Electrotechnology Practice

3rd EDITION

Jeffery Hampson
and
Steven Hanssen

ELECTRICAL SKILLS SERIES

ALWAYS LEARNING

PEARSON

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PREFACE

The third edition of *Electrotechnology Practice: A Practical Approach* has been written for the student of electrical studies centring on essential knowledge and practical skills for electrotechnology workers. Since its initial release, the text has undergone several version changes to keep it up to date. With this third edition the text has been revamped, reorganised and updated to meet the Electrotechnology Training Package **UEE11**. This text is a practical response to the changing needs of the electrotechnology industry and presents a broad-based expression of knowledge essential for workplace participation. It is also a practical reference text for anyone interested in aspects of electrical practice. In order to convey the real-world aspects of electrotechnology practice, particular attention has been given to diagrams and illustrations. The text utilises graphical ways of working with ideas and presenting information—to this purpose over 500 illustrations have been employed.

Individuals recognise and process information in very different ways and attain understanding at different rates. This text addresses the uniqueness of individual learning processes. The text is student centred and is suited to flexible delivery methods—self-paced learning, in-the-classroom delivery or as an on-the-job reference text. The aim of this text is to provide a sound understanding of electrotechnology practice. The content of this text is aligned with essential capabilities from the Electrotechnology Training Package **UEE11**, specifically the Certificate III in Electrotechnology Electrician.

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Work health and safety

Section 1

This section provides electrotechnology workers with knowledge and skills about work health and safety fundamentals. Electrotechnology workers will gain an overview of work health and safety knowledge and skills that will allow them to implement safe procedures for working in the electrotechnology industry.

SECTION OBJECTIVES

Work health and safety fundamentals
- State the primary principles of work health and safety
- List the role and responsibilities of employers and workers
- State the functions of health and safety committees
- List the powers of workplace health and safety inspectors
- Describe the principles of risk management
- Define 'housekeeping'
- Explain why personal protective equipment is used

Work environment
- Describe possible hazards at a worksite
- Recognise various safety signs
- Define an 'emergency situation'
- Identify a range of fire extinguishers suitable for a specific type of fire

Work environment safety signs
- State the aim of work environment safety signs
- Recognise the meaning of various safety signs

Fires
- State the four elements necessary for fire to exist
- Distinguish fire extinguishers from each other by their colour scheme

Workplace emergencies
- Recognise a workplace emergency situation

Manual handling
- Define 'manual handling'
- Describe correct lifting procedures
- List typical manual handling injuries

Chemicals in the workplace
- Recognise chemicals as hazardous substances
- Identify and understand a material safety data sheet

Material safety data sheets
- Recognise a material safety data sheet (MSDS)
- Locate various types of information on an MSDS

Storage procedures
- Understand the detail required of a chemical substance register

Working at heights
- Identify hazards, equipment and precautions when working at heights

Confined spaces
- Define a 'confined space' and its potentials hazards

Physical and psychological hazards
- Evaluate common hazards in the workplace

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Working with electricity
- Discuss the effects of electric shock and describe precautions to minimise those effects

Protective measures
- Recognise the various protective devices intended primarily for the protection of conductors and equipment

Common electrical hazards
- State the three categories of common electrical hazards

Rescue from a live situation
- Provide the requirements for a low-voltage rescue kit when working on or near live electrical equipment

Life support
- Explain the meaning of first aid
- Develop a priority action plan
- Understand what is meant by the term 'Emergency procedure at an accident'

Legal and ethical issues
- Understand the principle of 'duty of care'

First aid information (CPR)
- Determine a casualty's level of consciousness via gentle touching and loud talking
- Explain the meaning of 'COWS'

1.1 Work health and safety fundamentals

In force across Australia is the national harmonisation law which is a significant reform to WH&S legislation. This reform is reflected in new federal Acts called The Work, Health and Safety Acts (WH&S Acts). This legislation came into effect on 1 January 2012.

Previously, reference had to be made to the relevant state or territory legislation referring to WH&S in which the electrical worker resides. Today each of the state and territory WH&S laws are replaced by national laws based on the WH&S Act. This approach to WH&S provides consistency for workers (same work, health and safety protection and standards) anywhere they work across Australia. In Australia WH&S is watched over by Safe Work Australia.

Important changes introduced are:

- a broader definition of the term 'worker'
- clarification of the term 'due diligence'
- union rights
- worker consultation requirements
- incident notification
- role of inspectors and regulators.

All prudent electrical workers should read the WH&S legislation, which must be available to them in the workplace.

In general, work health (which includes psychological health as well as physical health) and safety provides a broad framework incorporating legislation (which codifies the duties of care that are owed under common law), policies, procedures, obligations and practical means that aim to protect the safety, health and welfare of all persons within a workplace. A workplace is any place where work is being performed. The harmonised principles of the WH&S Acts are as follows:

1. All persons in a workplace must be given the highest level of health and safety protection that is sensibly feasible.
2. Those who manage or control work activities that give rise, or may give rise, to risks to health or safety are responsible for removing or minimising health and safety risks, so far as is sensibly feasible.
3. Employers and self-employed people should develop a 'hands-on' approach and take sensible workable measures to ensure health and safety in their business activities.
4. Employers and workers should exchange information about workplace risks to health or safety and actions that can be taken to eliminate or reduce those risks.
5. Employees are entitled, and should be encouraged, to be represented on health and safety issues.

The objectives of WH&S are structured around the following eight core values:

1. to secure and promote the health, safety and welfare of people at work
2. to protect all people at a place of work against risks to health or safety arising out of the activities of persons at work
3. to promote a safe and healthy work environment for all persons at a workplace to protect them from injury and illness
4. to provide for consultation and cooperation between employers and employees in achieving the principles of the relevant state or territory WH&S Act or regulation

5. to ensure that risks to health and safety at a workplace are identified, assessed and eliminated or controlled
6. to provide a legislative framework that enables a living standard of WH&S to take account of future changes in technology and work practices
7. to deal with the impact of particular classes or types of dangerous goods and plant at, and beyond, places of work
8. to develop and promote community awareness of WH&S issues.

Every worker in Australia and New Zealand has a right to healthy and safe work and to a work environment that enables them to live a socially and economically productive life.

1.1.1 Responsibilities, rights and obligations

The WH&S legislation in Australia and New Zealand places an absolute duty on employers and controllers of workplaces (including directors and managers) to provide a safe and healthy workplace for employees and visitors to the workplace. The various Acts impose clear obligations on all persons to ensure safe work environments.

Employers are to provide work environments that ensure the health and safety of workers. Employers must also maintain the various classes or types of dangerous goods and plant and systems of work under their control without risking the health and safety of any person.

Workers have obligations not to put others at risk and to obey the reasonable instructions of their employer in relation to WH&S.

Persons other than employers and workers (visitors or unwelcome persons) must not put others and workplaces at risk and must obey the WH&S instructions specific to the workplace location they have entered.

1.1.2 Health and safety committees

Health and safety committees are set up in workplaces to help resolve health, safety and welfare issues that arise in the workplace. The committee is a representative group of the employer and workers that meets in a cooperative way to improve systems which assist proposed changes to the workplace, workplace policies, practices or procedures that could affect the health, safety or welfare of any person in the workplace.

Health and safety committees should:

- develop safe systems of work and safety procedures
- analyse accidents and causes of notifiable occupational diseases, and make recommendations to prevent recurrences
- review risk assessments
- examine safety audit reports
- consider reports submitted by safety representatives
- monitor the effectiveness of health and safety training
- monitor and review the adequacy of health and safety communication within the workplace.

1.1.3 Safety inspectors

A workplace health and safety inspector may enter any workplace to monitor its compliance with the WH&S Act and to exercise their powers while they are in that workplace. Usually the inspector will be visiting to undertake a health and safety inspection. However, they could also visit after an accident that may have been caused by work activities. After entering the workplace the inspector has the power to:

- search any part of the workplace
- carry out inquiries, examinations, surveys and investigations, including taking measurements, photographs and samples with respect to the degree of risk at the workplace or the standards of health and safety existing at a workplace
- inspect and copy documents
- make inquiries into the circumstances and probable causes of workplace incidents
- take any person, equipment or materials into the workplace to assist in the exercising of a power
- require any person in the workplace to give reasonable help
- require a person to produce specific documents
- issue improvement or prohibition notices
- seize evidence of a WH&S offence
- seize anything dangerous or otherwise used to commit a WH&S offence.

Note that it is an offence to obstruct, threaten or interfere with a WH&S inspector who is exercising their powers under the legislation.

1.1.4 Safety observers

Safety observers must receive specific instructions in their duties from the licensed electrical worker or

workers on potential risks associated with the work to be performed. Safety observers must:

- wear the necessary personal protective equipment required by personnel involved with the electrical work activities
- constantly observe the safety procedures that are carried out by electrical personnel working in a potentially hazardous situation
- be familiar with the location of all isolation points and how to operate them for the work being performed
- provide prompt warnings when necessary to prevent electrical workers coming into direct contact with exposed electrical parts
- provide help in the case of emergency.

Safety observers must also:

- have demonstrated ability in isolation techniques
- be proficient in rescue procedures and tools for extracting persons from live low-voltage circuits and equipment
- be skilled in resuscitation techniques
- render immediate first aid assistance in the event of an accident.

A safety observer is required for all instances of live work. For example, a licensed electrical worker has to perform the following tasks:

- fault finding on low-voltage electrical installations or equipment that is energised
- testing of low-voltage electrical equipment that introduces an energy source (voltage or current), that is, bench testing equipment.

1.1.5 Housekeeping

Housekeeping is not just cleanliness; it is a significant factor in creating a safe, healthy workplace for workers. The development of a good housekeeping culture in a workplace is a team effort and should be the desire of every worker. Best-practice procedures make housekeeping a standard part of working. Good housekeeping also raises awareness and highlights the importance of sustainability, environmental responsibility and hygiene concerns.

Where a workplace has been allowed to become cluttered and polluted, poor work practice procedures and frequent accidents often result. Good housekeeping means that:

- work areas are free from rubbish and obstructions
- surfaces are safe and suitable
- surfaces are free from slip/trip hazards
- appropriate waste bins are available
- stock/material is stored safely
- aisles are unobstructed and clearly defined with adequate lighting. There should be good vision at corners and the aisles must be wide enough for the processes carried out.

Remember: workplace housekeeping is a task of both employers and workers, for the benefit of both. Good industrial housekeeping creates a working environment in which workers can do their job correctly, professionally and in safety.

1.1.6 Personal protective equipment

Personal protective equipment (PPE) refers to garments, equipment or barrier substances designed to be worn by a person to protect them from exposure to risks of injury or illness. Different types of PPE may be used depending on the type of hazard. Note that all PPE must be approved by Australian standards.

PPE for electrical work

Clothing

Flame-resistant clothing (100% cotton clothing) that covers the whole body (neck to wrists and ankles) must be worn by all electrical workers involved with de-energised electrical work activities.

Flame-retardant clothing that covers the whole body (neck to wrists and ankles) must be worn by electrical workers involved with live work activities.

Insulating gloves

Insulated gloves for working on low-voltage equipment are to be rated to the highest voltage expected when performing the task. The gloves must comply with AS 2225:1994 *Insulating gloves for electrical purposes.*

Safety footwear

Safety shoes/boots must comply with the requirements of AS/NZS 210.2:2000 *Occupational protective footwear—Requirements and test methods.*

The shoes/boots selected should have minimal synthetic material in their construction and must have a full leather upper.

When in service the shoes/boots must be in good condition and are not to have any exposed metal such as steel toe-caps.

Face shields

Face shields are to cover the full face and have no exposed metal parts and have an electrical rating suitable for the task being performed.

All PPE must be checked regularly for condition, cleanliness and use-by dates, and the storage of PPE must be appropriate. If electrical workers do not use the correct PPE they will continue to be involved in accidents and they will suffer injuries.

TOPIC REVIEW

- In general, occupational health provides a broad framework incorporating legislation, policies, procedures, obligations and practical means that aim to protect the safety, health and welfare of all persons within a workplace.
- The objectives of WH&S in Australia are structured around eight core values.
- The WH&S legislation in Australia and New Zealand places an absolute duty on employers and controllers of workplaces to provide a safe and healthy workplace for employees and visitors to the workplace.
- Health and safety committees are set up in workplaces to help resolve health, safety and welfare issues that arise in the workplace.
- A workplace health and safety inspector may enter any workplace and exercise their powers while they are in a workplace.
- Safety observers must receive specific instructions in their duties from the licensed electrical worker or workers on potential risks associated with the work to be performed.
- Housekeeping is not just cleanliness; it is a significant factor in creating a safe, healthy workplace for workers.
- Personal protective equipment (PPE) refers to garments, equipment or barrier substances designed to be worn by a person to protect them from exposure to risks of injury or illness.

REVIEW QUESTIONS

1. State two common principles that unite all the state and territory individual WH&S Acts.
2. State two core values that the objectives of WH&S in the different states and territories of Australia are structured around.
3. Name one obligation that workers have to others with respect to WH&S.
4. State the purpose of a health and safety committee.
5. Name three powers of a workplace health and safety inspector.
6. Provide three responsibilities that a safety observer must demonstrate.
7. What does good housekeeping mean?
8. What type of clothing must be worn when performing de-energised electrical work activities?
9. State the requirements for safety shoes/boots when in service.

1.2 Work environment

1.2.1 Worksite

A worksite means the place of employment, base of operation or location of workers. It includes all of the employer's buildings or facilities located within the same building and their parking facilities.

1.2.2 Induction

Induction is a legislative requirement. The Work, Health and Safety Act states that a manager has an obligation to protect the health and safety of workers and others by ensuring that they are not exposed to risks to their health and safety arising from their employment and that they have enough information, training and supervision to stay safe.

Induction is imparting information to a prospective staff member at various points during the familiarisation process for a work program, for example at an interview and at the local workplace. All new staff should be given a general orientation program which includes providing information which is specific to the local workplace and all relevant safety information.

Induction is normally carried out by a nominated staff member who provides information about processes and activities regarding the work area including health and safety matters. All new staff must be informed about the hazards and the possible risks and know how to avoid or minimise the risks.

1.2.3 The work environment

In today's changing times safe premises, buildings and security address not only natural disasters but also crime, violence in the workplace and acts of terrorism.

Security means the protection of the premises, the employees working there, visitors and assets.

The most common threat in the work environment is workplace violence. Workplace violence includes cases of unhappy, angry workers causing harm to a building, its assets or other workers, and includes domestic issues that carry over into the workplace. This can have fatal consequences if these workers are not identified and counselled before the situation escalates.

Criminal issues include stealing and sabotage to buildings, assets or documents (paper or data). Persons engaged in these activities are usually disgruntled workers, opportunists or hackers. Our era has seen an increase in terrorist-related violence. Workplaces now have the potential to be used as weapons of mass destruction.

When developing a practical plan of action, the workplace environment must be examined from several viewpoints: operations, physical security and valid data-collecting processes. A practical plan of action theoretically leads to safer environments for workers and the surrounding community.

1.2.4 Standard work procedure

Standard work procedure means implementing specific, efficient plans of action for each task or process undertaken in a workplace. It starts with identifying the generally accepted safe and sound way to perform a particular task, then developing methods and procedures. These standard procedures become an effective baseline against which improvement actions are measured.

Standard work procedures enable each worker to learn and follow best practices that help them complete each task or process to a high level of efficiency with safety.

Observation and analysis of each process enables the identification of workplace activities that are not safe or are inefficient and that must therefore be eliminated or improved. This can be anything from a worker engaged in excessive lifting to having to work live. The process is then documented as a carefully planned step-by-step sequence of actions, applied and monitored to ensure it is implemented as planned. A flow chart for the establishment of standard work procedures is illustrated in Figure 1.1.

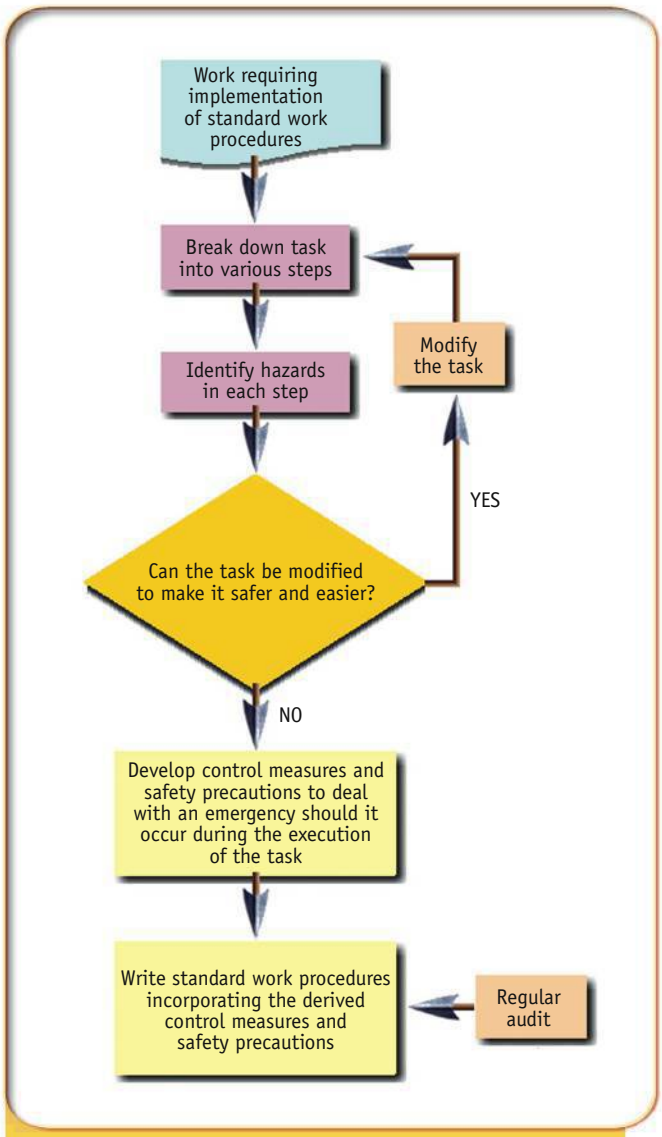

Figure 1.1 | Standard work procedure flow chart

1.2.5 Hazards at the worksite

A hazard can be work practices, procedures or everything that has the potential to harm the health or safety of a person. Risk is a measure of the probability of a specific harmful effect in particular circumstances. It is important to distinguish between hazard and risk. Worksite hazards occur:

- in the work environment
- as a result of the use of machinery, tools and materials
- as a result of unsuitable work systems and procedures.

Hazards encountered at a worksite can be classified into five broad areas:

1. *physical:* noise, radiation, light, vibration, temperature, humidity, ergonomic (movement)
2. *chemical:* poisons, dusts, lead, solvents, resins, glues, fluxes
3. *biological:* viruses, plants, parasites, vermin, insects, mites, wood and other plant material

(allergies), infections (tuberculosis), viruses (from needlestick injuries)
4. *mechanical/electrical:* slips, trips and falls, tools, electrical equipment
5. *psychological:* fatigue, violence, bullying, stress.

Worksite risk assessments and inspections are key activities in the prevention of accidents occurring from worksite hazards. Risk assessments and inspections:

- identify existing and potential hazards
- increase worker awareness, leading to the prevention of worksite accidents and illnesses
- ensure compliance with standards and regulations.

Existing or potential hazards identified by worksite risk assessments and inspections can be prevented or controlled by the following six levels of control measures, in order of priority.

1. Elimination—stop whatever is causing the hazard.
2. Substitution—use a lower hazard alternative.
3. Isolation—separate use from the rest of the workplace.
4. Engineering controls—install equipment that will reduce exposure or risk.
5. Safe work practices—change the way people work.
6. Personal protective equipment (PPE)—gloves, goggles, ear plugs and respirators, for example, can reduce worker contact and exposure to the hazard. PPE is always the last resort, but in some worksite situations may be the most practicable.

When assessing workplace hazards and risks always consider and document the probability of an event, length of exposure to the hazard or risk and the consequences.

TOPIC REVIEW

- A worksite means the place of employment, base of operation or location of workers.
- Induction is imparting information to a prospective staff member at various points during the familiarisation process for a work program, for example at an interview and at the local workplace.
- The most common threat in the work environment is workplace violence.
- When developing a practical plan of action, the workplace environment must be examined from several viewpoints: operations, physical security and valid data-collecting processes.
- Standard work means implementing specific, efficient plans of action for each task or process undertaken in a workplace.
- A hazard is something that has the potential to cause harm.
- Hazards that can be encountered at a worksite can be classified into physical, chemical, biological, mechanical/electrical and psychological areas.
- Worksite risk assessments and inspections are key activities in the prevention of accidents occurring as a result of worksite hazards.

REVIEW QUESTIONS

1. Give the meaning of the term 'worksite'.
2. Who normally carries out induction?
3. What is the most common threat in the work environment?
4. What should a practical plan of action theoretically lead to?
5. Define 'standard work'.
6. How is the identification of workplace activities that are not safe or are inefficient carried out?
7. What is the meaning of the term 'risk'?
8. What is the meaning of the term 'hazard'?
9. State the six levels of control measures with respect to existing or potential hazards identified by worksite risk assessments and inspections.

1.3 Work environment safety signs

The aim of work environment safety signs is to regulate and control safety-related behaviour, to warn workers and members of the general public of health and safety hazards and to provide emergency information, including fire protection information. The Australian standard setting out requirements for the design and use of safety signs is AS 1319:1994 *Safety signs for the occupational environment*. The standard specifies several sign classifications and layouts as follows.

1.3.1 Prohibition signs

Prohibition signs as illustrated in Figure 1.2 indicate that an action or activity is not permitted. Their designated symbolic shape is a red circle with a diagonal red slash through it. This is usually superimposed over a black pictograph, for example a person, to indicate what specific activity is referred to. The background is white and any text is black.

Figure 1.2 | Prohibition sign

1.3.2 Mandatory signs

Mandatory signs as illustrated in Figure 1.3 indicate that an instruction must be carried out. Their symbolic shape is a blue circle. A white pictograph such as hearing protection is superimposed on the blue circle to indicate the activity that is mandatory. The background is white and any text is black.

Figure 1.3 | Mandatory sign—hearing protection must be worn

1.3.3 Restriction signs

Restriction signs as illustrated in Figure 1.4 place a numerical or other defined limit on an activity or use of a facility. Their symbolic shape is a red circle, but without the diagonal slash as in prohibition signs. This would also have a black pictograph or other legend inside the circle, a white background and any text in black.

Figure 1.4 | Restriction sign

1.3.4 Danger signs

Danger signs as illustrated in Figure 1.5 warn of a particular hazard or hazardous condition that is likely to be life threatening. Their symbolic shape is the word DANGER in white on a red oval, which is surrounded by a black rectangle. This usually forms a heading for a white background on the sign. Alternatively, it may occupy the left side of a horizontal sign. Any text is in black.

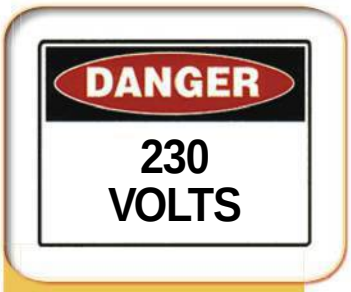

Figure 1.5 | Danger sign

1.3.5 Warning signs

Warning signs as illustrated in Figure 1.6 warn of a hazard or hazardous condition that is not likely to be life threatening. Their symbolic shape is a black triangular outline. A black pictograph usually appears inside the triangle to indicate the specific detail, for example an information symbol. The sign background is yellow with any text in black.

Figure 1.6 | Warning sign

1.3.6 Emergency information signs

Emergency information signs (see Figure 1.7) indicate the location of, or directions to, emergency-related facilities such as exits, safety equipment or first aid facilities. The background is green and any text or pictograph is white.

Figure 1.7 | Emergency information sign

1.3.7 Fire signs

Fire signs as illustrated in Figure 1.8 advise the location of fire alarms and fire-fighting equipment. The background is red and any text or pictograph is white.

The type of work environment safety sign used should be suitable for the intended application and workers should be informed of its purpose.

Work environment safety signs should be located where the message is legible, and where they attract the attention of, and

Figure 1.8 | Fire sign

are clearly visible to, all workers by being placed at eye height. Signs should be located against a contrasting background so they are more obvious, thereby reducing the risk of them becoming obscured by stacked materials or other visual obstructions.

For maximum effectiveness, work environment safety signs should be maintained in good condition, kept clean and well illuminated.

TOPIC REVIEW

- The aim of work environment safety signs is to regulate and control safety-related behaviour, to warn workers and members of the general public of health and safety hazards and to provide emergency information, including fire protection information.
- The type of work environment safety sign used should be suitable for the intended application, and workers should be informed of its purpose.

REVIEW QUESTIONS

1. What is a mandatory safety sign?
2. Describe a danger sign.

1.4 Fires

Fire protection in the workplace requires appropriate means of extinguishing local fires in all locations where workers are employed. These locations should have adequate safety notices to instruct, warn and guide workers about possible fires. Portable fire extinguishers apply an extinguishing medium that cools burning fuel, displaces or eliminates oxygen or stops the chemical reaction so a fire cannot continue to burn. When the safety pin is removed and the handle of an extinguisher is activated, a canister of high-pressure gas is triggered, forcing the extinguishing medium through a tube and out the nozzle. For fire to exist, four elements must be present at the same time:

1. some sort of fuel or combustible material
2. oxygen to sustain combustion
3. heat to raise the combustible material to its ignition temperature
4. a chemical reaction.

Not all fire extinguishers can be used effectively on all types of fires. Some fires involve combustibles such as paper, some involve liquids and others involve energised electrical equipment. Different types of fire extinguishers are distinguished from each other by their colour scheme and are designed to extinguish different classes of fire. Fire extinguishers empty quickly, anywhere from 8 seconds to 60 seconds. Fire extinguishers (see Figure 1.9) are classified by the type of fire they best extinguish.

Water is one of the most commonly used extinguishing agents for class A fires. Another extinguisher used for class A fires is the air-pressurised water (APW) extinguisher. An APW can be recognised by its large silver container. APWs are two-thirds filled with water then pressurised with air. APWs extinguish fire by cooling the surface of the fuel to remove the heat element of the fire.

Wet chemical extinguishers utilise an aqueous solution discharged in a fine spray to the surface of class F fires (see Figure 1.9). Wet chemical extinguishers extinguish fire by smothering the

FIRE CLASS	WATER AIR-PRESSURISED WATER	WET CHEMICAL	FOAM	DRY CHEMICAL POWDER	CARBON DIOXIDE (CO_2)
					
A Ordinary combustibles (wood, paper, plastics, etc.)	YES	YES	YES	YES	NO
B Flammable combustible liquids	NO	NO	YES	YES	YES
C Flammable gases	NO	NO	NO	YES	NO
E Fire involving energised electrical equipment	NO	NO	NO	YES	YES
F Fire involving cooking oils and fats	NO	YES	YES	YES	NO

Figure 1.9 | Fire extinguishers and classifications

surface of the fuel to separate the oxygen element of the fire from the fuel. The wet chemical also cools the surface of the fuel to remove the heat element of the fire.

Foam extinguishers contain a solution of aqueous film-forming-foam (AFFF) concentrate and water. When the extinguisher is operated, the solution is discharged through the nozzle that is designed to excite air to produce a foam discharge. Foam extinguishers extinguish fire by smothering the surface of the fuel to remove the oxygen element of the fire. The foam also limits the release of flammable vapours to prevent any re-ignition of the fire.

Dry chemical extinguishers coat the fuel with a thin layer of fire-retardant powder. Dry chemical extinguishers extinguish fire by smothering the surface of the fuel to separate the oxygen element of the fire from the fuel. The powder also works to disrupt the chemical reaction.

Carbon dioxide (CO_2) is a non-flammable gas placed under extreme pressure within a CO_2 extinguisher. CO_2 extinguishers extinguish fire by displacing the oxygen element of the fire. Because of its high pressure, pieces of dry ice are also emitted from the extinguisher which has a cooling effect on the fire.

There is another fire class, class D, for combustible metals. Some ships are made with magnesium steel to make the ship lighter and therefore faster in the water. However, if enough heat is generated the metal will burn.

Fire extinguishers should be serviced every six months. They are checked to make sure they are charged and nothing is missing on them. You can check the yellow metal tag on an extinguisher to see when it was last tested. Written on the front of each type of fire extinguisher are instructions for its correct use. To use a fire extinguisher properly all you have to remember is PASS.

P—Pull the safety pin
A—Aim at the base of the fire
S—Squeeze the trigger
S—Sweep at the base of the flame from side to side

Fire blankets as illustrated in Figure 1.10 extinguish fire by smothering the surface of the fuel to remove the oxygen element of the fire. They can be used for small class A and small cooking fat fires but are mainly used to wrap around workers if their clothes catch alight. Fire blankets are either a flame-retardant-treated woollen material or a combined Proban® cotton and Aramid (nylon fibre) flame-retardant textile.

Figure 1.10 | Fire blanket

TOPIC REVIEW

- Fire protection in the workplace requires appropriate means of extinguishing local fires in all locations where workers are employed.
- Not all fire extinguishers can be used effectively on all types of fires.
- Different types of fire extinguishers are distinguished from each other by their colour scheme and are designed to fight different classes of fire.
- Fire blankets extinguish fire by smothering the surface of the fuel to remove the oxygen element of the fire.

REVIEW QUESTIONS

1. State the purpose of portable fire extinguishers.
2. Name the four elements that must be present at the same time for a fire to exist.
3. Describe how a dry chemical extinguisher controls a fire.
4. What does PASS mean when referring to fire extinguishers?
5. How is a fire blanket used?

1.5 Workplace emergencies

A workplace emergency is a situation that threatens workers or the public, disrupts or shuts down workplace operations or causes physical or environmental damage. Emergencies may be

naturally caused or manmade and can include the following:

- cyclones
- floods
- fires
- explosions
- chemical spills
- toxic gas releases
- workplace violence.

The most effective way to deal with a workplace emergency is to prepare to respond to a possible emergency before it happens. Putting together a broad emergency action plan that deals with workplace issues specific to a worksite is not difficult. It includes involving both management and workers using brainstorming techniques to determine potential emergencies that could occur at the workplace. This technique helps to develop a workplace emergency action plan. An emergency action plan must include the following:

1. A method for reporting fires and other emergencies.
2. An evacuation policy and procedure.
3. Emergency escape procedures and escape route path. Include floor plans, workplace site maps and location of designated safe areas to account for all employees after an evacuation.
4. The names and emergency phone numbers of designated persons who have duties and responsibilities under the emergency plan.
5. Actions for designated workers who stay to shut down important machinery and equipment operations, operate fire extinguishers or perform other essential services that cannot be shut down immediately for every emergency before evacuating.
6. Rescue and medical duties for workers designated to perform them.

TOPIC REVIEW

- A workplace emergency is a situation that threatens workers or the public, disrupts or shuts down workplace operations or causes physical or environmental damage.

REVIEW EXERCISE

1. What is a workplace emergency?

1.6 Manual handling

The term 'manual handling' is used to describe any activity requiring the use of the hands or bodily force applied by a person to lift, lower, push, pull, heave, carry, move, support or restrain an object, person or animal. Manual handling also covers activities which require the use of bodily force such as operating power tools or crow bars and repetitive movements such as using a screwdriver or keyboard activity.

1.6.1 Manual handling injuries

Injuries most frequently associated with manual handling include:

- Back injuries—spine, joints, ligaments, muscles and intervertebral discs
- Fractures—to the fingers, hand, feet and toes
- Lacerations—to the hands and fingers
- Crush injuries—to the fingers
- Sprains—to the wrist, thumb and ankle
- Strains—to the back, shoulder, arms, hands and fingers
- Contusion—bruising to various parts of the body
- Hernia—an opening in the wall of a muscle, tissue or membrane that normally holds an organ in place.

Every muscular effort however slight involves the spine. When you lift, your back is put under stress, especially the lower spine. The lower spine is very mobile and is able to bend forwards, sideways and backwards but is capable of only very little rotation. Twisting or jerking while lifting and carrying can injure the small facet joints (stabilising joints located between and behind adjacent vertebrae) which guide movement of the back.

Intervertebral discs, which separate the vertebrae (spinal bones), and the ligaments, which hold the vertebrae together, are also at risk. The vertebrae of the spinal column run down the back as shown in Figure 1.11 on page 12, connecting the skull to the pelvis. These bones protect nerves that come out of the brain and travel down the spinal cavity and out to the entire body.

The intervertebral discs are composed of soft gelatinous substances which provide spinal column cushioning. The discs are also surrounded by a strong fibrous ring and with repeated incorrect lifting the discs, fibrous ring or its supporting ligaments may tear or rupture.

In general, back injuries are caused by wear and tear and damage to the joints, ligaments, muscles and intervertebral discs which occur during day-to-day