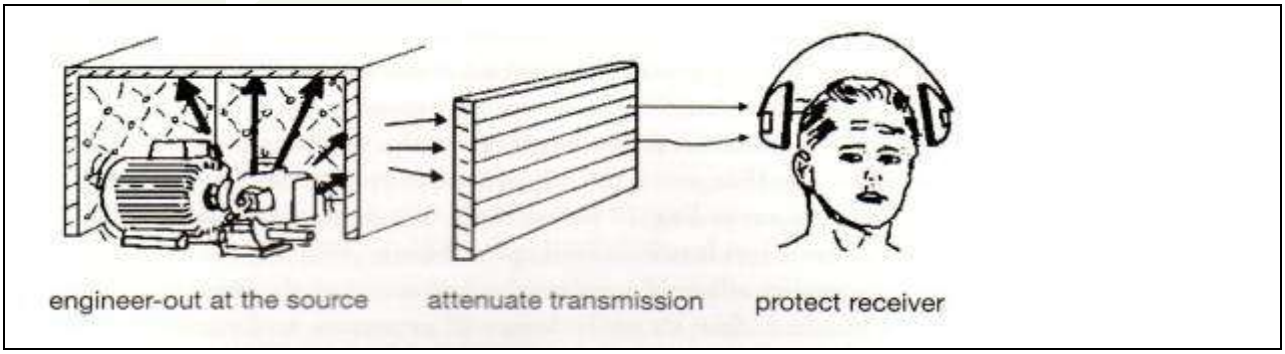
Maximum exposure for various equivalent continuous noise levels

Limiting dB(A)	Maximum exposure period allowed to stay within LAeq,8h 85 dB(A)
85	8 hr
88	4 hr
91	2 hr
94	1 hr
97	30 min
100	15 min

Controlling of Noise Hazards

If the results of a noise survey identify the likelihood of exposure to excessive noise, further investigation is necessary to identify noise sources and prioritise control strategies to reduce the hazard. Workplace noise control strategies fall into three categories and are indicated here in order of most effective to least effective:

- **Engineering-out** the noise hazard (*source* of noise)
- **Attenuating** the noise hazard (*transmission* of noise)
- **Hearing protection** programs (*reception* of noise)



1) Control at source: elimination or modification of noise source or process

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2) Control of transmission path: enclosures, barriers, machine mountings, sound-proofed control rooms, room sound absorbers, etcetera.
3) Hearing protectors should not be seen as a noise control device but rather a temporary way of minimizing a worker's noise exposure by reducing the noise that enters the ear canal.

Occasionally, the WSH practitioner may need to use two or even all three approaches. Attacking the source of the noise or preventing its transmission is always preferable to committing workers to wearing hearing protection. In practice it is often difficult to enforce hearing protection programs. Reliance on the use of hearing protectors by workers will in the long run outweigh the cost of other controls. The cost of many (engineering) noise reduction programs, although perhaps initially expensive, can be surprisingly cheap in the long run, and will remain consistently effective. Hearing protection should be used only if the alternatives are not possible, reasonably practicable or economical, or as an intermediate phase until more permanent noise reduction measures are in place.

Engineering Controls

Many noise hazards arise because no thought has been given to processes or to correct design or installation of equipment. High levels of continuous and impact noise are often traded off for immediate ease of operation, for example, hammering on metal to bend it rather than bending it with a machine or lever. Noisy motors, compressors, power saws and grinders can all be found in many workplaces, located near work stations, with little regard to their impact on the work environment.

Substitution of processes

- Use welding instead of riveting.
- Use hot working of metals instead of cold forging.
- Use impact-absorbing materials (plastic, rubber, nylon, etc.) rather than metals.
- Use of procedures such as lowering rather than dropping.

Minimising changes in force, pressure or speed which produce noise

- Eliminate impact noises, for example, use compression rather than impact riveters.
- Replace hammers with slow application of force
- Use hydraulic presses rather than mechanical impact presses.

Reducing the speed

The higher the speed, the higher the frequency and so the louder (as perceived by the ear) and potentially more damaging the noise. To alleviate this:

- Use larger, slower machines rather than small, fast ones.
- Run machines at lower speeds, but with higher torque.
- Air guns with air channels around the central channel reduce noise by not having all the air concentrated at high speed through the central air channel but spreading the flow of air through several channels around the central orifice at lower speed while not reducing the effectiveness. The air gun has air channels around the central orifice. This lowers the speed of the air and changes the pitch of the sound. This type of air gun can be up to 7 dB quieter than the 'traditional' air gun shown on the right.

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Prevent mechanical vibration being converted into sound-generating sources

- Isolate the vibrating unit to prevent it from transmitting noise.
- Optimise rotational speed (usually decreasing speed) to prevent oscillating vibrations.
- Alter size or mass to change resonant (i.e. natural) frequencies. Depending on their composition, size and shape, all objects tend to vibrate more freely at a particular frequency. This is called the resonant frequency. A machine transfers the maximum energy to an object when the machine vibrates at the object's resonant frequency.
- Use extra support or stiffeners to withstand vibrations. The circular saw sharpening machine causes an intense resonant (ringing) noise. By clamping the rubber sheet against the saw blade the resonance and thus the ringing noise is greatly reduced.

- Use vibration dampening surfaces. Steel plates have very poor internal vibration damping. By adding coatings of intermediate layers with better damping properties a reduction in vibration, and thus noise, can be achieved.

- Reduce radiating area. The control panel on the left is mounted on the pump system and vibrates with the system. By isolating the control panel, the vibrating surface of the system is reduced and therefore the noise level is decreased.

- Use perforated non-resonant surfaces. On the left, the guard over the flywheel and belt consists of a solid metal cover. This causes the large surface area of the guard to vibrate and act as a sounding board for noise. By replacing the guard with a perforated one the vibration is reduced and in turn the noise is reduced.

- Use active cancellation (artificial noise created 180 degrees out of phase) to negate the effect of original source.

Reduce transmission possibilities

Fluid pumping systems may be major sources of noise resulting from the intense pressure shocks created in the liquid from the compressors driving the systems. If such systems are mounted rigidly to a building structure, noise can travel through the building and cause problems for the occupants. To avoid noise problems, compressors and pipe systems should be isolated from the building:

- use springs, dampers, flexible couplings and mountings
- ensure ducts cannot carry sound.

Reduce the possibilities of noise being generated in air or fluid flow

- Use properly designed fans to reduce air turbulence. The air reaching a fan's rotor must be as unobstructed as possible to achieve quiet operation.

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- Slowly reduce speed of air or fluid flow to avoid turbulence due to sudden change in volume and pressure drop.
- Use reduced pressures and velocities
- Prevent rapid pressure change which produces 'cavitation' sound resulting from rapid pressure drops near control valves, propellers and pumps. To avoid cavitation noise, selected inserts could be placed in the fluid line so that the insert will not produce a greater pressure drop than required to prevent cavitation .
- Reduce turbulence on air exits . When the high speed exhaust air escaping from the grinder's handle mixes with the relatively still outside air the turbulence creates noise. By inserting a silencer consisting of a porous sound absorbing material the turbulence is broken and the exhaust noise is reduced.

Buy quiet

- Noise control techniques should be incorporated in the design and installation of equipment, since the cost of installing noise control at the design and installation stage is minimal compared to aftermarket design and installation. However, there is rarely an off-the-shelf solution for the suppression or control of noise, and it is necessary for the WSH practitioner to assess each workplace situation separately.
- While a piece of equipment may correctly claim to produce sound levels less than 85 dB(A), two or more operating side by side may still produce combined sound levels in excess of the regulatory noise level.
- Companies should be advised to include noise limits in purchasing specifications, keeping in mind the additive effects of more than one piece of equipment. If enough WSH practitioners and employers insist on quiet machinery, manufacturers will begin to provide it.

Control of noise transmission path

The location of a machine or process is often a significant factor in the noise it can transmit to the workplace. Several methods are widely used in workplace noise attenuation:

Isolating the noise source from the worker

If it is concluded that noise generation cannot be prevented, the following options can be tried:

- Locate the noise source remote from the workplace, for example locating pumps, compressors, generators, etcetera outside the building (provided this does not lead to environmental noise complaints).
- Use enclosures around the noise source .
- Confine sources to a noise-insulated room, using double walls with insulating material, double-glazed windows and solid core doors.
- Use an isolating enclosure around the worker.

Noise can be reduced by preventing much of it reaching the worker

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- Place noise sources away from natural reflectors, for example in corners.
- Use sound absorbers on ceilings and walls .
- Use noise baffles or deflectors to direct noise away from workers.

The efficacy of this method depends on frequency. Low frequency noise tends to pass through openings and around objects , while high frequency noise is more easily deflected .

Hearing Protection

Where it has been confirmed that workplace noise levels are in excess of any regulatory noise limits, for example LAeq,8h 85 dB(A), and other noise reduction programs such as those above cannot be (fully) implemented, personal hearing protective equipment (HPE) must be used until such time that the noise exposure has been reduced to below the regulatory limits. To have any chance of success, implementation of a hearing protection program requires complete management involvement and cooperation. From a management perspective, the program must demonstrate that a risk management process has been carried out.

The Hearing Conservation Program must at least have such elements as:

- a noise control policy
- a system for conducting noise level exposure surveys on a regular basis
- a program for the planning and implementation of engineering and administrative noise control, where possible
- a suitable hearing protection training program, including refresher training, and records of training topics and attendance
- continuous supervision and corrective actions by line management to ensure correct fitting of earplugs to ensure attenuation is maximised
- provision of personal hearing protectors and documented reasons as to why the selected hearing protectors were the most suitable
- provision for the use, maintenance, care and storage of the hearing protectors
- provision for audiological assessment of workers on commencement of employment (or the hearing protection program) and regularly thereafter ongoing monitoring and review of the effectiveness of the program.

Workers and management also need to be totally involved in the program and be trained and educated in the following:

- how the ear works, including how hearing loss occurs
- reasons why hearing protection is required; that is, importance of preservation, of legislation and limitations, and of other control options
- selection of personal hearing protectors
- fitting and use of hearing protectors, comfort
- good and bad habits of wearing hearing protectors
- wearing requirement for using the hearing protectors *all the time* when exposed to noise
- correct use and maintenance of hearing protection.

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The WSH practitioner will find that effective hearing protection programs are far from simply buying earplugs or earmuffs for workers. Any chosen earmuff or earplug will, just like a pair of shoes, not fit everyone or be comfortable for everyone. Different types of hearing protectors have different noise attenuation capabilities and may not necessarily be compatible with all work situations. The choice of hearing protectors depends on factors such as:

- the noise levels determined in the workplace
- the frequency spectrum of the noise
- the attenuation required to achieve compliance with regulations
- the worker's hearing ability
- the worker's acceptance of and the degree of good fit and comfort of the hearing protector. An earplug should be inserted for at least half of its length to achieve the rated attenuation
- compatibility with other personal protective equipment
- the need to communicate with others and to hear important signals and sounds cost.

Types of hearing protectors

There are basically four types of hearing protectors available, of which only two are in widespread use.

Acoustic helmets

These cover a large part of the head and the outer ear, such as those worn, for instance, by helicopter and jet fighter pilots. These helmets are bulky, expensive and not for general industrial use. Noise attenuation may be as much as 50 dB at the lower frequencies, 35 dB at 250 Hz, and it may also diminish bone conduction.

Ear canal caps

Ear canal caps (Figure 10.24) are made from a light rubber or PVC type of material and seal off the entrance to the ear canal without entering it like an earplug does.
Ear canal caps are held in place by a spring headband. Ear canal caps are gaining popularity on construction sites due to their ease of positioning over the ears when the worker is faced with noises usually of short duration and which can start suddenly and unannounced.

Figure 10.24

Figure 10.25

Earplugs

Earplugs are widely used, both as single-use disposable types and reusable types. They are typically manufactured from foam rubber, plastic or silicone, and may come user-formable, premoulded or custom-moulded. All these types can provide good noise attenuation, but attention has to be paid to correct fitting. All are designed to prevent noise reaching the inner ear

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by being placed directly into the ear canal. The formable types are designed to fit all ears; they are rolled between the thumb and finger into a cylindrical shape prior to insertion and held in place with the thumb or finger until they expand to block the ear canal. Reusable earplugs should be able to be inserted in the ear canal without having to be squashed to fit. Some premoulded earplugs have an acoustic resonator chamber included to provide an almost flat attenuation across the frequency range. This type of earplug may be beneficial for workers who have a higher demand for communication via noise, or who have a mild hearing loss, as the attenuation at 2 and 4 kHz (4 kHz is where NIHL typically manifests itself) is not as great as with normal industrial type earplugs.

 	Attenuation of noise level through proper wearing of ear plugs by following simple steps: 1. Roll formable ear plug before insertion 2. Pull outer ear backwards 3. Insert ear plug into canal 4. Do likewise for the other ear

Individually moulded earplugs are made from an acrylic or silicone mould of the wearer's ear canal. This means that the earplug can only be worn in the ear canal for which the mould was made. Individually moulded earplugs can also be fitted with acoustic resonator chambers to provide an almost flat attenuation over the frequency range, and can therefore assist in communication by offering less distortion than ordinary individually moulded earplugs. Individually moulded earplugs must be expertly fitted since performance and comfort may be poor if they are ill-fitting either in design or size.

Earmuffs

These are also very common, and consist of two padded and internally insulated domes which cover the entire ear. A spring-torsioned headband holds the padded cups to the side of the head at a clamping force to provide the attenuation desired. When selecting earmuffs, ensure that the cup is just large enough to clear the ear lobes. It is important that the cushions attached to the cups are soft and not cracked as they are essential in providing a proper seal. They should be cleaned after use and their condition regularly checked. When hard or cracked they can be easily replaced without having to replace the earmuff. In situations where communication via noise is important, so-called noise cancelling earmuffs can be used. These types of earmuffs have either mechanically or electronically activated shut-off valves which enable the earmuffs to allow noise up to a certain level, usually 82 dB(A); through and above this level the muff operates as a proper earmuff. Another type of earmuff is available with a built-in radio receiver. Although this may seem attractive for workers doing mundane or boring work, the volume of radio sound inside the cup combined with the level of workplace noise entering the cup may cause the 8-hour exposure limit to be exceeded. An employer providing this kind of earmuff to workers must ensure that the workers' in-ear noise level does not exceed the exposure limits imposed by WSH legislation.

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Low Profile Ear Muff 	

Heat Stress Related Illness

Workers in hot environments, around furnaces, smelters, boilers or out in the sun, can be subjected to considerable stress. Because of natural climatic conditions and outdoors life- and work-styles, many environments in Australia have a high potential for heat related work illnesses. The WSH practitioner should be able to recognise the physical factors contributing to heat stress, how the body responds, and be familiar with control procedures for these adverse factors. This section provides a basic introduction to the concepts of heat stress and its management.

Heat Stress and Heat Strain

It is important at the outset to define two key terms associated with work in the thermal environment. The combined effect of external thermal environment and internal metabolic heat production constitutes the **thermal stress** on the body. The levels of activity required in response to the thermal stress from bodily systems such as the cardiovascular, thermoregulatory, respiratory, renal and endocrine systems constitute the **thermal strain**. Thus environmental conditions, metabolic workload and clothing, individually or combined, can create **heat stress** for the worker. The body's physiological response to that stress, for example sweating, increased heart rate and elevated core temperature, is the **heat strain** (Di Corleto et al. 2002). During any activity, the body automatically attempts to maintain a constant working temperature range by balancing out the heat gain and heat loss. Working creates metabolic heat, and the heat is carried by the blood to the skin. The work causes the heart to pump faster and so carries the blood faster to the surface. The body dissipates heat through the skin via the cooling mechanism provided by evaporation of sweat.

Acclimatisation

Workers in hot environments can become acclimatised as a way of reducing the heat strain. Acclimatisation produces a lower heart rate and higher sweat rate with more dilute sweat. There are different rates of change in the acclimatisation process which have been broken up into three specific phases:

(I) Initial phase

The first stage of the acclimatisation process, which usually accounts for 33 per cent of the optimum acclimatisation by day 4.

(II) Intermediate phase

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When cardiovascular stability has been assured and surface and internal body temperatures are lower. Usually 44 per cent of optimum is achieved by day 8, although some research carried out in northern Queensland (Brake & Bates 2001) suggests that about 70–80 per cent will be achieved after about 7–10 days.

(III) Third phase

A decrease in the salt content of sweat and urine, and other compensations, to conserve body fluids and restore electrolyte balances. Usually greater than 65 per cent of optimum by day 10, 93 per cent by day 18, and 99 per cent by day 21.

It is very important to note that employees who have been on extended leave, new employees, and contract labour from a cooler climatic location, will not be acclimatised and this must be taken into consideration when scheduling work in a hot environment.
Generally new workers in hot environments must be permitted 1 to 2 weeks to acclimatise.

The Heat Balance Equation

In order for the body to maintain thermal equilibrium and avoid illness or injury, a thermal balance must be maintained. This heat balance equation is given by

$$H = M \pm C \pm R \pm K - E$$

where:

H = heat accumulation by the body
M = metabolic heat output
C = convective heat input or loss (can be positive or negative)
R = radiant heat input or loss (can be positive or negative)
K = conductive input or loss (can be positive or negative)
E = evaporative cooling by sweating (can only be negative).

The Basic Forms of Heat Illness

If environmental work factors prevent the body maintaining this balance because:

- air temperature is too high
- humidity is too high
- there is a high radiant heat load, or
- the worker is constricted by insulating clothing,

the body begins to experience physiological heat strain with different symptoms and illnesses depending on the degree of heat stress. The conditions of importance, ranging from least to most stressing, are:

- **Behavioural disorders**
  Chronic or transient simple heat fatigue often occurs in workers from colder climates who are unacclimatised to continuously hot weather.
  Lifestyle changes (appropriate clothing, mid-day resting) or avoiding strenuous work during the heat of the day, and acclimatisation are appropriate.

- **Heat rash**
  Usually occurs as a result of continued exposure to humid heat with the skin remaining continuously wet from unevaporated sweat. This can often result in blocked glands, itchy skin and reduced sweating. In some cases prickly heat can lead to lengthy periods of disablement (Donoghue & Sinclair 2000). Where conditions encourage occurrence of prickly heat (e.g.

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exposure to damp situations in tropical or deep underground mines), control measures may be important to prevent onset. Keeping the skin clean and as cool and dry as possible to allow the skin to recover is generally the most successful approach.

- **Heat cramps** These are characterised by painful spasms in one or more muscles.
  Heat cramps may occur in persons who sweat profusely in heat without replacing salt losses, or unacclimatised personnel with higher levels of salt in their sweat.
  Resting in a cool place and drinking 250 ml of saline solution (0.9% NaCl) will rapidly alleviate cramps. Use of salt tablets is undesirable. Counselling should be provided to ensure workers maintain a balanced electrolyte intake, with meals if possible. Note that heat cramps occur most commonly during heat exposure, butcan also occur some time after heat exposure.

- **Fainting** (or **heat syncope**)
  Exposure of fluid-deficient persons to hot environmental conditions can cause a major shift in the body's remaining blood supply to the skin vessels in an attempt to dissipate the heat load. This ultimately results in an inadequate supply of blood being delivered to the brain and consequent fainting. Fainting may also occur without significant reduction in blood volume in conditions such as wearing restrictive or confining clothing, or with postural restrictions.

- **Heat exhaustion**
  While serious, heat exhaustion is initially a less severe heat injury than heatstroke, although it can become a precursor to heat stroke. Heat exhaustion is generally characterised by clammy, moist skin; weakness or extreme fatigue; nausea; headache; no excessive increase in body temperature; and low blood pressure with a weak pulse. Without prompt treatment, collapse is inevitable. Heat exhaustion occurs most often in persons whose total blood volume has been reduced due to dehydration (i.e. depletion of body water as a consequence of deficient water intake), but can also be associated with inadequate salt intake even when fluid intake is adequate. Individuals who have a low level of cardiovascular fitness and/or are not acclimatised to heat have a high potential to suffer heat exhaustion, sometimes recurrently. This is particularly where self-pacing of work is not practised. Note that where self-pacing is practised, both fit and unfit workers tend to have a similar frequency of heat exhaustion (Brake & Bates 2001). Lying down in a cool place and drinking cool, slightly salted water (0.1% NaCl), or an electrolyte supplement, will usually result in rapid recovery of the victim of heat exhaustion, but a physician should be consulted prior to resumption of work. Salt-depletion heat exhaustion may require further medical treatment under supervision.

- **Heatstroke**
  This is a state of thermoregulatory failure and is the most serious of the heat illnesses. Heatstroke is usually considered to be characterised by hot, dry skin; rapidly rising body temperature; collapse; loss of consciousness; and convulsions.
  If deep body temperature exceeds 40°C, the danger of heatstroke is imminent. Without prompt and appropriate medical attention, including removal of the victim to a cool area and applying a suitable method for reduction of the rapidly increasing body temperature, heatstroke will be fatal. Immediate cooling is necessary to reduce the body core temperature to below 39°C. It has been suggested that the traditional method of immersion of the body in an ice bath should be replaced by the method developed for the many heat casualties regularly occurring in the Mecca pilgrimage (Weiner & Khogali 1980; Khogali 1987), that is, to spray the patient with cool water and fan to create evaporation. **A heatstroke victim needs immediate, experienced medical attention.**

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Factors Influencing Heat Stress

Heat gain by the working body is derived from several sources:

- **Muscular activity** from the work. As the muscles of the body undertake work and oxygen is consumed, heat is released, which increases core temperature.
- **Conductive and convective heat** from working in hot air. In some cases, heat is picked up from handling hot objects. Cool air can cool the body directly. If air temperature is hotter than body temperature, heat flows from the hotter air to the cooler skin surface. Air speed is also very important in workplace cooling because it influences evaporation rate and convective cooling. Normal skin temperature is around 35°C.
- **Radiant heat** from nearby or distant hot bodies. Hot bodies radiate heat in the infrared region which passes through air (or vacuum), heating it very little. The energy is absorbed by the body of the worker, by equipment

Prevention of Heat Stress

A number of workplace engineering, environmental and task factors can be varied to reduce heat stress. From the data collected in the risk assessment and measurement stages, controls may be determined. These may include:

- Reducing the workload factor by mechanising some tasks.
- Reducing radiant heat load by:
  - lowering temperature of hot processes or changing emissivity of the hot surface
  - relocating hot processes
  - using heat shields, reflective protective equipment, and heat shielding clothing.
- Increasing air speed with fans if air temperature is <38°C, and shedding clothing.
- Decreasing air speed if air temperature is >42°C.
- Dehumidifying air to increase evaporative cooling from sweating, perhaps by eliminating all sources of water vapour from leaks in steam lines or standing water evaporating from floors.
- Limiting the time exposure to the hot work by, for example:
  - carrying out hot tasks in the cool of morning or evening
  - providing cool areas for recovery
  - using extra manpower to reduce exposure time for each worker.
- Restricting overtime work in hot environments.
- Providing specialised vortex air-cooled or ice/phase change vests for some continuous demand tasks.

In addition, worker training and selection is important. Attention should be paid to the following:

- heat acclimatisation
- appropriate levels of physical fitness
- adherence to a liquid replacement schedule
- maintenance of electrolyte balance in body fluids, especially for unacclimatised workers
- training of supervisors and workers in the recognition of various heat illnesses
- information for workers on the impact of drugs, alcohol and obesity on heat illnesses
- screening workers for heat intolerance (particularly previous episodes)
- seasonal factors relating to climate.

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Application of these guidelines should ensure workplaces which are free of heat stress conditions. Illness from heat stress is totally preventable.

The importance of adequate fluid intake and the maintenance of correct bodily electrolyte balance cannot be over-emphasized. Maintaining the heat balance in the body in heat stress conditions demands the production and evaporation of enough sweat to produce sufficient evaporative cooling to balance the heat gain from the environment and metabolic workload. Sweat production is limited by the upper limit of fluid absorption from the digestive tract and the acceptable degree of dehydration once maximum fluid intake has been achieved. It has been found that the limit of the stomach and gut to absorb water is between 1.6 and 1.8 L/hr over many hours providing the individual is not dehydrated (Brake et al. 1998). Physiological effects from dehydration may commence at 1.5–2.0 per cent dehydration. Net fluid loss of 5 per cent in an occupational setting is considered severe dehydration. Thirst is an inadequate indicator for the replacement of fluids in an occupational environment.

In most cases individuals would already be experiencing some degree of dehydration at the onset of thirst. Workers should be encouraged to drink small amounts of water frequently rather than larger quantities infrequently. The water should be cool (10–15°C) and be available close to the workplace. In some cases it may be desirable to flavour the water to make it more palatable, but a low-sugar flavouring should be used.
It should be noted that high solute levels reduce the rate of absorption in the gastrointestinal system. Caffeine and alcohol are diuretics and hence increase water loss. In situations where there is a high loss of fluid, electrolyte replacement may also be required.

In most situations dietary salt intake is sufficient to maintain salt requirements for acclimatised individuals. With unacclimatised workers maintaining a high level of fluid intake in a high heat stress scenario, a deficiency in electrolyte can still occur. In such situations salt tablets should not be used for electrolyte replacement—there are a number of commercially available electrolyte replacement drinks that can be used sparingly under medical direction to fulfil this role.

TRAINING

Training is a key component in any health management program. In relation to heat stress it should be conducted for all personnel likely to be involved with:

- hot environments
- physically demanding work at elevated temperatures
- the use of impermeable protective clothing.

Any combination of the above situations will further increase the risk.
The training should encompass the following:

- mechanisms of heat exposure
- potential heat exposure situations
- recognition of predisposing factors

ASSESSMENT OF THE THERMAL ENVIRONMENT

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Figure 12.1
A modern wet bulb globe temperature (WBGT) instrument

Numerous factors can impact on the heat stress associated with a particular task or environment and no single factor can be assessed in isolation. A structured assessment protocol is the suggested approach, with the flexibility to meet the occasion. The sole use of a heat stress index for the determination of heat stress and the resultant heat strain is not recommended. Each situation requires an assessment that will incorporate the many parameters that may impact on an individual in undertaking work in elevated thermal conditions. In effect, a risk assessment must be carried out which includes additional observations such as workload, worker characteristics and personal protective equipment, as well as measurement and calculation of the thermal environment.

This process may involve a variety of heat stress indices which may include, but is not limited to: wet bulb globe temperature.

Wet bulb globe temperature (WBGT) uses air temperature (Ta), globe temperature (Tg) and a natural wet bulb temperature (Tnwb). These parameters are incorporated into one of two formulas for either indoor or outdoor measurements:

Indoor: WBGT = 0.7 Tnwb + 0.3 Tg
Outdoor: WBGT = 0.7 Tnwb + 0.2 Tg + 0.1 Ta

Ergonomic

Ergonomics is matching the job to the worker and product to the user. Ergonomics and human factors are often used interchangeably in workplaces. Both describe the interaction between the worker and the job demands. The difference between them is ergonomics focuses on how work affects workers, and human factors emphasize designs that reduce the potential for human error.

Ergonomic Hazards

Ergonomic hazards refer to workplace conditions that pose the risk of injury to the musculoskeletal system of the worker. Examples of musculoskeletal injuries include tennis elbow (an inflammation of a tendon in the elbow) and carpal tunnel syndrome (a condition affecting the hand and wrist). Ergonomic hazards include repetitive and forceful movements, vibration,

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temperature extremes, and awkward postures that arise from improper work methods and improperly designed workstations, tools, and equipment.

Common ergonomic injuries include carpel tunnel syndrome and related maladies of the wrist and hand. These can include tendonitis, trigger finger, hand/arm vibration disease, deQuervain's disease, and myalgia. These illnesses, known as cumulative trauma disorders (CTDs), are a family of muscle, tendon, and nerve disorders that are accelerated or aggravated by repetitive motion. Administrative actions can be taken to help alleviate the cause of these disorders. Some of the more common CTDs encountered in the workplace and suggestions to help reduce the potential for CTD injuries are listed below.

Control of Ergonomic Hazards

For repeated actions and sustained postures:

- Provide mechanical aids (e.g., arm and wrist rests) to employees that do repetitive computer work
- Incorporate task rotation
- Modify the work load required of the individual in a particular time frame

For work requiring lifting, carrying, hoisting, pushing, and related activities:

- Provide gloves to the employees that improve their grip on the object
- Reduce the working load, reducing stress to various body parts
- Incorporate rollers and powered belt conveyers to move material
- Utilize handles to make it easier to grip items

For prolonged contact stresses from tools and equipment:

- Use elongated handles on tools, such as scissors and pliers
- Utilize rounded edges on handles and work benches
- Utilize proper tools for impact or striking activities
- Avoid tasks that require the individual to lean on wrists, elbows, or the abdomen
- Provide cushioned tool grips

For posture of the employee:

- Ensure that the workstation, tool design, and tool shape are such that it will allow the employee's body to maintain an unstrained and comfortable position

Asbestos

The use of asbestos in buildings has been banned by the National Environment Agency since 1989. However, many old buildings in Singapore contain asbestos or have asbestos-containing materials. Special precautions are needed in the removal, repair, dismantling, demolition, renovation, maintenance and alteration of structures in buildings containing asbestos.

Sources of Asbestos

Asbestos has been widely used in a variety of building materials including floor tiles, ceiling tiles, asbestos-cement pips or sheets, refuse chutes and fire-resistant structure. It may also be present in pipe lagging or heat insulation materials and in cladding or sprayed on materials located on beams and between walls.

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The potential for an asbestos-containing produce to release respirable fibres depends largely on its degree of friability. Friable means that the material can be crumbled with hand pressure and is therefore likely to release fibres. The fibrous sprayed-on materials used for fireproofing, insulation or sound proofing area considered to be friable, and they readily release airborne fibres if disturbed. Materials such as vinyl-asbestos floor tiles and roofing corrugated sheets are considered non-friable if intact and generally do not emit airborne fibres unless subject to sanding, sawing or other aggressive operations, Asbestos-cement pipes or sheets can liberate airborne fibres ir the materials are cut or sawed, or if they are broken.

Health Effects

Asbestos fibres enter the body by inhalation of airborne dust or by ingestion, and can become embedded in the tissues of the respiratory or digestive systems. Exposure to asbestos dust can cause numerous disabling or fatal diseases. Inhaling or ingesting fibres from contaminated clothing or skin can also result in such diseases. Among these, diseases are asbestosis (scarring and fibrosis of the lung tissue), lung cancer, mesothelioma – a cancer of the thin membrane lining of the chest and abdomen, and gastrointestinal cancer. The symptoms of these diseases generally do not appear for 20 or more years after initial exposure.

Identification and Notification

The presence of asbestos materials may be indicated in the original building plans or specifications. It is advisable to check these before work is carried out on a building.

The Factories (Asbestos) Regulations, 1980 require, among other things, any person who undertakes work involving asbestos to notify the Chief Inspector of Factories at least 28 days before work commencement.

The Factories (Asbestos) (Amendment) Regulations, 1989 require, inter alia, occupiers, contractors or employers to check if materials to be used or handled contain asbestos. If necessary, they have to send those materials suspected of containing asbestos for analysis.

Medical Examinations

Workers who have to handle or be exposed to asbestos in their work should have a medical examination conducted by a Designated Workplace Doctor before they start such work. The medical examination should include a large-size X-ray examination, unless they have had one within the past 12 months. This is required under the Workplace Safety and Health (Medical Examinations) Regulations.

A copy of the Summary Report on these X-ray examinations and a list of asbestos workers should be forward to Occupational Safety & Health Division, Ministry of Manpower.

The chest X-ray films and original reports should be kept for at least 5 years by the employer and produced for inspection at any time. Employers of asbestos workers who have resigned or left their employment should inform the Occupational Safety & Health Division .

Engineering and Work Practice Controls

Preparation and Demarcation of Asbestos Work Area

- An asbestos work area should be established within which there is expected to be exposure to airborne asbestos fibres during the asbestos removal work
- Only persons who are directly involved in asbestos removal work should be allowed to enter the asbestos work area
- Barriers or barricades should be erected to prevent unauthorised persons entering the asbestos work area
- All movable objects, eg furniture, should be removed from the asbestos work area to prevent these from being contaminated with asbestos. Immovable objects should be

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covered completely with impermeable polyethylene sheeting. If objects have already been contaminated, they should be thoroughly cleaned with an industrial vacuum cleaner equipped with a High Efficiency Particulate Air (HEPA) filter or wet wiped before they are removed or covered.

- There should be no eating, drinking or smoking in the asbestos work area
- Warning signs should be displayed at each asbestos work area, and posted at all approaches to the asbestos work area. Where necessary, signs should bear pictures and graphics, or be written in appropriate language so that all persons understand them. These signs should bear the following information:

Asbestos Work Area
Authorised Personnel Only
Do Not Inhale Dust
Respirators And Protective Clothing Required

- Any ventilation system serving the asbestos work area should be disabled and the ventilation ducts leading to and from the asbestos work area should be sealed

Isolation of Asbestos Work Area

- Where walls, floors and ceilings do not completely enclosed the asbestos work area, the asbestos work area should be isolated from the surrounding environment by means of impermeable polyethylene sheeting or other suitable materials.

Windows and entrances to asbestos work areas are properly sealed with plastic sheets. The entrance openings are properly closed after entry or exit by worker(s).

- The polyethylene sheeting should be secured to the ceiling and floor using adhesive tape

Removed asbestos sheets are wrapped with

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polyethylene sheeting and labelled prior to disposal

- For major asbestos removal work, the isolated asbestos work area should be maintained at a negative pressure of at least Pascals, and supplied with an air exchange rate of at least 4 air changes every hour. Air that is removed from the asbestos work area should pass through a High Efficiency Particulate Air (HEPA) filter
- On completion of the asbestos removal work, the polyethylene sheeting should be cleaned either by vacuuming or damp wiping, after which it should be placed in a dust-tight, appropriately labelled container.

Safe Work Procedures

- Except for the removal of screws, power operated tools should not be used to remove asbestos-containing materials (unless they are incorporated with dust suppression or dust extraction attachments with a High Efficiency Particulate Air (HEPA) filter
- Compressed air tools should not be used to remove asbestos-containing materials (unless they are used in conjunction with a ventilation system designed to capture the dust cloud created by the compressed air
- Asbestos-containing sheets or panels should be removed with minimal breakage. The removed sheets or panels should be lowered to the ground to minimise dust generation

Wet Methods

- Wet methods should be used where feasible to ensure that asbestos fibres do not become airborne
- A wetting agent ,eg water or poly vinyl acetate, should be applied by means of an airless sprayer to the entire surface and depth of the asbestos-containing materials
- The water spray should be directed at the point of removal or breakage of the asbestos-containing materials
- Wetting should be done at the beginning of the asbestos removal work as well as continually throughout the duration of the removal work
- High pressure water or other fluids should not be used to clean up or remove asbestos dust from any surface
- The removed asbestos-containing materials should also be wetted until disposal. These materials should not be left lying about the site where they may be crushed

Personal Protective Equipment

Respirators

- Workers carrying out asbestos removal or any persons entering the asbestos work area should wear a respirator with a High Efficiency Particulate Air (HEPA) filter.

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- Respirators should be properly maintained and regularly cleaned. The filters should be changed whenever an increase in breathing resistance is detected.
- Every asbestos worker should be instructed and trained in the use of respirators
- Workers wearing respirators should be allowed to wash their faces and respirator facepieces whenever necessary to prevent skin irritation. This should be done outside the asbestos work area.
- Respirators should be issued to workers on a personal basis. The respirators should be tested for correct size and fit.

Protective Clothing

- Water-proof coveralls or similar full body protective clothing including snug fitting wrist, ankle and neck cuffs, head coverings, gloves and foot covering should be worn by all asbestos workers. Such protective clothing should not have pockets and should be made of a material which does not readily retain or permit penetration of asbestos fibres.
- Where there is a possibility of eye irritation, goggles should also be worn.
- On completion of the asbestos removal work, the work clothing should be vacuumed or wet wiped before removal to minimise the dispersion of asbestos fibres. Blowing or shaking should not be allowed to remove asbestos fibres from work clothing.
- The removed work clothing should be stored in closed, labelled containers that prevent the dispersion of the asbestos fibres into the surrounding environment.
- The removed work clothing should either be disposed of or washed on-site. No worker should be allowed to bring his work clothing home for laundering.
- Contaminated work clothing taken out of change rooms or the asbestos work area should be transported in sealed impermeable bags, or other closed impermeable containers. These containers should be appropriately labelled.

Washing / Changing Facilities

- Change rooms should be provided for workers to remove asbestos-contaminated work clothing. This room should be supplied with impermeable , labelled bags and containers for the containment and disposal of contaminated work clothing and equipment.
- Shower facilities should be provided for workers to wash themselves and change into street clothing after the asbestos removal work.
- The change room and shower room should be contiguous, and isolated from each other by a double curtain of polyethylene sheeting or other suitable material. They should be located as near as practicable to the asbestos work area.
- Laundering of contaminated clothing should be done so as to minimise the release of airborne asbestos fibres.

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- Laundries engaged in the cleaning of protective clothing should be informed of the precautions needed to prevent exposure to asbestos fibres, and warned against shaking or brushing prior to laundering.

Housekeeping

- During and after the asbestos removal work, the asbestos work area and all other asbestos-contaminated surfaces should be kept as free as possible from accumulations of asbestos-containing waste or dust by the use of industrial vacuum cleaners equipped with High Efficiency Particulate Air (HEPA) filters or by wet cleaning methods.

- Compressed air should not be used to clean surfaces contaminated by asbestos.

- Dry sweeping should not be carried out to clean any area or surface contaminated with asbestos.

Waste Disposal

- Asbestos waste, debris, bags, containers, equipment and asbestos-contaminated clothing and sheeting consigned for disposal should be collected into sealed, labelled, impermeable bags or other closed, labelled, impermeable containers.

- Warning labels should be affixed to all containers of asbestos-containing material. These labels should contain the following information:

Asbestos Material
Do Not Inhale Dust

- All bags or containers of asbestos-containing material should be consolidated and stored in a designated asbestos waste area. This area should be distinguished from other areas by means of warning labels.

- An application for written permission to dispose of the asbestos waste should be made to the Ministry of the Environment and Water Resources.

Warning label affixed on disposal bag containing asbestos waste

Transportation Of Asbestos Waste

- Containers of asbestos waste should be loaded onto the transport vehicle in a careful manner so as to prevent damage to the containers.

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- The vehicles used to transport containers of asbestos waste should have enclosed compartments or canvas sheets to prevent damage to the containers and also to prevent fibre release.

- Transportation of large quantities of asbestos waste should be in a 20 m^3 "roll-off" box in which the asbestos waste should be sealed.

- Compactors should not be used as they may cause rupture to the containers of asbestos waste.

- At the disposal site, the asbestos waste should be off-loaded into an excavated pit to avoid dust generation and release of asbestos fibres.

- The Ministry of the Environment and Water Resources should be consulted on the proper disposal and transportation of asbestos materials.

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COMPETENCY ELEMENT 3
Comply with safety and health management system

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Introduction on Safety & Health Management Systems

This Singapore Standard is prepared by the Occupational Safety and Health Management Technical Committee under the purview of the Management Systems Standards Committee and in consultation with the General Engineering and Safety Standards Committee.

The Workplace Safety and Health (General Provisions) Regulations requires certain classes of factories in the chemical industry in Singapore to set up a safety and health management system according to the elements provided in the Code of Practice on Safety Management System for the Chemical Industry. The Code of Practice is a set of process safety requirements developed jointly by the Ministry of Manpower and the chemical industry in 2001.

With the release of the occupational Health and Safety Assessment Series (OHSAS) 18000 series in 1999, many organisations have referred to the OHSAS 18001 for certification on top of the mandatory safety management system specified in the Code of Practice. This had resulted in a dual auditing system which requires organisations to be audited twice for a similar system, one for legal compliance and the other for business management and customer requirement.

In 2006, SS 506: Part 3 was then developed to meet the basic specifications in the SS 506: Part 1 and also the elements of the Code of Practice on Safety Management System for the chemical industry. The purpose of SS 506: Part 3 is to enable a single OSH management requirement satisfying both the OHSAS 18001 and the Code of Practice, as well as audit requirements for certification for the chemical industry.

In 2012, the Guidebook on Process Safety was publicised by the Singapore Chemical Industry Council (SCIC) and has been produced as reference for personnel involved in the chemical industry.

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3.1 Identify the structure of Occupational Safety and Health Management System (OSHMS)

Safety & Health Management Systems

The Safety and Health Management System is a systematic process for managing workplace safety and health, providing for goal setting, planning, performance measurements, and clear management commitments and direction. Under the WSH Regulations, Safety and Health Management Systems are mandatory for the workplaces listed below.

A. Any premises which is a worksite.
B. Any premises which is a shipyard.
C. Any factory engaged in the manufacturing of fabricated metal products, machinery or equipment and in which 100 or more persons are employed.
D. Any factory engaged in the processing or manufacturing of petroleum, petroleum products, petrochemicals or petrochemical products.
E. Any premises where the bulk storage of toxic or flammable liquid is carried on by way of trade or for the purpose of gain and which has a storage capacity of 5,000 or more cubic metres for such toxic or flammable liquid.
F. Any factory engaged in the manufacturing of —
   (a) fluorine, chlorine, hydrogen fluoride or carbon monoxide; and
   (b) synthetic polymers.
G. Any factory engaged in the manufacturing of pharmaceutical products or their intermediates.
H. Any factory engaged in the manufacturing of semiconductor wafers

Integral to the Safety and Health Management System is risk assessment. All workplaces must conduct risk assessments to identify the source of risks and shall take all reasonably practicable steps to eliminate any foreseeable risk to any person who may be affected by the undertaking in the workplace. Where it is not reasonably practicable to eliminate the risk, other reasonably practicable measures must be taken to minimise the risk.

Risk assessment, together with communication of risks, review and monitoring of the risk assessment, is part of the risk management process.

Audits & Reviews

Companies should review their Safety and Health Management System periodically to ensure there are continual improvements.

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Safety and Health Management Systems of the following workplaces must be audited by approved workplace safety and health auditors

Below are classification of workplaces that are required to be audited and the frequency:

	Classes or Description of Workplace	Frequency of Audit
1.	Any worksite with a contract sum of $30 million or more.	At least once every 6 months
2.	Any shipyard in which 200 or more persons are employed.	At least once every 12 months
3.	Any factory engaged in the manufacturing of fabricated metal products, machinery or equipment and in which 100 or more persons are employed	At least once every 12 months
4.	Any factory engaged in the processing or manufacturing of petroleum, petroleum products, petrochemicals or petrochemical products	At least once every 24 months
5.	Any premises where the bulk storage of toxic or flammable liquid is carried on by way of trade or for the purpose of gain and which has a storage capacity of 5,000 or more cubic metres for such toxic or flammable liquid.	At least once every 24 months
6.	Any factory engaged in the manufacture of - fluorine, chlorine, hydrogen fluoride or carbon monoxide; synthetic polymers; or	At least once every 24 months
7.	Any factory engaged in the manufacturing of pharmaceutical products or their intermediates.	At least once every 24 months
8.	Any factory engaged in the manufacture of semiconductor wafers	At least once every 24 months

Workplaces Requiring Internal Review

Below are workplaces that do not require audit but its Safety and Health Management System needs to be regularly reviewed:

	Classes for Description of Workplaces	Frequency of internal review
1.	Any worksite with a contract sum of less than $30 million.	At least once every 6 months
2.	Any shipyard in which less than 200 persons are employed.	At least once every 12 months

Clause 4: Elements of Safety and Health Management System:

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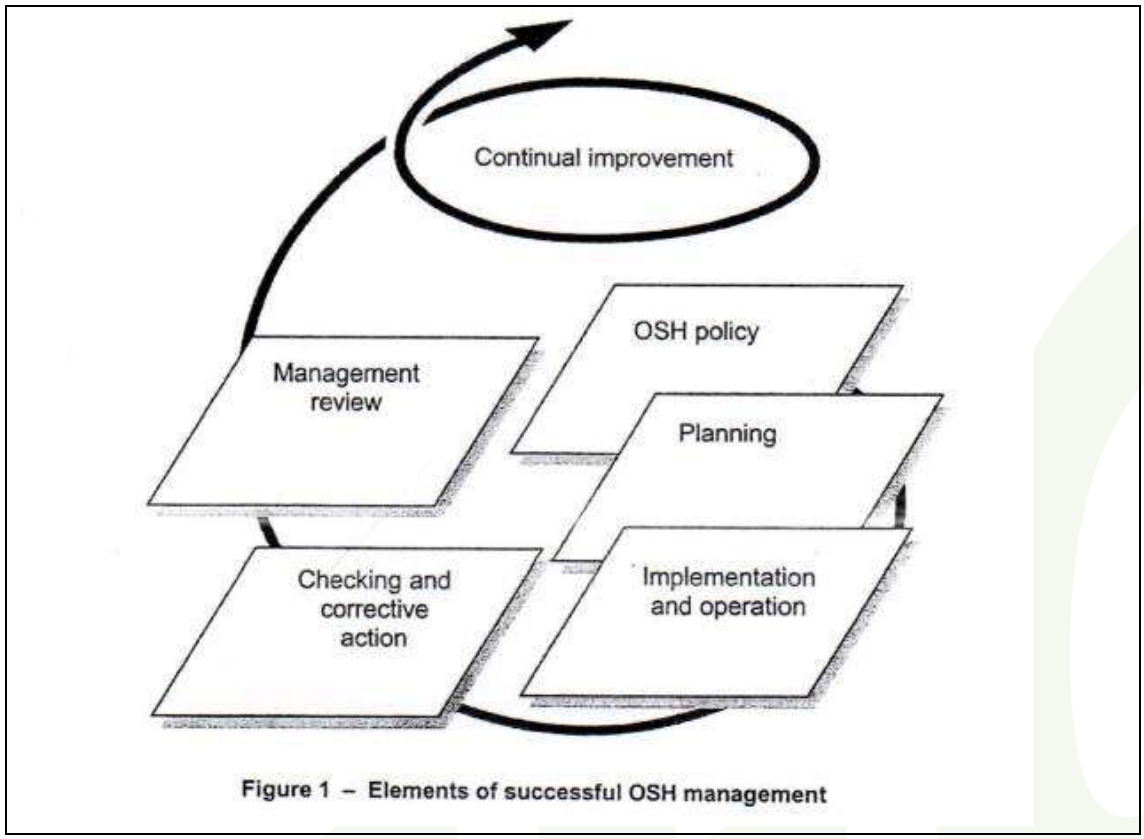

Figure 1 – Elements of successful OSH management

3.2 Recognise the core elements of Occupational Safety and Health Management System (OSHMS)

To fulfill the requirements, the company shall establish, document, implement, maintain and continually improve its OSH management system in accordance with the requirement of this standard. The organization shall define and document the scope of its OSH management system.

Clause 4.2: OSH Policy

The company shall have an occupational safety and health policy authorised and signed by the organisation's most senior person that clearly states overall safety and health objectives and a commitment to improving safety and health performance.

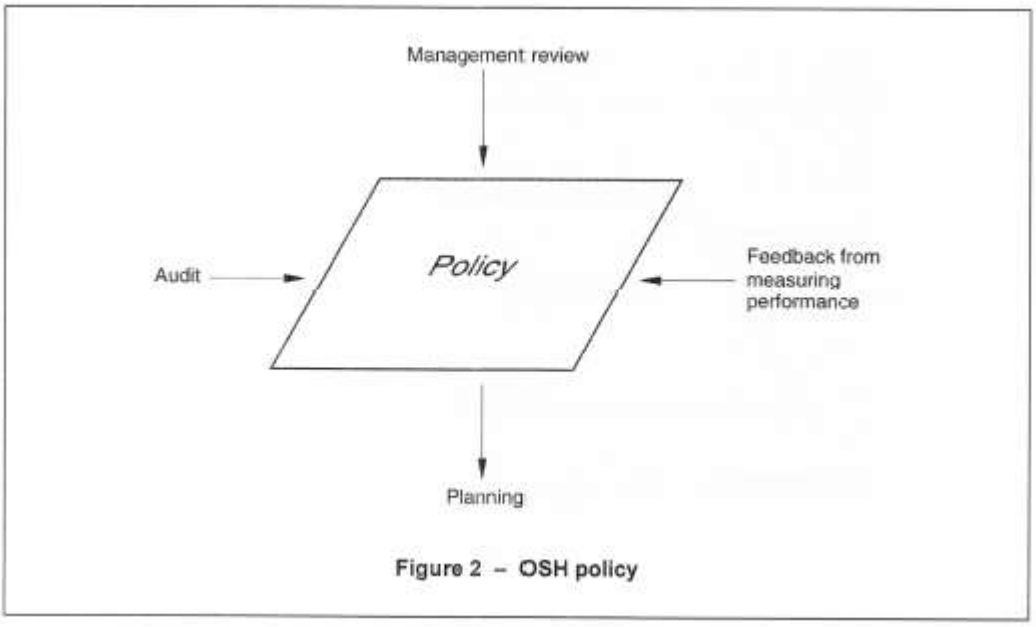

Figure 2 – OSH policy

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The policy shall:

a) be appropriate to the nature and scale of the organisation's OSH risks;
b) include a commitment to continual improvement and the importance to protect the safety and health and the general well-being of every personnel working in the organisation;
c) include a commitment to comply with applicable OSH legal requirements and with other requirements to which the organisation subscribes;
d) be documented, implemented and maintained;
e) be communicated to all persons working for or on behalf of the organisation with the intent that they are made aware of their individual OSH obligations and responsibility in preventing incidents;
f) be available to interested parties; and
g) be reviewed periodically to ensure that it remains relevant and appropriate to the organisation.

Clause 4.3: Planning

Planning includes for hazard identification, risk assessment and risk control.

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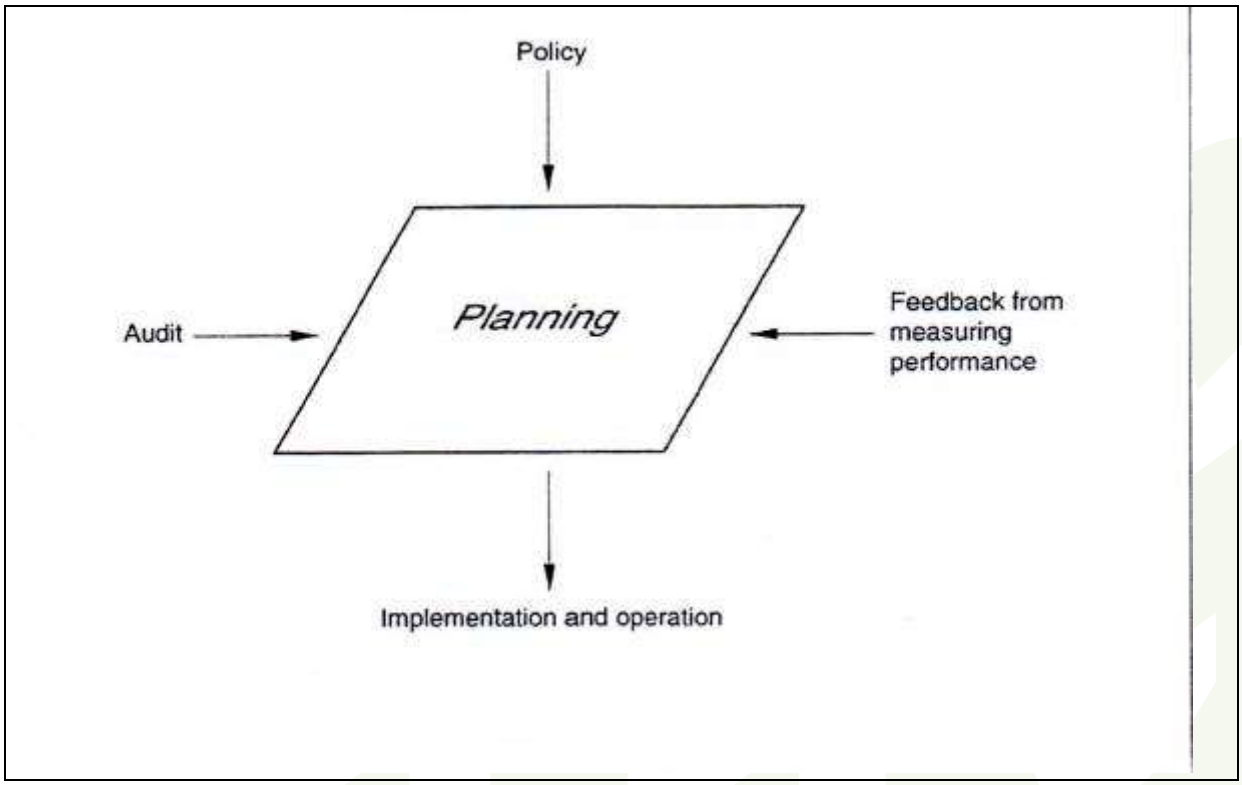

Clause 4.3.1: Planning for hazard identification, risk assessment and risk control

Clause 4.3.1.1 Process safety information

The company shall establish, document and maintain a compilation of the process safety information in order for the organisation to identify and understand the hazards associated with the processes and the workplace to have an effective integration of technologies, procedures, and management practices. The compiled process safety information will be a necessary resource for the organisation to perform the workplace/process hazards analysis and risk assessment, develop the training programmes and the operating procedures etc.

This process safety information shall include the following:

a) Information pertaining to the hazards of chemicals used or produced by the process. This information shall consist of at least the following:

- toxicity information;
- permissible exposure limits;
- physical properties;
- corrosivity data;
- thermal and explosive hazard data; and
- chemical incompatibility data.

NOTE - Safety Data Sheet (SDS) may be used to help meeting this requirement.

b) Information pertaining to the technology of the process.

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This information shall consist of at least the following:

- block flow diagram or simplified process flow diagram;
- process chemistry;
- maximum intended inventory;
- safe upper and lower limits for operations such as temperature, pressure, flow and
- composition safety and health related consequences of deviation.

c) Information pertaining to the equipment used in the process.

This information shall consist of at least the following:

- basis of safety;
- materials of construction;
- piping and instrumentation diagrams (P&IDs);
- hazardous area classification;
- relief system design;
- ventilation system design; and
- design codes and standards employed.

Process safety information shall be kept updated and available to relevant parties in the organisation.

Clause 4.3.1.2: Hazard identification, risk assessment and risk control

The company shall establish, implement and maintain procedure(s) for the ongoing identification of hazards (physical, chemical and biological hazards), the assessment of risks, and the implementation of necessary control measures to control risks in the workplace.

The hazard analysis shall include:

a) routine and non-routine activities;
b) activities of all personnel having access to the workplace (including contractors and visitors); equipment and materials at the workplace, whether provided by the organisation or others;
c) study on new or modifications to existing process, technology, equipment and use of
a. hazardous substances;
d) organised and systematic effort to identify, assess and address the significant risks associated with the process, facilities and the use of hazardous substances in the workplace; and
e) assessment of the potential harmful effect, the impact and control measures for a credible worst-case scenario in the workplace using either qualitative or quantitative techniques. The control measures to prevent the credible worst-case scenario from occurring and mitigation of the harmful effect and impact shall be documented and approved by the appropriate person at the senior management of the organisation. The control measures and mitigation methods shall be communicated to relevant parties of the organisation.

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The objective of the analysis is to ensure that the current OSH risks, which are either associated with the existing hazards or arising out of change or from new installation, are addressed and mitigated to as low as reasonably practicable.

The company shall ensure that the results of the analysis and the effects of these controls are considered when setting its OSH objectives.

The company shall document and keep this information up to date such that any new risks associated with hazards are identified and addressed as soon as possible.

The organisation's methodology for hazard identification, risk assessment and risk control shall be appropriate to the nature and complexity of the process and shall:

i) be defined with respect to its scope, nature and timing to ensure it is proactive rather than reactive;
ii) employ one or more recognised methodologies to identify hazards and assess the risks such as Checklist, What-if checklist, Risk Assessment Matrix, Job Safety Analysis, Hazard and Operability Study (HAZOP), Failure Mode and Effect Analysis (FMEA), Fault Tree Analysis or any in-house methodologies;
iii) be performed by a multi-discipline team as required by the methodology adopted;
iv) provide for the classification of risks and identification of those that are to be eliminated or controlled by measures
v) be consistent with operating experience and the capabilities of risk control measures employed;
vi) provide input into the determination of facility, equipment and materials requirements, identification of training needs and/or development of operational controls and/or safe work practices; and
vii) provide for the monitoring of required actions to ensure both the effectiveness and timeliness of their implementation.

The company shall maintain a system of periodic review to ensure recommendations are implemented to meet the intent. Follow-ups on recommendations shall be properly documented and communicated to relevant parties of the organisation.

Clause 4.3.2: Legal and other requirements

The company shall establish, implement and maintain a procedure(s):
a) to identify and have access to the applicable legal and other OSH requirements, and
b) to determine how these requirements apply to its OSH hazards and risks.

The company shall ensure that these applicable legal requirements and other requirements to which the organisation subscribes are fully addressed in establishing, implementing and maintaining its OSH management system.

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The company shall keep this information up-to-date, it shall communicate relevant information on legal and other requirements to its employees, personnel working for or on its behalf and other stakeholders.

Clause 4.3.3: Objectives and targets

The company shall establish, implement and maintain documented OSH objectives and targets, at each relevant function and level within the organisation.

The objectives and targets shall be measurable, where practicable, and consistent with the OSH policy, including the commitment to be in compliance with applicable legal requirements and with other requirements to which the organisation subscribes, and to continual improvement.

When establishing and reviewing its objectives and targets, an organisation shall take into account its legal and other requirements, its OSH risks, its technological options, its financial, operational and business requirements, and the views of interested parties.

Clause 4.3.4: OSH management programme(s)

The organisation shall establish, implement and maintain an OSH management programme(s) for achieving its objectives and targets. This shall include documentation of:

a) the designated responsibility and authority for achievement of the objectives and targets at relevant functions and levels of the organisation; and
b) the means and time-scale by which objectives and targets are to be achieved.

The OSH management programme(s) shall be reviewed at regular and planned intervals. Where necessary, the OSH management programme(s) shall be amended to address changes to the activities, products, services, or operating conditions of the organisation.

Implementation and operation

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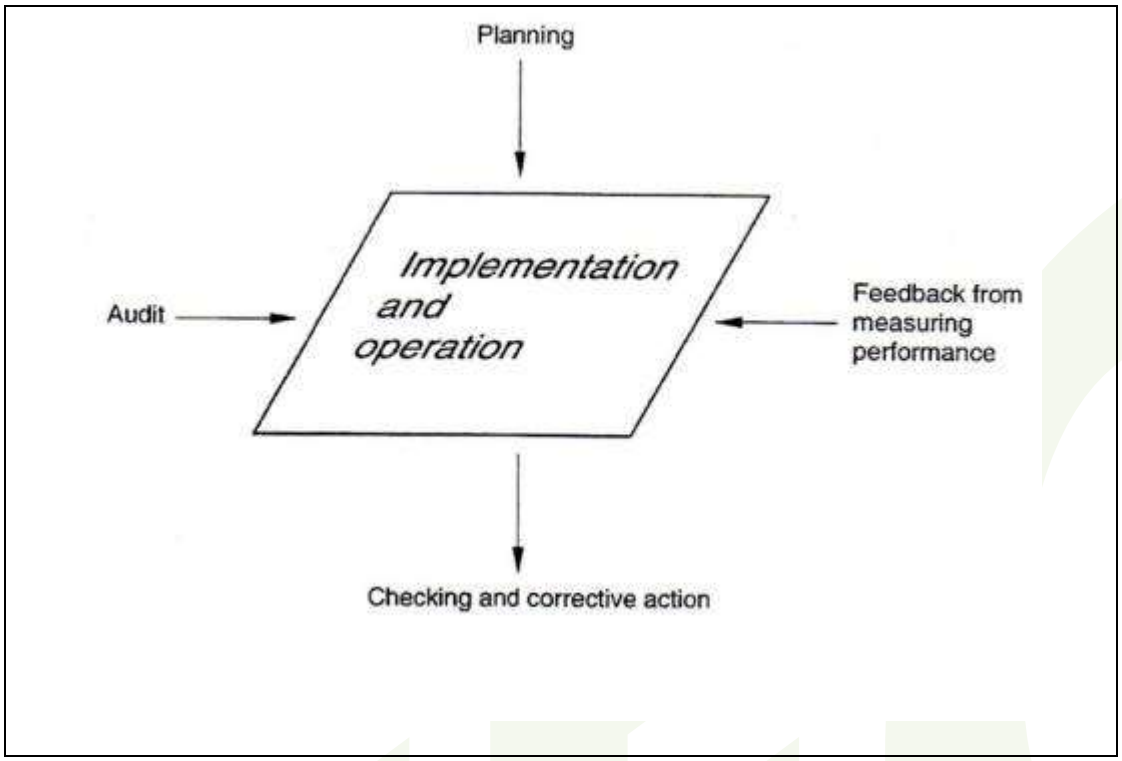

Clause 4.4.1: Structure, responsibility and authority and In-house OSH rules and regulations

Clause 4.4.1.1: Structure, responsibility and authority

An OSH organisational structure, consists of members of senior management led by an Appropriate senior person in the organisation, shall be responsible for the organisation safety and health management system.

The OSH organisational structure shall ensure that:

a) the roles, responsibilities and authorities of personnel driving and fulfilling the various safety and health management system requirements are clearly defined, documented and communicated;

b) the availability of resources essential to establish, implement, maintain and improve the OSH management system so as to meet the organisational OSH objectives and targets; and

NOTE - Resources include human resources and specialised skills, technology, financial resources and time.

c) the OSH consistency, accountability and compliance by making arrangements to:

i) develop and measure the mechanisms used by senior management for review and improvement of the OSH management system;

ii) promote a safety culture through positive feedback and coaching; and

iii) facilitate performance assessment of the OSH programmes and use it as part of the continual improvement process.

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Ultimate responsibility for occupational safety and health rests with the top management. The organisation shall appoint a member of senior management with responsibility for ensuring that the OSH management system is properly implemented and performing to requirements in all locations and spheres of operation within the organisation.

The OSH organisational structure shall ensure that its management appointee has defined roles, responsibilities and authority for:

a) ensuring that OSH management system requirements are established, implemented and maintained in accordance with this specification; and
b) ensuring that reports on the OSH performance is available to the appropriate function(s) of the organisation and be presented to top management for review and as a basis for improvement of the OSH management system.

All those with management responsibility shall demonstrate visible leadership and their commitment to the continual improvement of OSH performance and adopting a performance based to achieve the OSH objectives they set for the organisation. All stakeholders must take ownership of safety and health outcomes associated with their area of operation and work activities. They are accountable to eliminate, reduce and manage the risks at source as far as reasonably practicable.

NOTE - Duties may be allocated and delegated to line staff but top management shall retain overall accountability.

Within the framework of the OSH organisational structure, the organisation shall establish a Workplace safety and health committee, led by an appropriate member of senior management, for the purpose of improving, promoting, reviewing and communicating all safety and health matters in the workplace. The workplace safety and health committee shall have a clearly defined charter with prescribed functions and responsibilities.

Clause 4.4.1.2: In-house OSH rules and regulations

A set of basic OSH rules and regulations shall be formulated to regulate OSH activities and behaviours at the workplace. The rules shall include; but not limited to the following:

a) Operating procedures and safe work practices;
b) Incident and hazard reporting;
c) OSH training requirement;
d) Use of personal protective equipment;
e) Housekeeping and cleanliness; and
f) Fire prevention.

In the process of formulating the in-house OSH rules and regulations, reference shall be made to the relevant legal requirements, Singapore Standards and Codes of Practice, international standards and best practices. The in-house OSH rules and regulations shall be documented,

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effectively communicated and made readily available to all personnel including the contractors in the workplace.

The organisation shall periodically review the OSH rules and regulations to ensure its relevance and effectiveness. Records of such reviewed shall be maintained.

Clause 4.4.2: Training, awareness and competence

The organisation shall ensure that any person(s) performing tasks for it or on its behalf in the workplace shall demonstrate basic competencies in workplace safety and health. They should possess sufficient knowledge of safety and health to enable them to recognise potential hazardous situations, to know their responsibilities as per legal requirement and to know their roles in creating safe work and safe working conditions. Such knowledge, and that includes competency standards both generic and process-specific, could be imparted through formal courses or on-the-job training.

These persons include:

a) All front-line employees, contractors and vendors performing tasks in the workplace, such as supervisors and workers shall be knowledgeable in the OSH requirements for the task, and be competent in their skills;
b) All line-function supervisory staff of both employer and the contractors who plan to execute task in the workplace shall be competent in recognising roles and responsibilities of persons involved, effective communication on OSH preparation, sound understanding of the process operation, instrumentation equipment, and understanding of the documentation provided; and
c) Management staff of both employer and the contractors shall be competent in OSH management for the tasks carried out in the workplace, such as the permit-to-work system, and equipped in sufficient knowledge with tools and techniques needed for managing OSH at the workplace.

Competency shall be defined in terms of appropriate education, training and/or relevant experience.

The organisation shall identify training needs for each level of employees and contractors taking into account the applicable legal and other requirements and its OSH risks. It shall provide formal and on-the-job training or take other appropriate actions to meet these needs, evaluate the effectiveness of the courses conducted, periodically review the training programmes through feedback, maintain up-to-date and retain associated records.

The organisation shall establish, implement and maintain procedures and programmes to make persons working for it or on its behalf aware of:

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a) the importance of conformance to the OSH policy, relevant safe work procedures and practices including appropriate personal protective equipment, in-house OSH rules and regulations, and to the requirements of the OSH management system;
b) the OSH hazards and consequences, actual or potential, of their work activities and the OSH benefits of improved personal performance;
c) their roles and responsibilities in incident prevention and achieving conformance to the OSH policies and procedures and to the requirements of the OSH management system, including emergency preparedness and response requirements (4.4.8); and
d) the potential consequences of departure from specified operating procedures.

Training programme shall take into account the different levels of:
a) responsibility, ability, language, and literacy; and
b) OSH management and/or organisation's risk.

The effectiveness of training shall be measured and constantly reviewed by soliciting feedback from the employees, supervisors, managers and the contractors participating in the training courses. The organisation shall establish and implement promotional programmes to raise OSH awareness which should include the following:

a) conduct tool box meetings which provide the opportunity for operators and workers to discuss safety and health issues in relation to their work and to review the work carried out to highlight the potential hazards and necessary precautions to be taken;
b) OSH Improvement Teams to work through safety and health related projects for the purpose of improving the physical work environment and to reduce unsafe behaviours;
c) display of the OSH policy and commitment at strategic locations in the workplace;
d) conduct of structured or thematic OSH campaigns with active employees and contractors participation;
e) display of incident statistics and OSH performance charts;
f) conduct of topical OSH talks;
g) screen of OSH videos;
h) display of OSH sign, posters or other visual material to increase OSH awareness or to highlight a particular safety issues;
i) issue of OSH handbooks or brochures to both employees and contractors to increase awareness, as part of personal OSH training;
j) conduct first-aid and emergency response exercise and drills; and
k) organise visits to other organisations to share OSH practices and ideas.

3.4 Communicate to relevant stakeholders the requirement of OSHMS according to organization procedure.

Clause 4.4.3: Consultation and communication

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The organisation shall have a procedure(s) for ensuring that pertinent OSH information is communicated to and from persons working for or on behalf of the organisation, and other interested parties. This procedure(s) shall include:

a) internal communication among the various levels and functions of the organisation; and
b) receiving, documenting and responding to relevant communications from external interested parties.

The organisation shall arrange for persons working for or on behalf of to be:

a) involved in the development and review of OSH policies and procedures;
b) consulted where there are any changes that affect workplace safety and health;
c) represented on safety and health matters; and
d) informed as to who is their OSH representative(s) and specified management appointee

The involvement of employee consultation shall be documented and interested parties informed.

Clause 4.4.4: Documentation

The organisation shall establish and maintain documentation, in a suitable medium such as paper or electronic form. This shall include:

a) OSH policies, objectives and targets;
b) description of the scope of the OSH management system;
c) description of the core elements of the OSH management system and their interaction, and reference to related documents;
d) documents, including records required by this standard; and
e) documents, including records, determined by the organisation to ensure the effective planning, operations and maintenance of process system and items of plant, machinery and equipment.

NOTE - It is important that documentation is kept to the minimum required for effectiveness and efficiency.

Clause 4.4.5: Control of document

Documents and data required by the OSH management system and by this standard shall be controlled. The organisation shall establish, implement and maintain a procedure(s) for controlled documents to ensure that:

a) they can be located via maintaining a filing list of the controlled document and data;
b) they are periodically reviewed, revised as necessary and approved for adequacy by authorised personnel or by personnel who certified the original documents and data;
c) current versions of relevant documents and data are available at all locations where operations are essential to the effective functioning of the OSH system;
d) obsolete documents and data are promptly removed from all points of issue and points of use or otherwise assured against unintended use;

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e) documents of external origin determined by the organisation to be necessary for the planning and operation of the OSH management system are identified and their distribution controlled; and

f) archival of documents and data retained for legal or knowledge preservation purposes or both, are suitably identified.

Clause 4.4.6: Operational Control

Clause 4.4.6.1: General

The organisation shall establish, implement and maintain arrangements to ensure the effective application of safe operation in the workplace. These arrangements include the application of control measures to manage operational risks and in fulfilling the OSH policy, objectives and targets, and conforming to legal and other requirements. The organisation shall ensure the arrangements are properly supported by systems in-placed such as routine operations, maintenance work, emergency response, management of hazardous substances, management of change and equipment operation. The system in-placed can be carried out under specified conditions by:

a) establishing, implementing and maintaining documented procedures to cover situations where their absence could lead to incidents or deviations from the OSH policy and objectives;
b) stipulating operating criteria and know-why and know-how knowledge in the operating procedures for all routine operations;
c) establishing, implementing and maintaining procedures related to the identified OSH risks of goods, equipment and services purchased and/or used by the organisation and communicating relevant procedures and requirements to suppliers and contractors; and
d) establishing, implementing and maintaining procedures and, engineering standards for the design of workplace, process, installations, machinery, equipment maintenance ope rating procedures and work organisation, including their adaptation to human capabilities, in order to eliminate or reduce operational risks at their source.

Clause 4.4.6.2: Operating procedures and safe work practices

The organisation shall develop, implement and maintain operating procedures and safe work practices to administer the process critical operating steps, process parameters and control of work.

Operating procedures shall be in written form describing operating tasks to be performed, operating conditions to be maintained, records of operating conditions, samples to be collected, and occupational safety and health precautions to be taken. Operating procedures shall also be prepared for both normal and foreseeable emergency start-up and shutdown operations as well as ad-hoc or non-routine work such as maintenance work. Operating procedures also include the

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maintenance procedures of mechanical, civil, electrical and instrument equipment and devices in the workplace.

The process safety information package shall provide resources and references for the development of the operating procedures. The use of the process safety information shall ensure that the operating procedures are consistent with the known hazards identified in the processes and that the operating parameters are accurate. Operating procedures shall provide for any facility subject to the following:

a) Clear instruction and sufficient know-why explanation for the safe operation of equipment, instrumentation and facility that are consistent with the process safety information;

b) Process description with operating conditions and steps for the following phases operation:

i) start-up operation;
ii) normal operation;
iii) emergency operations, including emergency shutdowns;
iv) normal shut-down operation; and
v) other significant phases of operation such as plant clean-up or decontamination.

c) The operating limits resulting from the information specified in the process safety information and where safety considerations are present, a know-why description of the following:

i) the consequences of deviation;
ii) the steps required to correct or avoid deviation; and
iii) safety systems and their functions.

d) Occupational safety and health considerations including:

i) the properties of any hazards presented by the substances used in the process;
ii) special precautions to prevent exposure including engineering controls and use of personal protective equipment,
iii) the control measures to be taken if physical contact or airborne exposure occurs, and
iv) any special or unique hazards.

Safe work practices shall be established, implemented and maintained for ad-hoc and non Routine work to ensure the safe conduct of operating and maintenance activities by employees as well as contract workers including the opening of process equipment or piping, lockout and tagout of energy sources, hot work, entry to confined space, working at height, use of crane and similar heavy equipment and excavation work. Safe work practices are usually applied throughout the entire workplace and normally in written form. Safe work practices shall conform to the most current provisions of any applicable local regulations.

A permit-to-work system or a system of authorisation, an important element of the safe work practices, shall be in place. The permit-to-work system describes the steps that the maintenance, contractors or any other person must adhere to in order to obtain the necessary clearance to get

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the work started. It should also provide clear steps to follow after the work is completed in order to provide closure for those that need to know the work is completed and equipment can be returned to normal status. Safe work practices shall be used in conjunction with the work permit to ensure that all precautionary measures are taken before the commencement of work.

Operating procedures and safe work practices are important sources for training of operation personnel. Operation personnel need to have a full understanding of the operating procedures and safe work practices. Operating procedures and safe work practices shall be communicated and made readily available to all employees and contractors. Operating procedures need to be reviewed and updated when there is a change in the process as a result of the management of change procedures. Any changes to operating procedures need to be communicated to the relevant personnel. In addition, the operating procedures and safe work practices shall be reviewed periodically to evaluate their relevance and adequacy. Operating procedures shall be reviewed periodically by operating personnel with technical competence against information in the process safety information to ensure that they are accurate and provide practical instructions on know-why as well as know-how to carry out work safely.

Examples: Confined Space Management Programme

The Confined Space Management Programme aims to enhance confined space hazard management and prevent deaths from chemical poisoning and asphyxiation during confined space work and rescue operations. Iso-tank operations in logistics, shipbuilding and ship-repairing industries, manhole works and other workplaces with confined space hazards are required to implement a confined space management programme consisting of the following elements: hazard identification, evaluation and control, entry-permit system, atmospheric testing and monitoring, ventilation and emergency response.

Initiatives include:

- identification of workplaces with confined space hazards
- raising awareness and capability building for confined space management
- implementing effective in-plant confined space programmes

Clause 4.4.6.3: Management of change

Workplaces are constantly subject to continual changes to increase efficiency, improve operability and safety, accommodate technical innovation, and implement mechanical improvement. Very often temporary repairs, connections, bypass or modification are added into the process out of operating necessity. Any of these changes can introduce new hazards or compromise the safeguards built into the original design. Care must therefore be taken to understand the process safety implications of any changes made.

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The organisation shall establish, implement and maintain a procedure(s) to address all hazards/concerns that may be introduced by any changes in process technology and in facilities. Changes in process technology can result from changes in production throughput, materials used, process testing, equipment unavailability, new equipment, new chemicals, new product, new technology and changes in operating conditions to improve production or quality. Changes in facilities include change in materials of construction, equipment specifications, piping reconfiguration, modification of equipment, process computer revisions and changes in alarms and interlocks.

This procedure(s) shall include:

a) means and methods to detect changes in process technology and in facilities and flag them for managing changes;
b) the process and technical design basis for the proposed change;
c) an analysis of possible OSH considerations, their potential hazards and the risk controls required as a consequence of the change;
d) the necessary modification to the current operating procedures;
e) the necessary documentation for the proposed change;
f) duration of the change; and
g) authorisation requirement and ensuring that appropriate measures are in-placed before approving the change.

Employee involved in the process shall be informed of, and trained in, the change to the process prior to start-up of the process. Changes shall be subjected to process hazard analysis. If a change results in a change to process safety information or operating procedures, they should be appended and/or updated accordingly.

Clause 4.4.6.4: Pre-start-up safety

The organisation shall establish, implement and maintain pre-start-up safety procedure(s) to ascertain the organisational readiness of the operating function and the technical safety and integrity of the new facility under construction prior to the introduction of hazardous substances.

New facility includes new processes, installation or major modification on plant facility. The pre-start-up safety process shall confirm that the following criteria are met and that their areas of concern are all rectified before the initial commissioning:

a) technical safety and integrity of the original design of the new facility has not been compromised;
b) construction and equipment is in accordance with specifications;
c) safety, operating, maintenance and emergency procedures are in-placed and are adequate;
d) hazard identification and risk assessment has been performed and risk controls implemented;
e) training of affected personnel has been completed and;
f) supporting functions are adequately prepared

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Clause 4.4.6.5: Contractors

The organisation shall have a process in place to ensure contractors meet the safety and health requirements consistent with those required of organisation employees when working on organisation property and when providing services for the organisation. The organisation shall consider contractor's OSH performance as the key parameter for the selection process so that only contractors who can meet the organisation's OSH performance standards and requirements are permitted to work in the workplace. This procedure(s) include the following:

a) accountabilities and active engagement of contractors towards OSH requirements;
b) contractor's effort to conduct health screening of its workers and eliminate work injuries;
c) selection and evaluation of contractors to ensure that contractor has the appropriate job skills, knowledge and certification;
d) selection and evaluation based on OSH performance indicators such as contractor's OSH policy, OSH management system, OSH track records, training records and work procedures. The selection system may incorporate a formal system for pre-approval of contractors' for major or specialised work in the workplace. New contractors who are not in the pre-approved list will have to be subjected to a selection and evaluation process prior to inclusion in the pre-approved list;
e) periodic evaluation of contractor safety performance and assessment of contractor safety management programme;
f) OSH responsibilities and obligations that the contractors have to comply with upon selection of the contractors;
g) provision of OSH induction training for contractor personnel prior to the commencement of work. The induction training shall cover key areas such as procedures for reporting of incident and emergency situations and basic in-house rules and regulations;
h) on-site verifications of their workers pertaining to OSH training attended and skills certification and experience; and
i) inspection and checking of contractors' equipment before they can be taken into use in the workplace.

Clause 4.4.6.6: Mechanical integrity and reliability

The organisation shall establish, implement and maintain procedure(s) to ensure on-going Mechanical integrity and reliability of all equipment, electrical system and instrumentation (herein referred as hardware). A risk-based approach shall be adopted in order to improve the availability, integrity and reliability of hardware to reduce unplanned shutdowns and process upset conditions.

This procedure(s) shall address the establishment of written maintenance procedures for all the hardware; implementing inspection and testing programme; training of maintenance and contractor personnel who need to interface with these hardware; quality control and assurance of maintenance parts and equipment; and developed and maintaining reliability analysis for on-going equipment and facilities.

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This procedure(s) shall include the following provisions:

a) compile and categorise a list of process equipment, electrical system and instrumentation for inclusion in the mechanical integrity programme. The list includes machines, equipment, pressure vessels, storage tanks, piping, relief and vent systems, fire protection system components, emergency shutdown systems, ventilation systems, alarms and interlocks. The organisation shall prioritise this hardware in view of their critical OSH impacts resulting from mechanical integrity failure. Emphasis and closer scrutiny shall be planned for critical hardware;
b) establishment of work practices and maintenance procedures that ensure the mechanical integrity of the hardware;
c) maintenance inspection and testing programme to monitor the condition, structural and mechanical integrity of the hardware on a continuous basis. Such programme shall include the following items
    i) list of hardware and their safety critical indication;
    ii) the frequency and scope of inspection and testing;
    iii) procedure for inspection and testing, acceptable limits and criteria for passing the inspection and test;
    iv) documentation of inspection and test records and implementation of corrective actions which shall be reported to the responsible person; and
    v) system for reviewing changes in tests and inspections by designated persons.
d) training of maintenance employees and contractor workers in the maintenance tasks and the risk control measures. Maintain a selection system to ensure that maintenance employees and contractor workers are qualified;
e) quality control and assurance system shall ensure that the maintenance materials, spare equipment and parts used in the maintenance meet design specification, and any changes in material or equipment parts shall be appropriately reviewed before use. The system also helps to ensure that proper materials of construction are used, fabricated and proper inspection and installation procedures are carried out;
f) reliability analysis of hardware is applied in routine maintenance plan to ensure that appropriate intervals of check, inspection and testing are carried out for both corrosion and erosion rate of the materials of construction; and
g) development of long-term maintenance plan for periodic maintenance of major and critical equipment. Such plan shall be reviewed annually to take into consideration of the inspection findings, incident reports and regulatory requirements.

Clause 4.4.6.7: Control of hazardous substances

The organisation shall establish, implement and maintain procedure(s) for proper use, storage, handling, movement and disposal of the hazardous substances. This procedure(s) shall include:

a) the use of process safety information for the maintenance of a register of hazardous substances that is used, produced or otherwise encountered in the operations. Each hazardous substance shall be accompanied with appropriate Safety Data Sheet (SDS) to facilitate the risk assessment process and training of employees and contractors on proper

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handling techniques and precautionary measures to observe during its use, handling, storage and disposal;

b) proper receipt, storage, issue, distribution, handling and safe use of hazardous substances which includes:
   i) storing hazardous substances in designated areas, which shall be suitable for the storage and secured against unauthorised access;
   ii) storing incompatible hazardous substances in different storage areas or in areas separated from one another by physical barrier;
   iii) providing hazard labels on the external shells of storage tanks, vessels and containers and warning signage at entrances to the storage and other appropriate areas;
   iv) training of hazard communication to all employees and contractors, who may be exposed to the hazardous substances, and that such training covers the hazards involved, safe handling procedures, personal protection and emergency response; and
   v) disposal of hazardous substances in accordance with regulatory requirements or manufacturer's recommendations;
c) procurement approval prior to the acquisition or purchase or trial use of all hazardous substances until its chemical, physical and toxicological properties have been reviewed by the management of change procedure ; and
d) inventory management of the hazardous substances to ensure inventory stored at the process areas or at other designated storage areas shall not be in excess of the capacity for production or regulatory requirements as specified in the process safety information.

Example: Hazardous Chemical Management Programme

The Hazardous Chemical Management Programme covers chemical manufacturers and workplaces using hazardous chemicals. The objectives of the programme are to prevent and control chemical hazards and protect persons at work against such hazards.

Companies under the programme are required to implement an in-plant chemical management programme consisting of the following key elements: hazard communication (labelling and safety data sheet), training and education, hazard assessment and control (with respect to storage, handling and disposal of chemicals), personal protection equipment, workplace monitoring, medical surveillance, and emergency response.

The programme entails

- identification, evaluation and control of chemical hazards
- review of exposure limits
- regular monitoring or assessment of chemical exposure

Results of regular exposure monitoring are submitted to MOM and captured in our chemical exposure database. Where exposure levels are excessive, intervention actions will be taken.

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Clause 4.4.7: Occupational Health

Clause 4.4.7.1: Medical surveillance

The organisation shall establish, implement and maintain procedures to monitor the health status of employees who are exposed to excessive noise or certain toxic chemicals that have biological exposure indicators. The main objective of medical surveillance is to detect early signs of over-exposure to toxic chemicals or noise and thus help to prevent occupational diseases.

Medical surveillance shall include identification of employees and contractors at risk, regular biological monitoring, medical treatment of occupational diseases or illnesses, and health education of employees.

Biological monitoring is an essential component of medical surveillance. Where relevant, it shall include audiometric examinations for persons exposed to excessive noise, taking blood or urine samples for specific analysis, checking the functions of the lungs, liver or kidneys, and looking for signs and symptoms of occupational disease through physical examinations or chest X-rays.

Examples: Occupational Health & Hygiene Monitoring and Surveillance

The Workplace Safety and Health Act requires all stakeholders to ensure that risks to people's health are minimised. The subsidiary regulations require Employers to carry out two types surveillance: Medical Monitoring and Hygiene Monitoring.

- Medical Monitoring
- Hygiene Monitoring

Companies should conduct regular inspections to uncover safety or health lapses at the workplace. Such inspections also help to educate workers on the hazards they might face at work.

Clause 4.4.7.2: Hearing conservation

The organisation shall establish, implement and maintain procedure(s) to ensure that employees and contractors are adequately protected from exposure to noise levels exceeding the permissible exposure levels. The objective is to conserve the hearing of employees and minimise the risk of hearing loss.

This procedure(s) shall include:

a) display warning signage in all identified areas of the workplace where noise exposure exceeds the permissible exposure levels
b) regular monitoring of noise levels;
c) reduction of noise levels through engineering control measures;
d) selection, provision and maintenance of suitable hearing protectors;

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e) pre-employment and annual audiometric examinations of all exposed workers;
f) supervision of the usage of hearing protectors; and
g) training and education of employees and contractors.

Examples:

Noise Induced Deafness Prevention Programme

The NID Prevention Programme (NIDPP) aims to reduce the incidence of Noise-induced Deafness (NID). The target of this programme includes workplaces with noise hazards in the manufacturing, shipbuilding/ship-repairing and construction sector, through a series of outreach and enforcement activities. Key elements of the in-plant HCP include noise monitoring, noise control, hearing protection, audiometric examinations and health education.

Initiatives under this programme include:

- strengthening legislative requirements
- identifying noisy workplaces for surveillance and control
- managing noise hazards at workplaces through the implementation of in-plant Hearing Conservation Programme (HCP)
- raising awareness and building capability in noise hazard management

Asbestos Control Programme

The Asbestos Control Programme aims to eliminate asbestos-related diseases over the long term through progressive elimination of asbestos use, and the minimisation of exposure during the use and removal, and management of asbestos in buildings. Target processes include work involving removal and abatement of asbestos in buildings, vessels and other premises.

The programme involves

- strengthening the legislative requirements for asbestos removal work
- introducing a licensing scheme for asbestos removal contractors
- raising awareness and capability building; engagement and enforcement

MOM works with the Building Control Authority, National Environment Agency and other relevant stakeholders in implementing the programme

Clause 4.4.7.1: Respiratory protection

The organisation shall establish and maintain procedure(s) to ensure that employees who are exposed to a significant level of airborne contaminants (e.g. toxic dusts, fumes, mists, gases and vapours) are adequately and effectively protected by wearing suitable respirators. This procedure(s) shall include:

a) identification of the need for respiratory protection;

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b) regular monitoring of air contaminants;
c) reduction of air contaminants levels through engineering and administrative control measures;
d) selection, provision and maintenance of suitable respirators;
e) training of employees in the proper use, limitations and maintenance of respirators;
f) fit testing of respirators;
g) supervision of the usage of respirators and
h) medical evaluations of persons who are required to wear respirators.

Clause 4.4.8: Emergency preparedness and response

The organisation shall establish, implement and maintain an emergency response plan and a procedure(s) for each level of the organisation to:
a) identify potential incidents, accidents and emergency situations and their impacts; and
b) prevent and mitigate the likely illness and injury that may be associated with them.

The emergency response plan shall include the following:
a) establishment of a designated emergency control centre with the following necessary facilities and equipment to deal with any foreseeable emergencies:
   i) workplace and process layout maps or drawings;
   ii) fire fighting system and utilities drawings; and
   iii) emergency communications, lighting and emergency response equipment;
b) establishment of emergency team and their duties and responsibilities;
c) appointment of person-in-charge who shall command the emergency response plan;
d) emergency response notification and raising of alarms;
e) initial response to emergency situations such as preliminary fire-fighting, first-aid and containment responses;
f) response for evacuation and rescue, first aid and medical facilities; and
g) capability of nearest government response agency, their roles and the response time to the emergency situations.

The organisation shall periodically review and, where necessary, revise its emergency Preparedness and response plans and procedures, in particular, after the occurrence of incidents, accidents or emergency situations. The organisation shall also establish a programme of drills and exercises to periodically test such procedures, where practicable.

Clause 4.5: Checking and corrective action

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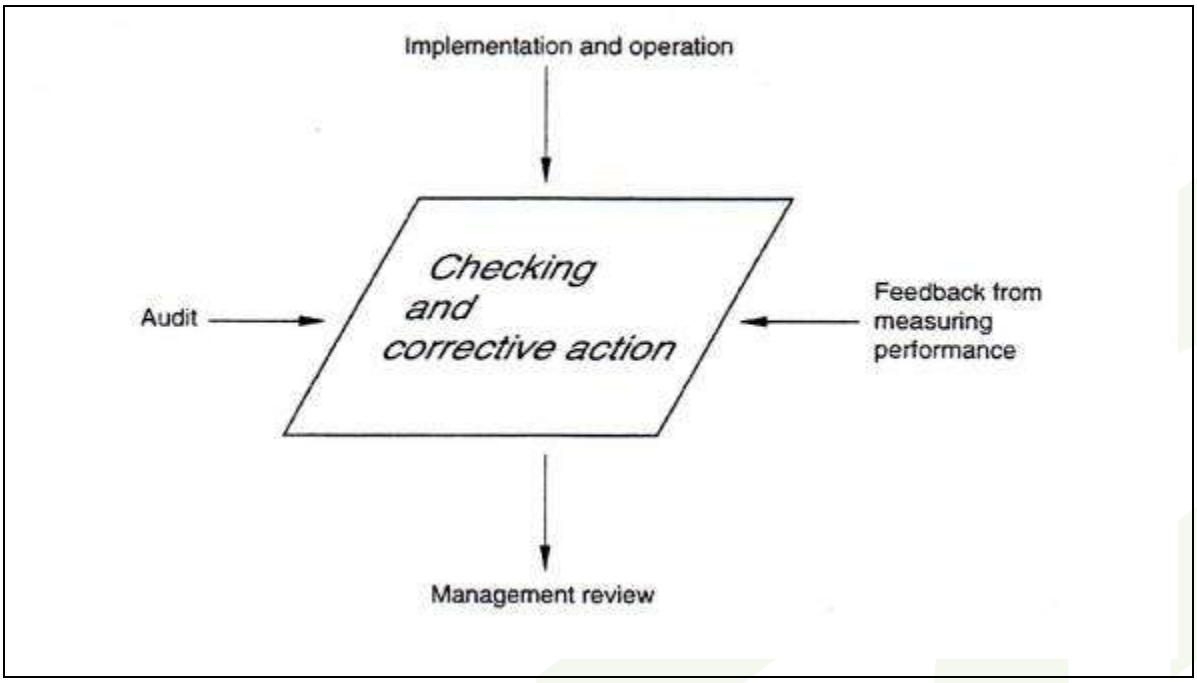

3.3 Check to ensure compliance of OSHMS

Clause 4.5.1: Performance measurement and monitoring

The organisation shall establish, implement and maintain a procedure(s) to monitor and measure OSH performance on a regular basis.

This procedure(s) shall provide for:

a) both qualitative and quantitative measures, appropriate to the needs of the organisation;
b) monitoring of the extent to which the organisation's OSH objectives and targets are met;
c) proactive measures of performance that monitor compliance with the OSH management programme and operational criteria;
d) reactive measures of performance to monitor accidents, ill health, incidents (including near-misses) and other historical evidence of deficient OSH performance; and
e) recording of data and results of monitoring and measurement sufficient to facilitate subsequent corrective and preventative action analysis.

Appropriate monitoring of work environment or employees who are exposed to chemical agents or physical factors shall be carried out to ensure that those hazardous agents/factors are within the permissible levels.

If monitoring equipment is required for performance measurement and monitoring, the organisation shall establish and maintain procedures for the calibration and maintenance of such equipment.

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Records of calibration and maintenance activities and results shall be retained.

The organisation shall monitor and evaluate the OSH performance of contractors in conformance with internal standards and within the limits as specified in the contract and should maintain and record OSH performance statistics for contractor companies working in the workplace.

Disciplinary or corrective procedures shall be applied where OSH performance is found unacceptable or breaching the internal standards, rules and regulations.

Clause 4.5.2: Evaluation of compliance

Clause 4.5.2.1:
Consistent with its commitment to compliance, the organisation shall establish, implement and maintain a procedure(s) for periodically evaluating compliance with applicable legal requirements.

The organisation shall keep records of the results of the periodic evaluations.

Clause 4.5.2.2:
The organisation shall evaluate compliance with other requirements to which it subscribes. The organisation may wish to combine this evaluation with the evaluation of legal compliance or to establish a separate procedure(s).

The organisation shall keep records of the results of the periodic evaluations.

Clause 4.5.2.3: OSH inspection

The organisation shall ensure that OSH inspections are conducted at planned intervals to verify compliance with applicable legal requirements, in-house safety rules and regulations and safe work practices. OSH inspection programme(s) shall be planned, established and maintained.

The programme should include Workplace Safety and Health committee inspection, routine OSH inspection, plant and equipment inspection and other special or surprise inspection. A list of protocol or checklist shall be established for identifying workplace hazards that covers comprehensively the workplace, equipment, tools, materials and work practices.

The organisation shall establish performance standards for the OSH inspectors. The standards shall specify the following:

a) the competency of OSH inspector - appropriate training shall be provided to personnel
b) involved in the inspection;
c) the frequency of the OSH inspection - this shall commensurate with the organisation's business operations; and the scope and coverage of the OSH inspection.

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The organisation shall establish an evaluation programme to assess the effectiveness of the OSH inspection system and to ensure standards are met.

Clause 4.5.3: Incidents, accidents, nonconformity, corrective action and preventive action

The organisation shall establish, implement and maintain a procedure(s) to ensure that incidents and potential nonconformity(ies) that result in or could reasonably have caused injuries, illnesses or release of hazardous substances be investigated, investigation shall be initiated as promptly as possible, considering the necessity of securing the incident scene and protecting important evidence and testimony. The intent of investigation is to learn and implement lessons from incidents, accidents, actual and potential nonconformity(ies) and for taking corrective and preventive action to prevent recurrence.

The procedure shall define responsibility, authority and requirement for:

a) reporting, recording and investigation of:
   i) incidents;
   ii) accidents; and
   iii) nonconformities which include unsafe conditions/hazards and substandard behaviours / acts found during OSH inspections;
b) taking action to mitigate any consequences arising from incidents, accidents or nonconformities;
c) determining the root causes, circumstances and other relevant factors such as human factors etc.,
d) evaluating the need to revise the relevant risk assessment ,
e) evaluating the need for action(s) to prevent incidents, accidents and nonconformity(ies),
f) initiating and completing any corrective actions and preventive actions to be taken; and
g) confirming the effectiveness of corrective action(s) and preventive action(s) taken.

These procedures shall require that all proposed corrective and preventive actions are reviewed through the risk assessment process prior to implementation.

Any corrective or preventive action taken to eliminate the causes of actual and potential nonconformity(ies) shall be appropriate to the magnitude of problems and commensurate with the OSH risk encountered.

The organisation shall implement and record any changes in the documented procedures resulting from corrective and preventive action and communicate the lessons learned from the accidents/incidents to all relevant personnel in the organisation for information and awareness.

Analysis of all reported incidents and statistics should be carried out periodically to identify type, frequency, severity and root causes of incidents, accidents and nonconformity(ies). Such

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information shall be considered in establishing safety and health strategic plans, promotional progamme(s) and training courses.

Clause 4.5.4: Control of records

The organisation shall establish and maintain records as necessary to demonstrate conformity to the requirements of its OSH management system and of this standard, and the results achieved.
The organisation shall establish, implement and maintain a procedure(s) for the identification, storage, protection, retrieval, retention and disposal of records.
Records shall be and remain legible, identifiable and traceable.

Internal audit

The organisation shall ensure that internal audits of the OSH management system are conducted at planned intervals to:

a) determine whether the OSH management system:
i) conforms to planned arrangements for OSH management including the requirements of this standard;
ii) has been properly implemented and maintained; and
iii) is effective in meeting the organisation's policy, objectives and targets;
b) determine compliance with applicable legal and other requirements to which the organisation subscribes;
c) review the results of previous audits; and
d) provide information on the results of audits to management.

Audit programme shall be planned, established, implemented and maintained by the organisation, based on the results of risk assessments of the organisation's activities, and the results of previous audits.

Audit procedures shall be established, implemented and maintained that address:

a) the responsibilities, competencies, and requirements for planning and conducting audits, reporting results and retaining associated records, and
b) the determination of audit criteria, scope, frequency and methods.

Selection of auditors and conduct of audit shall ensure objectivity and the impartiality of the audit process.

Clause 4.6: Management review

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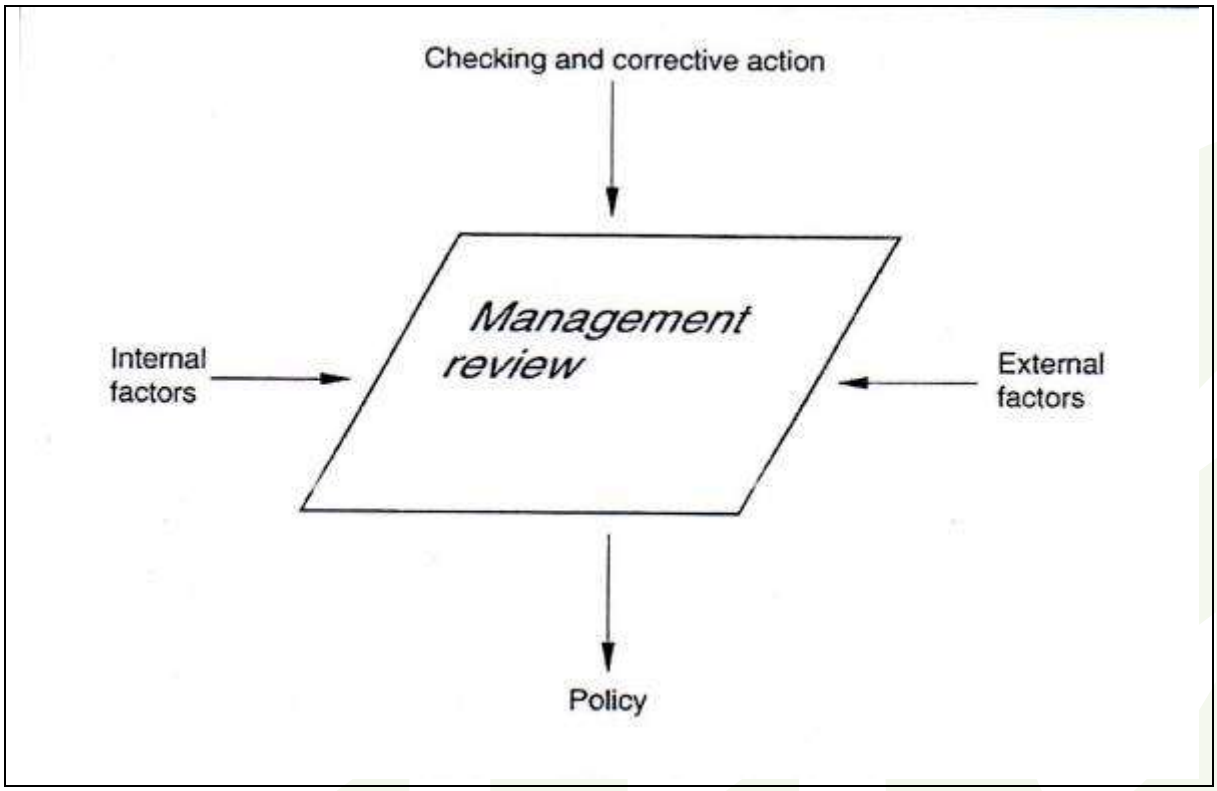

Top management shall review the organisation's OSH management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness. The management review process shall ensure that the necessary information is collected to allow management to carry out this evaluation.

Review shall include assessing the opportunities for improvement and the need for changes to the OSH management system, including the OSH policy, objectives and targets. Records of the management review shall be retained.

Input to management reviews shall include:

a) results of audits and evaluation of compliance with legal and other requirements to which the organisation subscribes;
b) communication(s) from external interested parties, including complaints;
c) OSH performance of the organisation;
d) extent to which objectives and targets have been met;
e) status of corrective and preventive actions;
f) follow-up action from previous management reviews;
g) changing circumstances, including developments in legal and other requirements related to OSH, and
h) recommendations for improvement.

The outputs from management reviews shall include any decisions and actions related to possible changes to OSH policy, objectives and other elements of the OSH management system, consistent with the commitment to continual improvement.

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Reference

- http://www.mom.gov.sg/workplace-safety-health/safety-health-management-systems/Pages/default.aspx
- Singapore Standard SS506 Part 1: 2009, Occupational Safety and Health (OSH) Management System - Requirements
- Singapore Standard SS506 Part 3: 2006, Occupational Safety and Health (OSH) Management System - Requirements for the Chemical Industry

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COMPETENCY ELEMENT 4
Follow a permit-to-work system

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4.1 Identify circumstances that require PTW

Permit-to-work (PTW) System

A permit-to-work system is a formal written system used to control certain types of work that are potentially hazardous. A permit-to-work is a document which specifies the work to be done and the precautions to be taken.

The permit to work system:

1. Specifies the work to be done and the equipment to be used
2. Specifies the precautions to be taken when performing the task
3. Gives permission for work to start
4. Advises occupants of the workplace that work is being performed within their building
5. Provides a check to ensure that all safety considerations have been taken into account, including the validity of permits and certificates and compliance to the workplace's policies and procedures and
6. On completion of work it provides a checking mechanism that all work has been completed to the workplace's satisfaction.

Why is PTW Required?

The objectives and functions of such a system can be summarized:

- Ensuring the proper authorization of designated work. This may be of certain types, or work of any type within certain areas, other than normal operations
- Making clear to people carrying out the work the exact identity, nature and extent of the job and the hazard involved, and any limitations on the extent of the work and the time during which the job may be carried out
- Specifying the precautions to be taken including safe isolation from potential risks such as hazardous substances and energy sources
- Ensuring that the person in charge of a unit, plant or installation is aware of all the work being done there
- Providing not only a system of continuous but also a record showing that the nature of the work and the precautions needed have been checked by an appropriate person
- Providing a procedure for times when work has to be suspended, i.e. stopped for a period before it is complete
- Providing a formal hand-over procedure for use when a permit is issued for a period longer than one shift or when permit signatories change
- Providing a formal hand-back procedure to ensure that any part of the plant affected by the work is in a safe condition and ready for reinstatement

4.2 Determine types of PTW required

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Types of PTW

Permits-to-work form an essential part of safe systems of work for many maintenance activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. A permit is needed when maintenance work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work. Examples of PTW include:

- entry into vessels,
- hotwork
- pipeline breaking
- Electrical work
- Excavation
- Radiography
- Work at height
- Crane work
- Road closure.

When Do We Need PTW System?

Permits to work should be considered whenever it is intended to carry out any work which may adversely affect the safety of personnel, the environment or the plant e.g. road work.
They are normally considered to be more appropriate to non- routine activities which may require some form of Job Safety Analysis prior to work commencing.

There will, however, be activities closely related to plant operations where PTW systems will be required. Maintenance work carried out by contractors, for instance, is usually be subject to PTW procedures. It is also advisable that companies assess the risk of their activities and list specific operations and types of work which should be subject to PTW.

It is not intended that PTW procedures be applied to all activities as experience has shown that their overall effectiveness may be weakened. It is very important for clear understanding by personnel moving from site to site, (especially contractors), that PTW systems are , as far as possible, harmonized between the different locations of the same company. It is essential that anybody starting work is familiar with the local instructions detailing when and how PTW systems are to be applied at a particular location.

Workplace Hazards

The oil and petrochemical industry has a great variety of safety and health hazards which includes but not limited to

a) Work at height related hazards – please refer to Module CE2a of this Guide
b) Fire and explosion hazards – please refer to Module CE2a of this Guide
c) Confined space related hazards – please refer to Module CE2b of this Guide
d) Mechanical hazards – please refer to Module CE2b of this Guide
e) Electrical hazards – please refer to Module CE2b of this Guide
f) Occupational health related hazards – please refer to Module CE2c
g) Traffic hazards

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Lock Out Tag Out
Please refer to Module CE2b of this Guide (for details)

Roles and Responsibilities
To ensure the permit to work system is effective all individuals involved must clearly understand and take an active role in meeting their responsibilities. Due to the potential hazards associated with permit to work, the specific responsibilities outlined below must be followed.

Occupier

To ensure:

- an appropriate PTW system is introduced
- Training programmes and competencies standards are established and maintained
- Monitoring/auditing/reviewing of the PTW system is established and maintained

Issuing Authority or Permit Issuer

To ensure:

- Identifies all hazards associated with the work
- Ensures all relevant parties agree and acknowledge the control measures,
- Ensure all control measures are implemented prior the issue of permit and commencement of work, eg, use of safety equipment and personal protection.
- Identifies any incompatibility arising from the activities of proposed work and those in the Process Unit, (so, cross referencing permits is essential)
- Ensures all personnel who may be affected by the activities are informed of all the potential hazards involved and the precautions to be taken
- Stipulates clearly the area and type of work to be carried out;
- Ensures adequate preparatory work are carried out;
- Identification of equipment and Location
- Isolation & removal of potential hazards,
- Blanking/spading, proper tagging (lock, tag & test)
- Equipment & surrounding environment (pipelines, vessels, columns, etc.) are safe
- Confirms all is SAFE at the worksite prior to signing and issuing permit.

Performing Authority Applicant or Permit Holder

The Applicant is normally a contractor that will carry out the work and is responsible for:

- Detailing on the permit the work to be done, the process unit / equipment to be worked on, the method to be used, the tools and appliances to be used.

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- Attaching to the permit any JSA, drawings or other details developed during planning of the work and assessment of the risks.
- Submitting the permit to Operations for the operational preparations to be made.
- Implemented all the safety requirements;
- Maintain safe conditions of work (work method and worker behaviors);
- Re-apply for permit if there is and change of condition / work arises;
- Stop work immediately in the event of emergency (understand emergency and reporting procedures);
- Ensure LOTO is done on equipment prior to work commencement.
- Discuss job fully with Permit Issuer before signing to accept permit.
- Show Work Team the exact location/ equipment to be worked on and
- Explain the details of the work, any potential hazards and precautions to be taken.
- Ensure that the precautions are maintained throughout the work, and the Work Team stays within the limits (process unit, types of work, time) specified on the permit.
- Displaying the permit and attachments at the worksite.
- Stop work and report to Permit Issuer if conditions at site change adversely.
- Ensuring housekeeping is done on completion of the work.

Authorised Safety Assessor / Gas Tester

- Plays an important role in the issue of permits;
- He determines the conditions for safe work including oxygen, flammable & toxic gas concentrations and record the readings

Workmen

Workmen in the work team to ensure

- They have received instruction and good a good understanding of the PTW system at the installation where they work
- They do not start any work that require a permit, until it has been properly authorized and issued
- They receive a briefing from the supervisor on the particular task and they understand the hazards and the precautions taken or to be taken
- They follow the instructions specified in the permit
- When they stop work, the site and any equipment they are using is left in a safe condition
- If in doubt or if circumstances change, they must stop work and consult with their Supervisor.

Contractor's Management

To ensure

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- They are informed of and understand the broad principle of the PTW system for the locations where their employees are to work
- Their employees have been given the appropriate training and understand the operations of the PTW system and their specific responsibility
- They monitor the training of their employees
    - Ensuring contractors have current workers compensation insurance
    - Ensuring contractors have public liability insurance and that certificates of currency are provided by the contractor prior to commencing work
    - Ensuring the safe execution of any hot work, and shall have authority to enforce the company requirements with respect to employees, contractors and other workers.

Competencies

Performing Authority Applicant and Permit Holder

- Have full working knowledge of PTW system, roles of signatories.
- Able to progress and deal with administration of permits.
- Fully experienced in all operational preparations including isolation and clearance of process materials.
- Able to integrate Risk Assessment, JSA and PTW systems to provide a safe work system
- Lead multidisciplinary teams to develop JSA for high risk tasks.
- Identify any incompatibility between proposed work and other activities in the process unit
- Monitor effectiveness of controls applied, intervene and rectify if necessary .
- Recognize changes in process conditions or the working environment that may require work to be stopped.
- Fully familiar with the legal regulations and company guidelines.
- Fully familiar with the operation of gas testing equipment and the acceptable limits for the commonly found gases.
- Have a detailed knowledge of relevant procedures and work instructions, including those associated with maintenance and shutdown activities.
- Explain the activities, hazards and controls to workers in toolbox meetings.
- Supervise work that is under permit control.
- Able to identify changes in conditions or activities that require the work to be stopped.

Authorised Safety Assessor / Gas Tester

- Know the acceptable concentration for the hazardous gases in the work environment.
- Fully familiar with the operation of gas testing instrument and able to interpret the results of tests.
- Recognise changes in process conditions or the working environment that may require work to be stopped.
- Able to calibrate and maintain the gas testing instrument.

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Preparatory work

Preparation of Work Area

The relevant work area and plant shall be prepared to eliminate or minimize the risk of incident such as potential for fire, explosion, or exposure of persons to a hazardous substance.
Precautionary measures shall include the following, as appropriate:

- identification of equipment to be worked on and any other equipment that may be affected
- energy isolation of the equipment, such as depressurization and disconnection
- removal of hazardous substances in the immediate work area that may be impacted by the work
- preparation of piping such as sewers, drain that may have the presence of hazardous or flammable substances
- provision of appropriate rescue or fire-protection equipment
- where required, atmospheric testing of the work environment for the flammable or hazardous vapours and oxygen content.

Permit Receipt and Acceptance

The permit receiver is required to sign the permit confirming their understanding of work to be done, hazards involved and precautions required.

Communication

The permit receiver is required to communicate the requirements specified on the permit to any workers involved in the work described in the permit.
If at any time conditions in the workplace change, the permit receiver must stop work and communicate this to the permit issuer.

Arrival at site

On arrival at the work area the employee/contractor notifies the appropriate person within the building/area that they have arrived to perform specified work.

Work commencement

Prior to beginning work the employee/contractor ensures that the site is controlled as per the requirements identified on the permit. Employee/contractor completes work as detailed in the permit and their contract/job specifications. Access to restricted areas will be granted for the duration of the permit via key access procedures if appropriate.

Where work is required to extend beyond the timeframe of the permit, the permit receiver must communicate this to the permit issuer. The permit receiver must ensure that a new permit is received before for the existing permit expires for continuation of the job.

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Duration

As conditions in the work environment may change permits are valid only for a specific period of time. Work permits shall be valid until the specified date on the work permit. Hot work permits are valid for eight hours.

Gas test

Gas test are required for hot work and confined space entry permits. Gas testing shall be conducted by a person who is competent in the gas test operations and the use of the relevant equipment. The test instrument shall have current calibration, which shall be displayed on the unit. The instrument type, serial number and date of calibration due shall be recorded on the permit. Testing for the presence of any flammable gas or vapours shall take place as late as practical before the commencement of hot works but no longer than two hours before. This includes continuous testing at all potential sources.

Confined Space

Before a person enters a confined space, it shall be ensured:

- the confined space contains an oxygen level of between >19.5% to <23.5%
- the concentration of flammable contaminant in the atmosphere is below 1% of its LEL
- the atmospheric contaminants in the confined space are reduced to below the relevant permissible exposure standards

If work stops for a period of more than one hour a re-test may have to be required.

Hot Work

Hot work requires the issue of a hot work permit prior to the task commencing. Hot work may only occur in the designated location as written on the permit. Hot work permits are issued for work that is non routine and/or the type of work is not normally performed in the specified location. Company areas designated for hot work (such as a workshop e.g. engineering) do not require the issue of a permit.

Except for routine, non-hazardous work, any work within the restricted area shall be authorized by means of a work permit. The concentration of any flammable gas or vapours shall not be more than 1 percent of its lower explosion limit (LEL).

Cancellation

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Where a permit has been written and is not required to be issued it is required to be marked as cancelled. The marking should include two diagonal lines across the page with the word 'cancelled' written in between.

Work Completion and Commissioning

Prior to leaving the site the employee/contractor is to clean up the workplace to ensure it is tidy and left in a safe condition and perform a final inspection of the workplace to ensure no hazards remain. When leaving the work area the employee/contractor is required to advise the appropriate person within building/area that work has been completed and that they are leaving the building/area. Once the work activity is complete, the permit receiver is required to return the permit to the permit issuer. When the permit issuer is satisfied that work has been completed to job specifications and safety requirements they may sign off the permit. On hand back of the work area the permit receiver should sign the permit stating that the work area is now ready to be returned to the issuer. On the completion of work and before the work area or plant is returned to service, a check shall be conducted to ensure:

- the work has been completed
- any temporary arrangements/installation such as temporary barricades, excavation holes etc have been removed
- all personnel and equipment are accounted for
- the work permit has been cancelled or signed-off as being completed, and
- all related equipment and facilities and fire systems are operational and have been inspected and tested appropriately.

Alarm Over-ride

A permit must be issued for any work involving overriding of any gas detection systems, fire alarm systems, fight protection system or process safe guarding systems. Once the permit is issued, both the Operations Shift Supervisor and the maintenance supervisor have to comply with the System Overriding Procedure.

4.3 Assist in preparing and submitting a PTW

PTW Processes

1) Application

- No Permit No Work
- Permit must be accompanied by specific instruction such as Method Statement or Job Safety Analysis (JSA)
- All Permit requirements must be complied with fully.
- Restrictive requirements must be understood and complied

2) Assessment

- Gas test must be conducted for Hot Work & Confined Space Work
- Re-application for extension of Permit duration

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3) Approval

- Permit must be appropriately authorised
- No alteration of Permit allowed
- Performing Authority must acknowledge acceptance of Permit

4) Execution

- Work ONLY in the process unit stipulated in the Permit.
- All Permit requirements must be complied with fully.
- Work Permit must be displayed at Job Site

5) Monitoring

- Permit automatically invalid when conditions changed
- Workers to notify supervisor immediately when conditions changed
- Stop work when emergency siren is sounded
- Revoked Permit cannot be reinstated without approval

6) Completion and Cancellation

- Upon job completion, Permit must be appropriately signed off
- Issuing Authority must acknowledge acceptance of completion of job.
- Permit to be kept for two years (legal requirement)

Guidelines
Identification of access controlled areas

A process is undertaken for the identification of workplaces or work locations requiring controlled access arrangements for all potential high risk areas within the company.
Areas requiring access control will be identified through the following:

- risk assessment
- WSH legislative requirements
- Company security arrangements.

Risk assessment

A risk assessment will identify the hazards in the company, this will be used to make a determination as to the type of access control to be implemented. Consideration will be given to the following:

- The skill level or specific qualification requirements of those required to enter the location
- The effectiveness of current control measures if any exist
- The potential for injury to employees and others without access arrangements being implemented.

A review of the risk assessment will occur when there are changes to processes, work practices or the company environment.

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Supervisors are responsible for identifying company locations and tasks where access control criteria are defined within legislative requirements.

Communication

Access control may be communicated through site maps or site plans which identify specific areas requiring access control. Alternative arrangements for the identification of specific areas requiring access control will be defined in local procedures. Adequate warning signs will also be displayed at or near any identified accessing control areas.

4.4 Ensure compliance to PTW according to legal and organization requirements

Types of permits

The company has determined through legislation, standards, industry practice and via a risk assessment that the following work activities require a permit in order to gain approval for the work to commence:

- Inert gas entry (working in nitrogen atmosphere)
- Confined space entry (drain pits, vessel pits and deep trenches)
- Hot work (welding, gas cutting and grinding)
- Excavations
- High pressure water jetting and blast cleaning
- Entry of vehicles (vacuum tankers and cranes into process units)
- Use of radiation sources
- Work at height
- Work on electrical equipment
- Cold Work (for activity involving hand tools only)
- Road Closure Permit

Permits are nominally issued by company officers to permit receivers which may include employees or contractors. The exception is that principal contractors may issue permits to sub-contractors only after approval from company. The permit issuer shall discuss the requirements and details of the work activity with the permit receiver.

Work extending over multiple permits issued requires communication and a handover of the relevant information pertaining to the job.

Associated documents

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Any work requiring a permit is considered to have a different risk compared to routine work. Each work activity requiring a permit also requires a risk assessment or safe work procedure attached to the permit.

Prevention and control

Energy and Process Material Isolation

Any energized equipment to be worked on must be isolated to ensure the energy is removed or controlled to prevent incidents. Where electrical isolation is effected at a removable or rack out circuit breaker or combined fuse switch, if practicable it must be racked out or removed, then locked open and danger tagged. Isolation of other services, i.e. gas, water or hydraulic systems are to be completed at the nearest point to the place of work, these systems are to be danger tagged and locked. After isolation check to ensure that the apparatus to be worked on is fully isolated and discharged of any stored energy that may be present (danger tags are only to be removed by the person issuing the tag).
Energy isolation must be conducted in accordance with CP91, Lock out and Tag out Procedure

Restricted Areas

There are areas of the company which are restricted to prevent unauthorized access and control the level of exposure to such things as mobile plant, electrical hazards, hazardous chemicals, hazardous machinery and electromagnetic radiation.

A risk management approach should be used to determine those areas requiring restricted access. This may be based on items such as:

- hazards and risk present
- nature of work or activities being performed
- working environment.

Generally restricted areas include, but not limited to:

- laboratories
- workshops
- confined spaces
- roofs
- waste stores
- chemical stores
- plant and process unit

These areas should not be restricted to operations staff who are trained and proficient in the operations of the machinery/equipment processes and who have a sound knowledge of the required safety procedures for the work area. Other staff/Contractors/visitors and those entering the area but are not working must be escorted by authorized persons. Controls for restricted areas

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should be routinely checked and tested to ensure the integrity of the installed access controls. A regular assessment should be performed to determine any additional areas that should be restricted using the restricted areas assessment form.

Hot Work

Prior to the commencement of hot work, the following precautions shall be undertaken:

- identify and control any fire hazard (including the presence of flammable or combustible liquids,
- gases, vapours, dusts, fibres or substances) within 15m from the hot work
- identify and control any hazards that may exist outside the area as described above
- identify the possibility of changing circumstances during the progress of the hot work and whether they may render the area unsafe for the work to continue
- ventilate the hot-work area
- identify and locate the equipment, including emergency firefighting equipment
- isolate the area where the hot work is to be performed
- ensure a safe entry and exit point from the hot-work area
- if specified by the hot-work permit, a firewatcher shall be stationed in the area near the hot work, for the purpose of safeguarding personnel and equipment.

Hot work permits may be prepared and authorized by the principal contractor and is required to be sighted and signed by the permit issuer. Where hot work is to be conducted in laboratory areas, the laboratory manager or supervisor is to be contacted.

Roof Access

The company recognizes that there are times people are required to access the roof of a building for a variety of purposes. Roof access requires a permit to be issued depending on:

- the nature of work
- working conditions
- workplace environment.

To ensure the roof area is safe for persons to perform the activity, a general inspection should be performed which recording details of the roof space. A completed roof access inspection checklist must be completed prior to the activity commencing in the area. A risk assessment is to be completed for any corrective actions identified through the inspection checklist or other hazards identified.

Confined Spaces

Where a confined space permit is required the permit issuer will sign the permit receivers confined space permit. This document must be sighted prior to a confined space permit being issued. More information regarding the procedure for working with confined spaces is outlined in

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the SS568 CP for Entry and working in Confined Spaces Guidelines. This document must be sighted prior to a confined space permit being issued.

Asbestos

Where work involving the removal or disturbance of asbestos containing material is conducted a permit is required from the permit issuer. A risk assessment is to accompany the permit to work form prior to work commencing. More information regarding the procedure for working with asbestos containing material is outlined in the Factories (Asbestos) Regulations

Reference

- http://www.powys.gov.uk/uploads/media/indg98_en.pdf
- http://safety.uwa.edu.au/policies/permit
- http://www.ogp.org.uk/pubs/189.pdf
- www.wshc.sg
- www.mom.gov.sg

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COMPETENCY ELEMENT 5
Conduct safety and health inspection

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Safety Inspections

Effective safety and health inspections are one of the most important incident/accident prevention tools in a company's safety and health program. Using properly trained inspectors in a planned inspection program will reduce incidents and property damage. An effective safety inspection program will improve worker communication, company morale and, over time, save the employer money.

Too often, safety inspections are aimed primarily at finding and recording unsafe conditions. This narrow focus tends to ignore other causes of incidents, such as unsafe actions and personal factors. In addition, workers and supervisors are generally well aware of the inspection teams arrival a day or two before the inspection. This warning system sometimes creates a preparatory atmosphere before the inspectors arrive. That means the inspectors often observe the workplace and those within it only on a superficial basis. The result is that safety inspectors rarely see the actual situations that are causing the incidents, injuries and property damage. In order for your inspection team to be effective, they must inspect the workplace in its day-to-day status. They must see the activities and the conditions in which incidents, injuries and property damage occur.

An inspection program takes planning, preparation and training. For inspectors to do a good job, they must receive training in what to look for and what to look at. There must be a guidance system in place to maintain consistency of inspections. A provision for recording and reporting any deficiencies to management, the safety committee and supervisors. The last part of the system should provide a means of follow up and the monitoring of any deficiencies identified.

5.1 Carry out safety and health inspection according to legislations and organisation's guidelines and procedures

Type of Safety Inspections

The various safety inspections to be carried out in the workplace can be classified as:

1) Statutory Examinations by Authorized Examiners e.g. boilers, steam receivers, air receivers, hoist, lift, lifting gear, lifting appliances, lifting machine, pressure vessels.
2) Mandatory examinations by Competent Person e.g. equipment for confined space rescue, scaffold, plant, tank or vessel which contains, or has contained, any explosive or flammable substance that are going to be subjected to process involving hot work
3) Mandatory inspections by Designated Person e.g. first aid boxes, inspections by WSH Committee Members and WSH Officers.

Meeting the Legal Requirements

Under the WSH (General Provisions) Regulations, these equipment have to be examined by Authorised Examiner:

Hoists and lifts

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Reg. 19 -

(1) No hoist or lift shall be used in a workplace unless an authorised examiner has —

(a) tested and examined the hoist or lift after its installation; and.

(3) every hoist or lift used in a workplace shall be thoroughly examined by an authorised examiner at least once every 6 months.

(10) In the case of a hoist or lift used in a workplace which is not powered with mechanical power —

(c) a thorough examination of the hoist or lift shall be carried out at least once every year by an authorised examiner.

(15) This regulation shall not apply to any lift which has been inspected and tested under the Building Maintenance and Strata Management (Lift and Building Maintenance) Regulations 2005 (G.N. No. S194/2005) and for which a Certificate of Lift Maintenance and Testing has been lodged with the Commissioner of Buildings.

Lifting gears

Reg. 20 -

(1) No lifting gear of whatever material shall be used in a workplace unless an authorised examiner has —

(a) tested and examined the lifting gear; and

(3) Every lifting gear used in a workplace shall be thoroughly examined by an authorised examiner at least once every year or at such other intervals as the Commissioner may determine.

(11) An inspector may at any time test any lifting gear and may prohibit its further use if he is not satisfied that the lifting gear is safe for the use to which it is put.

Lifting appliances and lifting machines

Reg. 21-

(1) No lifting appliance or lifting machine shall be used unless an authorised examiner has -

(a) tested and examined the lifting appliance or lifting machine; and

(17) An inspector may at any time test any lifting appliance or lifting machine and may prohibit its further use if he is not satisfied that the lifting appliance or lifting machine is safe for the use to which it is put.

Precautions with regard to explosive or flammable dust, gas, vapour or substance

Reg. 26 -

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(5) No plant, tank or vessel in a workplace which contains, or has contained, any explosive or flammable substance shall be subjected to any operation referred to in paragraph (3) (*a*), (*b*) or (*c*) unless such plant, tank or vessel has been inspected and a competent person has certified that -

(a) it is free from —

(i) any explosive or flammable substance; and

(ii) any fumes, gas or vapour arising from any such substance; or

(b) any explosive or flammable substance, and any fumes, gas or vapour arising from any such substance, have been rendered non-explosive and non-flammable, and that it is safe for the operation to be carried out.

Steam boilers

Reg. 28 -

(6) Every —

(a) electrical powered steam boiler referred to in paragraph (5), including all its fittings and attachments, shall be thoroughly examined by an authorised examiner at least once every 2 years and also after any extensive repair; and

(b) surface of the external shell of a steam boiler (which is pwered by electricity; has a maximum steam volume of not more than 40 litres and a safe working pressure of not more than 4 bars); shall be examined by an authorised examiner at least once every 6 years, and for the purpose of such examination, the insulation on the shell shall be removed completely.

(12) Every other steam boiler shall be examined by an authorised examiner —

(a) at least once every year; and

(20) Paragraphs (12) and (14) to (19) shall not apply to —

(a) any steam boiler with a maximum permissible working pressure not exceeding 0.5 bar;

Steam receivers

Reg. 29 -

(6) Every steam receiver shall be examined by an authorised examiner —

(a) at least once every 2 years; and

(b) after any extensive repairs.

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(11) However, Regulation (6) shall not apply to any steam receiver where the safe working pressure does not exceed 0.5 bar or the product of its safe working pressure and volume does not exceed 100 bar-litre.

Air receivers

Reg. 31 -

(5) Every air receiver shall be —

(a) thoroughly cleaned; and

(b) examined by an authorised examiner at least once every 2 years.

(12) Paragraphs (5) shall not apply to any air receiver where the safe working pressure does not exceed 0.5 bar or the product of its safe working pressure and volume does not exceed 100 bar-litre.

Pressure vessel containing hazardous substance

Reg. 33 -

(1) Owner of a pressure vessel used in any workplace that contains any hazardous substance to ensure that it is

(d) inspected by a competent person before use and thereafter within such period as the Commissioner may specify.

WSH (Confined Space) Regulations

Rescue operation

Reg. 23 -

(1) The responsible person of a person entering into or working in a confined space to

(c) ensure that there is a sufficient supply of suitable breathing apparatus, safety harness and ropes, suitable rescue equipment and suitable reviving apparatus which are -

(iii) thoroughly examined by a competent person at least once a month or at such other intervals as the Commissioner may require.

WSH(Scaffold) Regulations

Inspection of scaffolds

Reg. 26 -

(1) Occupier of a workplace in which a scaffold is constructed, erected or installed to ensure that no scaffold is used unless it has been inspected by a scaffold supervisor -

(a) upon completion of its construction, erection or installation, as the case may be;

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(b) thereafter, at intervals of not more than 7 days immediately following the date of the last inspection by the scaffold supervisor; and

(c) after exposure to weather conditions likely to have affected its strength or stability or to have displaced any part.

(4) This regulation shall not apply to —

(a) a trestle scaffold; or

(b) a scaffold, from no part of which a person is liable to fall more than 2 metres.

WSH (First Aid) Regulaions

Provision of first-aid boxes

Reg.4 -

(3) Every first-aid box provided in a workplace shall —

(c) be checked frequently to ensure that it is adequately equipped and that all the items in it are usable;

(f) be under the charge of a person appointed by the occupier of the workplace.

WSH(Workplace Safety and Health Officers) Regulations

Power of WSHO

Reg. 10 -

WSHO shall for the purpose of discharging his duties have the power to inspect and examine any machinery, equipment, plant, installation or article in the workplace.

WSH(Workplace Safety and Health Committees) Regulations

General inspection of factory

Reg. 11 -

(1) Occupier of a factory to ensure that the workplace safety and health committee of the factory inspects the factory at least once a month to ensure the safety and health of persons at work in the factory.

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Inspection of factory after accident or dangerous occurrence

Reg. 12 -

(1) Where any accident or dangerous occurrence has taken place in any factory —

(*a*) Occupier of the factory to ensure that the workplace safety and health committee of the factory immediately carries out an inspection of the factory;

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Planning

Safety and health inspection programs require planning. It is important that employers have adequate policies and procedures in establishing their safety inspection programs. Responsibility and accountability must be assigned, identifying who inspectors are and when inspections will be done.

The primary focus of this program should be accident prevention, through the maintenance of safe working conditions and the removal of any potential hazards that arise in the workplace.

Good inspection programs will also identify the items to be inspected and then set standards to be maintained in the workplace by supervision and workers. The program should include a system that will record inspections done and ensure that any problems identified are corrected by a responsible person who has the ability to carry out the necessary changes.

A follow-up system, through the safety committee and management, should be employed to ensure that all items are followed up and corrected. Once the inspection program is in place, the safety program should provide a means of monitoring it to see if trends arise that may be contributing to the company's accident or injury problems.

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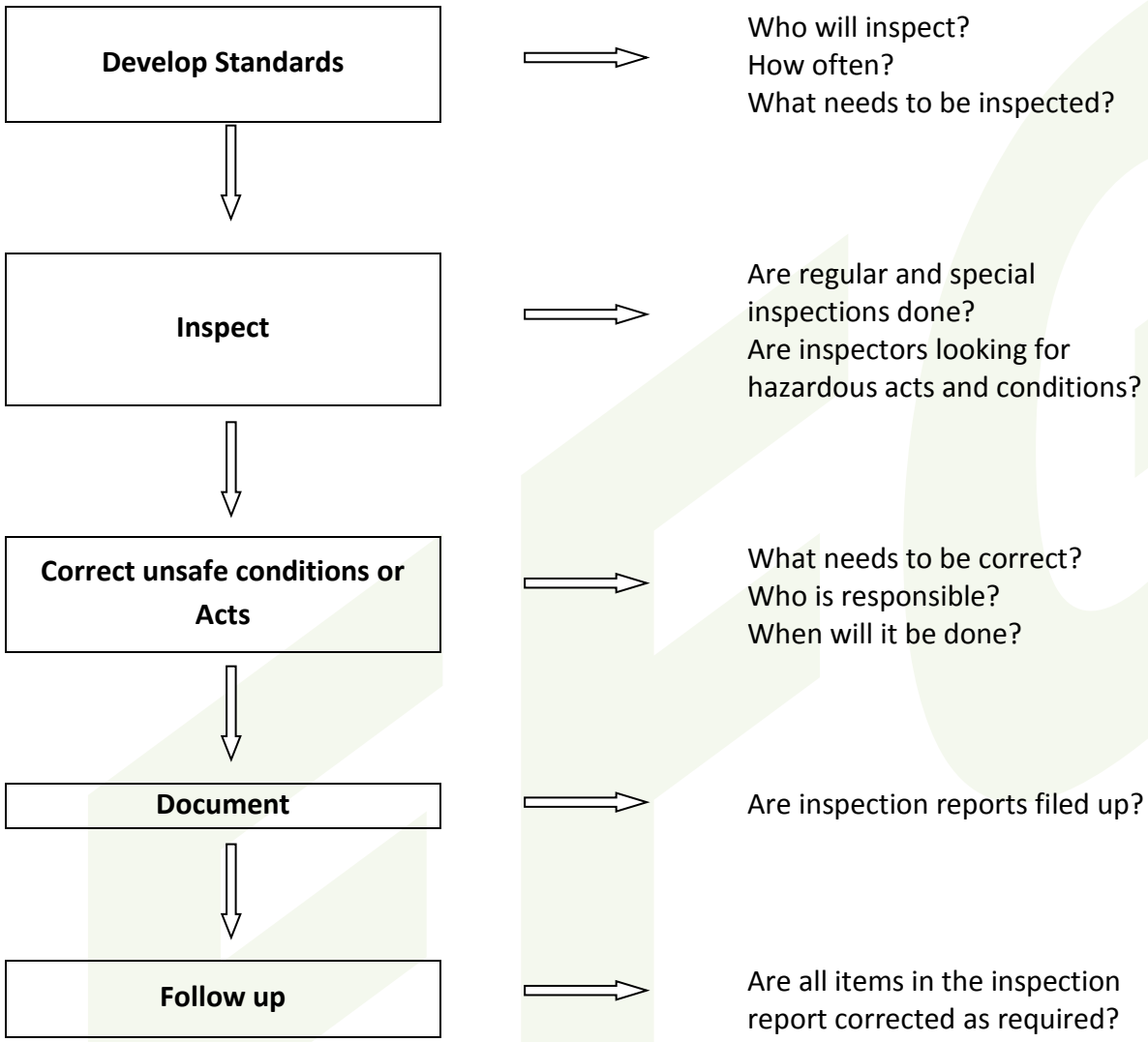
5.2 Document observations / findings of inspection using relevant inspection checklists

Developing an Inspection Program



Guidelines for Inspectors

To what standards should inspections be conducted?

The WSH regulations are only the general requirements and will require further detail from employers identifying the safe conditions, actions and work methods for their workplace.

Employers must develop their own standards and procedures of work to meet the requirements of the applicable regulatory, industry, and manufacturers' standards for their workplace. They are to develop procedures of work methods for hazardous jobs that their workers may encounter such as lockout, confined space work, emergency procedures and so on. Employers must maintain safe working conditions and practices.

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The extent to which a person can carry out an effective inspection depends upon their ability to identify hazards. Inspectors should be provided with a reference to follow during their inspections.

Using Checklists

Many companies use a checklist to ensure consistent and comprehensive inspections each time they are done. Appropriate checklists are developed for each job site and provide a guide to the various standards expected to be in place. A Checklist should inform inspectors what to look at and what to look for.

What should we be looking at?

Consider the following in the development of our checklists and guidelines:

- plant or job site layout (areas where work activities take place)
- building-structure
- basic floor plan layouts with equipment and machinery
- maintenance periods-shift work
- start up and shut down times
- hazardous substances used in the workplace
- storage areas
- exits

What are we looking for?

Operating standards or requirements within these areas:

- legal requirements (WSH Regulation, fire regulations, boiler pressure vessel, elevating devices etc.)
- company rules
- manufacturers' specifications and instructions (forklifts, maintenance and operating procedures)
- personal protective equipment required (headgear, footwear, gloves, respirators, locks)
- engineering controls (ventilation, guards etc.)
- emergency procedures (fire, evacuation etc.)
- first aid services and supplies.

Look at known problem areas and review records on the following:

- accident investigations
- first aid record books
- worker complaints and reports on hazards in the workplace
- recommendations made by safety and health committees
- previous inspections (including fire marshal, WSHO etc.)

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- maintenance reports
- what controls are used to ensure safe work practices and maintain conditions?

Floor plan helps

Workplace floor plans should be referenced during the planning stages of any checklist. They should include information that will indicate locations of previous incidents, hazardous work areas, health hazard areas, and any relative information that would assist in the development of a checklist.

Inspectors

Under the WSH (Safety Committees) Regulations, one of the roles for members of WSH Committee includes carrying out the "Regular" Safety inspections. Other than these staff, other people in the workplace should also carrying out inspections as part of their normal duties or at least be involved in maintaining a safe and healthy work place. Your "Regular" inspection team may be required to check on some of these people to make sure that these day-to-day activities are being carried out as needed.

Management

Management should, whenever possible, show their commitment to the program by being involved in the inspection process. When management becomes part of the regular inspection team, it will show commitment to the company safety program.

Department managers should be aware of the conditions that exist in the workplace and the various procedures necessary to carry out the work process. Management should review inspection reports and ensure that proper action is taken to correct any hazards that are reported.

Supervisors

Continuous inspections are generally done by supervisors and foremen each time they pass through their area of responsibility. Supervisors are accountable for the safety of workers under their control. Therefore, they should be constantly on the lookout for any hazard that might arise in the work areas. Supervisors should ensure that workers are carrying out preoperational checks when and where they are required. In some companies, additional responsibility is also assigned to safety captains and /or other workers who are on the alert for unsafe conditions and actions.

Area supervisors should be included during the regular planned safety inspection of their area. This has a number of benefits for both the supervisor and the inspection team. First, the supervisor gets to see firsthand, any hazards noted and written down by the team and is not "surprised" at the end of the inspection by a written report. Secondly, the team can often assign any corrective action of any hazards noted. In some minor issues, the hazard might be corrected before the inspection team leaves the area. This becomes a win-win situation for both parties.

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Workers

Although we have referred to workers as safety committee members and as part of the planned safety inspection team(s), we have not identified one important part of a workers' responsibility. This is the pre-job inspection. It should be one of the major parts of a company's accident prevention efforts. Workers must inspect their work areas for hazards to ensure that they will not be injured as a result of their job. This may mean nothing more than watching out for hazards or it may mean a detailed pre-job inspection checking out equipment before use.

Qualified Inspectors

Although we have indicated who will do inspections in compliance with WSH Regulation, we have not yet considered what expertise and training they should have to carry out effective safety inspections. Inspections should be done by employees who are familiar with the work process and the areas they are inspecting. They must be given instruction in the inspection system and be made aware of the standards that have been established in the areas they are inspecting.

Inspectors may inspect other areas where they have the qualifications to do so. For example, in some workplaces supervisors of adjoining work areas will inspect each other's area to ensure that a more efficient inspection is carried out. Inspectors should ensure that afternoon and night shifts are not forgotten and are also inspected during their work periods.

There are various types of inspections that must be done in the workplace. Some will be done on a daily basis by operators before using equipment and machinery, others are on going by supervisors each time they pass through the workplace. Some inspections will be done after an accident or the purchase of new equipment. Although this workbook is concerned with planned inspections, the other types must be included in the overall inspection program.

Frequency of Inspections

The following is an overview of various inspections that should be considered when developing a safety inspections system:

Planned inspections are to be done on a regular basis. Although the term "regular" does not specify a time period, these inspections are generally done in accordance with the hazards associated with a particular industry and its potential for serious incidents. An example of a low hazard industry might be an office which does its planned inspections on a 30-day basis. However, a higher hazard industry such as logging might be doing planned inspections every week or 10 days. Planned inspections are also the time to check on other persons who have inspection responsibilities to ensure that they are being done according to regulation and established standards.

Spot or Special Inspections should be done by management, supervisors and safety committee members from time to time. The purpose of a spot inspection may be to follow up on corrective action after an incident or accident. Other reasons may be the installation of a new piece of

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equipment or a change in a work process or procedure, which may prompt an update to the inspection checklists or guidelines.

Inspection Procedures

The success of your program will depend on ensuring that the inspection team is prepared to do their inspection. This planning will involve selecting trained team members who are familiar with the workplace, a review of the checklists they will be following and ensuring members are equipped with the appropriate personal protective equipment. Team members should review information from previous inspection reports and incidents. Check on any fire inspection reports. Proper preparation will ensure consistent and thorough inspections every time.

Recording the Safety Inspections

It will be necessary to record any unsafe actions or conditions observed during your inspection tour. A well-written inspection report will establish the location of the condition or action observed. Give it a hazard rating. Provide some guidelines regarding action taken by the inspection team. Recommend corrective action and assign accountability for ensuring corrective action by a certain date. Well-written inspection reports communicate to management, supervision and the safety committee. They will be used to make records, plot trends and develop statistics on the hazards found in the workplace.

Hazard Ratings

Classify each item that you observe and record during your inspection tour. This hazard rating establishes priorities for corrective action and also highlights the level of severity or seriousness of the hazards.

Having a Risk rating system helps

Having a risk rating method will be useful to rate items observed during a safety inspection. The reason for this system is to highlight the degree of risk of those hazards and to assist both the inspectors and the employer in carrying out corrective actions.

The following examples can be used as guidelines.

High Risk - "H"

Any condition or practice that has potential for causing loss of life, body part and/or extensive loss of structure, equipment or material. Generally this means that immediate corrective action is required. Activity should be discontinued until the hazard is corrected, e.g.

- A window washer is seen working on the third floor level without any safety belt, hanging on with one hand and leaning out to work.
- Workers are seen in a ditch, about six feet in depth, vertical sides, no shoring, sloping or other means of protection.

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- Bricklayers are observed up on scaffolding, 15 ft. high, without handrails or safety belts.

Medium Risk - "M"

Any condition or practice with the potential for causing a serious injury, illness or property damage. Urgent situation. Requires attention as soon as possible, e.g.

- Forklift trucks are rounding a blind corner into a loading area without stopping.
- Someone has spilled lube oil on the main floor, leading to the areas where workers must gain access.
- Workers observed smoking in a flammable storage area.

Low Risk - "L"

Any condition or practice with a probable potential for causing a non-disabling injury or non-disruptive property damage. These types of hazards should be eliminated without delay, but the situation is not an emergency, e.g.

- Worker using a hammer with a loose head, in use on a daily basis for odd jobs.
- Worker using a heavy file without file handle.
- Oxygen and acetylene cylinders stored together, caps on, good ventilation, fireproof surroundings.

Note all items observed

Record any items that are not up to your predetermined checklist standards. Do not eliminate any condition or action because you had it corrected during the inspection. Remember that you are developing a record of what you found during that inspection.

Any items from previous inspections should be noted as "repeat" items.

Copies of inspection reports must be sent to:

- Management
- Supervisors
- Members of WSH committees
- Workplace Safety and Health Officer
- Safety coordinator
- Operation & Maintenance

5.3 Take appropriate follow-up actions to monitor deficiencies identified

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Follow-up

Corrective action should be taken as soon as possible on any deficiencies noted in the inspections. Feedback on this action must be conveyed to the inspection teams. There should also be a system in place to follow up on any corrective action that will require time for completion, i.e., purchase of new equipment, building new facilities, etc.

Monitoring

Information obtained from your inspection reports should be reviewed and become part of your WSH program records and statistics. WSH Committees Representatives should review each inspection report to identify any trends that may be developing in the workplace. A proper analysis over time may reveal:

- a need for training in certain areas
- why incidents are occurring in certain areas
- the need to establish priorities for corrective action
- a need to develop or improve safe work practices
- problem areas that may require more hazard analysis.

Summary

Safety inspections should provide for a systematic examination of the workplace on a regular basis. In order to be effective, they must be planned and organized. Inspectors must be knowledgeable in the inspection system and must know what standards to look for.

Annexes:

Annex 1 – Sample Inspection Guidelines

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ANNEX 1 - SAMPLE INSPECTION GUIDELINES

The following inspection checklists are only examples. It is always best to design checklists or inspection sheets that are specific to your firm or operation. Inspections should be divided into two categories:

(1) What to "look at" and

(2) What to "look for".

What to look AT:	**What to look FOR:**
• Atmospheric surroundings: hazardous conditions of dust, gases, fumes, sprays etc. • Chemical substances: all liquids and solids that are toxic in nature. • Containers: all objects for storage of materials, e.g., barrels, boxes, bottles, cans etc. • Electrical conductors and apparatus: wires, cables etc.; switches, controls, transformers, lamps, batteries, fuses, etc. • Engines and prime movers: sources of mechanical power. • Firefighting equipment: all firefighting equipment and early detection systems, plus related structures such as sprinklers, fire plugs etc. • Guards and safety devices: all removable and fixed guards, and safety devices or attachments, excluding personal protective apparel. • Hand tools-all kinds: equipment that is held or carried when in use. • Hoisting equipment: air hoists, hydraulic lifts, jacks, electric hoists, wire ropes, chains. • Flammables and explosives. • Machinery and its parts: power equipment that processes or modifies materials, i.e. agitators, grinders, forging presses, pulverizing machines, drilling machines etc.	***Guards*** • Missing guards on gears, belts, pulleys and shafts • Missing guards on power saws • Missing point of operation guards on all machines • Grinding wheels guarded and tool rests adjusted. • Pinch points guarded against inadvertent contact. ***Support and Structure*** • Faulty bracing, shoring • Sharp-edged, jagged splinters • Worn, cracked, broken conditions • Slippery walking and gripping surfaces • Uneven surfaces • Missing hand rails and platform guardrails • Broken steps • Crating potential for worker or equipment to trip, fall, roll, collapse, slide etc • Protruding objects ***Electrical*** • Ungrounded machines and equipment • Low voltage leaks • Obstructed switch panels • Use of "lockouts" for mechanics and electricians • Close proximity to stop buttons on all

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- Mechanical and power transmission systems: shafts, bearings, gears, pulleys, drums, cables, belts, sprockets, ropes, chains etc., when used to transmit power.
- Overhead structures and equipment: any structural part of equipment that may fall from above.
- Personal protective apparel: goggles, gloves, aprons, leggings, etc.
- Pressure vessels, boilers and pipes: objects subject to internal pressure from compression of liquids or gases.
- Pumps, compressors, blowers and fans: objects that move or compress liquids, air, or gases.
- Shaftways, pits, sumps and floor openings: any type of opening into which a person may stumble or fall.
- Walking or standing surfaces: floors, aisles, stairs, platforms, ramps, roads, scaffolds, ladders etc.
- Warning and signal devices: direct communication systems such as radio, telephones, buzzers, bells, lights etc.
- Vehicles and carrying equipment: trucks, cars, motorized carts, and non motorized equipment for transporting materials.
- Miscellaneous: other potentially hazardous objects or conditions that do not fall into the above categories.

machines

- Defective cords, plugs, receptacles
- Overloaded circuits
- Use of light duty extension cords instead of approved wiring
- Power cords across aisles, under rugs etc.
- Use of low voltage systems or ground fault interrupters in wet locations

Ventilation, Illumination, Noise, Radiation

- Excessive heat
- Use of unshielded X-rays
- Arc-flash without shielding
- Excessive dust
- Exposure to toxic dust, fumes, gases
- Gas leaks
- Excessive noise
- Poor ventilation for chemical use and storage
- Failure to protect workers from the above hazards

Miscellaneous Items

- Poor housekeeping
- Proper storage of flammable liquids
- Exits clear for emergencies
- Adequate first aid supplies
- Fire extinguisher in working condition
- Damaged rigging
- Vehicle neglect
- Eye protection, head protection, breathing protection available
- Warning devices for work in streets
- New employees informed of work hazards

Work Practices

- Failure to use PPE
- Horseplay
- Failure to follow safety/health rules

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		and procedures • Misuse of tools and equipment • Failure to follow safe working procedures • Poor housekeeping

Reference

- http://www.mom.gov.sg/legislation/occupational-safety-health/Pages/default.aspx
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- http://www.mom.gov.sg/Documents/safety-health/WSH%20(General%20Provisions)%20Rgs.pdf
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COMPETENCY ELEMENT 6
Conduct incident investigation

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Incident Reporting

An incident report must be submitted to the Commissioner of Workplace Safety and Health for all accidents, dangerous occurrences and occupational diseases. Employers and occupiers are required to keep a record of all incident reports for three years. It is an offence to fail to make an incident report as required by the law.

The table below shows types of workplace incidents and the responsibilities of employers and occupiers. Examples of cases that need to be reported can be found below.

Incident	Who should report	What to do
A workplace accident that causes the death of an employee.	The employer of the injured worker.	• Notify the Commissioner immediately • Submit the incident report within 10 days of the accident
A workplace accident that causes injury to an employee, who is then: • Given more than three consecutive days of medical leave; or • Hospitalised for at least 24 hours.	The employer of the injured worker.	• Submit the incident report within 10 days of the accident • If the employee subsequently dies from the injury, the employer must notify the Commissioner as soon as he/she knows of the employee's death.
A workplace accident that involves a self-employed person or member of public, causing him/her to: • Die; or • Sent to hospital for treatment of injury.	The workplace occupier	• Notify the Commissioner immediately • Submit the incident report within 10 days of the accident
A dangerous occurrence	The workplace occupier	• Notify the Commissioner immediately • Submit the incident report within 10 days of the accident

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An occupational disease	• The doctor who diagnosed the disease; and • The employer of the person with the disease	• Submit the incident report within 10 days of diagnosis (Doctor) • Submit the incident report within 10 days of receiving the written diagnosis (Employer)

For incidents that require immediate notification:

- Notify the Commissioner of Workplace Safety and Health by calling +65 6317 1111 or sending a fax to +65 6317 1220.
- Provide the following information
  - Date and time of the incident;
  - Place of the incident;
  - Name and identification number of the injured / deceased, if any;
  - Name of the employer and occupier;
  - Brief description of the incident; and
  - Name and contact details of the person making the notification

Submitting the Incident Report
You are required to submit an incident report to the Commissioner of Workplace Safety and Health within 10 days. Only one official representative (e.g. HR or WSH Personnel) from the company is required to report the incident to MOM. Incidents should be reported using the iOSH service.

Accident Causation Theories

H.W. Heinrich, a pioneer in safety philosophy, first published his work on Industrial Accident Prevention in 1931. Many of his principles and basic philosophy of accident causation and prevention are confirmed by time and application, but, some are also questioned and criticised. His philosophy is based on his 10 axioms (self evident-truths) as follows.

Ten Axioms of Industrial Safety:

1. The occurrence of an injury invariably results from a completed sequence of factors - the last one of these being the accident itself. The accident in turn is invariably caused or permitted directly by the unsafe act of a person and/or a mechanical or physical hazard.
2. The unsafe acts of persons are responsible for a majority of accidents.
3. The person who suffers a disabling injury caused by an unsafe act, in the average case has had over 300 narrow escapes from serious injury as a result of committing the

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very same unsafe act. Likewise, persons are exposed to mechanical hazards hundreds of times before they suffer injury.

4. The severity of an injury is largely fortuitous the occurrence of the accident that results in injury is largely preventable.
5. The four basic motives or reasons for the occurrence of unsafe acts provide a guide to the selection of appropriate corrective measures.
   These are:
   - improper attitude.
   - lack of knowledge or skill,
   - physical unsuitability and
   - improper mechanical or physical environment.
6. Four basic methods are available for preventing accidents.
   These are
   1. Engineering revision,
   2. Persuasion and appeal.
   3. Personnel adjustment and
   4. Discipline.
7. Methods of most value in accident prevention are analogous with the methods required for the control of the 'quality, cost and quantity of production.
8. Management has the best opportunity and ability to initiate the work of prevention, therefore it should assume the responsibility.
9. The supervisor or foreman is the key man in individual accident prevention. His application of the art of supervision for the control of work performance is the factor of greatest influence in successful accident prevention.

   It can be expressed and taught as a simple four step formula –
   1. Identify the problem,
   2. find and verify the reason for the existence of the problem,
   3. select the appropriate remedy and
   4. apply the remedy.
10. The humanitarian incentive for preventing accidental injury is supplemented by two powerful economic factors:

    (A) The safe establishment is efficiently productive and the unsafe establishment is inefficient
    (B) The direct employer's cost of industrial injuries for compensation claims and for medical treatment is about one-fifth of the total (direct plus indirect) cost which the employer must pay.

These axioms were the first set of principles or guidelines ever set before in industrial safety and it has guided all safety activity till today. During the passage of 75 years, some of his axioms are questioned and disbelieved as truths, but, most of them are still true and deal with the important areas of safety, viz. Accident causation and prevention, reasons of unsafe acts and conditions, management control functions, responsibility of organisation, costs of accident, safety and productivity etc.

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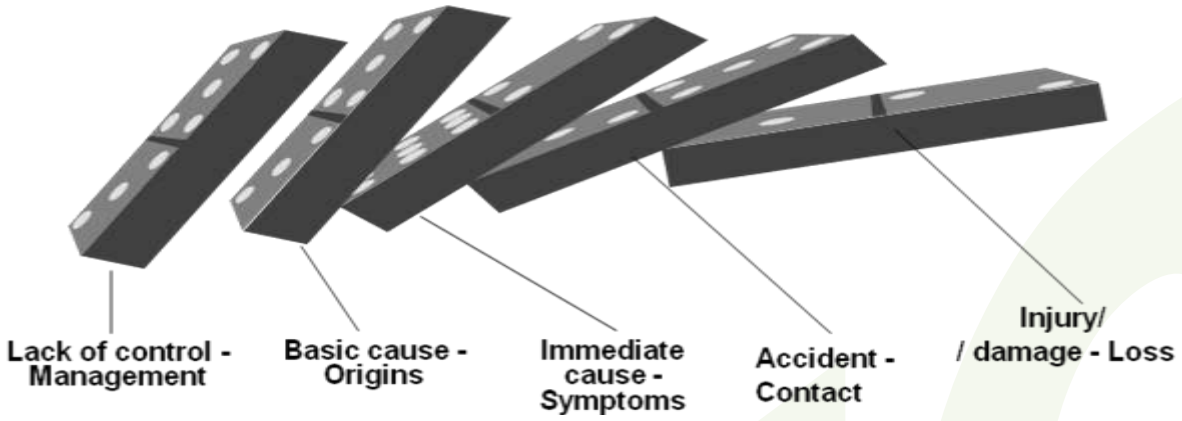

HEINRICH'S DOMINO THEORY

Domino 1 Lack of control - Management.

Domino 2 Basic causes - Origins.

Domino 3 Immediate causes - Symptoms.

Domino 4 Accident - Contact, and

Domino 5 Injury/damage - Loss.

FRANK BIRD'S DOMINO THEORY

Heinrich's theory of domino sequence is updated by Frank Bird Jr. to explain the circumstances that lead to losses (injury) in the chronological order of five dominoes.

1 Lack of control

is the first domino and refers the fourth function of the management (planning, organising, directing, controlling and coordinating). It involves accident investigation, facility inspection, job analysis, personal communication, selection and training, 'standards' in each work activity identified, measuring performance by standards and correcting performance by improving the existing programmes. This first domino may fall due to inadequate standards, programmes and follow up.

2. Basic Causes (origins)

are (1) Personal factors lack of knowledge or skill, improper motivation and physical or mental problems and (2) Job factors inadequate work standards, design, maintenance, purchasing standards, abnormal usage etc. These basic causes are origin of substandard acts and conditions and failure to identify them permits the second domino to fall, which initiates the possibility of further chain reaction.

3. Immediate causes

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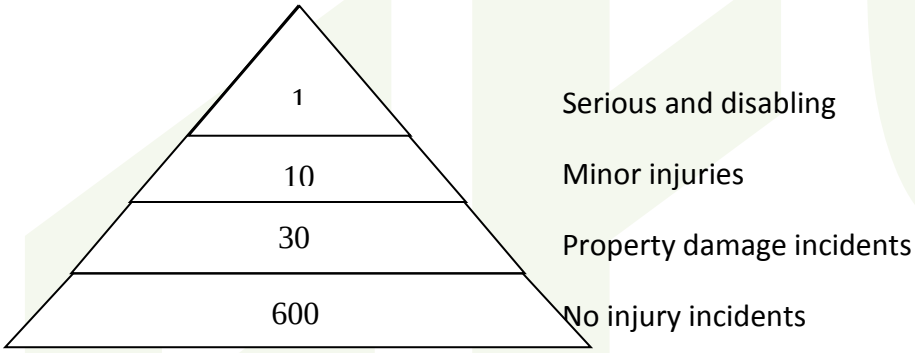
are only symptoms of the underlying problem. They are substandard' practices or conditions (known I as unsafe acts and unsafe conditions) that could cause the fourth domino to fall. These causes should be identified, classified and removed by appropriate measures.

4. Accident

or incident is the result of unsafe acts or/and unsafe conditions. This point is the contact stage. Some counter measures employed are deflection, dilution, reinforcement, surface modification, segregation, barricading, protection, absorption, shielding etc.

5. Injury

includes traumatic injury, diseases and adverse mental neurological or systemic effects resulting from workplace exposures. 'Damage' includes all types of property damage including fire. The severity of losses involving physical harm and property damage can be minimised by prompt reparative action, salvage in the case of property damage and fire control devices and trained personnel.



Frank E Bird, in 1969, analysed 1,753,498 accidents reported by 297companies of America Inference of this 1-10-30-600 ratio is that 630 no injury accidents, with 10 minor and I major (serious) injury accidents, provide a much larger basis for many opportunities to prevent any injury accident. Out of total 641 events, only 10 may result in minor injuries and only 1 in major injury. But this can happen at any time not necessarily at the end.

SWISS CHEESE MODEL

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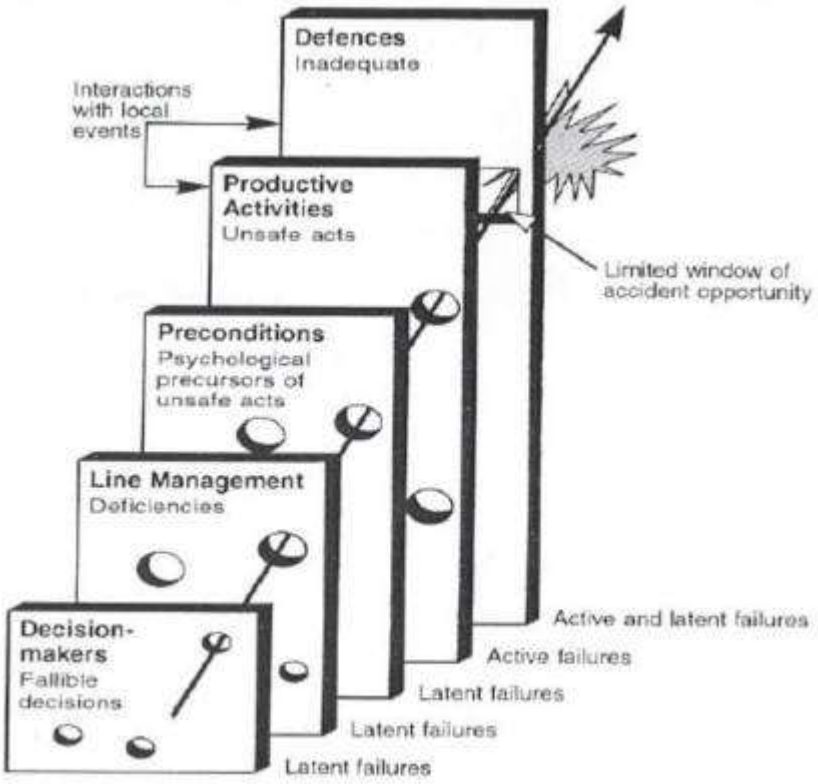

This Accident Causation Model is a theoretical model that illustrates how accidents occur in organisations. The model focuses on both organisational hierarchy and human error. It postulates that the typical accident occurs because several (human) errors have occurred at all levels in the organisational hierarchy in a way that made such accident inavoidable. For example, decision makers may have made ill decisions when purchasing aircraft (fallible decisions), line management may have pushed for faster turnarounds (line management deficiencies), pilots may have felt pressurised to cope with a stressful climate, an unsafe culture and little rest (preconditions), the particular pilot who suffered the accident may have gotten distracted with other tasks three seconds prior to the accident (unsafe act), and the aircraft systems fail in providing unmistakable warnings of the danger (inadequate defences).

Key concepts of this Accident Causation Model:

- **Active errors** (also called unsafe acts) are the proximal causes of the accident: the pilot got distracted. Hadn't the pilot got distracted, he would have prevented the accident.
- **Latent errors** are the remaining elements in the organisation which contributed to the accident: senior managers purchasing decisions, line management pressures, unsafe climate and culture coupled with fatigue and confusing warnings. Hadn't any of these latent errors occurred, the accident would have been prevented.
- **Windows of opportunity** refer to the opportunity for those active and latent errors to contribute to an accident. Hadn't the worker got distracted, he would have prevented the accident… this time. Yet, the latent errors remain unresolved, waiting for their opportunity (thus a "window of opportunity") to strike.

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- **Causation chain** refers to the alignment of all necessary windows of opportunity at all levels in the organisation, thus leading to the occurrence of a particular accident. That is, the causes of most accidents can be traced back to "windows of opportunity" opened at all levels in the organisation.

The Accident Causation Model was first published by Reason in 1990. Since then, it has progressively influenced contemporary views on the management of human error in organisations. For instance, the International Civil Aviation Organisation (ICAO) has formally adopted Reason's model to facilitate a systemic understanding of human factors issues within the aviation community.

6.1 Gather information and facts about incident

Objectives of incident investigation

The term "accident" can be defined as an unplanned event that interrupts the completion of an activity, and that may (or may not) include injury or property damage. There are many reasons to conduct a workplace accident investigation, such as:

- to fulfil the legal requirement
- to determine the cost of an accident
- to determine compliance with applicable safety regulations
- to process workers' compensation claims

Most importantly accident investigations are conducted to find out the cause(s) of accidents and to prevent similar accidents in the future. When accidents are investigated, the emphasis should be concentrated on finding the root cause(s) of the accident rather than the investigation procedure itself.

Who should do the accident investigating?

Ideally, an investigation should be conducted by an expert in accident causation who is experienced in investigative techniques, fully knowledgeable of the work processes, procedures, persons, and industrial relations environment of a particular situation. Unfortunately, such persons are hard to find. Especially in smaller organizations, both workers and supervisors with little, if any, previous investigative experience maybe called upon to participate in an accident investigation.

Who and how many people should investigate an accident?

The best team to conduct an accident investigation includes the injured worker, their supervisor and a safety representative. It is critical that the injured worker's supervisor is on the accident investigation team because this person will be the most knowledgeable about the work conditions

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and the people involved. Furthermore, the supervisor can usually take immediate remedial action if an immediate corrective action is identified. Other members that are valuable to the accident investigation team include maintenance, engineering, process support and other technical staff members that have a good understanding of the incident and the corrective action.

How to make sure that investigators are impartial?

An investigator who believes that accidents are caused by unsafe conditions will likely try to uncover conditions as causes. On the other hand, one who believes they are caused by unsafe acts will attempt to find the human errors that are causes. Therefore, it is necessary to examine briefly some underlying factors in a chain of events that ends in an accident.

The important point is that even in the most seemingly straightforward accidents, seldom, if ever, is there only a single cause. For example, an "investigation" which concludes that an accident was due to worker carelessness, and goes no further, fails to seek answers to several important questions such as:

- Was the worker distracted? If yes, why was the worker distracted?
- Was a safe work procedure being followed? If not, why not?
- Were safety devices in order? If not, why not?
- Was the worker trained? If not, why not?

An inquiry that answers these and related questions will probably reveal conditions that are more open to correction than attempts to prevent "carelessness."

What are the steps involved in investigating an accident?

The accident investigation process involves the following steps:

- Report the accident occurrence to a designated person within the organization
- Provide first aid and medical care to injured person(s)
- Investigate the accident
- Identify the causes
- Report the findings
- Develop a plan for corrective action
- Implement the plan
- Evaluate the effectiveness of the corrective action

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Make changes for continuous improvement

As little time as possible should be lost between the moment of an accident or near miss and the beginning of the investigation. This approach allows the investigator to observe the conditions as they were at the time, prevent disturbance of evidence, and identify witnesses. It is recommended that you have a pre-assembled "toolbox" prepared when you need to conduct an accident investigation. The tools that members of the investigating team may need are pencil, paper, camera, film, tape measure, statement forms, etc. These items should be immediately available so that time is not wasted.

6.2 Analyse information and facts to determine root causes of incidents

What should be looked at as the cause of an accident?

Accident Causation Models

Many models of accident causation have been proposed, ranging from Heinrich's domino theory to the sophisticated Management Oversight and Risk Tree (MORT). A simple model attempts to illustrate that the causes of any accident can be grouped into five categories - task, material, environment, personnel, and management. When this model is used, possible causes in each category should be investigated. Each category is examined more closely below. Remember that these are *sample* questions only: no attempt has been made to develop a comprehensive checklist.

Task

Here the actual work procedure being used at the time of the accident is explored. Members of the accident investigation team will look for answers to questions such as:

- Was a safe work procedure used?
- Had conditions changed to make the normal procedure unsafe?
- Were the appropriate tools and materials available?
- Were they used?
- Were safety devices working properly?
- Was lockout used when necessary?

For most of these questions, an important follow-up question is "If not, why not?"

Material

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To seek out possible causes resulting from the equipment and materials used, investigators might ask:

- Was there an equipment failure?
- What caused it to fail?
- Was the machinery poorly designed?
- Were hazardous substances involved?
- Were they clearly identified?
- Was a less hazardous alternative substance possible and available?
- Was the raw material substandard in some way?
- Should personal protective equipment (PPE) have been used?
- Was the PPE used?

Again, each time the answer reveals an unsafe condition, the investigator must ask **why** this situation was allowed to exist.

Environment

The physical environment, and especially sudden changes to that environment, are factors that need to be identified. The situation at the time of the accident is what is important, not what the "usual" conditions were. For example, accident investigators may want to know:

- What were the weather conditions?
- Was poor housekeeping a problem?
- Was it too hot or too cold?
- Was noise a problem?
- Was there adequate light?
- Were toxic or hazardous gases, dusts, or fumes present?

Personnel

The physical and mental condition of those individuals directly involved in the event must be explored. The purpose for investigating the accident is **not** to establish blame against someone, but the inquiry will not be complete unless personal characteristics are considered. Some factors will remain essentially constant while others may vary from day to day:

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- Were workers experienced in the work being done?
- Had they been adequately trained?
- Can they physically do the work?
- What was the status of their health?
- Were they tired? (how many hours had they been working?)
- Were they under stress (work or personal)?

6.3 Preparing recommendations for the consideration of management

Management

Management holds the legal responsibility for the safety of the workplace and therefore the role of supervisors and higher management must always be considered in an accident investigation. Answers to any of the preceding types of questions logically lead to further questions such as:

Were safety rules communicated to and understood by all employees?

- Were written procedures available?
- Were they being enforced?
- Was there adequate supervision?
- Were workers trained to do the work?
- Had hazards been previously identified?
- Had procedures been developed to overcome them?
- Were unsafe conditions corrected?
- Was regular maintenance of equipment carried out?
- Were regular safety inspections carried out?

This model of accident investigations provides a guide for uncovering all possible causes and reduces the likelihood of looking at facts in isolation. Some investigators may prefer to place some of the sample questions in different categories; however, the categories are not important, as long as each pertinent question is asked. Obviously there is considerable overlap between categories; this reflects the situation in real life. Again it should be emphasized that *the above sample questions do not make up a complete checklist, but are examples only.*

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How are the facts collected?

You may want to take photographs before anything is moved, both of the general area and specific items. Careful study of these may reveal conditions or observations missed previously. Sketches of the accident scene based on measurements taken may also help in subsequent analysis and will clarify any written reports. Broken equipment, debris, and samples of materials involved may be removed for further analysis by appropriate experts. Even if photographs are taken, written notes about the location of these items at the accident scene should be prepared.

Background Information

A very useful background source, but often overlooked, is the information that can be found in documents such as technical data sheets, maintenance reports, past accident reports, formalized safe-work procedures, and training reports. Any pertinent information should be studied to see what might have happened, and what changes might be recommended to prevent recurrence of similar accidents.

Why should recommendations be made?

The most important final step is to come up with a set of well-considered recommendations designed to prevent recurrences of similar accidents. Once you are knowledgeable about the work processes involved and the overall situation in your organization, it should not be too difficult to come up with realistic recommendations. Resist the temptation to make only general recommendations to save time and effort.

In the unlikely event that you have not been able to determine the causes of an accident with any certainty, you probably still have uncovered safety weaknesses in the operation. It is appropriate that recommendations be made to correct these deficiencies.

Remember, the purpose of an accident investigation is to determine the cause(s) of the incident and to implement corrective actions in order to prevent this accident from happening again. A thorough accident investigation is always worth the time and effort!

6.4 Report findings according to relevant legislations and guidelines

Writing the Incident Report

Nobody likes writing reports. Nobody really likes writing anything; this applies to professional writers as much (if not more) than to the rest of us who have to write to communicate, on top of our other responsibilities. Fortunately, there are some ways of making it a relatively painless process - and a good thing too, because writing the report is absolutely crucial to any investigation.

The Point of it All

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In fact, you wouldn't be far wrong if you defined the report as the most important component of your investigation. It's the bit that communicates your findings. The bit that explains what went wrong. The bit in which you express your recommendations. And the bit which can change the future - for the better. That, after all, is the whole point of investigating in the first place.

Writing to Persuade

The first thing to remember is that when you're writing an investigation report, you're trying to persuade someone to do something. Just like an advertisement or a direct-mail shot, you want the reader to get to the end of your report and take action. In this case, the action is: to put your recommendations into practice. Before your reader can do that, therefore, they have to be persuaded. And to be persuaded, they have to understand.

That means – KEEP YOUR LANGUAGE SIMPLE AND STRAIGHTFORWARD.

We can break this down into a few simple components.

1: Keep it simple - that's self-explanatory.

2: Avoid jargon and pomposity - Don't forget: not everyone reading your report will be an expert in your field. They may not know the jargon. It doesn't mean that professional jargon is wrong; just that it's specialised. In a report, write for the non-specialist. As for pomposity…have a look at what you've written. Does it come across as really serious and important but you can't tell what it means? Okay: it's too pompous. Simplify. Talk straight. Plain words.

3: Keep It Active - Don't say, "The man was bitten by the dog." Say, "The dog bit the man." The first way is called the "passive voice" and usually is a way of keeping yourself at arms' length from what you're saying. The end result lacks conviction and is unpersuasive. Which – since you're writing to persuade - you don't want.

4: Short Takes - This is an old newspaper anecdote. Reporters used to write their stories a sentence at a time. Then they'd hand it to the copy-boy. One sentence contained one statement.

One paragraph contained one idea. For the next idea, they'd start another paragraph. It worked for them. It still works for them. It will work for you.

5: Get A Second Opinion. If you can get someone outside your investigation, your department or, best of all, your industry, so much the better. If you can get a reasonably intelligent 12-year-old to read it, better still. The average senior executive wants something straightforward and unambiguous. That doesn't mean they are stupid. Far from it; it just means that reading dense texts isn't one of their skills. And why should it be? Nor do they have the time. We understand, of course, that in many cases there are other considerations. Legal implications. Confidentiality. Trade secrecy. Fair enough; but, all the same, you will be able to find someone to cast an eye over your report, for sure. So please do so.

Structuring the Report

The other main thing which will help you write clear, pain-free, persuasive reports is following a clear and logical structure.

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By this stage, you'll have all the facts (or at least all the facts you're going to get). You'll understand the timeline and the sequence of events. You'll have worked out your root cause analysis. And you'll know what your recommendations are going to be. So where do you start?

You may have a company reporting form where you just fill in the blanks. In that case, fill them in. On the other hand, your investigation may be too complex to fit on the standard company form. What do you do if that's the case?

Here's a simple structure which will help you get the information across in a clear, logical and persuasive way. It's not something we've made up. It's standard. And we suggest that, if you follow it, you won't go far wrong.

Summary

The formal report and the news story are the only two human activities which start with the climax. In this case, start with your summary of the incident. Keep it short, tight and clear.

Conclusions

Next, set out the conclusions you reached in your investigation.

Recommendations

Finally, lay out your main recommendations which will prevent this sort of thing happening again and which are the whole point of the exercise.

Congratulations! You've now written the only bit of the report that 90% of people will actually read. All you have to do now is write the…

Main Report

Which outlines everything in much more detail. Notice that we are following that structure here. So now… here comes the Much More Detail.

SUMMARY

In the summary, you explain briefly:

– Who was involved in the incident.

– What actually happened

– When it happened

– Where it happened; and

– Who you are (and why you are investigating it)

CONCLUSIONS

In this section, you give a broad overview of WHY it happened. Summarise the Immediate causes and the Root Causes and anything else you think is specifically relevant, but don't go charging off into detail. That comes later.

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RECOMMENDATIONS

In the Recommendations, you are simply answering the question: "What now?". You might recommend changing procedures, re-training someone, installing new equipment; whatever it may be. For the sake of clarity, we suggest you link your recommendations with the causes which prompted them. For example: “Root Cause #1: Driver of the trailer to be retrained. (Has ‘can do’ attitude and reluctance to listen to advice.) Then your reader can not only see what you recommend, but why. Giving the reason makes it much more persuasive.

MAIN REPORT

Now we come to the main body of the report. This expands on all the points in the initial part of the report. It, too, falls into clear sections, as follows:

1: Aims & Objectives - Tell the reader what you were trying to do in the investigation (e.g. “The investigation was designed to get to the root causes of the fire in the Loading Dock”) and what you hoped to achieve by doing it (e.g, “We intend, by addressing those root causes, to prevent similar and related incidents happening in the future”).

2: Incident Description - Describe precisely what happened, beginning with the initial incident statement and resisting the temptation to launch straight in with underlying or root causes or inappropriate detail. They come later. At this stage you should be objective (e.g. Incident Statement - “Train ran off rail. Damage to property and potential injury.”). The Incident Description expands on that adding the rest of the detail which is known to be true.

Make sure you cover the Who, What, When and Where in your description, and add any significant and immediately striking factors which are known to be true. But this is not the place to go into your methods of investigation or your findings. They come next.

3: Methods of Investigation - Begin this section by describing your investigation team: who it was made up of, their qualifications, their positions and anything else relevant about them.

Next, detail any site visits you made. Attach any photographs, diagrams or drawings you may have — but remember: many people aren’t skilled at reading engineering drawings or technical diagrams, and they may need some explanation.

Summarise any findings you may have made concerning documentation. You don’t, though, need to include all that documentation. It’s enough to say “Permit to work had expired the previous week”. Just make sure you can locate it - or a copy of it - if you’re called upon to produce it (or you can include copies of documents, photographs etc as appendices).

Summarise, too, the results of any interviews you conducted. Who did you talk to? Where? What was the relevant information the interviewee gave you? Again, no need to include the whole transcript or detailed notes - just be sure you can lay your hands on them if necessary. In all these cases, it’s worth noting the location of supporting data in your report; in the future, another investigating team may want to consult your own records and it will help them if they can find them as easily as you can.

This section should also contain a summary of the details and the results of any simulations, tests or reconstructions you did in the course of the investigation.

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4: Findings - This section is - as you'd expect - where you set out your findings. There are plenty of perfectly good ways of keeping your findings in some sort of logical order. The main thing is not to jump around all over the place like a cheap detective story; that just confuses. We find that arranging your findings in the following order is extremely helpful:

T ime / **O** rganisation / **P** eople / **S** imilar events / **E** nvironment / **T** echnology

We'd suggest you use these as sub-headings, and you may even want to put your findings in the categories of the planning chart you will have used on the course. Having set out your findings, also – as in the introductory sections - set out your:

5: Recommendations. In this fuller version, you will want to address not only the root causes but also all the individual contributory causes you found along the way; they have to be dealt with also. In any case, once again, we suggest you tie in your recommendations to your findings for clarity's sake.

6. Appendix - We would seriously suggest that you should attach, as an appendix, a clearly drawn root cause analysis chart. This will clarify everything have said in the previous pages of your report, and, as you yourself will have seen, a well-drawn-up root cause analysis is something that even someone completely unfamiliar with the incident can come to afresh, read through, and understand. That's all there is to it. Follow this structure and much of the drudgery will be taken out of report-writing.

6.5 Maintain proper documentation of incident investigation

Maintain proper documentation

All relevant reports of incident investigation shall be documented for at least three years.

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- http://www.kelvintopset.com/index.php?option=com_docman&task=doc_view&gid=79

- For additional information regarding accident investigations and accident prevention, please refer to the many links located on our safety page located on the Osh.Net home page at http://www.osh.net/directory/safety/index.htm

REVISION OF DOCUMENT

This document is subject to revisions and updates. The revision status is indicated at the cover page of this document, and version number is reflected in the footer throughout this document.

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